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Managing Mega technological projects : The case of the defence industry and Network Centric Warfare projects

Lars Löfgren

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Managing Mega technological projects: The case of the defence industry and Network Centric Warfare projects

Thèse de doctorat de l'Institut Polytechnique de Paris
préparée à l'École polytechnique

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Lars Löfgren

Composition du Jury :

Richard Le Goff Directeur, l'ENSTA ParisTech (– l'Unité d'Économie Appliquée)	Président
Staffan Furusten Director, Stockholm School of Economics (– Stockholm Centre of Organizational Research)	Rapporteur
Sylvain Lenfle Professeur des Universités, Conservatoire national des arts et métiers (– Laboratoire interdisciplinaire de recherches en science de l'action)	Rapporteur
Philippe Baumard Professeur des universités, Conservatoire national des arts et métiers (– Management, Innovation, Prospective (MIP))	Examineur
Gunnar Hult Professor, Swedish Defence University (– Systems Science for Defence and Security)	Examineur
Hervé Dumez Directeur, École polytechnique (– Institut Interdisciplinaire de l'Innovation (UMR 9217) i3-CRG)	Directeur de thèse

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Lars Löfgren

On résiste à l'invasion des armées; on ne résiste pas à l'invasion des idées.

Victor Hugo

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Introduction

Military technology development and military acquisition programmes are frequently large and complex and some can be defined as mega projects. The dimensions of such activities can engage large parts of governmental defence budgets and require extra funding in order to be successful. The large scale of the undertakings necessary to initiate and implement mega projects can easily make subsets of mega projects become very large. With the considerably increased dimensions of mega projects, the stakes are increased likewise including risk and uncertainty. The failure of mega projects can have vast and incalculable consequences. Despite the risk and consequences of failure, mega projects continue to be planned, initiated and implemented and sometimes fail. In addition to the interest in developing military technology systems with mega projects, developments can show a tendency towards a general pattern of development in several countries during the same time span. Several military mega projects with similar or the same aims and purposes have been implemented more or less in parallel. Mega projects do involve more components than complex technologies, large project organisations and great risk and uncertainty. The economical and industrial stakes are high when a mega project is about to be commenced.

Mega projects in military contexts can have an impact in several dimensions due to the scale of the activities. Decisions about how and what to acquire can influence how military end users of technology systems intend to act in conflicts but also how entire defence industries will plan their firm strategies. Pure technological reasons, meaning the engineering projects and project management, are in this environment facing powerful wills and forces originating from, for example, politicians and high-ranking military leadership. Powerful wills and interests can easily come into conflict with realistic development goals and the kind of procurement strategy to be used and can have a large impact on the success of development projects.

A number of technological, economic, bureaucratic and strategic factors play an important role when considering decisions for starting and during implementation of new development projects.

Development programmes can be very uncertain with respect to outcome if potentials, possibilities and limitations of technology are not handled with restraint. Technology systems in the early stages of development can involve a great deal of risk when strategic and operational conditions are adopted based upon technological discoveries from laboratory level. Because of the necessity for defence industry contractors to acquire contracts in a steady flow, new plans and ideas for new military technology systems are often said to be invented by the defence industry. If the defence

industry and not the military end user is inventing new defence technology, military planning is then said to be changed in order to fit with the new technology and not the possible intended aims and needs of the military end user. The bureaucratic factors refer to the organisational behaviour of the different services of military authorities. Armed forces services have a certain kind of autonomy from each other, but budget restraints and different agendas can result in interfering aims of different services related to decisions about acquisition programmes. Strategic factors that may be important include the concern of trying to know the unknown when intelligence regarding estimated future threats is unclear. As a result, decisions regarding vast development programmes can be easy to take, but sometimes must be taken with a great degree of uncertainty (Brown, 1992).

It is easy to consider that at least some, but probably all of the above-mentioned factors can come into conflict with conclusions and decisions aiming at the most relevant or best choice. Management systems for decisions exist for choosing and taking accurate action even under difficult circumstances with, for instance, risks and doubtful information and other possible uncertainties (Goodwin & Wright, 2009). Defence acquisition can be very large and involve many actors with different and powerful interests. Another factor that complicates the situation is perceived changes in basic circumstances for how military affairs and defence technology will serve in the future. Some actors with strong influence think that complete transformation would be a fruitful means to succeed with planned changes. Such changes occurred with the end of the Cold War and military mega projects were seen as a tool for change. The fast pace and scope of development and immense amount of new kinds of technologies in combination with the amount of resources compared to the resources of each of the respective armed forces involved in the developments lead to a need for defining such vast and comprehensive mega projects.

What are mega projects?

Mega projects are projects that generally meet the description of being vast in dimension and scope compared to what is manageable; captivating due to the dimensions, design and engineering accomplishments; frequently having underestimated costs; and controversial with respect to funding and impacts on third parties. Mega projects, like other more normal projects with less scope, can still be regarded as “a temporary group activity designed to produce a unique product, service or result” (Project Management Institute, 2015). Furthermore, mega projects are complex regarding risk and uncertainty related to design, funding and construction. Control is also a common problem with mega projects when dealing with funding and important decision makers and operations. Mega

projects developing infrastructure can tend to be developed partly to demonstrate the technology development and innovation itself creating the best that can be done with technology (Frick, 2008). A mega project can be defined as a very large investment project; as a major infrastructure project that costs more than one billion dollars, as the term is used by the US Federal Highway Administration; or a project that attracts a great deal of public attention or political interest due to significant direct and indirect impacts on the community, environment, and budgets. The word "mega" "also relates to the levels of skill and attention required to manage the project successfully" (Capka, 2004). The context of the mega project is also important where even a lower cost than for instance one billion dollars can be seen as a mega project, since for a smaller buyer the impact of the project can make it "mega sized" even though the project does not reach the US Federal Highway Administration definition. The level of risk, which is considerable in mega projects, and the difficulty associated with developing, planning and management is also articulated in the expression "mega" according to Flyvbjerg (2009). Mega projects tend to differ from other normal business relationships, which keep control over the rather free development. Mega projects can easily have new kinds of strategy defined by a limited group of actors who normally would have little legitimacy to affect, for instance, design of the result of the mega project. Other actors than would be normal tend to be involved in strategic decisions behind mega projects. Mega projects are characterised by continuous negotiations between actors involved creating a continuous changing mega project. As a result mega projects can easily have hidden disputes due to, for instance, unclear goals and rivalry over design choices (Gil, Lundrigan, & Pinto, 2017, p. 50, 81 & 107-109).

Typical clients of mega projects are governments or public sector authorities, and the contractor or contractors are normally private (Sanderson, 2012). Additionally, in the cases connected to military mega projects, there has been a considerable amount of new types and uses of information technologies (IT) in a time where proper knowledge compared to its intended context and area of use would still be scarce. The complexity of IT and large scale IT-projects can then probably assume similar properties to mega projects and may encounter similar problems with management, cost overruns, schedule overruns, complexity and quality (Henderson, 2006).

This thesis is about the development and acquisition of military technology systems with mega projects, how the first ideas for the development are formed, how the planning, initiation and implementation of such projects are done and how actors are acting in mega projects. It is about complex technology systems including computerised communication systems, although the complexity does not only exist in the technology as such but among actors their ideas, agendas,

wishes, wants and the vast magnitude of the project itself. The studied and compared mega project does not only involve complex technology development but also profound organisation transformation of entire branches of the armed forces. Unlike most mega projects, military mega projects can differ with the added aim of using mega projects to transform entire branches of the respective armed force involving organisation transformation for the United States Army (Markard & Truffer, 2006; Pernin et al. 2012) and for the Swedish Armed Forces (Science Applications International Corporation, 2000, pp. ES 4-6). Military mega projects focus on systems development which means that in addition to the technology development interfaces between system components, humans and organisations are also considered into the overall development (Hughes, 1998). This also means that any development of a single system will probably not be defined as a mega project unless there is significant funding and political attention.

The thesis focuses on the management of mega projects in a military context and the reasons for their success or failure. With a comparative case study, the thesis aims to enhance our understanding of mega projects and their failure studying and compare three different military mega projects. Case study methodology is motivated by the many different kinds of variables and dynamics between actors in mega projects (Yin, 2014, p. 17; Eisenhardt 1989, pp. 534-535). Searching for success and failure of military mega projects with a comparison has not been made and should be proper means find reasons to success and failures of mega project of military kind. Based on the events of new emerging technologies, mega projects that were aimed at developing and integrating the new technologies in new and networked systems, a comparison between different mega projects will be done. The aim of the comparison is to find similarities and differences with respect to why, and if, the projects failed, and then to what extent. Therefore, two research questions are posed.

Research questions

How are complex mega projects emerging and are there different types of management of these projects?

Why do mega projects sometimes fail and why do they sometimes succeed?

The first Chapter of the thesis gives the historical context and discusses how the first ideas for the studied mega projects emerged. I also explain two approaches of inventing and developing new technology for the armed forces. From there, I continue to explain defence technology and how it

transfers to the wider society. Then I describe the roles of different actors in and around defence technology development and military mega projects.

Chapter 1 - Background to the Network Centric Warfare projects and the involved ideas and actors

During the 1990s, the land forces in many countries wanted to start development programmes of a vast scope aiming at creating similar systems that already existed in the air forces and navies. Earlier land forces had been provided with equipment when specific equipment systems had been exhausted or new needs of different kinds emerged. Land forces equipment had also mostly been replaced by one equipment system at a time. The aim was instead to transform entire land forces into interconnected systems according to United States Government Accountability Office (Pernin et al, 2012). Similarly to air forces and navies, land forces were supposed to be able to combine interconnectivity with widespread use of precision weapons unlike what had been the situation before. To put this development into context, a background explanation is needed.

To understand and create a picture of the situation for military technology acquisition during the 1990s and 2000s the situation during and after the Cold War is important to keep in mind. Changes took place in security politics but also in the conditions for how defence technology was sold and viewed. In most cases, the defence industry and therefore defence technology had a different relationship to government acquisition before and after the Cold War. During the Cold War, the defence industry had stronger ties to the different armed forces in most countries due to the tensions between the main military alliances, the North Atlantic Treaty Organisation and the Warsaw Pact. Armed forces had a relatively steady flow of technology acquisitions from the respective governments and their armed forces. During the Cold War, the state for the defence industry was stable. Armed forces in most parts of the world had relatively well-defined tasks and plans for organisations and equipment, and their development and replacement. The settings for different armed forces were stable.

After the end of the Cold War, the need for defence equipment decreased considerably and budgets for armed forces were decreased, which eventually affected the defence industries. Parallel in time new and different issues arose, where mostly in the Western part of the world, peacekeeping missions became an issue to deal with and became more important compared to the situation during the war. Decreased defence spending also affected the situation for the defence industry generally. The less secure flow of acquisition from governments created a need for the defence industries to think about what to develop and they could not necessarily wait for acquisition initiatives from armed forces.

When defence budgets shrank, the need for selling defence equipment increased, including complex military technologies to elsewhere as well as in the homeland of the defence industry (Kovacic & Smallwood, 1994). The defence industry can deal with decreasing market and has been shown to be similar to any other strategic business change in other industries by changing within the company. Defence industries had to start adapting to the new circumstances (Smith & Smith, 1992). Strategy changes, like increasing the number of mergers in the defence industry, were also a means to deal with decreasing defence budgets (Markusen, 1997). Still, the austerity among the armed forces would have consequences if defence budgets were decreased in such a way that the defence industry were no longer able to exist or keep qualified competence. The defence industry can adapt to new circumstances but also make use of new emerging opportunities.

The situation after the Cold War also meant that a moment of *détente* started a time of austerity during the 1990s in the United States and in Europe. New ideas spread about changing the perceived inefficiencies of the land forces in Europe and the United States. These ideas were built on emerging communication technology developments, which were driven mainly by civil society. It was also thought that the increasing pace of technology development could no longer be led by military technology development but instead had to be followed according to Swedish officials (Nilsson & Nordenberg, 2014). The descriptions of the new ideas were about revolutionary events in military development and more specifically concerning military technology and its impact on military affairs. The ideas were described in concepts with names like Revolution in Military Affairs, Network-Centric Warfare and System of Systems. The new ideas in combination with the austerity and lesser resources for armed forces, but also a will to create better and more effective land forces, led to studies for vast projects aiming at defence transformation. The transformation was supposed to be implemented radically as described by Markard & Truffer (2006) and related to high technology industries. The transformation should be implemented in a radical manner by the US Army, according to Pernin et al. (2012). The radical transformation was planned to be implemented through mega projects developing a Network-Centric System of Systems of a new and different kind.

New times and emergence of new ideas

The new ideas about how future conflicts might play out were to a large extent principles and concepts based on how a technologically qualified opponent would be fought with the help of

sensor-supported precision weapons interconnected through automated computerised networks. Soviet Marshals had expressed the basic ideas long before, during the 1970s and 1980s. During the 1990s, it was suitable to create the Network-Centric Warfare concept, a so-called System of Systems, since the Cold War had ended and the absence of tensions made it possible for a changed course in Military Affairs. What the Soviet Marshals had called the Military Technology Revolution now became the notion called Revolution in Military Affairs. At the same time, the common technology development had increasingly been taken over by civil society. The development of high technology solutions regarding mainly communication systems would not be developed by acquisition of armed forces from the defence industry. Instead, commercial firms would lead communication technology systems development according to official (Nordenberg, 2013). The price and development times for military technologies were continuously increasing for several reasons which did not affect civilian technologies. Cost efficiency had started to become an important factor and increasingly important to address in large defence acquisitions (Hult, 2015). The development of systems for computerised communication was no longer done by military standards specifications since the developments in computerised communication were much faster than any expected lifetime for the average military communication system. High-ranking officers understood the potential of combining computerised communication systems with precision weapons.

The foremost advocates for the new ideas were the supreme leaders of mainly the land forces in the US and in Western Europe, who saw the equivalents in air forces and navies that already had network-based systems for precision engagement. High-ranking decision makers wanted the same capability for the land forces. An additional but parallel concern had earlier been about how to counter the Warsaw Pact forces in Western Europe. Now it was believed technology could be developed to counter such adversaries.

These ideas led to plans for completely new kinds of defence equipment that would be capable of fighting in combined computerised communication networks and capable of combating an enemy before those had even discovered the then future System of Systems. Some perceived necessities for reaching a new kind of fighting capability was the capacity to lift entire land forces by air, which required very light vehicles. All new technologies comprised comprehensive systems with new organisational concepts and were supposed to be developed through vast comprehensive development projects.

The scope for the development projects would be huge. For example, almost the entire US Army and the entire Swedish Armed Forces were subject to change under the respective plans. Great expectations were raised of creating new land forces which would be using computerised communication system technologies to a degree never seen before. Furthermore, the aim was to use the much faster civilian pace of communication technology development that would create networks with new types of vehicles. New principles of functions and automated functions and vehicles with different subsystems were supposed to be implemented. The start of planning for large and complex projects, with vast ambitions was initiated during the mid- to late 1990s.

The objectives were ambitious, since a great deal of the involved technology was immature or not yet developed, and some of the technical requirements were incongruous. New materials needed to be developed before any implementation and to fulfil the main precondition, swift reaction forces capable of combating any enemy with the so-called “fog of war” dissolved. The planned development included new components with a great amount of not yet developed and unknown technologies, which were intended to be developed at a fast pace.

The plans and implementations could instead have been made in a less ambitious manner with the development implemented in steps followed one after the other. It would have been a slower way to implement the developments, but perhaps less risky. The development could for instance also have been easier to discontinue if obstacles emerged. Two kinds of approach can be noted in the development of military technology when considering the amount of resources used for development and possibly how complicated a development is planned or turns out to be: radical (or revolutionary) and incremental (or evolutionary) (Norman & Verganti, 2014).

Different methods of inventing and developing new defence technology

Development of military technology can be done using two main approaches. The first is to put a large amount of resources and energy into development to try to reach a breakthrough in development. Such radical innovation sometimes involves new or even completely new technology from each new technology generation or system. The second is to put fewer resources into development of more isolated smaller components of, for instance, a comprehensive system. This is a more evolutionary development, where technology is developed in incremental steps (Markard & Truffer, 2006; Srinivasan et al., 2002, respectively). In military terms, radical development of

technology can potentially create a large advantage against an adversary who does not possess such technology or by sudden use of new technology against an unprepared adversary. For the defence industry, radical development could give larger resources to be used for upholding technology development activities unlike with incremental development, which would lead to comparatively less resource-demanding technology development. Having described the different main approaches to defence technology development, the context of the economy around defence acquisition needs to be understood.

The times of change and vast development projects with radical aims should also be understood in conjunction with the workings of the defence industry and the economy regarding governmental acquisition. In the society defence technology is developed and produced by defence industries and only armed forces, or a specific intermediary authority, are buying defence technology systems.

Defence technology economic domicile

Defence technology owned by the armed forces is economically related to society as a common resource, since the purpose of the armed forces and the technology they use are concerned with the defence of entire societies. In an economic sense, national defence is connected to the economics of goods as being a public resource and public good that nations own which becomes a resource for countries. The type of goods that defence technology economically belongs to depends on the ownership of the technology because it can belong to either the defence industry or the government as being the armed forces. Defence products are not publicly accessible for the public to buy and use freely, which makes the domicile of defence technology a special area. The ownership of defence technology shifts from being public enterprise goods when developed and produced when an armed force finally buys it and it becomes pure public goods. Defence technology goods can then be categorised economically.

Goods can be arranged in terms of rivalrous or non-rivalrous. A rivalrous good is consumed when used, while non-rivalrous goods are not. Goods can also be divided into excludable or non-excludable, which considers whether a good can exclude anyone from using the good. The different properties of excludability and rivalrousness can be put in a table with excludable and non-excludable opposite rivalrous and non-rivalrous. Table 1 illustrates extreme alternatives where four

different categories can assume gradual examples in the classification. Many types of goods can be positioned in between and possess more than one of the different properties and classifications.

	excludable	non-excludable
rivalrous	private goods	open access common property
non- rivalrous	public enterprise goods	pure public goods

Table 1: Types of goods according to Leach (2004, pp. 155-156) and Hess & Ostrom (2003, p. 120).

The four basic categories are private goods, open access common property, public enterprise goods and pure public goods. Private goods are rivalrous and excludable and can be exemplified by typical private items such as clothing. Housing can also be public private goods if, for instance, a state provides houses for a population. Open access common property is rivalrous and non-excludable, for example, public waterways of fish in open sea. The goods are open for everyone but are limited to its existence.

Club goods are non-rivalrous and excludable, which means they are open access for everyone but that individuals can be excluded - for example, public sporting grounds. Non-rivalrous goods are those that when consumed, will still be present for others to consume, such as knowledge. When new knowledge is gained, others can use the knowledge (Leach, 2004).

Public goods are non-rivalrous and non-excludable, which are public assets open to the public and are not depleted when used. Governments normally provide public goods since alternatives from any private sector would have difficulty making profit from such activities. Streetlights, internet search engines and national defence are examples of public goods.

The economy of defence goods and technology

Defence equipment and defence technology systems are defence goods that are developed and produced by the defence industry and later become the equipment of the armed forces. Between the defence industry and the armed forces, defence equipment and technology are transferred from the developing defence industry to the armed forces who are the end users. An explanation of what kind of goods defence technologies are is shown in table 2. Defence industry goods are excludable and non-rivalrous since only those paying for the goods are able to access them, and only

governments are buying defence technology. Defence industry goods are also non-rivalrous as consumption of defence goods can occur without preventing others from using, or depleting, the technology and the organisation which both are aimed at defending nations. The transfer of goods is illustrated in Table 3.

	excludable	non-excludable
rivalrous		
non- rivalrous	defence industry technology	national defence technology

Table 2: Suggested types of goods between the defence industry and national defence.

	excludable	non-excludable
rivalrous		
non- rivalrous	defence industry technology	national defence technology

Table 3: Defence technology goods change in public economy when the technology transfers from the defence industry to the armed forces.

Defence technology belonging to the defence industry would be excludable and non-rivalrous, while defence equipment belonging to the armed forces would be non-excludable and non-rivalrous. When the technology but also complex technology systems are switching ownership, the economic domicile of the goods changes and the technology can be goods for everyone to use as means for society. The circumstances of the defence industry and armed forces have been established for a long time, but a change concerning the strength of the connections between the defence industry and the armed forces occurred after the Cold War. Considering Table 2, one could perhaps claim that since the ties between the armed forces and the defence industry were stronger before, the defence industry has gone from being more an integrated part of national defence, as non-excludable and non-rivalrous, to being more self-sufficient as an actor, according to Table 3. With the changing times, the defence industry became more self-sufficient due to decreased defence budgets and decreased defence technology acquisitions. This development also resulted in greater competition between defence industries.

Acquisition of defence technology, studies for development projects, technology and systems development, producing for the country's own armed forces and possible selling to other nations are decided upon by governments. The defence industry may develop defence technology by itself, but this is less common due to the price of defence technology and the lack of appeal of simpler technology to potential customers. Around development activities of defence technology, actors from various groups of interests are interacting and decisions are taken on what kind of technology, in the end, would be acquired. Governments, end users and politicians decide what to acquire with different external and internal interests affecting the status, purpose, quantity and quality of defence technology and equipment systems. Regarding goods and defence technology, groups and individuals have a relationship with technology and have or create interests and different agendas about what is supposed to happen with the technology systems.

As the ways in which defence technology is managed change, actors and how they behave in combination with defence technology development and comprehensive and vast development projects is crucial to understand. Defence acquisition is controlled by extensive standards and rules with actors that want to, and do, influence the outcome of, for instance, mega projects.

Organising of marketing and selling of defence systems

Marketing of military equipment and systems is done in an environment with military technology systems developed, produced, owned, renovated, modified and taken out of services by the acceptance of governmental actors. The customers of military systems are governments who are also the end users, who use military equipment and technology systems throughout the entire life cycle until the systems are sold further to other governments, or scrapped. Frequently governments favour their own defence industry with few exceptions and then mostly in cases where specific technologies do not exist within the country in question. It also means that the selling of military systems is done in a market with decision makers and customers being high-ranking officers within the armed forces and politicians. Also involved are other government officials and actors in the defence industry who may influence decisions on development and acquisition of military systems.

A way to increase selling further is by offering an entire system to be sold to the end user. This method is called Systems Selling, and is a way of selling entire systems but also of making it difficult and expensive to select only parts of a system to buy (Mattsson, 1973).

Delivered value for the military customer

Using relationships as marketing methods to increase value is important for adding better value for the customer. A satisfied customer is believed to stay loyal and buy more products or services but also more frequently than other less loyal customers. Product quality is increased by adding value, for instance services and support services. By doing this, the connection between customer and seller is strengthened. Value in Business-to-Business can also be extended beyond only cost/benefit focus. Other factors like personal value, financial value, knowledge value and strategic value are important and can be included under relationship value. These factors are considered important for assessing the relationship value (Sergio Biggemann, 2011). To organise marketing and practise relationship building and upholding is thus not enough; the product should also be defined. Selling systems creates an opportunity to motivate the selling of entire complete systems, which are considered as entities with the different parts difficult or impossible to separate. The complete value delivered can be aimed at delivering not only single technologies and components of armed forces, but entire systems that allow for increased selling.

Packaging of defence technologies with Systems Selling

The term System of Systems is not new and has existed since the 1970s to describe technologies composed as systems of technologies or several technical items which in turn can be seen as systems (Ackoff, 1971). Since then, the phenomenon of selling systems has existed. According to the strategic marketing concept of Systems Selling, advantageous technology can be sold to a customer, i.e. end user, who is considering an entire technology system. In this way, selling volumes can be increased, if systems are sold compared to selling components of systems. Furthermore, if Systems Selling is put into practice, an actor, i.e. seller, that provides entire technology systems has an advantage in comparison to a competitor or potential entrant into the market. The difference between the price of a system and the cost of developing a system can be made large and create difficulties for competitors to enter the market if the development of entire systems becomes too expensive and resource-demanding. If this is done, the seller of systems will simply earn more money. Within Systems Selling, the expression “barrier to entry” can be described as the difference between the price and cost and constitutes the barrier for a new competitor to enter a market. The purpose of increasing the barrier to entry can be to prevent others from entering the market and then later to

increase or keep an already higher price of products, which otherwise would have been difficult. The outcome of such event can be, if barrier to entry is a common occurrence, less competition in the market which in turn can lead to higher prices on the systems acquired (Mattsson, 1973). Systems can be offered instead of components to increase selling. However, not only technology systems can be offered to enhance value. Services of entire technology systems can be added in order to increase selling and tie customers closer to the defence industry. In the period after the Cold War, a marketisation of the defence industry occurred with different kinds of service offerings emerging when defence industries adapted their behaviour to this marketisation.

Packaging of products with Product Service Offerings

The marketisation of the European defence industry policy can serve as an example of emerging closer relationship between the armed forces, the end user of technology and the defence industry. The model for creating closer ties between the end user and the defence industry is similar to a normal customer-producer relationship (Britz, 2010). In the non-defence business, market offering of entire systems including services and consultancy advice, life cycle reliability maintenance is an important part of business (Davies, Brady, & Bobday, 2006; Raddats & Easingwood, 2010). Together with different kinds of service offerings added to the systems, the marketing of projects can create better value for the customer. Project marketing has become an active integrator of actors to create value for customers, which has become an important part of building the customer network according to Jalkala et al (2010). The provision of entire systems and with services added to technology like different kinds of service offerings exist with, for instance, how system support is done in acquisition with a complex systems environment with deeper defence industry involvement. It can include services of complex technology and maintaining equipment through its entire lifetime where the defence industry in practice replaces large parts of what the armed forces normally managed before (Kapletia & Probert, 2009; Johnsen et al, 2009). The concept of industrial Product Service Systems for the defence industry is about selling not only a product that is a technology system, but also services to maintain the system. Performance-based industrial service contracts then become a vital part of having technology and equipment working at an agreed level of readiness. It means that technology and systems should be kept ready for use in combat environments according to agreements between the armed forces and the defence industry (Datta & Roy, 2011). There can be risks regarding maintaining equipment with contracts. It can result in insecurities regarding costs and dependence of the customer with respect to service delivery. The

service dominant logic has a potential to increase value for the industry but also potentially decrease value for the end user (Ng & Nudurupati, 2010; Ng, Maull, & Tip, 2009). There is further potential for problems to occur with processes, activities and systems when different kinds of contracts based on performance or outcome are to be implemented (Ng & Yip, 2009). The selling of defence technology does not only refer to the marketing and selling of single items of technology or several items. It can be about selling entire comprehensive systems with an additional possibility to market and sell services connected to such comprehensive systems. The organisation of marketing of systems, systems service-selling and marketing of comprehensive development projects promises creation of comprehensive technology systems. An important means to sell comprehensive systems, systems services and projects to build systems, is by ideas. These ideas are available when an important change is at hand and when a perceived need occurs.

Systems is a notion of importance for the thesis because it has been used to describe, motivate and explain how military organisations should work. The Appendix contains a section where I describe what Systems Engineering Management and System of System are as well as existing controversies concerning those disciplines. The section is based upon a text I, Löfgren (2014), published in the journal *Le Libellio d' AEGIS* and much of the content from the article is similar or the same.

Some concerns regarding defence goods and interests of actors

When individuals and groups gather and create larger groups with certain interests and intentions, in order to further those interests and intentions, this can be called Collective Action (Olson, 1971). Not only are there industry interests in the industry itself, but there is also another interest of having the industry surviving in government and perhaps also in an armed force. Additionally, different kinds of individual interests and agendas in, for instance, government and armed forces play important roles. Individuals and groups furthermore do not necessarily act according to what can be predicted. Olson (1971, p. 2) claims that, “unless the number of individuals in a group is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, *rational, self-interested individuals will not act to achieve their common or group interests*. In other words, even if all of the individuals in a large group are rational and self-interested, and would gain if, as a group, they acted to achieve their common interest or objective, they will still not voluntarily act to achieve that common or group interest”. A different example is showing that “what it makes sense for an individual to do is not what it would make sense for the group to do – if one could meaningfully speak of what the group should do” (Hardin, 1982, p. 2). Ostrom (2000, pp. 137-138) concludes that there are many different types of individuals where some are more willing than others to contribute

to Collective Action. All different actors can have different kinds of interests connected to defence technology development and development of vast technology systems. There are numerous kinds of potential incentives and factors, where each actor can gain, not gain or even lose competition. Socioeconomic environments and social dynamics mixed with new paradigms and institutional environments matter greatly in managing large endeavours such as mega projects (Lehtonen, Joly, & Aparicio, 2017).

The interests of different actors

The different main actors are the defence industry, government decision makers and the armed forces in the country where the defence industry is situated. The circumstances for how the actors can behave is special and is different compared to most other business and government issues. Interests and incentives are, for instance, security politics, national security, industrial commercial interests, job-related concerns and industrial base knowledge. Security politics and national security and the strong dependence on governmental acquisitions make defence acquisition different from other kinds of business. Other important factors that can influence events are similar to other industries. The defence industry, but also armed forces, can be pressure groups capable of keeping latent groups of selective incentives. Olson (1971) describes properties of Collective Action that would fit into the special relationship and environment between the defence industry, government decision makers and armed forces in, for instance, the changing environment of the 1990s but also during the times after that. Actors can become pressure groups for certain interests and act according to different kinds of interests by cooperating or opposing certain events and developments. Collective Action is important to take into account before, during and after a military mega project with a possibility to observe actors both internally and externally relative to the project. The economic relationship that is created by defence technology can be understood from a societal view with actors possibly acting both inside and outside a military mega project.

As dominant actors, the armed forces and the defence industry are not the only ones with an important influence on defence technology and military technology systems. Politicians take final decisions concerning the purchase of larger military technology systems based upon the requirements from the end user. The defence industry has an important influence on politicians regarding, for instance, knowledge and job creating concerns. It means that the armed force is the end user of military equipment and systems and the defence industry is developing, producing and

maintaining the same systems and politicians or political parties are taking decisions concerning military systems.

Mega projects in a military context aimed at acquiring defence systems is a state concern involving governmental political and military involvement together with the defence industry which is dependent on not only governmental acquisitions but also permission to export defence systems. This makes military mega projects potentially different from other mega projects in other contexts than military.

The different actors can be divided into three main required groups, which may have similar or different agendas and wills and sometimes internal differences. These actors - the defence industry, the armed forces, which is the end user of defence equipment, and the political decision makers - have a strong influence on defence acquisition and will now be presented.

The defence industry actor

The defence industry as a part of economics, foreign policy and as a defence actor is considered as an actor affecting the defence ability of the host country and other countries buying defence technology from it. The society around the defence industry is also strongly influenced in several ways as well as in direct defence matters for different dimensions of defence concerns and even defence related to capability to create military forces (Heidenkamp, Louth, & Taylor, 2011). Influence is also manifested in deliberate relationship building with armed forces and decision makers.

An example of increasing relationship building between end user and seller is a more common use of technology as a component for domestic security within the European Union. Larger defence and security firms have played a key role in the definition and development of policy regarding technology for security purposes. Subsequent analyses of whether the technology is really needed as specified have however in some cases been missing (Bigo & Jeandesboz, 2010). The defence industry influences both the armed forces and politicians by marketing to enable their interests.

The defence industry needs contracts in order to survive and especially during times of retrenching. To maintain production capability but also development competence, the defence industry needs contracts in order to maintain its critical functions of production and development. If then large

development projects including development of complex technology are carried out, stable revenue can be reached and maintain the industry.

When defence equipment is acquired, it is done by the government of a country and mostly from the defence industry in that country, which acquires the defence equipment if any defence industry exists that fulfils the requirements. The reasons why the defence industry mostly receives the relevant orders from the country where the defence industry is situated and owned is that it composes an important factor for long-term military capability and qualified high-technology jobs. In order to develop and maintain defence equipment, technology competence and knowledge but high technology industry commonly, the defence industry is vital. The defence industry forms furthermore a component of security policy. However, the ways in which different countries practice and choose to value or acknowledge defence industrial implications can shift. The second actor concerning military systems is the end user and armed forces.

The end user actor

The radically changed basis for military affairs has also changed the perception that armed forces need other aims than traditionally military ones. The end user perspective regarding complex military technology would mainly consist of technology aiming at ability to take part in and carry out military activity of all relevant kinds, which is given by political directives. The aim of technology acquisition would then be to acquire qualified technology and equipment compared to the end user's aim and need for the equipment that would also take into account the end user's organisation and staff. Technology for effectively accomplishing military activities does not necessarily consist of a certain technology system for sale by the industry, but it can be necessary to developed. Radical military technological achievements may not necessarily have occurred, but the basic military circumstances can be like before. Additionally, hasty or "unsound predictions" made regarding Revolution in Military Affairs and could have been avoided with some basic knowledge about difficulties regarding technology (O'Hanlon, 2009, p. 171). An important actor involved in the development and acquisition of military systems is the political dimension. The armed forces are the end users of military technology systems and create much of the design specifications, which are developed and produced by the defence industry. The third main actor involved in military systems is the political.

The political actor

The defence industry has important concerns regarding jobs, competence creating, the maintaining and development of the military industry and security policy dimension of foreign policy. The foreign policy aspect can then refer to the security policy of the home country with dimensions like independence regarding the defence technology. A state may wish to maintain a defence industry in order to be able to build all or some defence force domestically, since future development in foreign policy can be uncertain. Avoiding being dependent or being less dependent on other countries for upholding a military force and/or military ability can also be reason to uphold a defence industry. The defence industry political security dimension can also have the role of defence technology as a measure in building relations between states, but can also work as a multiplier of countries' relevance in international relations. It constitutes a security component for a country that maintains it (Heidenkamp, Louth, & Taylor, 2011). The defence industry also maintains many jobs including qualified engineering jobs that can be lost if the industry is not gaining contracts, and would then create an absence in knowledge for maintaining or, for instance, creating ability in a military branch within the security policy (Gholz & Sapolsky, 1999) and (Guay, 1997). In order for the defence industry to sell defence technology systems, influencing politicians can be important. Armed forces may prefer specific technology systems, which also can require influencing politicians. It may be important to be aware of communication as marketing in political environments and that there is a connection between marketing, political communication and lobbying (Andrews, 1996). Marketing addressed directly or indirectly to political spheres moves towards influence with political communication and lobbying. There is a possibility that marketing in this context can create democratic concerns related to marketing done within politics because business-marketing influences can be organised to influence politics (Lees-Marshment, 2009).

To influence political decisions in business is a rather common feature in military acquisition. In practice, different kinds of oligopoly dominate the defence industry with tendencies towards monopoly and ostensibly free market (Heidenkamp, Louth, & Taylor, 2013). Structural power is through these activities not only accumulated in the political domain but also leaves the business sector to affect political decisions. The structural power of business over political decisions depends on the reputation it can cost to lobby and the cost regarding the reputation of the policymakers (Bernhagen & Braeuninger, 2005). Having described the notion of separate interests that actors are likely to have and the three different main groups of actors, the respective actors in the studied

mega projects will now be presented. Within and outside of those three main dimensions, different actors exist who can influence mega projects as groups or as individuals.

The different actors have now been introduced, discussed and arranged in three main groups, all having different competence, perspective and interests regarding complex military technology. In this context, the end user - the armed forces - is one of more or even many actors with possibly differing interests and agendas. We will now present the different actors in the studied cases.

The different actors in the Network-Centric Warfare cases

Development and acquisition of defence equipment and equipment systems involves different kinds of actors. The buyers of military technology systems are the armed forces, which is valid for all countries that have been studied. Depending on how the political and authority arrangement is organised, an additional specialised authority exists to deal with the development and acquisition. These kinds of authorities can be understood as being the technical and managerial part of the armed forces because it is the buyer of the technology systems intended for the armed forces. In the US, the acquiring authority is the Department of Defense (DoD) which buys defence systems for the US Army. In France, the acquiring authority is the Directorate General of Armaments (DGA) which acquires defence systems for the French Armed Forces and in this case the French Army (Armée de Terre). In Sweden, the acquiring authority is the Swedish Defence Materiel Administration (FMV) which acquires defence systems for the Swedish Armed Forces. For all countries, defence systems are then overseen and final decisions about buying technology systems for the armed forces are taken by the political layers of the governments. This means the buyers of defence systems are not only the respective armed forces with intermediary defence acquisition authorities, but also the leading politicians of each country.

The selling of defence equipment and defence technology is done by the defence industry in mainly the home country. All the countries studied during the projects had, and still have, rather strong defence industries capable of developing and producing technologies relevant for the respective intended systems development. Foreign defence industries can however sell technology systems to other countries, but if there is a domestic defence industry, those tend to get orders for what they can develop and produce in matters of relevant defence equipment and defence systems. In the US, the main actors in the case that has been studied are The Boeing Company and Science Applications

International Corporation (SAIC). These companies cooperated in order to sell and develop Future Combat Systems for the US Army. In France, the selling of defence technology systems is connected to the defence firms Thales, Nexter and Sagem. These were involved in a consortium named TNS-Mars in order to manage the vast task of developing a completely new armed forces formation, the *groupement tactique interarmes* (GTIA). The GTIA is the French version of Future Combat Systems for the US Army. The sale of defence systems in Sweden in the case of the Swedish Network-Based Defence development was the consortium of the domestic defence firms SAAB Technologies and Ericsson. Other firms that were also involved were The Boeing Company and IBM. The selling of the Network System for the Swedish Armed Forces was done mainly by the domestic defence firm actors, supported by The Boeing Company and IBM as partners in the consortium SAAB Ericsson NBD Innovation AB. The order in which the buying and selling actors act is that the buying actors formulate specific needs for technology or technology systems. The needs are normally based on the replacement of aging legacy systems and development of what is needed to handle current and future conflicts. In addition to the basic needs of replacing older systems and adapting to known emerging conflicts, the development of technology systems of which a large part are not yet known technologies and those for not yet known future conflicts can also become technology systems development of its own. It means that technology systems development does not necessarily need to have a very clear aim and purpose, i.e. to develop technology for an armed force. However, purpose and aim is overseen, planning and other measures are reviewed and information about potential flaws normally exists early in development.

There are also other actors involved in defence acquisition beyond the armed forces, defence industries and politicians taking decisions to buy specific technologies or systems. There are audit authorities, which in the United States is the United States Government Accountability Office (GAO) who reviewed the Future Combat Systems development. The United States Government Accountability Office started the reviewing when the project moved from being a planned development to a real development with real system components and through the entire project life span. The Ministerial Committee of Investments (CMI) reviewed the French Scorpion project. Two different audit authorities have reviewed the Swedish Network-Based Defence development: the Swedish Agency for Public Management and the Swedish National Audit Office, who as in the case of the Future Combat Systems development started the reviewing when the development moved from planning to real systems development. The audit authorities influence the project with written audit reports. However, other actors that influence or can influence a mega project have been studied. In mainly the Swedish Network-Based Defence projects there were external groups of individuals

belonging to other armed services of the Swedish Armed Forces seen from the main project Ledsys that were influencing the project when they opposed the future change. A clear similarity in the other two projects does not exist because the Network-Based Defence development eventually went outside the armed service borders, unlike the other two projects, which were aimed at the land forces only.

Other actors are other defence industries who are, or can be, involved during competition for tenders before any project is started. However, having in mind the main task and focus regarding the military mega projects as being aimed at land forces. Those defence industries involved in consortiums were also the main suppliers of technology systems for the different projects. Some industries did have a larger and leading role in the consortiums but the main defence firms focused on land forces technology development in the different countries' mega projects.

Comprehensive defence development and acquisition have now been described, as well as the changing times after the Cold War including the initiation of vast and comprehensive mega projects. Subsequently, an explanation of defence technology goods concerning defence industries and armed forces has been introduced to show the economic and societal role of these kinds of technologies. The ways in which goods like defence technology can matter and what kind of main groups of actors dealing with defence industry and military mega projects have been addressed.

Thesis structure

In order to answer the research questions, Chapter 2 consists of three sections of literature in order to create a range of perspectives to view the events and dynamics in the different cases that have been studied. Chapter 2 consists of the Institutional environment and power among groups and individuals, Ideas for change and transformation of organisations, Technology management and management of mega projects. I claim that the content of Chapter 2 helps to understand the dynamics and phenomena in the mega projects. The reason for the choice of content in Chapter 2 is to view the cases through the different perspectives in order to understand the dynamics and complex interactions within and outside the different developments before, during and after the mega projects.

Chapter 3 is about the methodology I have used to structure my material and the comparison of the cases in time sequence. I explain the choice of the three compared cases and the main similarities and differences between them. I then continue to describe structured narrative, which is the arranging of events and dynamics within the cases. The methodology chapter continues with a discussion about the credibility of the case study. I then describe how the literature study has been done, followed by a description of the empirical material and method of data processing. The methodology chapter ends with a section on an identified need for an additional part to narrative inquiries; an epilogue to follow and structure the events after a project has formally ended.

Chapters 4, 5 and 6 are the empirical case chapters that deal with the three different mega projects. Chapter 4 contains the introduction to the cases and explains the role of the reference case. Chapters 5 and 6 describe the other two mega projects. The end of each case contains an analysis of each mega project. After the three chapters about the mega projects, the respective dynamics in each mega project are discussed and compared in Chapter 7. The final Chapter 8 contains the conclusion and contribution of the similarities and differences between the mega projects and the contribution of the thesis.

Three different but similar mega technological development projects related to the defence industry have been studied. The scope of the projects involved large parts of three different armed forces and involved concepts of System of Systems with large numbers of computerised communication systems. The System of Systems development also involved new kinds of planned organisations and organisational behaviour. For the mega projects, entire transformations of the different armed forces

were planned to be implemented. Individual and similar but also different mega projects compared to the dimensions and budget of each armed force were started and finished in the United States (US) and Sweden, and started in France but have not yet been finished.

The three cases have been chosen due to a combination of similarities and differences. The projects are similar regarding the communication technology systems and relative land force focus. All projects are, or have been, built on the ideas of Revolution in Military Affairs and armed forces composed as System of Systems. One large difference is the resources for each armed force. The finished mega projects in the US and Sweden were unsuccessful, while the French mega project is being implemented over a long period of time and has not yet been finished. The mega project in the US and the French mega project are focused on implementing System of Systems only in the respective land forces. The Swedish mega project is aimed at integrating all the different armed forces - land, sea and air services - into one System of Systems.

I will now turn to the background to the studied cases, giving a historical and contextual explanation regarding defence acquisition and how the mega projects emerged.

Chapter 2 - Literature and theoretical framework

Institutional environment and power among groups and individuals

To explain how power and ideas are related needs first an explanation of the phenomenon of power, which in the simplest form can be described thus: [actor] "A has power over B to the extent that he can get B to do something that B would not otherwise do." (Dahl, 1957, pp. 202-203). This view has been criticised but has become one important part of how to view power. Not all interactions in which groups or individuals are influenced are distinguishable with clear aims and actors. Different kinds of interest groups have also been found to affect how the interaction between actors works with other methods (Guzzini, 2005) and (Isaac, 1987). Power can also be exercised in different manners by, for instance, tampering with the possibilities for actors to deal with concerns or not. Questions and concerns can be taken up or not dealt with and avoided in different contexts involving decision-making. This is the second face of power according to Lukes (2005) and it is the capability to affect the agenda of what is occurring and what is dealt with by, for instance, an organisation and thus affect what decisions will be taken or not taken. It is the kind of power which sometimes can be related to actors having different agendas with decisions taken behind closed doors. In such circumstances, it can be very difficult to grasp who is taking decisions. Some individuals and groups are benefitting at the expense of others who become suppressed. Those who benefit are put in positions from where they can defend and promote their own interests.

The third face of power is the manner in which individuals and groups can be affected to do things seemingly by their own will, with an ability to influence perceived reality and how reality is understood, and thus change others' wishes and wants. Ideology can be seen as parallel to understanding how this kind of power works with the third kind of power which aims at changing values about what actions are considered for decisions. This kind of power also means that any clear conflict does not have to be obvious because the influenced actor has received the same wills and wants as the influential actor (Lukes, 2005, p. 27). It is this last kind of power that has a link with ideas though ideas influences individuals and groups' perceived reality of what is desired. The three kinds of power matter because each kind of power can be used depending on the context and situation. Ideas and power are to be understood within and outside of mega projects.

Looking outside the technical and administrative parts of defence acquisition, there are political considerations to take into account. The political inducements can refer to domestic and/or foreign

policy, and can be put against other alternatives, which can reach from other domestic spending to foreign relations (Born, 2008). In large public infrastructure projects, power has been shown to have the ability to affect economic and engineering planning and decisions. To understand the driving forces between the industry, government end users and politicians, it is important to keep in mind the interaction resulting in a given technology development and later procurement. Interaction can contain open decisions and formal relations between actors but can and will likely also contain unofficial interaction between interest groups and actors. It has been shown that power and rationality are dependent on each other and activities like planning, administration and politics will not necessarily function in a rational way, with respect to the aimed intention of the project; because of power and interests, groups will affect the outcome of planning and decisions (Flyvbjerg, 1998). Ways to overcome the problems of differing interests have been suggested in large public infrastructure projects (Flyvbjerg, Bruzelius, & Rothengatter, 2003; Flyvbjerg, 2009; Priemus, Flyvbjerg, & van Wee, 2008). Individuals' and groups' perception and understanding of which best possible choice to make is the basis for what decisions are taken.

Rationality is an important consideration in this context because it is claimed that "rational judgement used by decision scientists is one in which a person chooses options based on which option has the largest expected utility" (Stanovich, 2010, p. 8). The interests of different stakeholders are subjective perceptions of the expected utility, and will in most cases result in different ways of maximising the subjective expected utility, regarding complex military technology (Stanovich, 2010). In order to avoid sub-optimisation due to different existing interests and motivations of strong actors, an analysis of the kinds of stakeholders and actors can be done. The aim of such an examination would be to control and create better knowledge about the actors with their interests.

Different groups of interests and stakeholder surveying in organisations and in project management

Different groups can comprise stakeholders and have different interests affecting decisions and development concerning strategic management. There are methods of stakeholder analysis for management of mega projects in order to investigate the interrelations and potential concerns of how stakeholders affect decisions (Freeman, 2001). Stakeholder analysis coupled to interest groups and power includes different views that can be taken into account aiming at understanding how power is structured within and around organisations (Brugha & Varvasovszky, 2000). The aim for project management is then to identify, visualise and map influences of stakeholders in connection

to the project (Bourne & Walker, 2005). In the same manner, stakeholder analysis is integrated in Systems Engineering (Dare, 2000). Used wisely, stakeholder analysis can have the potential to create important resources and capabilities but also save resources by creating knowledge of possible later concerns and resistance (Hillman & Keim, 2001).

When considering different stakeholders, their respective wills and agendas may include different kinds of rational behaviour. Rationality will mean different things for the stakeholders and will affect their decision making. Different stakeholders have different ways to fulfil their goals and can or will maximise the expected utility in a subjective manner (Stanovich, 2010). The matter of different rationalities is important because it can be a source of resistance to change. Differing rationalities relate to the development of planned changes because some groups may advocate certain ideas and want certain planned changes while other groups who are part of the same development may be against such definite changes. A means for actors involved in the direct or indirect selling of military technology systems can be to use marketing of technologies and systems.

If a mega project is described and defined by specific actors it can be considered very promising and as such used as strategic means to create participation through the ideas. But unclear ideas and plans can function to increase interest and help keep critics away (Sahlin-Andersson, 1992, p. 76). Social factors like ideas, rules, fashion, knowledge, ideologies and norms become tools for furthering mega projects also regarding military mega projects. The environment in and around a mega project is to a large extent created by social contexts with interacting individuals and groups of individuals (Furusten, 2013).

I have now described the changing times during and after the Cold War with the perception that new preconditions were about to emerge regarding military affairs. The reasons for the changed conditions included the relaxed tensions between the main potential adversaries in Europe and that defence budgets were decreased. At the same time, new kinds of communication technologies driven by civil society and not by military development were also emerging. I have also described how military technology and goods are handled in society between the defence industry and the armed forces, which are the technology end users. Defence technology is transferred in a special manner in society and though the defence industry might seem to be as any other industry, it is not. Unless there is any specific technology not found in the defence industry in a specific country, the armed forces will rely strongly on the local defence industry. From having existed without clear measures during the late Cold War, I have also described the emergence of new ideas for how new technologies and concepts would create new conditions for how future wars were imagined to be

fought. The ideas should be viewed in the context of the changing times and changing interests of different actors around the armed forces and the defence industry. The ideas should also be understood together with how defence technology is developed and produced and how defence acquisition works as a more or less internal governmental concern with defence industries strongly dependent on governmental acquisitions in times of decreased budgets.

The spreading of ideas as marketing

In very large acquisition programmes of military systems, descriptions and explanations of new concepts used to be a common component. New concepts in military contexts mostly involve new technologies and systems but also new thinking regarding the technologies and systems. This means that marketing is about creating and shaping new ideas concerning new technologies and systems and their use. Ideas can have the function of creating a common understanding in a social context in an organisation and influence the acceptance of social ideas, such as plans for development projects, social marketing can be applied. Social marketing is “the design, implementation, and control of programmes calculated to influence the acceptability of social ideas and involving considerations” (Kotler & Zaltman, 1971, p. 5). Social marketing has been defined as development and integration of “marketing concepts with other approaches to influence behaviours that benefit individuals and communities for the greater social good” (International Social Marketing Association, 2013). Social ideas are introduced and then pave the way for changed behaviour that can convert into objects and actions (Czarniawska & Joerges, 1998). Objects and actions can be the planning and initiation of mega projects. However, when exactly ideas are becoming known is normally difficult to recognise. Instead, ideas are considered to float around constantly and therefore the term “attention”, instead of “information”, is considered more relevant when viewing a process where ideas transform into actions (p. 209).

To create attention around ideas, it is important to address the problems perceived by people in organisations, and depict the process as functional, with the goal to tackle a specific problem. So-called “master-ideas” describe how notions connect with an institution that could cause a paradigm shift to occur, given enough interest focused on a specific idea. An important concern regarding master-ideas is “that they are taken for granted, unproblematic and used for all possible purposes” (p. 222). The ways ideas can be spread have increased with the development of modern media, which provides possibilities to reach different actors.

According to Silverman (2011), possibilities to reach out with information and marketing through new media have changed the way marketing and information sharing is done. Very large amounts of information are today flooding actors, as if people are “drinking from a fire hose”, according to (Silverman, 2011, p. 12). In this context, word-of-mouth marketing is claimed to be a completely new form of marketing incompatible with common marketing. Its definition is “the exchange of information about a product or service among people who are independent of the producer” (Silverman, 2011, p. 51). Where the people in an organisation are overloaded with information, they do not listen to normal marketing arguments and behaviour and instead respond to simplified messages, preferably coming from their friends and not from obvious external actors. Silverman (2011) describes further that studying a product and learning about it, including going through a decision process, and becoming responsible for decisions related to the product, is something that overloaded decision-makers want to avoid. Individuals with better knowledge can be made do the work for less cost and in a more effective manner. Word-of-mouth marketing is about division of labour in order to ease up the decision process and consultants, advisers and trusted friends are used to the adapted recommendations. It is about making the decision process easier and therefore, products that favour easy decisions tend to win out, since the so-called law of least resistance is followed. This behaviour favours increased decision frequency and makes decisions a very important element in marketing to increase volumes and sales (pp. 28-37). Word-of-mouth marketing has the potential to spread information exponentially through recommendations by trustworthy channels. This kind of marketing is claimed to be effective due to a number of properties important for understanding the connection to different notions. The notions can for instance be represented by acronyms made up of a number of letters. In order to make a product – a system – reliable in the eyes of a customer and the armed forces, knowledge and experience about military systems needs to be obtained. Experience about a product is commonly acquired in the form of indirect experience, which means that others are testing products together. When several individuals test something together, impressions about the product are reinforced, which has been shown to be very effective for word-of-mouth marketing. Experience about something that does not exist is however impossible to acquire. Instead, experts can be used to recommend technologies and technology systems.

Recommendations from trusted experts are also a feature of this kind of marketing, especially when the experts can be the 'favourite' experts, who are trusted (Silverman, 2011, pp. 51-77). Using experts for creating trust has been discussed for instance by Brunsson (2002) in the case of consultant firms claiming to possess the right expertise but sometimes also avoiding control and quality assured environments that would make profit margin and competition too difficult. Such

consultant firms are also active within defence technology, reforms and transformation. Like Czarniawska-Joerges and Sevón (1996, p. 18) describe, ideas become one way in which marketing of defence technology, reforms and transformation can be done. Ideas need to be rectified within a similar institution to bridge the wide array of different actors and create shared understanding (Levitt & Scott, 2017). Values and social structure can be created from habits that eventually form a culture where actors get information about how ideas and development should be implemented to become real (Swidler, 1986).

Ideas for change and transformation of organisations

Transformation of organisations can be understood as planned activity where logic and rationality are ideal and a formal description of how change in an organisation can be explained and later carried out (Brunsson, 2006). Motives to transform organisations involve strategic considerations and decisions and can be illustrated with the intended change and transformation of entire armed forces services based on new insights from the Revolution in Military Affairs and Network-Centric Warfare. The transformation was aimed at creating Network-Centric computerised communication systems for all the armed forces' branches interconnected and organised into a System of Systems. The change and transformation was to be done regarding not only technology systems but also armed forces organisation and ideas about how war was fought. This also meant new ways in which organisations and staff were supposed to act. Decisions about such changes are a long-term strategic consideration.

It is tempting to arrive at decisions via rational decision-making methods, since actions would then be directed by reason. Rational decision-making methods means, in this context, that ingoing and outgoing facts and preferences are known, analysed and followed by a decision. Misperceptions are thereby decreased to a minimum and action is executed by decision with ideas then controlling actions (Brunsson, 1992, pp. 172-173). However, the notion of choice leading to a sequence of decisions about alternatives and analysis, and later, evaluation of their consequences and to further decisions, does not give the entire picture of events (Cohen, March, & Olsen, 1972). In processes within an organisation, different kinds of opportunities of individual and group choices interact. Complicated interactions between different events and actors in time and place with different kinds of problems affect choices depending on how long it takes for a specific problem or solution to be noticed and solutions to be implemented (Cohen, March & Olsen, 1972). Structured and rational

decisions would be preferable, but decisions involve different types of individual and group preferences about the change and transformation of entire organisations.

Organisation change and transformation involves decision-making by different individual actors with different interests and beliefs, and thus decisions can be both rational and irrational compared to the overall aim of the change. Expectations, motivations and commitment are important elements for how individuals and groups of individuals believe in what they are doing and how they choose to act. Individual perception is also important for how ideas are depicted. Perception can also be selective, which means that ideas about how organisations and the systems on which they are based should be constituted. Ideas about technology systems and their physical appearance and activities can create chains of assumptions that do not need to be rational and based on practical experience but can consist instead of hope. Tied to the ideas and individuals that spread ideas, transformation of organisations and technology and the pace at which it is done, matters. A combined technological and organisational transformation can be implemented in incremental steps and follow an evolutionary-like development, with each step evaluated before next step is initiated. The supposed opposite, a radical transformation, means that technological and organisational changes are made simultaneously and at a fast pace. Such change and transformation could be called revolutionary. The difference between the two approaches is significant because some actors prefer radical change while others prefer step-by-step transformation. What different actors consider necessary for change and transformation can affect what kind of preferred change and transformation is considered necessary to use.

Human interactions and perception of organisation change

In the view of strategic choice, decision making and organisation development are regarded as rational and results of problems and choices. Organisation choices then further lead to decisions in order to make decisions that are as well-informed as possible. However, decision-making processes are carried out by individuals and are both rational and irrational due to complex environments and differing values among groups in organisations. Seemingly irrational attitudes can be held for reasons based on more inputs than can be addressed by structured problem solving and choices. For an organisation to start acting, expectation, motivation and commitment are important conditions for individuals (Brunsson, 1985). All three conditions relate to how individuals believe in what they are doing, their will to contribute and trust in others' behaviour, and attitudes in an organisation and in decision processes according to Brunsson (1985, pp. 19-21). Behaviour and attitudes in organisations

are also largely affected by individual perceptions, with individuals interpreting their environment and situation. Perception can be divided into selective perception and stereotyping, where selective perception is the process of screening out uncomfortable information that contradicts beliefs, and stereotyping is about labelling and classifying people and things due to just a few attributes. Both selective perception and stereotyping can have consequences for organisations where, for instance, managers may neglect important concerns resulting in a more difficult change process or incurring increased costs, according to Griffin (2015, pp. 272-273). Overlooking concerns can happen for different reasons. Selective perception and stereotyping are some examples of how issues are overlooked, but there can be other features difficult to notice or discover, like habits and customs that are taken for granted.

Invisible taken-for-granted structures in organisations

So-called taken-for-granted structures in organisation cultures can be difficult to define or invisible for individuals both within and outside an organisation. The reason for the invisibility is claimed to be long experience within a specific cultural context leading to so-called “colour-blindness”. Examples of colour-blindness are according to Czarniawska-Joerges & Sevón (1996) managers that are power-blind and social scientists that are ideology-blind. In the context of decision making, an individual or small group can anchor an idea with other probable supporters, but not with potential opponents. If instead an individual or small group is presenting an idea in front of a decision-making unit, the risk is high that any decision based on the suggested idea is dismissed. With taken-for-granted processes, new structures can be created. Decision rituals still need to be performed, but the progress of ideas that emerges and materialises comes from coinciding private obsession and public need.

Individuals and different interests in organisations

Individuals in organisations and their actions can be understood in different ways with respect to individual and collective intentions and motives. Intentions and actions of individuals can be based upon either personal motives or shared group intentions and motives. Individuals, their attitudes, and the interrelations between individuals create shared group intentions (Bratman, 1993). A different approach can be to emphasise the importance of collective intentions and instead of individual perspective, argue for a collective perspective on Collective Action problems. However, Gilbert (2006) uses the example of the prisoner’s dilemma to illustrate why a collective perspective

should also complement the more individualistic version of Collective Action argued for by Bratman (1993). Due to different intentions and incentives, some common Collective Action problems arise from individual and group intentions. It is not always so that members in large organisations act to reach a common goal in order to maximise their own welfare. Pressure that forces individuals to act according to a common goal is also important. Groups and individuals do not necessarily act according to their interests. Groups of mainly “altruistic individuals or irrational individuals may sometimes act in their common or group interests” (Olson, 1971, p. 2). How individuals act does not need to be certain even with apparent rational context.

In a competition perspective, actors involved in defence technology, and its development and acquisition, have contradictory interests. Profit maximising firms can, for instance, be acting contrary to their rational interests. When maximal profit on certain goods is at hand, output will increase and lower prices can result, according to (Olson, 1971, p. 9). Defence industry acquisition deals with public goods in a large group environment, and incentives and interests both common and individual would exist at the same time (Olson, 1971, pp. 9-22). Hardin (1982, p. xiii) claims that “Collective Action is a prisoner’s dilemma writ large” and could be understood as individuals and groups in relatively simple environments and larger groups with complex interactions. The pure prisoner’s dilemma can illustrate Collective Action if the context is relatively easy to depict and comprehend, not only for decisions about two alternatives but also for larger numbers of the prisoner’s dilemma. It has furthermore been concluded that different people behave differently in prisoner’s dilemma-like situations where individual learning communication also affects how individuals act (Ostrom, 2000). If the context and number of factors increase, it can be necessary to use other measures such as anthropological inquiries considering complicated interactions if the context is relatively complicated to describe. Related to mega projects involving large organisations and numerous interactions and stakeholders, Collective Action according to Hardin (1982) would be complex with complex relationships, incentives and interests. Collective Action would therefore be possible to apply to mega projects related to the defence industry, since complex interactions and various relationships, incentives and interests imply numerous possible outcomes (Hardin R. , 1982). Not all kinds of interests and wills are weighted the same. Some actors have the ability to put more pressure on events than others and some interests have greater commitment.

Large pressure groups and special interests

Comprehensive change and transformation, including complex development through mega projects is implemented by defence industries or consortiums within defence industries. In order to keep such organisations undisturbed and supported with, for instance, steady and competent staff, large defence firms need to overlook their interests. The interests of organisations are taken care of by their members in a supposedly unusual way in the sense that groups of individuals with coinciding interests are acting according to their common interests. This idea has according to Olson (1971) been common among Marxian theories of how class action would work. However, groups do not only act according to a specific common interest. Group theories, on the other hand, claim that groups will act when they need in order “to further their common or group goals” (Olson, 1971, p. 1). However, there are not only groups that have interests and work for a common goal, but also individuals having interests. If interests were only altruistic, individuals would act according to what is best for an organisation with no self-interest involved, setting personal welfare aside and any selfish common interest would likely not occur. According to Olson (1971, p. 1-2), this kind of altruistic behaviour is extraordinary and instead the rule would be selfish behaviour to different extents. This would especially be the fact when dealing with economic issues when, for instance, higher profits for large firms lead to higher financial compensation for individuals in management. However, there are other actors than management influencing with interests and behaviour.

Some important actors with special interests and behaviour create and spread ideas in order to further those interests. The actors can be self-appointed experts, pressure groups and consultants as described by (Brunson, 2000). The main task for those organisations, like firms and individuals, can also promote different behaviour rules in order to assist their activities to markets. Consultant firms claim, for instance, that being experts they have unique knowledge and are not bound to any special organisation seen from the client’s perspective. When claiming to have unique competence and services to offer, new market areas can be won in less mature markets (Furusten & Werr, 2012).

When claiming to have new unique knowledge, firms can also keep higher prices on services they offer, since a standardised market would decrease the ability to keep high pricing on offered services. A mature market, with unique and personalised adapted services, affects how offers can be made, with adapted rules and standards. Consultant firms would, for instance, prefer to keep a market with few standards and regulations in order to keep high pricing (Alexius, 2007, p. 153). Apart from consulting firms, there are other kinds of groups organised to influence decisions with similar aims but possibly considerably more resources to further their interests.

Olson (1971) describes different kinds of large pressure groups as by-products and groups with special interests that can have a lobbying function. The by-product is lobbying of large economic pressure groups. Only large organisations are considered to have capability to organise the by-product as “a latent group with ‘selective incentives’” (Olson, 1971, p. 133). Organisations with the capability to have selective incentives are organisations are able to be coercive or to give individuals inducements in the latent group. Examples of pressure groups relevant but also capable of affecting and forming a latent pressure of a special interest are professional lobbies. They relate to and involve the kind of professional associations composed of members belonging to a special profession. Similarly to the guilds during the Middle Ages, professional associations may be mandatory in some professional categories and have considerable power according to Olson (1971, p. 139). A second example of a pressure group in special interest theory is the business lobby that constitutes a large number of the lobbies belonging to trade, business and other commercial organisations. Groups constituted of oligopoly like latent groups of industries, having special interests, would be a foundation for creating lobbies working for a specific industry business. To some extent, political power would flow to industries with special interests and property owners. Unlike many other types of special interest groups, such as professional associations, “business interests are organised as a general rule” (Olson, 1971, p. 143). I have now described different individual and group actors’ possible interests and potential will to influence decisions from within and from outside of organisations. Actors are influenced by ideas, which in turn drives the intentions of other actors.

According to Czarniawska-Joerges & Sevón (1996, p. 18), “Ideas are turned into things, and then things into ideas again, transferred from their time and place of origin and materialised again elsewhere.” The way in which ideas are transferred around in different ways and with different purposes and can lead to the marketing of projects that otherwise would be considered too difficult or uncertain. These projects are presented as copies of projects already successfully managed. An advantage in marketing and gaining contracts regarding civil infrastructure mega projects has been to present claimed earlier success in advanced countries or organisations, giving credit to such endeavours. According to Czarniawska-Joerges & Sevón (1996), that foundation to technology development can emerge in the form of vague ideas connected to some actions or events of development. When the technology is about to be developed, the difficulties and problems are disclosed which require additional financial support and commitment. This kind of change is not only about how leaders and engineers are acting or what kind of environment the technology development and the project exists within. Instead, what is happening “is that the materialisation of a technical idea starts a chain reaction of consequences which are not only unplanned, but

sometimes undesirable as well” (Czarniawska-Joerges & Sevón, 1996, p. 19). Unplanned changes can occur when actors change thinking and acting during a development due to, for instance, newfound insights. As part of unplanned change, different kinds of epiphanies, when actors change their thinking and acting, can result in a changed course for development activities (Denzin, 1989; Dumez, 2016).

Ideas materialise and then become ideas again

Change in organisations tends to be explained in terms of planned activities but not in terms of emergence of ideas, from where many organisation changes originate. Ideas about technology development and technology development projects are an important part of how technology emerges. According to Brunsson (1992) organisations consist of two kinds of systems. The first is a system of ideas, which is controlled by means of mental and communication processes. Ideas are mostly spread, verbally, to other individuals in an organisation or to listeners from outside the organisation. The other system consists of action, which is controlled, in physical processes. The action system consists of individual actions coordinated and acts together. The results of the actions then become goods or services. The link between ideas and actions is decisions, according to Brunsson (1992), where decisions, in a normative way, can be viewed as a method to decrease the number of alternatives of choice to one. A similar result can be achieved if the possibilities to search for different alternatives are reduced by rules. Decisions are claimed to occur between ideas and actions, and depending on context, with different distances to the ingoing ideas and actions. However, ideas and actions do not need to correspond considerably. Talk within an organisation can be aimed at or adapted according to certain norms, while actions follow other norms. The kind of hypocrisy this creates between ideas and action is assisted by the distance between ideas and action. If, for instance, those who talk are far from the action, the probability decreases for talk to be adapted to action or action to talk.

The relevance of the hypocrisy around ideas and action is emphasised in situations regarding plans and upcoming events. Brunsson (1992) describes this by presenting actions that could please some demands when other unsatisfied actions are talked about in order to fill demands with words instead of action. A concern connected to hypocrisy is the so-called futures approach, which means that the future always implies talking about something which does not exist. Future actions will then satisfy the unfulfilled demands assuring improvements to be done, which also is a method to manage

contradictions (1992, pp. 172-173). To make future actions possible, the prerequisite conditions to control actions, like rules and norms, could be necessary to change, including what people believe in.

An institution is constituted by behaviour, material resources, rules and norms but also cultural-cognitive beliefs (Scott, 2014). Human behaviour and interaction preserve and modify rules, norms and meaning. Social action forms and gives organisation culture an articulating form (2014, p. 57). As argued by Weick & Sutcliffe (2015) there are different kinds of elements affecting organisations like organisation structure, strategy and staff composition, where culture is one among the other elements and implies shared meanings that affect individual and organisational behaviour. As norms, beliefs and shared meaning are important aspects, thoughts and hopes can influence and shape ideas. Swidler (1986) describes how culture affects action in profound social transformation and during less intense social transformation. In times of social transformation, during unsettled times, actors can tend to follow cultures similar to ideology if action is wanted. When there is no social transformation, during settled times, cultural action is more independent from ideology. Resources can then be given to create different courses of action.

Ideas and anticipation of change

It is common throughout the Western world to give attention to hope and anticipation of what will happen in the future. Two versions of the world can exist at the same time: the world as we believe it to be, and the world as we think it should be. "Hope includes expectation and desire. We hope whenever we perceive that there is at least some chance that something we desire will occur" (Brunsson, 2006, p. 11). Previously, actions and social status could be motivated by tradition or God. In modern times, however, we are expected to be rational and have motives and intentions for what we are doing. There is a difference between what is talked about and what is done, and if the difference between talk and action is systematic, it is hypocrisy. Official knowledge controls what is talked about, and tacit knowledge, like ideas and experiences of individuals, controls what is done. What is talked about can mainly also be realistically achieved, but ideas and experiences are not necessarily possible to achieve. The difference between what to want and what can be done can create false expectations, problems and also failures. It is however rational for individuals to act according to wishes. Acting against wishes is contradictory and can be understood as being the same as failure or, taken a little further, as immoral. "When what we want reflects our high ideals, the difference between what we want and do may be called sin" (Brunsson, 2006, p. 25). Individuals who

are about to reform rational models, plans or organisations can regard the reform as good for other parts of an organisation. The other part of the organisation can then be regarded to be lacking purpose and aim for their activities. The reform would be the solution to a perceived problem of only following old routines and could allow for more adequate thinking. But it is not certain that the reformers themselves understand the rational rules and follow the rules themselves and the realities concerning a reform and the consequences thereof.

Reality, in the form of complicated practice, can be a problem for ideas, wishes and principles. Organisational practice can be resistant to reform attempts driven by, for instance, hopes of change. But ideas, wishes, principles and hope can be equally resistant to reality. Brunsson (2006) describes different behaviours to protect hopes and thus allow them to survive and the world of ideas to continue undisturbed. By avoiding practical experience and consequences of practice, reality is avoided, and only those practices that do not threaten hopes are, for instance, selected. Practice can be interpreted in a favourable manner that does not threaten hope. In order for ideas and principles to survive, there cannot be any interaction with practice. One way in which this can be done is by separating them in time and place, and thus different parts of the organisation work with principles and practice are separated. Avoiding experience and thoughts of consequences of a reform or change is a tool in order to avoid practice and thus allow ideas and hope to survive. People who have both contradictory and supportive information at hand have a tendency to emphasise the supporting information, which is similar to confirmation bias (Brunsson, 2006). Ideas are not only notions that can be followed and create hope. Ideas can also acquire the status something that is understood as good and should be followed.

Ideas as fashion

An idea with the status of being something new, considered good and to be followed and tested, resembles the concept of fashion. That is, following an idea and notion that because they are considered a good and appealing development and therefore easily internalised is similar to the behaviour around fashion in combination with institutionalisation according to Czarniawska-Joerges & Sevón (1996). Fashion is claimed in this context to stand for temporality and a tendency to be changeable, while institutionalisation stands for solidity and seriousness. Interdependent and interconnected fashion acts as a challenge to the normal order of things and is open for the testing of new applications, which then can be institutionalised or dismissed if institutionalised applications or

ideas are integrated into the existing institutional order (Czarniawska-Joerges & Sevón, 1996, p. 25). Fashion can be used not only for testing new and perceived good things but can become a means of managing new developments and organisation changes (Furusten, 2013). When, for instance, old rudimentary ideas and concepts are dressed up continuously in new labels with the effect of seeming to be new, this again resembles the concept of fashion. An organisation can then be prevented from learning from their own or others' experience because the only thing new is a label that is spread as the new fashionable idea and notion to be understood. The effect is that fashion creates an image of change that does not need to occur and allows for preservation of idea and hope (Brunsson, 2006, p.185-195).

People tend to approach ideas according to what they already know or what can be confirmed. However, for an idea to survive, a person's or a group's discovery of an idea is not enough, and there are other persons and groups in an organisation context that need to be influenced in order for an idea to be materialised. In order to find how ideas materialise is by the decision making in organisations. Actors are knowledge-bearers about ideas and consultants are good examples of carriers of knowledge about ideas and also function as knowledge-bearers as organisational support but also in roles involved in projects (Lundin, et al., 2015, p. 193).

The expectation of change and the will to change and the mechanisms that create the will to change are carried by ideas. In order for ideas and hope to explain, create and motivate real change among individuals and groups of individuals, control needs to be inculcated and implemented.

Ideas and control

The notion of ideas that change into things and then transfer into objects and actions, and change into ideas again, can be controlled. Czarniawska-Joerges & Sevón (1996) categorise ideas as images known as pictures or sounds. Pictures and sounds can then be materialised into objects or actions. The application of ideas is done by continual communication in time and location. The spreading of ideas also tends to occur from less saturated into more saturated environments. This implies that where ideas already exist, new ideas can be, or are, used as physical metaphors. Metaphors need to be used in order to fill the space where old ideas can no longer be used without embarrassment. Physical metaphors for ideas are not used as defence for older ideas. Instead, new ideas are substituting older ideas according to Czarniawska-Joerges & Sevón (1996, p. 23). It is people, as

creators or users of ideas, that provide the energy for ideas to travel and that find ideas that travel, and who need the process of translation. People are assumed to be rational and controlled by leaders in hierarchical organisations. Rationality and control, of individuals, does however not need to be strict and contact between the leaders and the led in organisation does not need to be close, but can be sparse (Brunsson & Olsen, 1993, p. 63).

The meaning of translation refers to the occurrence of displacement, drift, invention, mediation, creation of new connections and modifications. The concept becomes interesting for the people involved since it includes “what exists and what is created; the relationship between humans and ideas, ideas and objects, and humans and objects – all needed in order to understand what in shorthand we call 'organisational change'” (Czarniawska-Joerges & Sevón, 1996, p. 24). Originally, translation was a micro-process occurring between small groups or organisations like two or a few people and during sequences of hundreds of years. Today, however, translation is done by the help of mass media, and is mass replicated. Mixed human and technology networks create a complex basis for complex translation mechanisms by fashion such as impact and institutionalisation.

Apart from perceptions of technology, technology also becomes socially constructed with products and facts described in metaphors which creates images of technology to study and understand. Using metaphors in order to understand technology can however be difficult and different perspectives may be needed when discussing organisations and technology using metaphors (Morgan, 1980). Physical phenomena should be used with prudence as metaphors in connection with organisation issues, including transformation of organisations, since entire “chains of assumptions” could be drawn out of nothing because in a social world even technologies can be understood, and interpreted, in different ways according to Czarniawska-Joerges & Sevón (1996, pp. 6-7). There are also organisational issues regarding mega projects and the organisations dealing with them in a transformation perspective. Technology can be used as a motive for mega projects, which would also transform organisations. In a transformational perspective, organisations can also be viewed as having a core where decisions about goals of the projects and high-level design decisions are taken. Outside the core, in the periphery of the organisation, the supply chain designs and constructs the infrastructure or the systems. The periphery however does not have the authority to affect high-level decisions. With time, mega projects develop and actors become involved in the project development. Depending on how different actors are influenced by the project, goals can be altered and high-level decisions can be renegotiated as a result of change of circumstances. Nuno, Lundrigan, & Puranam (2015, p. 2) therefore argue that underperformance of mega projects could be the result of how the

structure of an organisation develops due to changed organisational high-level decisions and goals resulting in failures. The reasons for failure in this perspective would not be to do with the organisation or competence as such, but with changed conditions during an ongoing project (Nuno, Lundrigan, & Puranam, 2015).

Pressure on organisations from the Institutional environment

Military mega projects can assemble extensively complex and large projects but also, at the same time, vast organisation transformations. The environment around such activities puts very large pressure upon such organisations aimed at transforming vast development projects. The institutional environment of such organisations becomes comprehensive with cooperating actors and groups of actors containing information, rules and services like, for instance, specific forms of management and concepts. The institutional environment also includes long-term factors such as social movements and trends, which are practices of a uniform kind that are systematically promoted by many and different actors doing the same thing over a long period of time. The societal trend means the way people think about the development of society around them. Together the different layers illustrated in figure 1 put a concrete pressure on organisations, which makes organisations clearly limited in their actions (Furusten, 2013, p. 29-31).

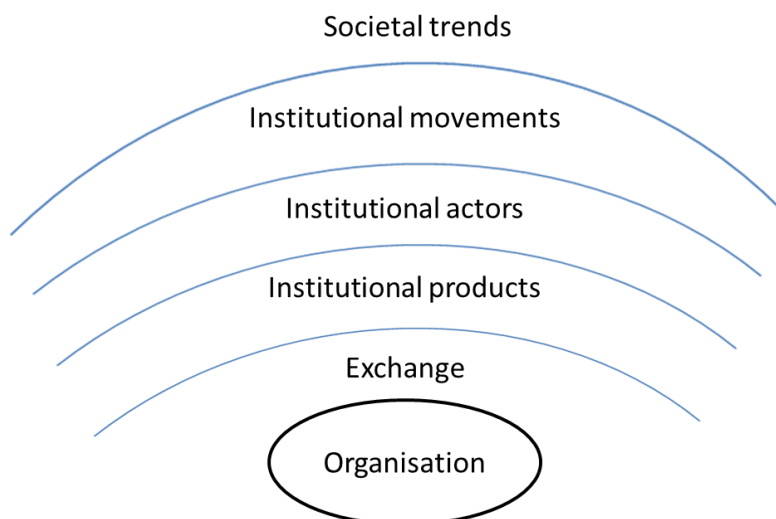


Figure 1 Institutional pressure affects organisations as described by (Furusten, 2013, p. 30)

Transformations and vast mega projects driven by ideas and anticipations about what could happen in the future are important for understanding of how to view change and transformations. In order

to reach an intended change and transformation, the magnitude and pace of change and transformation can be important elements. A slow but steady transformation can be easier to stop than a fast and radical transformation that is mostly aimed at creating irreversible change for the organisation that is subject to the transformation. In the context of mega projects aimed at military developments, not only technologies and systems are subject to development and change. Second order organisation change is also included according to Bergquist (1993, pp. 7-8) which means irreversible change and avoiding doing things as they had been done before, which would have been the case regarding a first order change.

Radical or incremental transformation by technology development

Technology change and organisation transformation can be carried out in a way that is incremental or evolutionary with development done by, for instance, innovation in incremental steps. Examples of innovations made by evolutionary development are the World Wide Web and better engines for cars. Evolutionary innovation tends to ask questions based on the limitations of existing technology. Radical or revolutionary innovations, on the other hand, aim at questions that no one has thought about before, with examples like the Internet and the car when it first was introduced (Stibel, 2011). Technology innovation and development can be both radical and incremental involving large parts of a society, different industries and complex interactions between the involved actors. To reach a development aim some technologies could have to be developed radically but other technologies could be developed by adapting already existing technologies for new purposes (Bainée & Le Goff, 2012, p. 315). While both types of innovation occur in the development of technology, successful revolutionary development and innovation is what makes the most significant advances. A vast amount of incremental improvements of evolutionary development, on the other hand, create better products and business (Stibel, 2011). Norman & Verganti (2014, pp. 82-83) suggest some criteria to fulfil in order for an innovation to be radical. Firstly, the innovation must be novel and different from earlier inventions. It also needs to be unique and thus different from existing inventions. The last criterion demands the invention to become accepted and adopted. This last criterion is also what can cause many attempts at radical innovation to fail and is possibly one reason for the high percentage (96%) of failures of such innovations.

Incremental product innovation is about small changes and improvements to existing products, introducing lower costs or new models. Innovations of both the incremental and radical kind are

considered necessary, with radical innovation as a creator of, for instance, new paradigms and the potential for comprehensive changes (Norman & Verganti, 2014). Paradigm shifts are claimed to be created by disruptive innovation, which is an additional element, and which needs to be managed because of the potential impact of unknown technologies. Still with potential profound impact, disruptive technology innovations leading to disruptive breakthrough is inherently uncertain. One way in which to create disruptive innovation is to allow independent smaller innovation organisations to be embedded in other organisations that need the innovations (Christensen, 2011, pp. 118-119). The typical way of managing disruptive innovation is to arrange already existing and proven technologies in entirely novel architecting ways and is then best applied in an independent organisation (Christensen, 2011).

Innovation activity can be facilitated by, for instance, market liberalisation, which has led to learning-oriented innovation strategies. Market liberalisation has also led to firms observing each other in order to discover innovations in time. The general level of innovation is increasing with market liberalisation, but the aim with research and development can shift and result in more short-term-oriented projects. This could possibly be so that the trend goes towards short-term projects aiming towards radical technology innovations instead of long-term incremental projects. Incremental innovations would instead be decreased and selected radical technologies invested in instead, as has been done in the electricity sector (Markard & Truffer, 2006). Uncertainty is considerable concerning radical technology development due to new and unknown science, technologies and industrial structures. Still, the potential for technology development, even radical technology development, can be so high and lucrative that it leads to success and proactive adoption of radical technology change (Srinivasan, Gary, & Rangaswamy, 2002). In large development projects, the amount of stakeholders involved can lead to both complexity and uncertainty considering, for instance, differing ideas and demands. This means that not only would the technology and technology systems themselves be a source of complexity and uncertainty regarding development, but the different actors involved can also possibly add organisational and social uncertainty (Hall & Martin, 2005). Added to the number, complexity and interests of the different interacting actors, the preferred pace and magnitude of the change and transformation can lead to additional uncertainty and thus risk.

Technology management and management of mega projects

Technology development projects can fail due to too little knowledge available, excessive optimism, or underestimation of budget or time necessary to reach project aims. The development and acquisition of comprehensive technology systems affect how defence industries will be constituted as organisations and how defence market competition will be managed. How armed forces will be constituted is also defined to a large extent by what kind of technology focus is practiced. An entire country's position in a political security perspective can be affected depending on what technology management and development of defence technology projects are aimed at. Countries, their armed forces and defence industries can position themselves depending on how technology management and defence industrial mega projects are achieved. This means that not only deliberate but also unintentional positioning can be achieved using technology if the situation allows large transformation of technology and organisations to be done with technology development. Technology developments can be driven by ideas based on new ways of how war may be fought and thus solve eternal concerns in military affairs. Projects aimed at defence technology development involve strong interests on the part of political, industrial and military end users. Additionally, projects that directly or indirectly aim at the transformation of entire armed forces services regarding technology and organisation can lack competence among the main responsible authorities, but technology maturity can also be an obstacle that is very difficult or even impossible to manage. The number and resulting complexity of activities carried out in parallel in complex mega projects is a potential source of project failure.

Technology-intensive firms have previously been considered to be without a specific management for innovation achievement, creating and upholding awareness and knowledge of technology and innovation development. The pace and impact of technology development have increased and have become vital in competition between firms. Among armed forces, similar conclusions have been drawn that technology can be crucial in military affairs. The concept of technology management came from the US towards the end of 1980s, claiming that advanced technologies were vital factors for effective competition among firms, governmental effectiveness and well-being of the economies of nation states. Thus, technology became more important for management and technology came to be considered a key feature for a competitive future of trade and industry in the United States (Tschirky, 2004). With increasingly technology aware management, technology management strategies have emerged that aim at using technology as a tool for competition.

Technology management

Technology management is practised in order to comprehensively manage the use of technology for value chains. It is used when considering an organisation's resources connected to technology and the best use of the organisation design in order to create the best value for technology. With the right collection of technologies, a competitive advantage is created. Different technologies can then be adapted and organised and create value. How many technologies are to be owned and managed is also a concern to be taken into account, because in terms of competition, keeping a position in several fields of technologies is difficult (Burgelman, Maidique, & Wheelwright, 2001, p. 36). By adapting different technologies, the defence industry can position itself on the defence market and by adapting systems of several technologies, potentially even stronger market positioning can be achieved than if fewer technologies are used. Organisationally, technology management has spread due to increased focus on other types of management areas.

Concerns related to technology have impact on the management of engineering, science and technical organisations, R&D Management, product and project management, management of critical resources, management of new emerging technology and technology innovation, strategic and policy questions and international enquiries. The overall concern is to assess what kind of technology would be best and how to categorise technologies into product and market strategies and link product and market strategies towards comprehensive strategies (Erickson, Magee, Roussel, & Saad, 1990).

Market positioning was previously not a traditional defence industry concern, but has developed into an area of maintaining existing defence technology and equipment with, for instance, service and technology maintenance offerings, in addition to new areas of developing new technologies. For a firm, a potentially large part of maintaining technologies can be claimed if a System of Systems is supposed to be maintained because the scope of such a task could include maintenance of technology belonging to an entire armed force. Actors other than the armed forces, like the defence industry and other private actors, can offer services for defence technology and technology systems. Services for maintaining defence equipment throughout the entire life span of defence equipment can then be offered, according to Kapletia & Probert (2009) and Johnsen (2009). For technology-intensive firms, technology management is a tool for connecting management with engineering activities and innovation development.

The aim and task of Technology Management is to tie Engineering and Science together with General Management. The aim of Technology Management is to identify and evaluate technology options, manage research, development, and feasibility of technological development projects. The task then also includes integrating technology into the operations of the organisation, implementation of technologies into products or other activities, and replacement of obsolete technology. To handle technological change, the right competence is needed, but it is an additional competence compared to general management (Tschirky, 2004, pp.13-14). Technology-related concerns and knowledge about technology are considered a relatively recent need among common industries. It illustrates the impact modern technology has had on development for doing business. However, firms are not isolated from the rest of the society and the impact of technology and innovation is not confined to firms, but all of society is affected by the accelerating development of technology and innovation. Technology-related strategies and management of technology are not only focused on better products to sell and on market positioning, but can also be related to decisions about where to develop technology products geographically. An example of technology functioning as a tool for strategic management decisions is the outsourcing of technology production resulting in reduced costs. Commonly, this development has occurred when work can more easily be done elsewhere and produced more cheaply (White & Bruton, 2007, p. 9). The role of technology management is also to create, develop and/or acquire new technologies, which can be done by mainly two methods: using an internal strategy relying on innovation and research, or an external strategy by buying technology. One of the strategies does not exclude the other, and both internal and external technology strategy can be used at the same time. Firms with several types of technologies can use both strategies in order to maximise business and market position.

The emerging greater focus on technology has started an era of technology-based strategies, with the common denominators of technology development and innovation to be used in competition. Basing development focus on technology has then been considered to be generally more effective than basing focus on markets and letting markets lead what should be developed (Dussauge, Hart, & Ramanantsoa, 1992). With technology-based successes of firms, the importance of technology for potential technology turned profit has emerged and increased over time. Technology development, when successful, is used in market positioning but can also be used as a barrier to entry for competitors (Burgelman, Maidique, & Wheelwright, 2001). The greater focus on technology has also led to market positioning involving industrial marketing. Efforts regarding technology selling is critical for industrial marketing and can be seen with the described notions of spreading ideas about

promising future comprehensive technology systems. Efforts in selling aim at promising new kinds of superior systems for the future conflict. Developments with vast scope using technology as a tool for creating strategic change include some special considerations.

Concerns regarding difficulties with technology development

It is claimed that the competitive advantage for technology and innovation is a function of technology complexity. Greater market advantage and success can be reached if technology and system complexity is great because it could create a greater distance compared to competitors. Not only technology and systems complexity add to the complexity. The organisation also needs the ability of skill and knowledge growth, and organisational capability to learn. When technology complexity increases, the pressure on a business to have proper human knowledge and skills increases. With an increased number of involved technologies, technology complexity is not the only factor that creates difficulties for management. Complicated administration connections and problems regarding correct organisation and further managerial structures, increase with larger and more complex product platforms. For management of technology and innovation, Portfolio Management characterises the most complex conditions, where there are different kinds of technologies, products, processes and different strategic considerations as illustrated in figure 2 (White & Bruton, 2007). With the increasing scope of technology development, some concerns have emerged.

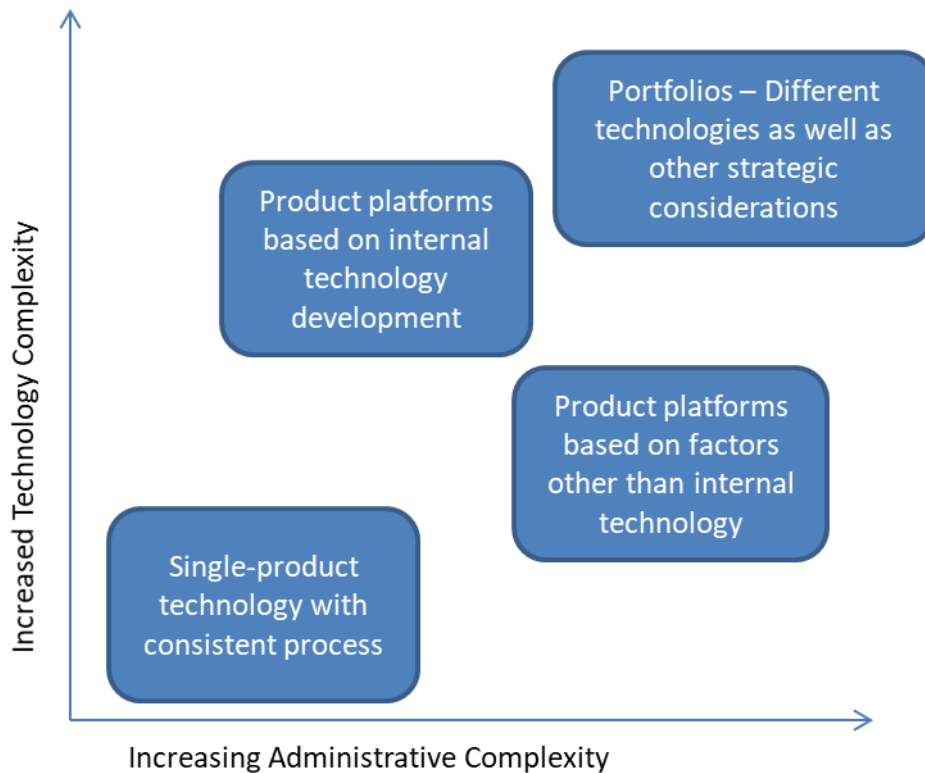


Figure 2 How administrative complexity relate to technological complexity (White & Bruton, 2007, p. 305)

Knowledge about technology and maintaining steady knowledge growth is necessary for new and unique inventions. Knowledge about technology is furthermore essential for integrating different technologies, both newly acquired and already possessed technologies, and is needed to foresee technology development in order to utilise predictions in business or other activities. Knowledge has proven important to complement pure experience because of difficulties in relying only on experience concerning the development and design of complex machines, complex technology systems with delimiting properties and the combination of technologies. To have, maintain and continuously create knowledge is a challenge for development organisations but is also difficult for management. Despite the obvious importance of technology for business management of high-technology firms and businesses, business management has a history of being rather unskilled in technology concerns. Technology has been understood as a so-called black box, where money and staff are put in and something comes out the other end. Knowledge is one element which is necessary, but can turn out to be an obstacle for successful technology development. When the scope of technology development increases, all unknown elements of future developments are added and uncertainty can become problematically high (Burgelman et al, 2001).

If uncertainty increases, development and project risk increases at the same time. It is difficult to predict if and when technologies that are planned and developed and not yet known will require new human skills and knowledge, because it is not easy to predict completely new technologies.

Uncertainty in development can be a risky path to take, but for the defence industry that reaches the knowledge and develops successful technologies, strong competitive advantages can be reached. The competitive advantage should then be maintained over time and be made difficult to imitate for as long as possible if both administrative complexity and technological complexity are managed properly (Burgelman et al., 2001). The development of technologies is associated with uncertainty and difficulties in evaluating the performance and the utility of different innovations. Knowledge and experience is then important to possess (Pavitt, 1999).

One of the main concerns for technology management is to manage initiation, evaluation and overlooking of technology development projects. The increasing complexity of technology combined with increasing administrative complexity also applies to projects for technology development.

Project management

The complex military technology of today is also expensive to acquire and often includes large development projects that involve excessive spending. Military technology development projects are similar to large civil infrastructure projects in the sense of being large, expensive and acquired by a government or authorities, and mostly implemented by a contractor (Flyvbjerg, 2007).

For technology-based business, whether large information technology projects or a mega project including many different kinds of technologies, development projects are the key area for successful activity. Such development projects can lead to a better market position or market leadership in increasingly competitive markets. Successful technology development projects can lead to leaps in technology innovation and development with the potential to create barriers to entry that would prevent other competitors from entering the market segment. Newly developed products can additionally open new channels for selling. Development projects can also create increased value for existing products if those products are enhanced using knowledge from the development. But projects can also result in tensions within an organisation due to lack of resources and being difficult to manage because technology developments are dealing with developing technology for the very first time.

Projects are frequently competing with the parental line organisation and/or other projects with limited resources and can often result in conflicting environments for project management. Moreover, when projects have a start and an end date, they are also unique because no two projects are exactly alike. There are always differences to some degree. Another common attribute of a typical project is the way in which the level of effort relates to the time consumed for the project. A project usually begins with a concept phase and a build-up in the beginning of the project, reaching its peak during planning, scheduling and monitoring the project. The ending is supposed to be done with an evaluation and a final termination of the project (Meredith & Mantel, 2012).

Management of mega projects

The management of mega projects is a special challenge for management. The projects are commonly integrated into programmes of vast scope where project management is required to handle the development of new and complex technology while simultaneously organising vast project organisations and structures, dealing with costs that can reach considerable parts of government budgets.

With respect to the basic properties, mega projects and normal projects are similar but mega projects have additional properties and can also be associated with trends of different views on management and control and what kind of technology development and focus should be adopted. A change in how projects could be managed and what should be focused on began to emerge during the second half of the 20th century. Large endeavours of technology development were started aiming at creating systems. Earlier, focus had been on individual artifacts but with the arrival of systems development groups of technologies were to be integrated. The focus became the interface between individual technologies. System creators also focused development and adaptation of organisations together with technology systems development. This means that mega projects, unlike normal projects, are largely socially constructed with different kinds of actors with different kinds of aims for mega projects (Hughes, 1998). With the increased complexity that followed with the emergence of systems creation, management control became increasingly important and needed to be maintained in mega projects. It can be done if mega projects are undisturbed and clear aims are kept with measuring project performance. Arrangements should also be made so that defence industries can be contracted for efficient competition having options, for the acquiring part, to use if development fails at specific stages (Sapolsky, 1972, pp.143-151). But development can be made simultaneously as is done in many computer software projects, where the different sub-parts, or sub-

routines, in a project have little use until the sum of them is put together, creating a useful whole. When all of the sub-projects have been successfully executed, the project is completed (Meredith & Mantel, 2012). Well-specified sub-projects and clear aims have been a success factor for management of mega projects including keeping project management and thus the project control free from intervention. Focus can then be concentrated on moving the mega project forward instead of, for instance, focusing resources on justification and renegotiations of different aims and goals of the mega project (Sapolsky, 1972, pp. 94-95). Mega projects, however, do differ from normal, smaller projects, mainly in terms of scope, time frame, complexity, uncertainty and number of stakeholders (Zidane et al, 2012). More than normal projects mega projects are difficult to change and adapt to new emerging needs once started with decision making that lasts continuously for several years (Miller et al, 2017). Socio economic aspects are important reasons why mega projects involve complexity and a good deal of uncertainty. Due to different actors' differing agendas and relative rational perceptions, resistance and continuous renegotiations during ongoing mega projects are common but create great uncertainty. The iron triangle of managing project time, budget and specifications becomes very difficult. Managing mega projects is a networking activity for actors to a much greater degree than in smaller projects (Lehtonen et al, 2017). The complex interactions between actors within mega projects creates concerns due to, for instance, the fact that plans, events, administration and documents are interpreted and understood individually. Sensemaking evolves continuously among actors in and around mega projects and is connected to power, which can become problematic and increases complexity and project uncertainty (Clegg, 2017). And actors can change their mind during development and this gives rise to extensive unplanned changes due to epiphanies (Denzin, 1989, p. 37; Dumez, 2016, p. 128).

The complexity involving integrating actors can also include unspoken and hidden agendas. Mega projects can have other aims than just the main public description of the end product. The scope of such a vast scale of mega projects can alter the future behaviour and dependence of entire countries technologically and politically (Ahlers et al, 2017). The connection with, for instance, power does not need to be clearly visible before and during a mega project but can appear with time and be evident after a mega project is finished. The three faces of power described by Lukes (2005) can be differently perceived. The first face of power can be rather clear and visible. The third, more ideological, face of power can be difficult to perceive even though it still has a great impact on actors.

The large sums involved and the vast technological plans result in actors joining mega projects because of the possibility to obtain some of the financial resources allotted to these activities. It is

therefore common to have an optimism bias or perhaps even be deceptive about the prospects of success (Flyvbjerg, 2017, p. 8 & 155-156).

Underestimation or neglect of uncertainty, neglect of internal or external stakeholders and, for instance, mismanagement are common ingredients in mega projects related to the will of the different actors directly or indirectly involved. Mega project results can easily become affected negatively when, for instance, stakeholders are neglected (Lenfle & Loch, 2017). Some concerns about uncertainty of mega projects can be predicted with proper risk management. If proper risk management is practiced it is then mostly about adjusting back to the original plan instead of adjusting the entire mega project to new directions and new knowledge creation (Davies, 2017). The scope and daring ideas for the aim and purpose of mega projects in military contexts can frequently become unrealistic. Uncertainty increases if mega project that needs controlled environments to be efficiently and successfully managed, are instead aimed at solving dynamic problems or concerns. Such problems and concerns can easily turn out to result in complete failures of mega projects as shown by Edwards (1996). It can perhaps be understood that vast endeavours should consequently be more at risk of failing but it is not necessarily the case. There are different views and understandings of what could be best - big, mega projects or implement new development incrementally. Advocates for vast and big undertakings commonly motivate locking out competitors or, for instance, creating capability preemptively. Advocates for incremental development tend to use motives that rationality becomes clearly limited concerning decision making under uncertainty (Ansar et al, 2017). The normal manner of managing complex policy-like problems is to take small steps incrementally and consider the consequences gradually according to Atkinson (2011) because mega projects become very sensitive to change which tend to occur continuously (Ansar et al, 2017, p. 63). In the case described by Edwards (1996, p. 5) vast and resource demanding sensor systems installed by the US Air Force were shown to be useless when humans could easily tamper with the technology in order to deceive the installed sensor systems. The project had been developed around computerised systems to make the battle field in Vietnam automated with new technologies and new management principles. The concept and the system could easily impress decision makers and sounded impressive when presented.

In the case of military mega projects I have claimed that the studied projects also involve extensive development of integrated systems aimed at creating an end product, a flexible System of Systems. It is then necessary to integrate numerous subsystems into one holistic integrated System of Systems

which requires very careful management of numerous integration points inside subsystems, between subsystems inside a System of System and with the external environment (Davies, 2017).

Other characteristics that distinguish mega projects from other smaller projects are the number of staff and continuous organisation changes due to different smaller projects within the mega project having different developments and life spans. Some of the main difficulties caused by the characteristics of mega projects are lack of staff, knowledge, proper training, and raw material, if lack of raw material is applicable (Kerzner, 2013). In technology projects, only limited parts deal with the technology as such in the project activities. Perhaps more important are, as we have seen in the discussion about change and transformation and the spreading of ideas, the different actors with different expertise and interests within and outside the project which can cause difficulties in cooperation. New kinds of organisational solutions can be created, but in reality, it is not of huge importance due to, for instance, necessary changes of competence or ideological conflicts. Competence discrepancies and ideological conflicts can have greater importance. Mutual understanding of what to do and how to do it differs within such projects and can easily create problems (Midler, 2012). With a large amount of activities in ambitious mega projects and the increasing risk of problems due to new and unknown elements, the impact of failure would be large and difficult to be assessed beforehand. Similarly to vast change activities, concerns about the failure of mega projects are not only about time, development complexity and technological uncertainty of development but also about groups and individuals influenced by anticipations of ideas. Nuno (2015) claims that in mega projects, fragile environments of groups and individuals are created where different stakeholders and participants are controlling the resources for the activity to continue. By controlling the resources, the expectations of the project outcome are affected. This can result in by-products of mega projects with large voluntary and consensus-focused networks working under rather flat and democratic structures instead of being controlled by any hierarchical organisation, market forces or legal contracts (Nuno G. , 2015). Due to different participants' and stakeholders' interests and organisational concerns, the nature of mega projects is uncertain and can involve poor cooperation between different actors involved. This leads to greater risk associated with mega projects compared to other projects (Marrewijk et al, 2008). The development of technology is associated with considerable uncertainty and does not only refer to technology but to many ingoing elements influencing such developments in different directions (Depeyre & Dumez, 2009). Because of the scope of mega projects and the vast resources such endeavours require, any risk becomes greater compared to a more normal project. If vast numbers of completely new technologies and

new kinds of organisational concepts are involved, the degree of uncertainty will also be greater compared to more normal projects.

I have now shown some normal project concerns that are similar to those involved in mega projects. I have also shown some concerns that tend to be mega project-specific. The result of unwanted events in a mega project environment would seemingly have greater impact compared to more normal projects. One element with the potential to assume mega dimensions along with mega projects is the ingoing risk. Risk and risk management will now be considered.

Risk management in mega projects

The definition of risk is the probability times the consequence for not reaching the intended aim of a mega project. Because of the vast numbers of completely new and unknown future technologies and emerging events in mega projects, exact predictions can probably not be made about the outcome of mega projects. The element of uncertainty can be great for mega projects due to the large numbers of unknown interdependable technologies and different interacting actors that can have different interests and influences and add to the number of unexpected and unknown events and developments (Kerzner, 2013, pp. 873-874). Examples of factors that cause risk before any project is initiated are poorly defined requirements, too few qualified resources, lack of management support, poor estimating and inexperienced project management. Factors that can increase project risk during a project may be cost increase, time increase, wrongly defined project scope, over-optimistic project schedule, incorrect work breakdown structure, wrong skill level to work task, improper accounting for risk, and not poorly understood accounting, leading to cost escalation or an inaccurate estimating technique. Project risk denotes the precarious activities of factors that can increase the probability for the project goals not to be reached. The consequences of failures can be loss of follow-on contracts and loss of future development activities. Many of the different concerns of failure are not apparent until they are discovered by the cost control system far into the project (Kerzner, 2013, pp. 706-707). There are, however, measures to assess risk in high-risk projects and decision support for risk management (Kerzner, 2013). Miller et al (2017, pp. 234-235) suggests a way to deal with the complexity of mega projects by accepting complexity and becoming proactive and avoiding one single vast mega project but implementing several smaller projects instead.

Risk Management is activity undertaken to manage risk and includes planning, identification, analysing, creating responses to, monitoring and controlling risks. In that order, Risk Management

can be a process, which should be addressed continuously during a project to minimise risk and unintended increase of risk and to avoid additional risk factors (Kerzner, 2013, p. 883). The number of different factors for risk management to deal with can be difficult to define in normal projects due to the inherent difficulties in foreseeing the future. There are different methods, tools, and processes for structuring Risk Management that aim at taking risk and risk assessment into account. Still, shortcomings are common in such activities. Examples of common failures in risk management of projects are wrong adopted phases in the risk process, invisible phases, failure to identify uncertainties, some parts of the process not being addressed, wrong assumptions about the purpose of process phases, and combination several uncertainties and their respective interdependencies (Chapman & Ward, 2003, pp. 75-76). Risk management is also not an activity separated from the other parts of project management but an integrated part of it. There are also different ways of viewing uncertainty, either as the absence of certainty, or as variability and ambiguity as general reflections. If a reason for variability exists, variability represents ambiguity. In many situations, the factor of variability is connected to ambiguity because it is relatively more difficult than dealing with, for instance, framing assumptions (Chapman & Ward, 2002, p. 453). There is risk regarding ordinary projects, but with the special circumstances of mega projects, risk and uncertainty become even greater. Risk has now been addressed and the results of potential risks, i.e. failure of mega projects, will now be considered.

Risk of pitfalls and failures of mega projects

Both the military end user side and the defence industry side in the acquisition process of military technology have been shown as having insufficient competence to manage the actual acquisition of planned technologies (Depeyre, 2009). Large amounts of money can sometimes be used for development projects based on technologies and plans for technology systems that are far from being technologically mature. Future success has been claimed in advance based on the large financial resources added to the development. However, unrealistic expectations can make development projects difficult or even impossible to manage. Similar issues regarding unrealistic expectations have happened in contexts other than mega projects, in other large and complicated projects as in failing information technology projects (Henderson, 2006). Those failures compose parallels to defence technology development problems. An additional reason for failure of information technology projects can be management aiming at excessively large systems development done at once and with insufficient control (Doi, 2006). Technology-driven mega projects involve large numbers of unknown and future expectations of what technology can do based

on ideas, and becomes uncertain as to its nature. Mega projects also need specific and fast knowledge growth in order to manage the development. In ongoing mega projects, new project aims tend to be added and shifting purposes can occur. Uncertainty, knowledge growth and changing requirements on the mega project cause reasons for problems with the development or even failure of mega projects. Those concerns will now be described.

Failure and uncertainty

The failure or success of a mega project can be debated because these two concepts can be difficult to define. There are examples of arguments that claim mega projects are not automatically failures if schedules are not met or costs are increased considerably. It has been considered that as long as a new product is created at some point in time, a mega project can be claimed not to have been a failure. The difficulties in defining the failure or success of a mega project could perhaps be one reason why few mega projects are terminated when project aims cannot be met although warnings of failings are known and sometimes obvious (Kardes et al, 2013, p. 915). The role of management matters, which can easily believe that it has more control over the mega project than it actually has, but can be overwhelmed by, for instance, swift project changes and information overflow (Baumard, 1999, p. 47).

Deficiency of management skills or experience from earlier projects is not always the reason for underestimation of complexity. Project management commonly fallaciously believe that they can influence project outcomes in spite of the nature of projects as including risk and uncertainties. Management overconfidence can be the cause of this illusion of control bias that also leads to management underevaluation of risk and overestimation of too-optimistic information (Kardes et al, 2013, p. 910). The uncertainty of development furthermore has few real factors to use for estimation of risk because of the inherent concerns of knowing the unknown. It is then easy to start to believe in developments, present or future, that do not actually occur. With greater uncertainty, the perception of control and the degree of overconfidence increase, which also leads to a higher probability of underestimation of involved risk (Kardes et al, 2013). Burgelman et al (2001, p. 741) concludes that many development projects fail to reach their intended goals. Even carefully planned development projects with project milestones, significant organisational involvement and aggressive plans for introducing a product onto the market, can fail. Further reasons why mega projects can fail related to management are insufficient competence and skill.

Lack of competence and management skills

Complex technology mega projects need to have proper knowledge creation and skills, tools and concepts. The management itself needs such knowledge, but there is also a need for focus towards the right activities in the project development phases consisting of, for instance, knowledge acquisition, concept investigation, basic design, prototype building, pilot production and manufacturing ramp-up. Fast knowledge growth is important in vast and complex development projects but is also difficult to create and maintain along with an increasingly complex and knowledge-demanding project. Too-slow knowledge growth has been shown to be a risk and a potential reason for project failure (Lenfle, 2012a; Lenfle, 2012b). Exploratory projects require specialised learning approaches and to handle flexibility in order to manage the project environments. (Lundin, et al., 2015, p. 117). Unexpected changes in mega projects cause large extra adaptations of project activities and can cause considerable delay and waste of resources.

Project changes

Commonly project management attention to project activity connected to development occurs rather late and after product development. Changes and intervention at such a late stage in a project is difficult to achieve. It has been shown to be very hard or impossible to affect the outcome of already started developments and project activities. Instead, management attention and influence should focus on the beginning of a development project, when the chance to influence the project is greater. One reason why management attention can be focused too late in projects is a cultural difference in how management handle their role, and the difference in focus can be divided into two main ways of behaviour. Burgelman et al (2001) describes the traditional senior management approach and the alternative development strategy leadership approach. Senior management traditionally has a role in pre-project planning, selecting, assessing and deciding whether projects are to be commenced or not, illustrated in figure 3. Later in the development project timeline, senior management are usually less active, which results in, for instance, an inability to deal with sudden emerging events.

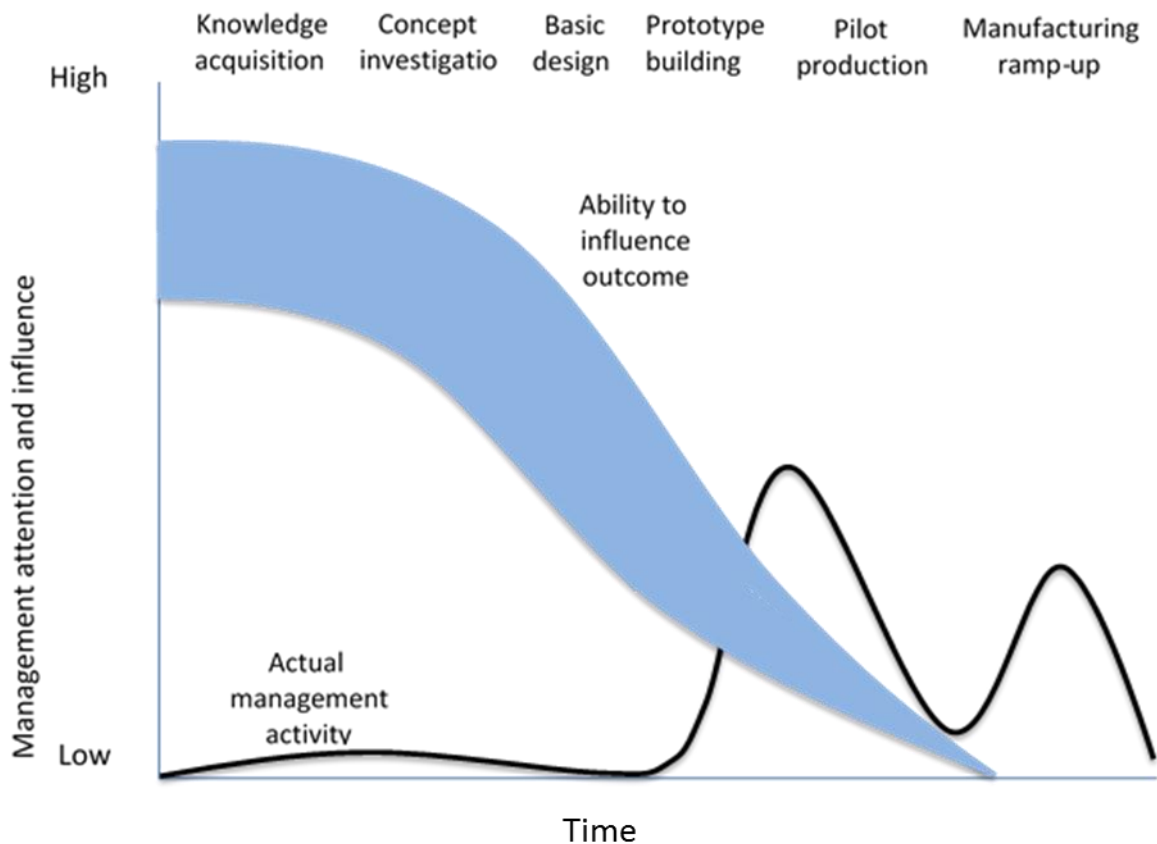


Figure 3: How management engages in development projects compared to ability to affect outcome of development projects (Burgelman, Maidique & Wheelwright, 2001, p. 743).

This kind of management approach has shown to be ineffective by being reactive, piecemeal and giving too little time for planning. Instead, attributes like proactiveness, comprehensiveness and strategic planning activities over the long term would be preferred for management. The alternative approach for senior management to handle development projects is the development strategy leadership approach. It is considerably more proactive than the traditional senior management approach but also has the role of motivating, guiding and leading towards better projects. Guidelines and delimitations for each project would also be an important task for management of the development strategy leadership approach, because project management could then focus on senior management intentions. Technology is one important element to focus on, but with interactions and actors' interests involved internally and externally, many more elements of influence can cause a mega project to change path. The best project results are achieved when management is motivating, guiding and leading the organisation proactively (Burgelman et al, 2001, p. 744).

The two different kinds of management handling changes in projects have been described briefly. Changes in mega projects increase risk, causing disturbances to mega projects regardless of the management type in place to deal with project changes, although the reasons for change are rational and legitimate.

The literature and theoretical framework started with a description of the institutional environment and ideas that can be taken up by actors and evolve the ideas into development plans. This involves social relationship building and knowledge creation about the customer as important ingredients. Czarniawska-Joerges and Sevón (1996) describe how ideas that addressed promised solutions to problems can be used in selling and Furusten (2013) describes how the ideas can function as, for instance, fashion and ideology like mechanisms to support the creation of mega projects which to a large extent become socially dependent. Brunsson (2002) explains how consultants and other trustworthy actors spread ideas and function as facilitators for selling systems, while Silverman (2011) describes a potential manner in which ideas can be deliberately spread with word-of-mouth marketing. Levitt & Scott (2017) write that shared understanding is created and Swidler (1986) describes how the culture containing the ideas leads to action and development activities.

According to (Lukes, 2005) the third face of power are motives for new promised technologies that are claimed to be better for future capabilities and are presented in general terms thus appealing to many using means to persuade and initiate action similar to ideology. The mega project is the entity that will implement the transformation with technology leading the way for the comprehensive development.

It is important to note that ideas can strongly influence actions of change, motivate transformations, and create anticipation with notions to follow that can become the control mechanism for the change (Czarniawska-Joerges & Sevón, 1996; Brunsson & Olsen, 1993). The notion of idea-driven change and transformation also involves a question about whether implementations should be made in incremental steps or in a radical manner. Ideas can lead to the emergence of cultures with different opinions on how change should be implemented (Swidler, 1986). We will see that, depending on choice of implementation - incremental or radical - the related risk will be of a normal kind or very large and possibly unknown. Unforeseen emerging changes in the form of actors' thought and action epiphanies also affect entire transformations (Denzin, 1989; Dumez, 2016).

From institutional environment and ideas for change and transformation the theoretical framework focuses on Technology management and management of mega projects. After illustrating mega projects and the possible negative implications if plans and developments are not met, risk of failure and risk management in mega projects were discussed. I continued with some specific problems that can be sources of failure of mega projects. For instance, when little is known about future development and there is inherent uncertainty, according to Kardes et al (2013), with undervaluation of risk and trust in developments that do not progress. Lenfle (2012a; 2012b) adds the concern of competence growth which is difficult in some mega projects involving considerable completely new elements. Burgelman et al (2001) describes concerns about project changes and the difficulties in changing projects, but also that changes interrupt projects.

The main actors to keep in mind are the defence industry and the armed forces as end users of the imagined future systems. It is also important to note that high-ranking officers in the armed forces want new technology systems and the defence industry needs to sell technology systems. High-ranking officers convince politicians and other high-ranking officers about the promising ideas and the planning and creation of the concepts based on the idea originating from Revolution in Military Affairs. At this stage in the development, the main groups of actors belong to the armed forces, the defence industry and politicians who are positive about the development. With time and absence of progression, the ideas and concepts encountered problems with organisational and technological reality. Changed conditions for some interested actors from inside and outside of the development made them start resisting the changes.

The main actors involved in change are mainly a core of actors that lead the change activity and have strong influence. Resistance to change consists of actors outside and within the change activity. The relationships between actors are stronger if the aim is mutual which implies that the relationships will alter during the change and transformation.

Chapter 3 - Methodology

To approach the questions of how military mega projects are initiated and managed and why such endeavours sometimes fail and sometimes succeed the aim has been to search for dynamics around and inside the mega projects. Dynamics can have a profound impact on the implementation of mega projects, making them fail or succeed. Mega projects exist in environments with actors which motivate my choice of institutional theory as an important part of the theoretical framework. The role of the literature is to create knowledge concerning the mega projects and frame the subject field with an array of different but closely related literature. Marketing, which is a tool to sell comprehensive defence systems but also transform armed force services in military contexts, is included in the literature because of the actors' desire to buy new technology systems created by mega projects. The literature also contains Systems Engineering and System of Systems. The reason is simple, all of the compared mega projects have been managed with Systems Engineering as System of Systems and knowledge is crucial to understanding how the systematic work concerning mega projects works. Because all the first two mega projects were also organisation transformations of entire armed forces' branches, organisation change and organisation transformation are also covered in the literature. The last part of the literature is management of mega projects. The literature has been used together with the methodology to understand the dynamics within the different mega projects. Any event of significance directly or indirectly in the respective mega projects has been noted and categorised aiming at how mega projects can emerge and develop and why mega projects fail or succeed. Since the dynamics of mega projects can differ greatly it may be difficult to structure the information about them and judge if each event of the project is significant or not, which might determine the success or failure of the project. The narrative structure is a way of structuring information from the mega project cases and it is in the dynamics between actors before, during or after a mega project that failure or success can be noticed and traced. For structuring a heterogeneous material a narrative structure should be fruitful and useful in such circumstances, with individual and social contexts explaining my choice of methodology as a narrative inquiry (Connelly & Clandinin, 1990; Clandinin, 2006, p. 45).

The methodology adopted for the research question is a case study containing three different case studies, the mega projects. The choice of case study methodology is motivated by the fact that the main aim of the research is to study the dynamics as phenomena within and around mega projects. The dynamics in the three different mega projects have been studied using structured narrative inquiries identifying the dynamics between individuals and between groups of actors within and

around mega projects (Eisenhardt, 1989; Dumez, 2016). All three case studies concern the planning, studies and developments of Network-Centric Warfare projects aimed at creating new types of military combat forces. The three different but also similar projects have been parts of a larger development based on ideas that computerised communication systems would be a factor in revolutionising the warfare of the future. The development occurred mainly in the western part of the world in the early 1990s after the Cold War, when fewer resources had to be used for upholding a large number of combat-ready forces.

The mega projects have been chosen due to their scope and aims, which have the dimensions of technology complexity, vast organisation change, and budget-related reasons making them have mega properties. This phenomenon, having the same origin and aims, has occurred at about the same time in several countries and several continents independent of the budget and size of the nation working on the respective mega project. The reason for the choice of the different mega projects is to investigate how implementation of mega projects has been made and if the size of budget and respective defence industry and armed force could affect the outcome of each mega project. One additional reason for the choice is that there has been only one situation with such distribution of similar mega projects in each country.

The narrative structure is appropriate as a means for structuring the information gathering in each mega project in a timely manner to create a picture of different events searching for phenomena in the dynamics of each mega project (Dumez, 2016, p. 127-130; Creswell et al, 2007, pp. 239-240).

The creation of the new types of military combat forces was supposed to be conducted by vast high-technology development projects with scopes of mega magnitude concerning all three projects including transformation of entire branches of armed forces. The combination of mega projects and organisation transformation in the first two cases intended to create second order irreversible change according to Bergquist (1993, pp. 7) with interconnected systems focusing on technology systems, humans and organisation interconnections according to Hughes (1998, p. 7). The events in such projects are largely a social interaction between individuals and groups of individuals in different organisations. The research question posed is about how complex mega projects are managed and whether there exist different types of management, and success and failure factors regarding these projects. The answers to such a question would be found among interacting social contexts in and between organisations with logic, concerns, and sense originating from technology, organisational, and social factors from groups and individuals (Dumez, 2016, p. 121).

The aim is to look for important events, key elements, of information as described by (Creswell et al, 2007, p. 244) in such contexts with complex phenomenon around, within and possibly between the mega projects that have been investigated. The aim has been to examine and compare the three cases including complex events and individuals and groups of individuals with their relationships. I have searched for the dynamics including ideas affecting decisions and behaviour of individuals and groups. It is then not necessarily about numbers of different decisions, which can be considered as motivated and rational, but also about searching for actions and dynamics and ongoing overtime. The dynamics can then take other directions if, for instance, actors come across situations which affect the development for different reasons. Narrative connects actions and changes of direction of acting. People involved in such events interact and create meaning through conversation like language and language evolvment. Because information about a narrative is found from interviews, the information is rather an interpretation of the narrative (Piore, 2006, p. 21) which would be relevant for the creation of narratives of which the interviewer can easily become a part in a conversation with a respondent.

In combination with the research questions, the case study methodology has been considered the most appropriate to use as the inquiries about the dynamics around and within the projects can have a vast amount of different variables (Yin, 2014, p. 17).

Research design

The three mega projects have similarities with respect to their overall tasks and the expected basic events have been similar. However, all cases have also had different contexts because of their taking place in different countries with different security policies, defence industries and end user perspectives. The dynamics, events and other factors in the different mega projects, such as technology, organisation, transformation of end users and industrial involvement, have been studied and compared over the project boundaries. Large public endeavours and mega projects are to a large extent social activities with actors acting for their respective rational aims and purposes. To follow how mega projects emerge and answer why mega projects sometimes fail becomes an act of studying social activities and actors and groups of actors interacting with their ideas, hopes, norms, ideologies and ways of understanding different new influences. Unclear boundaries between events, contexts and real life events in social contexts between organisations, individuals and systems must be observed (Hughes, 1998; Furusten, 2013; Lehtonen, Joly, & Aparicio, 2017, pp. 241-242; Brunsson,

2006). The different kinds of data that I have collected also point to case study design being appropriate (Eisenhardt, 1989, pp. 534-535). Therefore, the basic case study design is a holistic multiple-case design studying the global dynamics within the respective ingoing cases as illustrated in figure 4 and according to Yin (2014, p. 50). The case study design then consists of several cases, three mega projects, with their respective contexts which have been compared with each other.

All cases have been studied using structured narratives with sequential analysis to order the material and create questions about the respective cases according to Dumez (2016, p. 125).

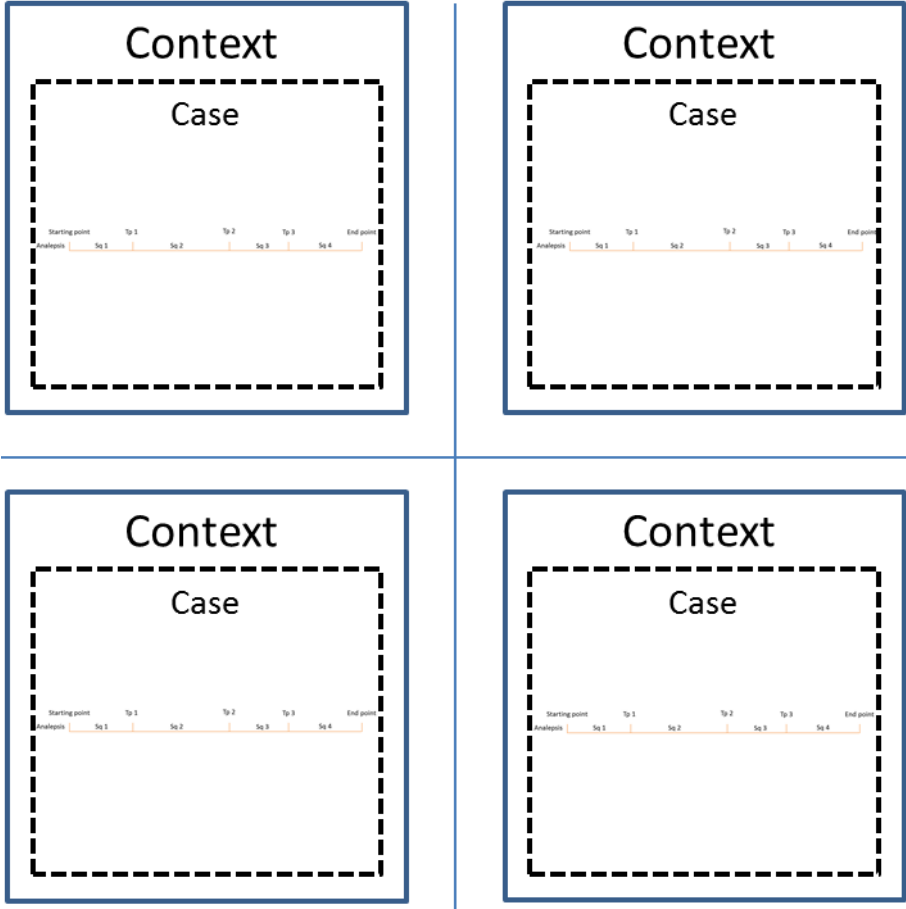


Figure 4: Basic principles of study design according to Yin (2014, p. 50). The number of added narratives illustrated in the principle example is n=4.

The number of studied cases is then three, with three different but also similar contexts, which have been studied and later compared. The actual study is illustrated in figure 5, consisting of three cases. The research is however not limited to keeping a global view of each of the cases, which means that the information found during the study could consist of only common global information but also

possibly details of information. Both common global information and detailed information can point towards critical dynamics and events within each mega project and case. The holistic multiple case design combined with the narrative template to structure the information attend to both comprehensive views and factors, and possible detailed views and factors are taken into account.

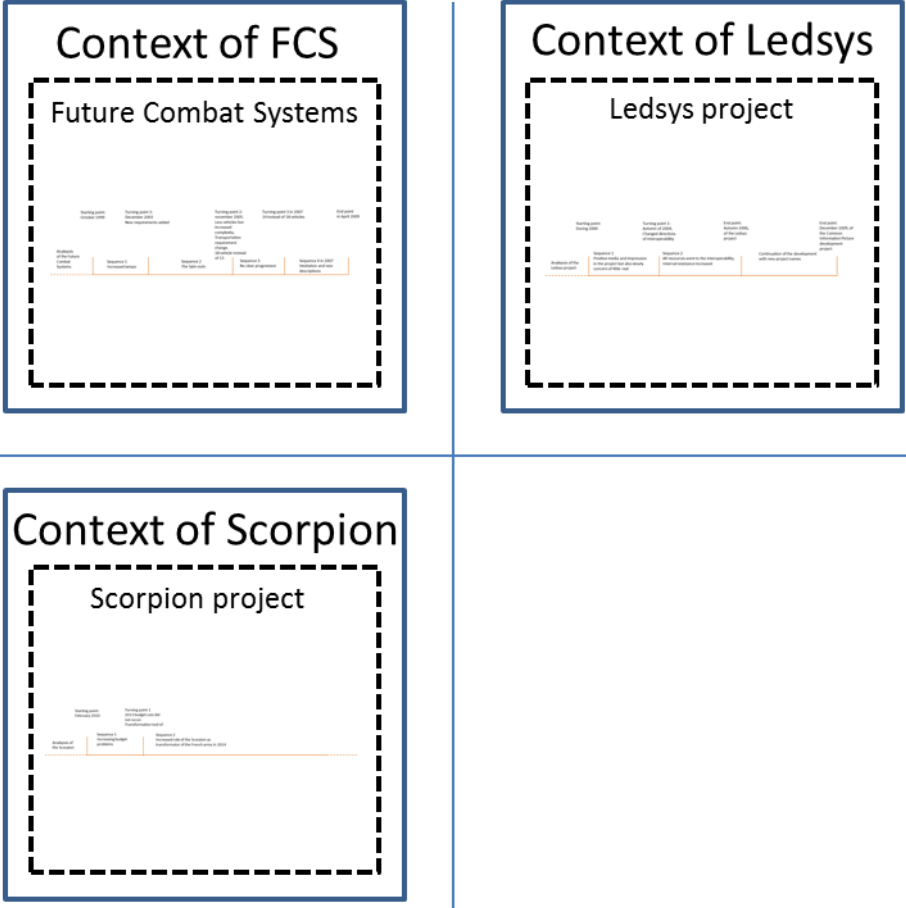


Figure 5: Actual study design showing the actual case of the Network-Centric Warfare projects.

Background and choice of cases

The motivation for the research and comparison of the three mega projects is the emergent development during the 1990s of planned mega projects in the defence industry with similarities across large parts of the Western world. Countries had their own kinds of development based on the basic principles of Network-Centric Warfare, with projects becoming scoped according to the amount of resources in the country concerned. Like many other mega projects regarding civil infrastructure,

the two mega projects which have been finished have already been debated during their lifetime for becoming failures and thus when later finished also became failures.

The reference case of the Future Combat Systems

The three different cases were chosen to be examined individually and later compared with each other. The largest case of the three is Future Combat Systems which constitutes a reference case due to a number of reasons. Future Combat Systems had the largest scope of the three projects and the project had a clear history before it started, progressed and later stopped. It also has results after the project ending, consisting in fragments of technology and concepts that have been integrated into the alternative forces that were developed instead of Future Combat Systems. The project was also the first with the ideas and later studies for the new kind of System of Systems creation. The development of Future Combat Systems was then the first considering entire specific combat formations and aiming at creating such combat formations for an entire armed force service. The development project resulted in failure, but included from start to finish exceptional project and development risk. The project is also finished and numerous reports and articles have been written about it.

Future Combat Systems also used a new kind of management for the project due to the assessment based upon the idea that other innovative management principles were necessary in order to reach the end goal of the project.

In a sense, the other projects, the Ledsys and Scorpion projects, have been carried out in light of the Future Combat Systems. No perfect mega project likely exists, but if there can be any among the three studied, it would be the Future Combat Systems. The other mega projects will then be compared to the Future Combat Systems as the archetypal mega project.

Similarities of the different mega projects

The different cases have then been compared with each other with the reference case serving as a more stable activity to compare the other two projects against. However, the Scorpion project and the Network-Based Defence project have also been compared against each other. The study and the comparison have been done by creating a sequential analysis of the different projects.

The aims have been to create and implement System of Systems based on Network-Centric Warfare concepts or a considerably complex system of land forces. Compared to the aim of transforming the relevant land forces with single very comprehensive projects, the mega projects have large differences but are also similar with their respective relative aims. The dimensions of the respective armed forces' organisation, defence budgets and, for example, defence industry can be relatively compared knowing the differences but also the similarities. The technology scope was also similar and meant the development and integration of communication technology in vast amounts throughout entire services. In the US, almost the entire army was supposed to be changed according to the development plans. In France, the new development was aimed at the entire army. In Sweden, the aim was not only to change the army but also the entire Swedish Armed Forces were supposed to benefit from the new kind of technology and System of Systems. The defence industries of all three countries had been assessed to be competent enough, even if the aims were ambitious, to manage the mega projects in the respective countries. However, the US Army and its acquisition authorities were in the beginning not considered capable to manage the vast project. Another factor to take into account is the kind of defence industrial consortia that feature in the different mega projects. All the projects had or have the kind of scale that resulted in several defence industries working together in consortia in order to manage the projects.

Due to the similarities and similar aims, the projects are furthermore not independent from each other. Contacts and information have been shared between the different projects with, for instance, Swedish officers traveling to the US to acquire information about their ideas and later progression of the development plans and project Future Combat Systems. French authorities have used much of the lessons from the Future Combat Systems development to avoid the same obstacles encountered by the American project several years later. All the mega projects were planned during times of austerity regarding the political security situation. There was a perceived opportunity for starting vast transformations.

Differences between the mega projects

The differences between the three projects are, however, also large. Possibly the most apparent concerns the budget and industrial resources of the US, by far the largest, followed by France and then Sweden being the smallest. There were also rather large differences concerning what the military posture was, and still is.

Different scopes of the different mega projects

The magnitude of the mega projects differs, which needs to be taken into account. Future Combat Systems as a mega project is vastly larger than the Swedish Ledsys project. The differences should be put into the context of the amount of resources available for each armed force. Compared to the resources of each armed force, the respective mega projects used or use large resources.

Different perspectives of the different mega projects

The three countries differ in perspective with respect to the prevailing military posture, historically and in the present. The US is also in possession of the second largest stockpile of nuclear weapons and the mainland is situated far from the closest potential adversary. The US is therefore using an expeditionary practice in military activity with dealing with different conflicts far from its borders.

France is also a nuclear weapon state in possession of either the fourth or possibly the third largest stockpile of nuclear weapons, with the mainland situated far from any apparent adversary since the end of the Cold War. France has a similar manner of military activities to the US and conflicts are dealt with at a rather far distance from mainland France.

Both the US and France are members of North Atlantic Treaty Organisation (NATO), which has led to position on political security, and a tradition of solving conflicts together with other NATO member states if necessary. Both France and Sweden are members of the European Union, which implies some grade of military and political security consensus. France and Sweden have taken part in several military operations together during the 1990s and 2000s.

Sweden is not in possession of any nuclear weapons and has a long tradition of an armed force aimed at managing a conflict with what was the Soviet Union. Furthermore, Sweden does not take part in any expeditionary activities on its own and the Swedish Armed Forces are not mainly aimed at large-scale expeditionary activities. However, since the end of the Cold War, it was decided that any kind of large defence force aimed at dealing with potential threats from the Soviet Union would be changed. Instead, the Swedish Armed Forces were to become more like the expeditionary armed

forces with the capability to resolve conflicts far from its borders. An intended change was planned during the 1990s and 2000s.

Sweden has never been a member of NATO, although it has a very close relationship with the organisation.

An important concern when trying to deal with the similarities and differences between the different mega projects is that the driving force of something new is on the horizon, technology that would revolutionise warfare further on. Anyone who does not follow and transform accordingly would risk to not being able to cooperate with allied countries and becoming inferior to some future war opponent. This fact of new technology being about to enter into military affairs has affected all nations in the study and all development projects aimed at completely new technologies, transforming organisations and the behaviour of organisations and their staff.

The choice of three projects

The first of the three cases and the reference case is Future Combat Systems that was aimed at transforming almost the entire US Army with respect to the equipment inventory and organisation. The Future Combat Systems project was the first to start and the ideas concerning the new kind of war fighting System of Systems was established in the United States with the US Army as the main subject to be renewed. The Future Combat Systems project is by far the largest mega project compared to the other two projects concerning scope, aim, pace, complexity and resources to carry the project through and implement the development. The amount of different subsystems in the associated future planned System of Systems land force was also the largest of the different mega projects.

The Swedish Ledsys project as a part of the Network-Based Defence development was the smallest in terms of economy, but put in a context of relative resources to the associated armed force, the Network-Based Defence project had a scope encompassing the entire Swedish Armed Forces. The aim did not only include the Swedish Army but aimed at including also all other services of the Swedish Armed Forces, the air force and the navy. By aiming at a complete integration of the different services and not focusing on one service, the relative scope of the Network-Based Defence project would have been large. The Ledsys project occurred at about the same time as Future Combat Systems but was very small in comparison. The Ledsys project has been chosen due to

coinciding in time with Future Combat Systems and the relatively large communication technology industry in Sweden. The fact that Sweden had a very different kind of defence approach compared to the US can also help to find reasons why failure or success occurred. The similarities in technology base as well as differences in scope, and to some extent aims, can increase the factors for failure and success of the respective developments.

The Scorpion project aimed at the French Army has been chosen due to the aim of creating a new type of fighting force for the French Army. The aim is then similar to the other two projects, but the difference is that it is smaller than the Future Combat Systems project but larger than the Network-Based Defence project. The Scorpion project was also chosen due to the difference in time compared to the other two projects going on during the late 1990s and 2000s. The Scorpion project builds on the same principles of Network-Centric Warfare, but the later implementation has made it possible for the project management to avoid risks and uncertainties that the earlier project encountered.

The events of the different cases

Future Combat Systems and the Ledsys project had ended when the examination of the cases started. The Future Combat Systems project and the Ledsys project were done in an ex-post perspective with much information at hand, and some reports about the results have been written and used as a part of the narrative constructions. The Scorpion project had started when the examination began, but at the time of writing the project still has many years before it reaches the scheduled ending. This means that the perspective on the Scorpion project is not purely an ex-post perspective but also an ex-ante perspective. Lessons from other similar projects have been drawn, but while the earlier projects could be summarised with all their respective progress and failures including by the project actors after everything was finished, this is not the situation with the Scorpion project. Planning and implementation of the Scorpion project has been ongoing during the examination. An example of this difference can be illustrated by, for instance, the interview situation for the Ledsys project and the Scorpion project. Regarding the Ledsys project, the interviewed actors knew the results of the project and could view the activities and events retrospectively. Since Future Combat Systems and the Ledsys project had been stopped before the study started, those cases have been studied ex-post with final project conclusions drawn. The Scorpion project is not finished and has subsequently been studied both ex-post but also to some extent ex-ante with, for instance, the interviews concerning intentions and future project aims.

Structured narratives

The mega projects involve vast technology development but also the interaction between individuals and organisations in a changing context of development of unknown technological Systems of Systems. The manner in which the research has been done in order to explain the complex dynamics of the development activities has been by structured narratives which allow for understanding the interactions. The structured narrative involves for instance organisational interactions between people, norms, and values, changing sensemaking, before, along and after the mega projects (Riley & Hawe, 2005, p. 229). The narrative is created by each project chronology, followed by a sequential analysis of each project. Three different narratives have then been constructed with the gathered material.

A narrative consists of a chronological presentation to establish an understanding of events before and during the process of the project (Creswell et al, 2007, p. 244). In the study, three different chronologies have been created based on the three different projects. The character of the included events of each chronology encompasses rather clear points in time and decisiveness but also paradigms including sometimes indistinct events and different degrees of insight and resistance. The function of the narratives has been to collect and order events in a structured manner and to search for all kinds of acts within and outside the different projects which would affect the events. No specific view has been practiced that would have excluded any specific event or define any specific event as irrelevant. Therefore, distinct and clear acts and developments over time have also been considered as important (Piore, 2006, p. 19). Based on the different chronologies, three different sequential analyses have been created.

A sequential analysis is the chain of events during but also before the project, because no project starts out of thin air. There were pre-histories to each of the project beginnings. A sequential analysis therefore consists of a pre-history to the project, which is called an Analepsis. The sequential analysis then continues with a starting point of a project followed by the first sequence of the project (Dumez, 2016). The first sequence 1 and the following sequences to n, are interrupted by turning points 1 to m, which finally are followed by the last point in a project, thus marking the end of the project according to the principal illustration of a project in figure 6.

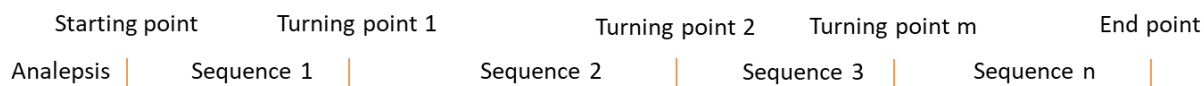


Figure 6: Principal illustration of one sequential analysis for one project.

A sequential analysis has been done for each project and three different sequential analyses have later been done with one sequence analysis for each mega project, illustrated in figure 7 as three different and generic illustrations of three projects.

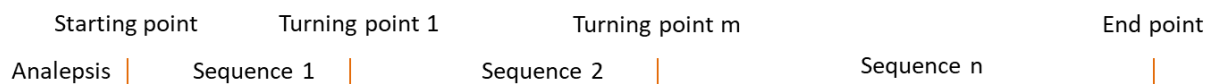
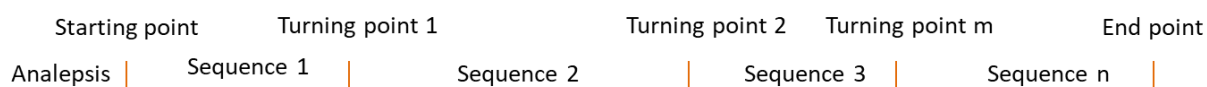


Figure 7: Principal illustration of three different sequential analyses for three projects.

The different sequential analyses will later be used to compare the different sequences in the different projects with analepsis, sequences, turning points, end points and epilogues.

Arranging dynamics and understanding of the narrative

Comprehensive information of actors' actions and interactions is arranged in chronological patterns in order to make the information understandable. It is also intended to make a distinction between the information accessible for the actors when events occurred and the information available when the narrative chronology was created. The creation of the narrative timeline has mainly been done as ex-post due to the fact that two out of three projects are finished and one is not yet finished. The narrative chronology and the project milestones can perhaps be misunderstood as plausible to coincide, but it is not necessarily the case, although project milestones generally do constitute clear

shifts in the chain of project events. General development evolution can still be emerging despite project milestones.

According to Dumez (2016) there can furthermore exist five different kinds of situations and phenomenon between the researchers' view and the actors' view concerning the narrative study. There is the actors' knowledge, view, discourse and practice on one side and the researchers' perspective and understanding of the actors knowledge, view, discourse and practice on the other. The different kinds of phenomena are the understanding of intentional change, delayed understanding, epiphany, inflection, fallacy of change and crystallisation.

Intentional change

Of the different kinds of change, intentional change is about declared and then completed change according to what was intended in the beginning. In order to discover whether change is occurring, of discourse and practice or not, the difference between what is intended and what really happens, including unexpected changes, is important to find. The difference between intentions and resources can be made, but also difference between development and intentions can develop and adapt accordingly. Another example of difference which possibly could be successful to measure is between the creation of knowledge at the time of the activity and ex-post when the examination is made.

Delayed understanding

Change can also occur by delayed understanding in a cognitive meaning. This is an event, a time delay between actors' practice and their understanding of the practices directed towards new experiments. Discovery of such a time delay can be made by noting the difference between observation of actors' actions and what actors are saying. It can also be done ex-post with actors explaining when they understood that a change of their behaviour and thus practice had occurred.

Epiphany

Abrupt change, or epiphany, can also affect both practice and discourse of thinking and can be a major, minor or cumulative type epiphany. A major epiphany would be an abrupt shock which creates a sharp adjustment of thinking and acting. A cumulative epiphany can be a series of smaller events experienced by actors, which eventually leads to changes in thinking and acting. A minor epiphany is a small change which can lead to major reform of thinking and acting if the small change

is interpreted correctly. A major change can be, for instance, a turning point in a chain of events which can be preceded by either a major epiphany, a cumulative epiphany or by possibly a critical meaning to a small fact.

Inflection point

Varieties of different small developments are constantly occurring among individuals, organisations, institutions and governments. Such small development signals are mainly of little importance and do not significantly affect organisations, and thus do not become reason for change. However, some small signals can mark the beginning of a significant change. An inflection point is such an event. This also means that an inflection point is impossible or very difficult to understand as an inflection point, the start of some major change, by the actors themselves during the chain of events. An inflection point is normally identified ex-post with explanations of, for example, misdiagnosis and/or cognitive bias for overlooked signals in the chain of events.

The fallacy of change

The inverse situation of an inflection point is the fallacy of change, and is when actors in real time understand a development as a major change, when instead a researcher understands the development either in real time or ex-post as having little or no significance with no real change occurring. It can concern, for instance, an involved actor's perceived understanding of an event as being abrupt, but the event would rather be a long-term continuous development.

Crystallisation

Change, viewed in a historical perspective, is not always characterised by causal reasoning. Events are not always explained by causes, but instead by a process of crystallisation of several independent events, which combined in unexpected ways can cause sudden shifts in the dynamics (Disch, 1993, s. 683). Dumez (2016) writes that events are obviously connected to the past and always have links to what has happened before. However, some events derive their meaning from what will come in the future and thus can be disruptions. In a sense, it is about the ability to draw conclusions from history, which is possible on some occasions but not others. When it is not possible or at least difficult, it could be that the events have their meaning derived from what will happen or is expected in the future.

Systematic and structured comparisons can be made between narrative and theory, but the narrative can also become a tool for discussing theories with a structured comparison. It is furthermore important to have balance between restraint regarding details and to avoid unnecessary descriptions on one side, and the necessity to describe important ingoing factors for the actors' behaviour on the other. If the details are too vivid and deeply described, there could be too little place for describing theories; with too little description, there would be too little explanation and the result would risk being too vague. The balance needs to be kept and one has to do both, with not too much detail and description, but neither too little description which would result in vagueness.

Counterfactual reasoning

The narrative as a unit of analysis deals with change and the dynamics between actors, in this case different mega projects. It is partly different from how a description would be constituted of the same mega projects, which deals more with static or semi-static conditions. When searching for dynamics, events and changes, the narrative does not have only one potential, possible and real development. Therefore, counterfactual reasoning is frequently used in the discussion to highlight potential other paths of development. It is about describing other possible paths of development which could have occurred if what did occur had not happened (Dumez, 2016, pp. 130-131).

Cultural driven change

Ideas influence hope and thought and create shared meanings among actors. These shared meanings can lead to the emergence of change cultures that aim for action especially during times of profound social transformation and while less so during periods of less intense social transformation. When times are unsettled and social transformation occurs, actors can tend to gather and follow change cultures similar to ideology. When times are settled and no social transformation occurs, cultural action is more independent from ideology. Throughout the mega project narratives, cultures are competing for power and how and if change should occur (Swidler, 1986). Actors gather and create change cultures that isolate themselves from actors who resist change.

The dynamic appearance in the project cases

Of the different phenomena intentional change, delayed understanding, epiphany, inflection, fallacy of change, crystallisation and cultural driven change, several have appeared in some of the different cases. Intentional change can be observed at least as intended change which later has been planned,

started and continued but not unambiguously ended. Of the projects studied, the Scorpion project would possibly be the easiest to view as involving intended change which is planned, started and continued. The absence of any clear ending to the project, and thus, for instance, a final report, does make it difficult to know if the intended change really would be a success. Still, no obvious discrepancy between intended and real change is clear, though one can still suspect later a difference between what was planned and what later happened. The two other mega projects do display discrepancies about what was intended and what really happened. Future Combat Systems showed differences between intended change or intended aim of the mega project and what later was concluded to be possible to achieve. Unrealistic possibilities of what could be done with the mechanical technology are one apparent factor that was shown to be impossible to overcome. The development regarding the military interventions of the US also altered the kind of technologies and then overall systems which Future Combat Systems was aimed at. The real development took a different path than what had been planned and intended in the beginning. Regarding the Network-Based Defence project, the Ledsys mega project, a similar development can be seen with intended development disrupted not necessarily by technology or the indirect impact of conflict involvement, but by differing opinions of politicians and military leadership about the project taking too long to show results. This can be seen as difference between intended change and real events with similar results to Future Combat Systems of growing budget concerns, though the root of the development is different.

The phenomenon of epiphany can be observed in the entire mega project if the perspective is on the pre-history, or analepsis, of the project case. The reasons for the development projects starting were cumulative epiphanies in the three cases - the two more or less parallel developments of final austerity in military affairs during the 1990s and growing speed of development of computerised communication technologies. If instead the projects are viewed during the project developments, minor epiphanies can be seen with growing insights about the mega projects not developing according to intended aims. For the Scorpion project, it is more difficult to identify any epiphany because of the project not yet being finished. The epiphanies in the other two mega projects would be cumulative signals that eventually forced the development projects to change into development for Future Combat Systems and also later to be stopped. The cumulative signals for the Ledsys project may have been about an absence of apparent success of the overall project and later a decreased budget.

There is here an obvious similarity or connection between the two kinds of change, intentional change and epiphany, and it can perhaps be easy to mix them together. However, the phenomenon intentional change would be the difference between what was intended in the beginning of the development. The phenomenon epiphany is the small cumulative signals which change events and force actors to re-evaluate thinking about a particular mega project and its evolution, possibilities and limitation.

Inflection points exist in the finished mega projects. These are decisions that disabled project development. The Scorpion project is not finished and inflection points are difficult to identify; they may exist but would be difficult to find before the project can be seen from an ex-post perspective. Some inflection points may be managed by waiting with the development for several years after the other projects and perhaps avoiding others' mistakes. Avoiding mistakes, and thus inflection points, demands however that the Scorpion management have learnt what others failed to see. It seems that the other mega projects do have inflection points in the meaning of a small signals which are difficult, or even impossible, to discover by the involved actors and explained ex-post as having been misdiagnosis or results of cognitive bias. The conclusions of how the mega project was to be conducted and implemented would be based upon wrong assumptions during the planning of the projects. Inflection points became built into the Future Combat Systems and the Ledsys mega projects from the beginning. Three possible decisions may be reason for the same number of inflection points in the Future Combat Systems mega project and possibly two inflection points regarding the Ledsys mega project. For Future Combat Systems, the conclusions and decisions can be sorted in a sequential manner. The belief in creating capability to defeat all enemies with new conceptual technology and organisational systems almost certainly requires the belief in a passive military opponent. However, the opponent concerned in the planning in the early 1990s was the scope of the Soviet Armed Forces, which was not passive, but could definitely both act and react. Later on, much of the motive for the technology development was the emerging communication developments of the 1990s which were claimed to be followed since they could not be led by the military development. Still, the mega projects were managed so that technology development to some extent still led. The last inflection point is the ambitions for the dimensions of development according to the requirements, making discoveries of new material and new technologies absolutely necessary to succeed with. A failure in discoveries and development of new technologies would most probably result in some kind of failure for the entire mega project. The described three different inflection points are connected and can be understood as hidden misdiagnoses which could easily

lead to large problems or even failure if the Future Combat Systems project went into any kind of disturbance during the time of implementation.

Similar signs can be seen in the other cases with, for instance, misinterpretations of technology and the possibility to influence the development of future technology. Such developments can probably be more clearly understood ex-post and would have been more difficult to understand during the events. The inflection points for the Ledsys project are connected in the same way as the inflection points of Future Combat Systems are linked, but also involves an exception. The kind of budget cuts were not made for the same reasons in the US and in Sweden. The Future Combat Systems project had its budget cut due to being about to fail and the resulting risk of not adding to the future combat capability. The Ledsys project budget was cut due to basic differences around whether or not an armed force is needed to be responsible for defending the country it exists in. Therefore, the signals that would have existed between the Swedish Ministry of Defence and the Swedish Armed Forces were affected by something like misinterpretations and cognitive bias.

Military technological development can be understood as a comprehensive development over time, which would probably be followed by others that would want to follow it with an interaction of measures and countermeasures. The promised change in communication technologies and their impact on war, which was predicted already in the Soviet Union, can be understood in broadly two ways. It would be seen as a very comprehensive change, affecting everything and emerging fast in a revolutionary manner; or as a part of the normal development of technologies. Like Dumez (2016, p. 129) claims, if a development is not an abrupt event but part of a continuous development, then the motive for much of the comprehensive mega project would have been based upon fallacies of change. The first two mega projects were motivated by ideas about technology that was about to create a sudden shift and have a vast impact in military affairs, but the new emerging technology development was rather about having an additional dimension leading to an incremental step in development. To follow that development would then rather be like following something leading to a cumulative epiphany.

Viewed in real time, and without any ex-post report, recollection or analysis, the Scorpion project has possibly avoided some unexpected changes. A future ex-post view on the mega project could however show differently, with unexpected changes within the project timeline.

Credibility of the case study

The different kinds of data sources for the case study and comparison between them consisting of reports, news articles and interviews furthermore motivates the chosen case study methodology for the research.

Material

The material consists largely of reports of different kinds and, with respect to the Ledsys and Scorpion projects, of interviews to complement the studies. Findings have been searched for in the entire material, but findings have been made in all of the possible combinations of the material: in the reports only, in the reports and interviews, and in the interviews only.

Literature study

The ideal manner to study the three cases has been described, but the literature has also been studied parallel to the study of the different cases. In parallel with studying the different case projects, the literature study was started with industrial marketing, which was motivated by the sense of marketing for selling very large-scale systems to government end users. The next part of the literature was the idea of System of Systems, due to the emergence of the notion connected to the development of new kinds of communication technology combined with vast modernisation projects like Future Combat Systems and also commonly in the development of air traffic systems. The third part of the literature to be studied was technology management, which was motivated by the need to understand how management of technology in firms has developed and can be dealt with. The fourth part of the literature review was project management, due to the vast mega projects apparently needing a review regarding projects and their management.

The different parts of the literature review have been supplemented with additional parts due to how the study on the three cases has gone forward. The literature was expanded due to findings along with the studies on the cases. An area of collective action was studied in order to deal with the area of actors that acts in different interests. From this area, another area of the spreading of ideas was studied because of the apparent impact of ideas on the development of new technologies and organisations. The spreading of ideas is to some extent present in all parts of the literature because of its influence on industrial marketing. The answer to the questions posed by the development plans

is Systems Engineering and System of Systems. The ideas also logically led to transformation efforts because of the perceived need for such actions in order to reach the new kinds of technology and organisation.

Systems Engineering was needed to review how technology projects were managed due to the concern that System of Systems was claimed to be the discipline from which the studied mega projects were developed. However, in reality, Systems Engineering is probably the most relevant for how the projects are being implemented in practice. The areas of technology management and project management were bundled and composed into a literature section and a new area of literature, change and transformation of organisations, was studied with collective action. The logic of that section is the scope of the mega projects and the view and intended aim with System of Systems to implement vast transformations of organisations.

Taken together, ideas were found, spread and marketed by promising new systems with integrated technologies, which were to be acquired and implemented by technology and organisation transformations executed by mega projects affecting entire armed forces.

Empirical material

The empirical material consists of official authority reports, news articles from daily and professional newspapers, internet blogs and interviews for complement the material from reports, news articles and blogs.

Reports

Reports have been used in the gathering of information on the different mega projects and have been used to the greatest extent regarding the reference mega project, the Future Combat Systems. An important source of information has been the United States Government Accountability Office, who started to review Future Combat Systems at an early stage of the project. The corresponding accounting authorities have been used as sources regarding the other projects (Francis, 2003).

The reports for the study of the Swedish Network-Based Defence development and Ledsys project have come from both the reviewing authorities, the Swedish Agency for Public Management and the

Swedish National Audit Office. Both authorities started the reviewing in the beginning of the beginning of the Ledsys project (Grufberg & Andrén, 2004; Dager, 2007). Other reports that have been used to review the Ledsys project development are from the Swedish Defence Materiel Administration, which wrote a report about the development after the project had been stopped (Arnoldsson, 2010).

The French Scorpion project has been studied in a slightly different manner. Due to the project still being ongoing, there are no final concluding reports. The Scorpion project is still be somewhere in the first part of the process. Reports have still been used to study the project, but the concluding remarks from the reviewing authorities are still unclear due to the project not having been finished. The project is meant to be reviewed by, for instance, the Ministerial Committee of Investments and able to be reviewed at all project stages (Senat, 2016).

News articles

An important source of information about the projects has been news articles from both daily and professional newspapers. The Future Combat Systems case is however mainly covered in a professional newspaper. For the two other cases, the Ledsys project and the Scorpion project, a combination of newspaper articles and professional newspapers has been studied for information about the respective project developments. The daily newspapers have written about the projects from a public resources point of view and discussed how public resources have been used, following the projects with mainly public interest motives. In a sense, the French Scorpion case resembles the early part of the Swedish Ledsys case in that much of the material consists of information from newspapers.

The professional newspapers have focused on the defence and defence industry perspective and have investigated the respective mega projects. In order to create as wide a range of information as possible, both defence newspapers and technology newspapers have been used.

The different cases differ concerning the newspaper focus of the different mega projects. Relevant and useful articles about the Future Combat Systems and Scorpion projects are mainly found in professional newspapers of defence industrial type. The Ledsys project is reported on by mainly one specific technology newspaper.

Blogs

One source for empirical information concerning the Swedish Network-Based Defence development and the Ledsys project has been blogs on the internet. Information about the events and dynamics in the Network-Based Defence development included the fact that individuals and groups of individuals were not able to speak openly about perceived problems in the Network-Based Defence development and the Ledsys project. Individuals have discussed the matter using blogs in order to remain anonymous.

Interviews

The interviews have been done to support the information about the Network-Based Defence and Scorpion projects. The interviews were intended to cover as many of the different actors in the projects as possible on both the end user side and the industry side. Findings from other sources have been confirmed by the interviews, but the interviews have also been used to search for possible major findings. In the case of complementary questions during the interviews, these have been asked after the main open-ended interview in order to avoid the possibility of redirecting focus (Yin, 2014, p. 111).

As already discussed, a narrative inquiry connects actions and changes in direction of actions. Interaction and creation of meaning is done between individuals through language and with the evolvement of language. In such environments, an interviewer can also become a part of the interpretation of the narrative if, for instance, unstructured or semi-structured interviews are used (Piore, 2006, p. 21).

The interviews have been conducted as open-ended and if necessary, questions have been asked to complete the interviews. All interviews were however prepared with questions from a protocol in advance in order to create focus for the interviews. The answers given in the interviews have then been transcribed and translated. After the transcription the interview results have been interpreted according to what has been written down in the transcription notes (Piore, 2006).

Notes have been taken during the gathering of information from the documents and the interviews. To manage the information gathering from the documents, notes have been taken during reading and written into a computer document. Information from the interviews has been collected in two ways, either with both a voice recorder and note-taking or without a voice recorder and with note-taking. The notes have in both cases been written into a computer document.

To include as much as possible about the story of each mega project, the interviews normally had a duration of around two hours each. Some had a duration of three and even up to six hours, and in a sense can be compared with the scope of the mega projects, resulting in “mega interviews”.

With the Swedish Ledsys and the French Scorpion projects, the number of interview occasions has been different, with six occasions for the Swedish case and three for the French case. The number of interviewees has been approximately the same, with seven interviewees for the Swedish case and approximately seven for the French case. The reason for the approximation is that during one of the interviews regarding the French case, persons came and went during the session. The duration of that interview was almost four hours.

The material has then been searched through several times in order to make findings where any obvious, potential and unclear events and dynamics eventually have been noted from the material.

Regarding order of work, only part of the literature had been read before the interviews began. The focus of the literature study before most of the interviews were done had been on industrial marketing, technology management and Systems. At around the same time as the interviews and after the interviews, literature regarding the spreading of ideas, collective action and organisation change were studied. That literature showed a closer relation to the dynamics of the interior work shown by the interviews.

Data processing

Information and findings from reports, articles and papers for the empirical material concerning the different mega projects have been compiled ongoing with the reading. The compiled information about the projects has gradually grown and the narrative timeline has been created. The study has led to findings from the documents but also from the interviews with the interviews as mainly an additional source for findings.

The interviews were conducted with different actors with different perspectives and views on how activities had been implemented. Therefore, the interviews have been analysed in order to find the similarities and links between the different views of the different actors, the perspectives of the different interviewed actors, and their ability to tell as much they could.

My perspective

Before and during the work with information gathering and interviewing, my own perspective needs to be mentioned. I knew no details of the different projects before beginning the study. My profession has however given me possibilities to find the right information and possibly also to ask the right kinds of questions in interviews in order to receive answers that perhaps other interviewers would not be able to get. Regarding the interpretation, there is also the possibility that I have interpreted certain information in a certain manner, which perhaps would not have been done in the same way by someone else. Another concern, which has already been mentioned, is the possibility of becoming a part of the interpretation of the narratives during, for instance, interviews. As Piore (2006, p. 21) mentions, interviews can be a source of common language, especially when both sides in the interview have a similar background. A possible example could perhaps be that findings from interviews or report searches are taken for granted, and not interrogated.

Working method

The thesis was started with the simultaneous collecting of literature and information and the writing of two different texts about industrial marketing and the Future Combat Systems project. The literature text about industrial marketing was later complemented with texts about technology management, Systems Engineering and Systems of Systems and project management. The Swedish equivalent to the Future Combat Systems was studied in the same manner with the added increment of interviews on the development of the Network-Based Defence activities. The last project to be studied was the Scorpion project, but this was still done mostly in parallel to the study about the Network-Based Defence development. Figure 8 shows the basic way in which the study was implemented. However, what can be difficult to see is how the data collection and simultaneous writing of the literature sections and the cases have interacted with each other when new literature and more information about the different projects have been studied. During the literature and case studies, new dimensions have grown out from the literature but also from necessity from the project cases.

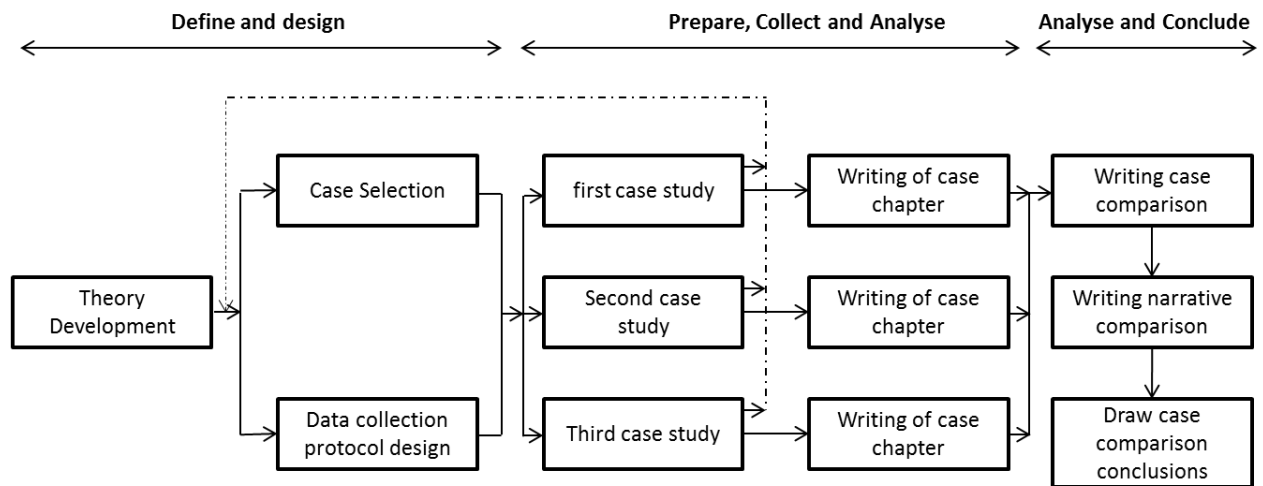


Figure 8: The basic ideal manner in which the study should proceed according to Yin (2014, p. 60).

In the beginning of the literature studies, there was industrial marketing, System of Systems, technology management and project management. As the study progressed, Systems Engineering and change and transformation of organisations also became necessary to add. As a pervasive part of the literature, the spreading of ideas is important and was added because of the large impact that ideas can have on very thorough changes, such as the transformation of entire armed forces by mega projects. The different projects have then been studied in parallel but mainly in the order of the reference case first, followed by the Swedish Ledsys project and lastly the French Scorpion project. The study of the literature and the material has however been written continuously during the work. The writing and conclusions about the material has been an ongoing process. It resembles the study by Bryman & Burgess (2002, p. 218) in that the research was started rather early with the writing of the text. The material has been treated in an organised manner, but with the gradual emergence of the results from the studying of reports and interviews, the respective literature and case parts have been written. Parallel to the reports and interviews, the literature study has been completed as mentioned by Okely (2002, p. 21). The principal order in which parts have been studied is illustrated in figure 9, with the first two parts being industrial marketing and the Future Combat Systems project. The following parts have been influenced to some extent by the previous parts. Information from the material has been noted continuously from the start and throughout the work, with each of the different projects and literature areas. In connection with findings, further notes have been taken about the material but also regarding other projects and literature. This method has made the material able to be shaped and formed with respect to its perspective and information content.

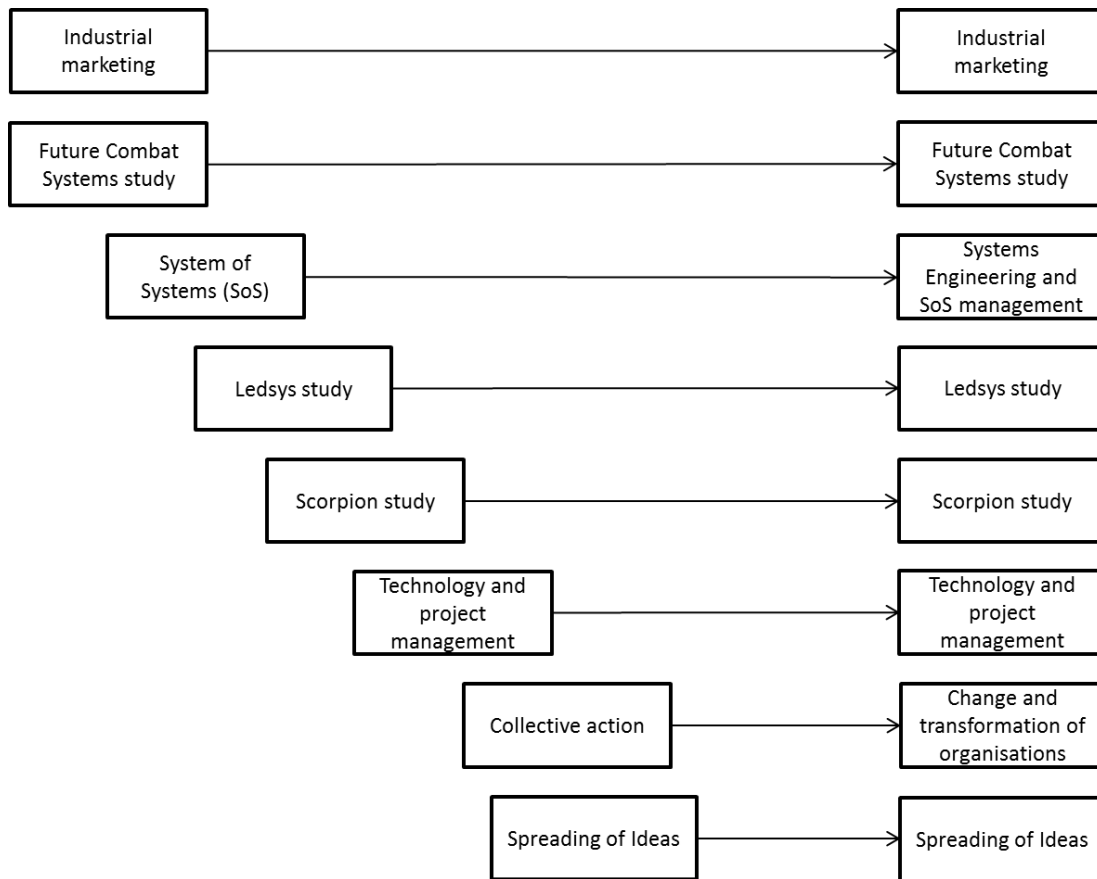


Figure 9: Flow chart overview of material gathering and the shaping of the main object of unity.

The need for an epilogue in narrative inquiries

The inquiries about the narratives show that the chain of events of the mega projects does not necessarily end with the finishing of the project. Instead, the mega projects or parts of them continue, since the aim of the mega project has been some kind of transformation which has remained unfinished to some extent. Dumez (2016) has described a narrative with an analepsis, sequences, turning points, end point. The narratives of the cases show, however, that an additional notion is needed to describe the narrative: the epilogue, which describes the dynamics after the formal ending of a mega project. An epilogue could possibly be similar to the Analepsis, which encompasses the events that lead to the project, because although the epilogue is concerned with the events after the project itself, it can contain important events and outcomes. For instance, critical parts of a mega project could have been successive if transferred to external activities. Furthermore, if an epilogue is studied, this can create better understanding of how a mega project can be claimed to be a failure or a success. The Future Combat Systems project was formally ended in 2009, but the development of the technology continued. The development of the Swedish Ledsys project was

similar in that it was stopped but continued and changed name and continued twice. The development that both mega projects were aiming at continued after the formal ending of the respective projects. In the case of the Scorpion project, though such an epilogue may take time since the ending of the project is said to be in 2032. An alternative development could be if the Scorpion project is growing into the ordinary line management of the French Armed Forces, which would also make an epilogue a possible component of a transformation, i.e. a shift from mega project to line management.

Mega projects are not ordinary projects, which can be rather easy to stop with limited consequences. Mega projects seem to be able to grow into something more than just very large projects and thus considerable parts of not yet finished mega projects tend to continue after project termination. A narrative inquiry concerning mega projects would therefore need an addition to the narrative, the epilogue, to follow the parts of mega projects, since a formal ending does not necessarily mean the complete ending of the project.

The chapter on methodology has described how the research has been organised and structured. The conceptual structure has first been explained with fundamental figures and specific figures about how the actual cases have been structured. The choice of cases has then been described with the use of a reference case and the two other cases to be compared to the reference case and between themselves. The way in which the structured narrative is used to arrange and structure the collected information and different kinds of dynamics concerning the different cases has been described. Apparent differences and similarities between the cases have then been described. After the choice of cases and the comparison between the cases, the methodology chapter continues to describe how the literature and the empirical study have been done. The different parts of the literature have been described and how the work with the literature has progressed depending on how the work with the cases has progressed. The empirical part of the case studies has then been described, with the ingoing parts of the case studies including reports, news articles and interviews. I then describe my perspective on the study and provide a description of how I worked with the literature and the material. The chapter on methodology ends my suggestion for an addition to the method of narrative case study, an epilogue.

A mega project has an apparent analepsis, a main project, and a continuation after the formal project ending, a project epilogue with unclear and diverse endings. Successful parts of the development that are possible to solve are finished or continue, and other failed parts of the development are discarded. What differentiates a mega project from an ordinary project is already clear. A question to ask can then be: what differentiates a mega project from an ordinary line of activity of an organisation whose existence depends on the taxpayer?

Chapter 4 - The emergence of the Future Combat Systems programme

Background to Future Combat Systems

The ideas leading to the origin of the Future Combat Systems project originate in the 1970s Soviet Union and continue until after 2009, when the Future Combat Systems programme terminated. After 2009, the Future Combat Systems project evolved into an unmanned part of the programme and different manned parts like the Brigade Combat Team (BCT) programme, the Ground Combat Vehicle (GCV) programme and the Early Infantry Brigade Combat Team (E-IBCT) programme. A basic ex-post illustration of the sequential dynamics with prehistory of the project, the project and the development after the project was ended is illustrated in figure 10.

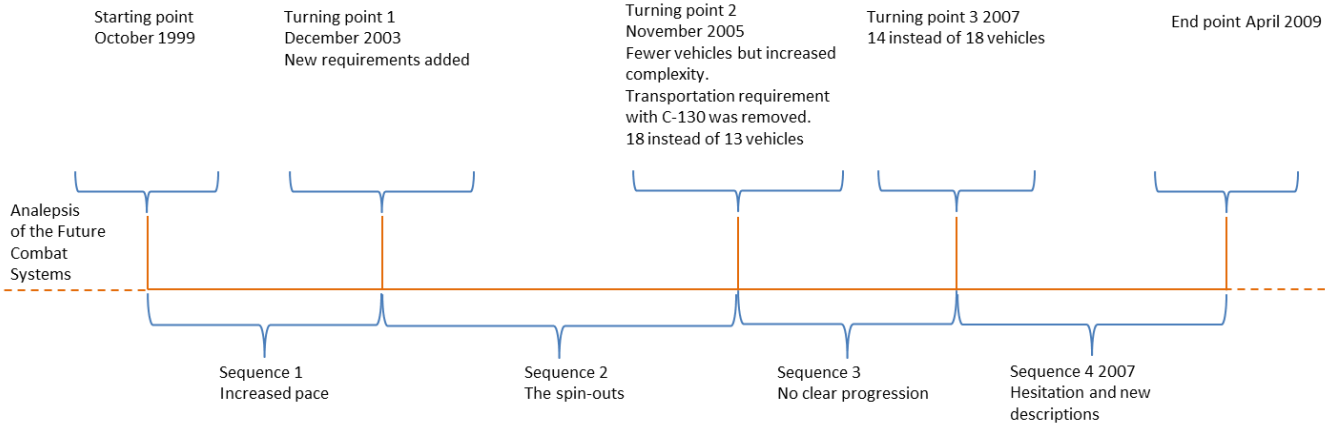


Figure 10: The sequential dynamics of the Future Combat Systems project.

The US Army initiated the Future Combat Systems project in the 1990s, aiming at acquiring completely new technology systems for the army. The idea was to change virtually all technology systems in the existing army into completely new vehicles, computers, radios and weapons in order to adapt to modern technology developments. The scope of the mega project was vast and was driven by the US Army and the industry, with The Boeing Company as the main contractor and Lead System Integrator.

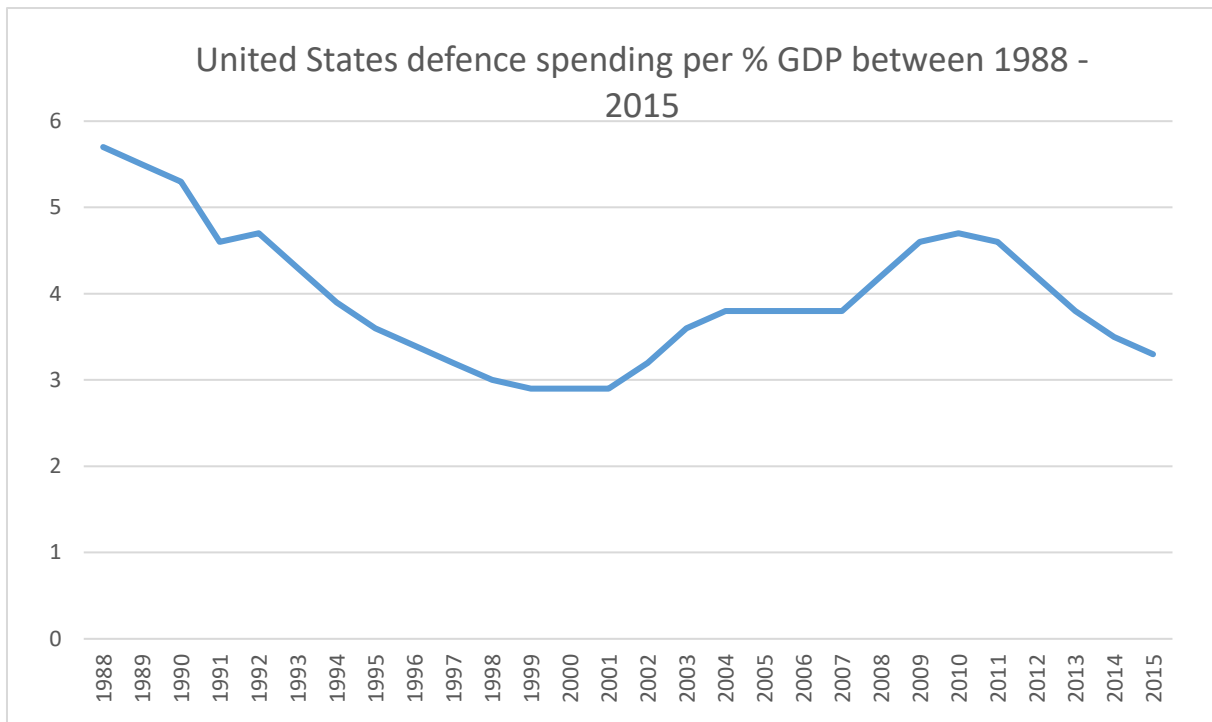


Figure 11: United States defence spending changes according to Stockholm International Peace Research Institute (2017).

The overall defence spending in the US during the period before, during and after the Future Combat Systems project is potentially important to note. A decrease is clearly visible regarding spending directly after the Cold War, whereas an increase, probably related to the conflicts, started in Afghanistan and Iraq during the 2000s as shown in figure 11.

The different actors furthering the ideas of new development and initiation of Future Combat Systems will now be shown to create an understanding of how the environment looks regarding actors.

The actors within and around the Future Combat Systems Project

The main actors in the case of Future Combat Systems are the governmental side of the acquisition and the defence industry. The responsible body for acquisition of defence equipment for the US Army is the Department of Defense that cooperates with the army. The US Army and the Department of Defense investigate what kind of future systems are needed and the final decision on acquisition is a political matter. With the Department of Defense and the US Army creating the first ideas and planning for acquisition programmes, the political layer sees the progression of

developments. The political layer also becomes the critical layer in defence acquisitions when development programmes and mega projects are not reaching the intended aims.

Normally, the US government with the Department of Defense and the US Army have ideas, concepts and needs that require answering. The industry is then contacted and contracted and development and later acquisition of technologies and technology systems is to be made.

The selling of defence equipment and defence technology in the US is done by the defence industry, which is a strong actor in selling defence equipment. The main selling actors in the case that has been studied are The Boeing Company and Science Applications International Corporation (SAIC). Those companies cooperated in order to sell and develop Future Combat Systems for the US Army. The Boeing Company and SAIC were also involved in other similar mega projects in other countries, such as the Swedish development project Ledsys.

When any development and acquisition is made, there is an important authority in the United States that has the task of auditing government acquisitions including military acquisitions. The United States Government Accountability Office reviewed the Future Combat Systems development. The GAO started its review when the project went from being a planned to a real development project with real system components and throughout the entire project life span. A second actor which had the task of reviewing the Future Combat Systems project was the Rand Corporation, although not as extensively as the United States Government Accountability Office.

The ideas leading to the project and the analepsis

The analepsis of the project and ideas regarding the ability of new technologies to change the way the US Army would fight in the future were born already in the late 1980s. Based on ideas from the industry, common technology development and the will of military decision makers, possibilities, ideas and concepts were developed regarding what could be done in military contexts with potential future technologies. New and unexpected military tasks would be solved in new ways with better use of modern technologies in complex systems or what is sometimes called System of Systems and also Network-Centric Warfare. The basic concepts behind the ideas of military tasks to be solved with modern technologies with their intrinsic potential to make military activities and organisations considerably more effective did not come from the US Army itself. The ideas can be understood to originate from the science of military management in the Soviet Union, which had two influences:

Defence Management in the US, and Soviet attention to cybernetics as a general theory of management (Holloway, 1971). Cybernetics originates from the 1940s and can be described as a comprehensive theory of control and communication, whether in a machine or in living things (Maron, 1968). During the 1970s and 1980s, the Marshals of the Soviet Union Andrei Grechko and Nikolai Ogarkov, the chief of staff of the Warsaw Pact forces, made announcements. They spoke about the ability of technology to have a large impact in military contexts and the potential for technology affecting how war could be fought, which was called the Military Technology Revolution (Grechko, 1977, pp. 156-161). Important examples of those abilities during recent decades have been communication and precision engagement, resulting in conventional weapons with deep precision strikes, improved command and control systems and information warfare (Ogarkov, 1982; 1984). Technological development was about making conventional weapons relevant also without nuclear weapons due to increased precision capability changing modes of combat (Ogarkov [Огарков], 1985, pp. 67-70). The ideas were then spread to the Western world and were dubbed Revolution in Military Affairs (RMA) which is a part of the concept of Network-Centric Warfare that later became the basic idea for Future Combat Systems. Thinking regarding Revolution in Military Affairs was later described by, for instance, Metz & Kievit (1995) and later Chapman (2003).

The first indications of ideas and plans regarding a new concept with a potential radical impact on the US Army and the way it would fight in the future started to emerge in 1988 (Ben-Horin & Schwartz, 1988). A contributing factor was later the fact that larger parts of the US Army became based throughout the Contiguous United States (CONUS-Based) and unlike before to a large extent in West Germany and in South Korea (Pernin, 2012, p. 5). Revolution in Military Affairs became generally known as a concept among the military thinkers in the US and its allies during the beginning of the 1990s. The new concepts and future transformation were evaluated in a report, "The Army 21 Interim Operational Concept", in which new concepts and doctrines for future conflicts were evaluated. The report claimed that the concept had radical new ideas including non-contiguous battlefields on land and almost did not need any tactical rear echelons as combat reserves but also an increased degree of decision initiative for officers commanding land forces. There were also questions about whether the Army 21 Interim Operational Concept was a realistic future development or not. Already at this stage, criticisms had started about the assumptions concerning potential adversaries. It was thought that the US Army would not play as important a role as would the other arms of the US armed forces. The Soviet Union was assessed to develop the Soviet Armed Forces independently and in response to US concepts, as had been the situation before (Ben-Horin & Schwartz, 1988). After the end of the Cold War during 1993, the signs of the coming project were

written about in an article in the *Washington Quarterly*. Fast changes were taking place and security issues evolved from pure military to “new kinds of security issues—the economy, the environment, human rights, and so on” (Bracken, 1993, p. 157). Instead, the issue was to design the US Armed Forces for completely new environments dealing with changes of revolutionary kind concerning military technology. In times where there were no clear enemies but potential future security issues existed, there was an urge to rethink everything from the start and examine the factors affecting military organisation and also the impact of technology on military activity and force organisations (Bracken, 1993). Within a year, an exploratory project was started to investigate the character and behaviour of the army in the coming 25 years.

A planned exploratory programme became known and started in 1993. It was to examine possible developments for the US Army in the coming 25 years. Factors affecting how the US Army would be shaped in the future were mentioned and the role of the military-technical revolution in military planning was also discussed (Bracken, 1993, pp. 155-157). The name of the study was “The Army After Next”.

The Strategic Studies Institute (SSI) of the US Army War College created around the same time an advanced course called *The Army After Next*, which included debate and reflection on the scope and depth of likely future developments (Fontaine, et al., 1998, p. viii).

The *The Army After Next* assessment programme from 1996 until 1999 and was an important pre-study done by the US Army and included advanced concepts and studies in order to understand how new technologies could be used. It was a pre-project to view how the future US Army could be equipped and organised (Fontaine, et al., 1998; Matsumura et al., 1999). Two major actions of the US Army during the 1990s became motives for the ongoing changes and transformations. The first occurred during the military intervention in Iraq from 1990 to 1991, for which the US Army took six months to prepare. The second motive was Operation Hawk against the Serbian intervention in Kosovo, when the US Army could do nothing but observe NATO air forces and had to “consider its ability to affect at long ranges and in short order” (Pernin, 2012, pp. 5-6).

The purpose was “to assist our leadership in developing a vision of future Army requirements”. The focus of the AAN project had a long time span of 25 years, allowing the ideas and vision not to be constricted by near-term budgetary and institutional influences. The approach was meant to avoid the action and reaction cycle of incremental change. Important focuses in the programme and

research were “probable geopolitical realities, evolving military art and science, human and organisational behaviour issues, and technology” (The Chief of Staff of the Army and the Commander, 1997, p. 2). Between 1996 and 1999, within the AAN project, a series of war simulations in different scenarios were done in order to verify whether a lighter force with an information network could be possible and realistic to create (Matsumura, et al., 1999). In May 2000, the Defence Advanced Research Projects Agency (DARPA) and the US Army chose four contractor teams to develop the first phase of Future Combat Systems. Two concepts were to be developed: the DARPA’s version of Future Combat Systems and the contractor team’s own version (Brook & Hilton, 2002, p. 47). The army wanted to create an “irreversible momentum” by 2003 in order to reach conditions for initial operational capability within a decade (Brook & Hilton, 2002, p. 51). Selected contractors for the two-year initial conceptual design phase were: The Boeing Company phantom works, Science Applications International Corp (SAIC), Team FoCuS Vision Consortium led by General Dynamics Land Systems Inc, Raytheon Company, Team Gladiator including TRW Inc., Lockheed Martin Inc., Lockheed Martin Vought Systems, CSC/Nichols Research, Carnegie Mellon Research Institute, Battelle Memorial Institute, and IITRI/AB Tech Group (USA International Business Publications, 2011, p. 122). According to the United States Government Accountability Office report, the Future Combat Systems project was officially started in 2003, with its project milestone B, but the plans for transforming the US Army into a strategically more mobile force were announced in October 1999 (Anderson et al, 2003).

Revolution in Military Affairs

In the Strategic Military development planning context during the 1990s, the notion of Revolution in Military Affairs and the debate surrounding it was an ongoing theme and concerned what military planners in the Soviet Union had already described during mainly the 1980s. Revolution in Military Affairs was conceived as a new way in which technology would be understood for future wars. Reports and articles have been written about Revolution in Military Affairs from a historical perspective including criticisms of military transformation through technology development (Brett, 2005). Military transformation and how to sell military transformation has also been reported on and how concepts like Revolution in Military Affairs and Network-Centric Warfare have been used in such contexts. Other thoughts and concepts described with the description of System of Systems but also Network-Centric Warfare which means armed forces being interconnected at all organisational levels using computerised communication systems networks (Dombrowski, Gholz, & Ross, 2002). The addition of computerisation of networked communication systems is probably the main point in the

Western notion of Revolution in Military Affairs and the main part of what is behind the descriptions System of Systems and Network-Centric Warfare.

Looking at the networked technology around Future Combat Systems, there are many similarities with the events of the so-called “dot.com revolution”, which occurred at around the same time at the end of the 1990s and beginning of the 2000s. Networked information technologies were supposed to replace traditional technologies in society but also in military systems. The evolution and development of network technology did not occur without problems, and networking projects and developments related to military development were stopped one after another due to insufficient funding (Thompson, 2010).

The pressure to transform was however still great and a transformation is easier to sell when a change is considered important. During 1998 through to the end of the 1990s, the US Army became pressured to transform into a force better adjusted towards new upcoming threats and challenges. At the same time, the defence industry was invited to have ideas about structure and technologies for evaluating and studying how the emerging threats could be met (Yakovac, 2007, p. 4). The Balkan wars including other conditions from the Cold War had affected the thinking behind the US Army’s Training and Doctrine development (Yakovac, 2007).

The thoughts and emerging plans on the coming Future Combat Systems led to assumptions that it was supposed to involve the replacement of almost the entire vehicle fleet of the US Army and “change the way it organises, trains, deploys, and equips its forces” (Francis, 2003, p. 2). The Future Combat Systems project was planned to include complex manned and unmanned land vehicle systems and very complex IT infrastructure for the US Army. Everything was supposed to be integrated in a project of mega dimensions with very complex technology to manage in order to succeed with the task (Francis, 2003, p. 8; Klein, 2007).

High-ranking military officials in the US wanted to buy military transformation through new technologies to reach similar results as, for example, modern communication systems in civil societies, the Internet, cellular phones and computer games consoles (Dombrowski & Gholz, 2006). However, it is debated whether buying transformation through technology development is effective or can be done in a simple manner. There is a difference between sustaining innovation and disruptive innovation and when they appear. Sustaining innovation is made by cooperation between supplier and customer, whereas disruptive innovation is very difficult to predict and disruptive

technologies often come from new firms and companies and not from already large and dominating industries (Dombrowski & Gholz, 2006, pp. 526-527). The will to create a new and better army was immense. The aim was a strong force that would be able to respond to all kinds of threats including several conflicts at the same time by using Revolution in Military Affairs with the important ingredient of new technologies as argued for in the report "Rebuilding America's Defenses". The purpose of the organisation and its report in this case was to "promote American global leadership" (Donnelly, 2000, p. 1). An article in the internet magazine Government Executive also indicates some of the connections that resulted in the projects leading to Future Combat Systems. The US Army turned to the industry (The Boeing Company) in order to create a more modern force. Competing with the US Navy and US Air Force, which already had their complex and prestigious projects and equipment, was also part of the idea to begin planning for a similar project for the US Army (Grant, 2007).

Early criticisms during planning of the Future Combat Systems project

Criticisms regarding the Future Combat Systems development project already existed before the project milestone B was reached. Example of criticisms are indications that much of the technology was not mature enough to build Future Combat Systems with, for example, sensors, networks, robotics, armour, munitions and hybrid power (Mait & Grossman, 2002). The Center for Strategic and International Studies (CSIS) has studied the Future Combat Systems project and criticised it from several point of view. The Future Combat Systems project was done by a schedule-driven approach where technology, systems development and demonstration and production would be developed concurrently. Every setback in any of the more than 50 different programmes could severely affect the rest of the project. Normally, a development project is done in a knowledge-driven way. The different development stages are completed after each other with reduced risk as a result, compared to the Future Combat Systems approach, which meant that many uncertain and interdependent technologies would be developed parallel. The CSIS has also criticised the way in which Future Combat Systems was developed with respect to the competence and ability of the industry, since the industry was doing much of the development in the project, the reason being the increasing complexity of military systems combined with lack of competence in the government to manage complex acquisition (Kaeser, 2009). Issues ranged from special kinds of management organisation like the Lead System Integrator concept, certain perspectives like System of Systems and delivery of military capability by new technologies (Laird, 2003). In order to manage technological mega projects, knowledge is of great importance, and knowledge needs to develop as integrated in the

project in order to manage the project and to succeed with it. Knowledge is needed not only for managing the task ahead, but also for grasping and managing different opportunities that might arise from the project (Lenfle, 2012b).

Regarding scope and budget, the Future Combat Systems project was a mega project aiming at changing almost the entire vehicle fleet of the US Army. What the project also aimed at was to introduce new technologies and new concepts of how to act with Future Combat Systems as a System of Systems. The development of Future Combat Systems can then be addressed as a mega technology system, a more complex System of Systems than had ever before been planned and acquired. I will now introduce some facts to show the scope of the mega project and will then describe the project in order of events. I will also give two illustrations of criticisms that were given in the beginning and after the end of the project. To conclude the chapter on Future Combat Systems, an analysis in roughly the order of the literature is made.

Future Combat Systems as a defence acquisition mega project

The Future Combat Systems project has been examined from the first indications of ideas until it was terminated in 2009 and after the formal project was finished in the form of fragments of the Future Combat Systems development. The Future Combat Systems mega project has similar features as mega projects developing information technology and development of large physical infrastructure.

The cost of the Future Combat Systems project has been calculated with respect to its development cost until it was cancelled. An ex-post perspective on the Future Combat Systems project is that in 2009, when the programme was cancelled, 18.1 billion dollars had been spent (Kaeser, 2009, p. 3; Reed, 2011). Assessment of the planned total acquisition cost by the US Army grew between 2003 and 2006 from 91.4 billion to 160.9 billion dollars, while independent estimations in 2006 pointed to a sum between 203 billion and 234 billion dollars (Kaeser, 2009, p. 2; Charette, 2009). Future Combat Systems is the most expensive, complex and biggest programme in the history of the US Army where the companies, people, number of systems and technologies to integrate, including the computer software, exceeded what the Department of Defense had done in earlier programmes (Kaeser, 2009, p. 29). An example of technological complexity that grew immensely was the growth of computer code lines during the programme, from planned 33.7 million lines in 2003 to 63.8 million in 2007. When terminating the Future Combat Systems programme in 2009, the number of code lines was around 114 million which shows the growth of complexity in the technology development (Charette, 2009). A parallel may also be drawn with communication technology at the time in terms of amount of computer code in the development, with Future Combat Systems as part of the dot.com boom, where networked information technologies were supposed to replace traditional technologies both in society and in military systems (Thompson, 2010).

Future Combat Systems project review and the starting point

The project was announced in October 1999 and reached its project milestone B in 2003, and the Systems Development and Demonstration phase was started. Many of the main project's different sub-projects were later stopped at different stages due to unfulfilled project goals and project overspending. Criticisms of technology led-military transformation from a military industrial point of view have been made concerning whether the transformation really created the military advantages that Revolution in Military Affairs or Network-Centric Warfare were claimed to do. Technology-led military transformation can easily become more industry-led and focused on the technology

development, which in turn can become more of a military industry concern than what is really needed for the armed forces buying the transformation (Peter & Ross, 2008). Assessment of what is considered necessary for military needs is mostly otherwise done where supremacy or balance of military force would be compared to other military forces of other countries or potential military adversaries. The consequences of large costs and usefulness of military forces should be compared to potential adversaries and their plausible and potential way of acting (Jaiswal, 1997, s. 1).

The Rand Corporation, in order to discuss and analyse the project and its main events, reviewed the Future Combat Systems project in five stages. The first stage of the Future Combat Systems project, Early Development, is the same as the Concept and Technology Demonstration phase. The project began by an announcement made by the Chief of Staff of the US Army, General Eric Shinseki, in October 1999. This event is also the starting point of the project according to the narrative of the Future Combat Systems project shown in figure 12. It is where the first sequence of the Future Combat Systems project starts. The US Army was planned to transform, through the project, into a more strategically responsive force and different smaller study projects were started (Pernin, 2012).

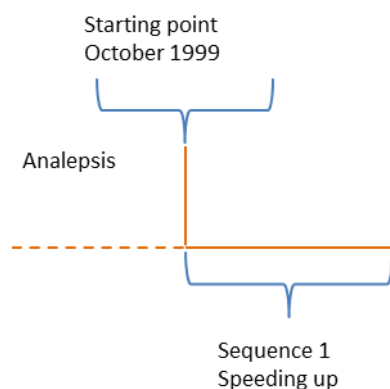


Figure 12: The project sequence 1 and the starting point of Future Combat Systems.

In February 2000, a team led by the Defense Advanced Research Projects Agency organised a competition to find contractors by May 9, 2000. The Defense Advanced Research Projects Agency and the US Army then selected four contractor teams in order to develop the Future Combat Systems design and concept, named the Concept and Technology Demonstration (CTD) phase. The so-called objective force deployability, lethality and survivability were supposed to be evaluated. Two concepts were to be created, one by DARPA's concept and one by the contractors' own concept (Brook & Hilton, 2002, p. 47).

The second part of the CTD phase was the signing of the contract between DARPA and a team made up of The Boeing Company and Science Applications International Corporation (SAIC) in March 2002. The Lead System Integrator also signed as a part of the contract (Pernin, et al., 2012).

In March 2002, Other Transaction Agreement (OTA) was awarded to The Boeing Company for the CTD phase and Boeing became the Lead System Integrator. The contract was signed including by the joint venture team consisting of Boeing and SAIC. The CTD phase had two purposes: it was a competition for choosing a lead contractor and investment into different technologies that had been developed by DARPA and the US Army. The purpose with the lead contractor was to direct the Future Combat Systems project (Pernin, 2012, p. 27).

In July 2002, the US Government Accountability Office started to review the Future Combat Systems programme, since the project was about to reach the project milestone B. Erwin (2011) concludes that during August 2002, contractors were perplexed because of the absence of a clear acquisition strategy in the US Army.

The Army After Next (AAN) project had previously pressed the US Army on transformation “for a long technical gestation period” (Pernin, 2012, p. 30). The transformation was supposed to go on for several decades until 2020 and beyond. The development was supposed to result in new technologies and new concepts for military operations. The Future Combat Systems programme had an aggressive schedule from the start and was changed several times during the project timeline. As an example, the Memorandum of Understanding between DARPA and the US Army in 2000 included a CTD phase of six years. The CTD phase of the project should lead to a decision regarding project milestone B in the fiscal year 2006, when the Systems Development and Demonstration (SDD) phase would start with the US Army as the manager of the programme instead of DARPA. However, the six-year CTD phase was later decreased and Milestone B was moved from 2006 to 2003, during the Requirements Review Council (RRC) on September 5, 2001. During the same event, activities were speeded up in order to reach the development stage of First Unit Equipped (FUE) by 2008 and Initial Operational Capability (IOC) by 2010. The later Milestone C was also changed from 2008 to 2006. According to the Rand Corporation, the former DARPA director Frank Fernandez claimed that the Future Combat Systems project had an aggressive schedule and was a high-risk effort with radical and revolutionary scope and concept, and would probably encounter technical and conceptual problems during the development process.

to continue to the SDD phase. At this point, the United States Government Accountability Office started a review of the Future Combat Systems programme (Anderson et al., 2003).

The Government Accountability Office Testimony August 13, 2003

There were three reasons for the review of the Future Combat Systems programme according to the United States Government Accountability Office. The first was to understand the context, approach and schedule of the programme; the second was to observe the positive and challenging features of the programme; and the third reason to examine different approaches to proceed with Future Combat Systems.

The United States Government Accountability Office Testimony from August 13, 2003 contains a short background to the project, features and challenges of the project and options for proceeding with the project. The United States Government Accountability Office also concluded that the US Army cost for the Future Combat Systems programme would be 22 billion dollars between the years 2004 to 2009 and several billions more in other programmes that Future Combat Systems would depend upon. Schedule changes were also to be implemented, causing a delay to the SDD phase of two years (Francis, 2003). According to a Bloomberg article, Future Combat Systems would risk costing more than 159 billion dollars if continued (Kendall, 2010).

The US Army, who was the intended end user of Future Combat Systems, had planned to change its way of organising, training, deploying and equipping its future armed forces. Eighteen networked fighting systems would be included in Future Combat Systems, and together become more deadly, survivable, deployable and sustainable than existing heavy combat systems. In order to become faster and deploy within days and not months, Future Combat Systems needed to be lighter, with armour decreased considerably on vehicles. The system was to be self-sustained and have a small logistical footprint compared to other existing combat forces of similar dimensions. Information superiority would be acquired by the network system synchronising activities coupled with non-traditional tactics to compensate for the loss of protection. Survivability would then be equal to the existing force by locating, identifying and killing adversaries at distance. All enemies must be engaged before they even detect Future Combat Systems. Advanced signature and advanced armours are examples of systems to avoid detection. A radical transformation was planned with manned and unmanned "18 direct FCS Systems" included. The main basic combat unit would be the unit of action and consist of 690 different direct Future Combat Systems. All platforms would be connected in a

joint C4ISR communication system. Situational understanding and synchronised operations never before managed would be possible with the C4ISR network. In addition to the 18 manned and unmanned platforms and the C4ISR system, 17 examples of complementary systems necessary for Future Combat Systems to work were reported. Other features regarding Future Combat Systems would be changes to the culture including delegating the decision-making authority close to combat action, doctrine, personnel and training. The Operational Requirement Document includes seven crucial parameters: joint interoperability, network battle command, network lethality, transportability, survivability, sustainability including reliability, and training. The United States Government Accountability Office writes in the report about the significant challenges to proceeding with Future Combat Systems as planned, and at the same time comments, “doing nothing would not allow the Army to meet its transformation objectives” (Francis, 2003, p. 3). Three optional ways of proceeding with Future Combat Systems with reduced risk were proposed by the United States Government Accountability Office. Two of the proposals addressed the problems with immature technologies and the third addresses better incorporation of systems into the SDD phase (Francis, 2003).

Date	2003 Acquisition Programme Baseline	2005 Acquisition Programme Baseline	2007 Selected Acquisition Report
Milestone B	May 2003	May 2003	May 2003
SoS Preliminary Design Review (PDR)	Dec 2004	Aug 2008	Apr 2009
SoS Critical Design Review (CDR)	Mar 2006	Aug 2010	Apr 2011
Milestone C	Feb 2008	Sep 2012	Apr 2013
Initial Operational Capability (IOC)	Dec 2010	Dec 2014	Aug 2015
Initial Operational Test and Evaluation (IOT & E)	Jun 2012	Apr 2016	Sep 2016
Full Operational Capability (FOC)	Dec 2012	Dec 2016	Aug 2017
Full-Rate Production (FRP)	Jun 2013	Sep 2016	Feb 2017

Table 4: Future Combat Systems Selected Acquisition Report showing three different options for schedule change from 2003 to 2007 according to Pernin et al (2012, p. 48).

Even before Milestone B, different problems had started according to United States Government Accountability Office. Some of the issues at this stage were the schedule being driven too fast and issues about technology readiness, i.e. immature technology. The “concurrency within the programme” was also considered to be a problem, meaning that many different systems and a network supposed to be developed in a shorter time frame than normal would have been the case for one single system acquired by the Department of Defense. The pressing schedule combined with the spoken intentions of the Chief of Staff of the Army, Shinseki, created huge pressure on the US Army staff and project staff members to field a first army unit by the end of the decade. The plan was to field brigades in portions over time for the US Army. Using the way of portioning out technologies to the field gave flexibility to the project, since what would be fielded depended on risks and affordability (Pernin et al, 2012, p. 32). In 2003, the formal management of the programme was

supposed to be transitioned from DARPA to the US Army and in May 2003, the project milestone B was reached and the SDD phase started. The number of army units planned to be produced was in 2003 two brigade combat teams per year.

The second project stage, the SDD stage, started on May 17, 2003 with Milestone B. At the time, the planned number of vehicles had already been reduced from 18 to 13, but the same pressed agenda was kept (Pernin et al, 2012). Starting from the spring of 2003, attention is drawn to the immense complexity of Future Combat Systems but also to the idea that, what was being developed was not needed in the ongoing conflicts (Erwin, 2011).

The first sequence was a period in the beginning of the project that included a pressed time schedule, a lack of thorough acquisition planning and minimal design work with an absence of real developed equipment. Already at this stage, technological and budget concerns started to emerge. Changes were made to the project but the results of the changes did not set in fully during the first sequence. An ex-ante illustration of the planned changes to the Future Combat Systems project is shown in Table 4.

The picture this gives for an observer is of an aggressive plan that reaches contact with some of the reality of technology development, but uses new methods of development and makes very daring assumptions to base the development on. It is clear that there was strong interest in creating the new System of Systems, but technology and budget were the first elements to become obstacles. The review by the United States Government Accountability Office was started with investigative intentions in the beginning just after the project milestone B had been passed. The review was critical, but the will of the US Army was strong at this stage. The United States Government Accountability Office can also be understood as having a double role to review and also to support claims that the US Army would not reach its transformation aims if Future Combat Systems was stopped. The United States Government Accountability Office reviewed the development and the project, but did not consider whether the very aims of the development were wrong or misguided.

The influence that started changes in Future Combat Systems were mainly of another nature. The first turning point is due to such influence.

First turning point

The first turning point, shown in figure 14, developed over some time and was announced in December 2003 by the Chief of Staff of the Army General Peter Schoomaker. The issue had been developing for a while. It did not have anything definite to do with the review by the United States Government Accountability Office, but rather with the growing perception that the Future Combat Systems project did not contribute to the ongoing conflicts in Iraq and Afghanistan. Other kinds of systems and vehicles were needed in those conflicts than what was being developed in the Future Combat Systems project. The project was at this stage no longer considered as a long-term transformation project. Instead, the decision was taken by Peter Schoomaker to adapt the aim and direction of the project to meet the needs of the ongoing conflicts in Afghanistan and Iraq at the time. The US Army started to plan to deliver technology from the project to the conflicts at short notice. The public relation strategy changed accordingly and talked about Future Combat Systems as delivering technologies to the soldiers in the ongoing conflicts. Because of the changed directives, the technologies aimed at being delivered to those conflicts had changed technical requirements. This turning point would cause considerable disturbances in the otherwise future-oriented project (Erwin, 2011).

The first turning point was a result of the growing perception that what was being developed by the Future Combat Systems project was not what was needed in the ongoing conflicts at the time. The decision to adjust Future Combat Systems can be traced back to the spring of 2003 in an ex-post manner. The Department of Defense reacted to the vast complexity, prior to the decision to adjust the mega project. However, the decision to adjust the project was motivated by the ongoing conflicts and not for complexity reasons as such. It should have been known that restructuring such a complex development would be very risky. By the time the decision was made in December 2003, the project was in a way becoming a part of the normal acquisition activity of the US Army, with the focus of the project being changed in order to develop and deliver defence equipment and technologies to ongoing conflicts. With the first turning point, a development began that turned towards fielding technology to the troops and also turning away from complex technologies as decision makers understood the needs of ongoing conflicts.

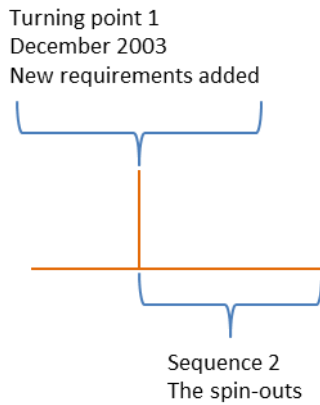


Figure 14: Turning point 1 of the Future Combat Systems project.

Sequence 2

During the second sequence from December 2003, the project work was aimed at creating technologies for ongoing conflicts. This meant a vast amount of re-planning and adjustment of the entire project, including in July 2004 the expected so-called spin-outs introduced by the Secretary of the Army and the new CSA, General Peter Schoomaker. The aim was to obtain technologies for the ongoing conflicts from the Future Combat Systems project. Technologies useful in the ongoing conflicts were to be fielded in order to add to the armed forces' capabilities. The plans for the Future Combat Systems project were adjusted down concerning the aims of the development and focused on delivering technologies for the ongoing conflicts using the spin-outs (Erwin, 2011; Pernin, 2012, p. 27). On December 17, 2004 the US Army authorised what had been planned and discussed for almost a year and a half. In an Acquisition Decision Memorandum (ADM), the US Army was allowed to articulate the adjustment according to the spin-outs taken from Future Combat Systems (Pernin, 2012, p. 37).

The second sequence was characterised by increased doubt about the budget and pure physical concerns with vehicles being too light and little protected to survive in conflicts, and by the work of restructuring the mega project towards the spin-outs from the project to the conflicts. The spin-outs however are not easy to incorporate in a project that originally aimed at future tasks to adapt technologies to urgent needs. Sequence 2 involved adapting towards new aims and restructuring. This is why the large change in the number of vehicles is a part of the sequence which is a consequence of the decision taken earlier in December 2003 to add new requirements.

Second turning point

The changes created by the added new requirements in December 2003 remained in the project until November 2, 2005 when the number of vehicles was decided to be taken back to 18 from the previous 13 and four spin-outs to deliver technologies to the ongoing wars were added. In 2006, the aim and plan for equipment supply was 1.5 brigade combat teams to be produced per year when production started (Pernin et al, 2012, pp. 1, 28-29). Several events occurred in November 2005 making that period the second turning point in the project, shown in figure 17. An Acquisition Decision Memorandum (ADM) was signed, resulting in significantly increased costs and with shifts to the schedule. The decision to restructure the Future Combat Systems project was taken on November 2, 2005 and changed the Acquisition Programme Baseline illustrated in Table 7. A new project baseline was set and because of restructuring of the programme and increased complexity, the programme cost increased from the baseline of 77.8 billion dollars in 2003 to 120.2 billion dollars in 2005. There were still 1.5 brigade sets of equipment, but instead the number of included technology items acquired in each brigade increased, which in turn added to the technological complexity of the entire brigade system. The changes to the management had significant impact on the development project (Pernin et al, 2012).

Something else to consider is that in November 2005 the US Army also changed its specification with respect to the entire Future Combat Systems being transportable in the aircraft C-130. This decision removed the futuristic demands of the technology and opened up the way for creating technology possible to field in a shorter time frame. Vehicles could then be heavier than what C-130 could lift. Due to the decision, the vehicles could instead weight 24 tons instead of around 17 tons (Erwin, 2011).

The sum of the events in November 2005 makes the second turning point illustrated in figure 15. One decision, to change the transportation requirement from 17 to 24 tons, opened up possibilities for continued development. The requirement had otherwise put a physical end to the development. The fact that it took until the end of 2005 to comprehend this indicates that strong wills wanted to continue developing and hoping that technology development would eventually succeed in inventing completely new armour for the vehicles. Other changes added to the repeated disruptions to the mega project. The number of vehicles to be included changed again to 18 instead of 13 and with increased complexity in each vehicle. This was a problem in terms of the complexity of the mega project, and as in the transportation requirement, it is the actors wanting the vehicles developed who struggled against the increasing criticisms and in a way against the laws of physics.

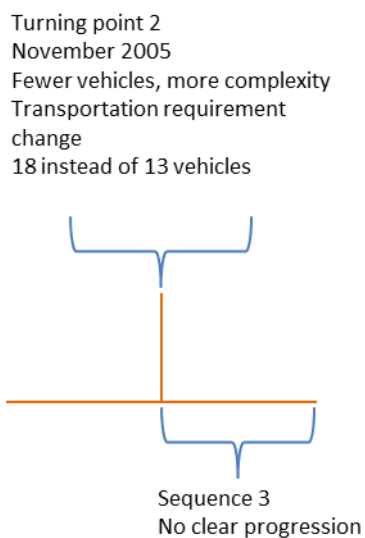


Figure 15: Turning point 2 of the Future Combat Systems project.

Sequence 3

During this period from the beginning of 2006, there is no clear progress in the project or technology except in the continued spin-outs. Instead, the US Congress now advocated for the Future Combat Systems to provide hope for an end to the different conflicts of the day. Criticisms of the project had been growing for years and distrust in the project was great in 2006 and 2007. The mega project was using a third of the US Army research and development budget, and there was decreased confidence in the possibility of shifting the development into something that could be acquired by the US Army (Erwin, 2011).

Sequence 3 is distinguished by little activity in the development and depleted levels of energy due to immense technical difficulties in combination with the two ongoing conflicts and repeated extensive changes to the development. Long-term criticisms from the political sphere could no longer be rejected.

Third turning point

The next point at which considerable changes were made in the project was the adjustment of vehicles from the planned 18 in 2006 to 14 in 2007, shown in figure 16. The different changes also forced the Future Combat Systems programme to use resources for repeated re-planning and re-evaluation of consequences of the changes. The project was also subject to budget cuts because of the changed needs due to the conflicts (Pernin et al, 2012).

Turning point 3 was caused by an additional change to the sensitive mega project that had already undergone several alterations. Except for the turning point and the change of numbers of vehicles, the decreasing budget due to the ongoing conflicts and criticisms from politicians continues. Reducing the number of planned vehicles, budget cuts and repeated re-planning took a great deal of energy from the mega project.

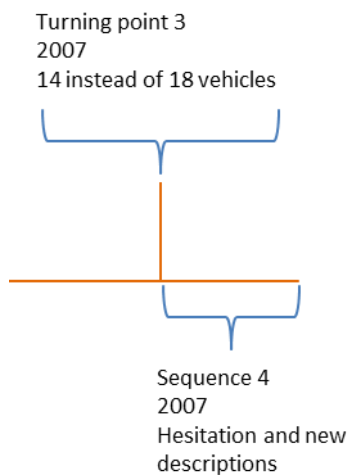


Figure 16: Turning point 3 of the Future Combat Systems project.

Sequence 4

During sequence 4, the amount of vehicles started to increase. Additionally, questions about the complex technology and possibility to fit the technology in all the vehicle systems were still casting doubt on the likelihood of reaching the aims of the project. At the Defense Acquisition Board (DAB) in May 2006, the number of vehicles was decided to be increased again to 18 and in June 2006, the spin-outs were increasing. The planned speed of the future production of a brigade combat team was, however, reduced from two per year to 1.5 per year in 2006. The second restructuring of the

Future Combat Systems programme occurred in 2007, when the programme was adjusted again down to 14 vehicles and with additional spin-outs and the aim of reducing the scope of the project. In a memo from January 11, 2007 the Army's Acquisition Executive (AAE) alleged that cuts to the project were needed mainly due to the ongoing conflicts in Iraq and Afghanistan which needed resources more urgently than the Future Combat Systems project itself. During 2007, other descriptions of land forces were introduced that were different from the brigade combat teams supposed to consist of the Future Combat Systems technologies. The new type of land force was to include brigades with Stryker vehicles, heavy brigades and infantry brigades not necessarily consisting of technologies from Future Combat Systems. The upcoming problems with pressed schedule and immature technologies were not addressed in the new administrative changes to the project. The real changes were the spin-outs, which were the fielding of different new technologies created from the Future Combat Systems project. The fielding of different technologies however also changed the aim of the project and increased the risk of losing focus in the project. One of the factors later learned from this event was that it is commonly very difficult to spin out technologies from a long-term project like Future Combat Systems. In June 2008, the spin-out efforts were further increased and refocused on the Infantry Brigade Combat Teams instead of the Heavy Brigade Combat Teams, which was due to the ongoing conflicts where infantry-like forces were used (Pernin et al, 2012, pp. 37-38).

In 2007, the Lead System Integrator had to be changed and thus renegotiated in order to manage additional tasks. Additionally, the Lead System Integrator would also be the main contractor for the first spin-outs and for low-rate production of the Future Combat Systems "core systems" (Pernin et al, 2012, p. 142). In 2007, the number of planned brigade combat teams to be produced per year was decreased to one, and the number of spin-outs was adjusted to three. The spin-outs were later changed to be aimed for Infantry Brigade Combat Teams and not as initially intended for Heavy Brigade Combat Teams. In July 2008, there was a feeling in the US Army that too many eggs had been put in the same basket. Future Combat Systems had not been able to equip the army with what it needed. The US Secretary of Defense, Robert Gates, also said the project had been too focused on the next conflict and not on the present (Erwin, 2011).

With no real progression or development in the mega project since sequence 2 in 2004, when spin-outs were introduced, the sequences since then show a project management with decisions taken that slowly lead to a final failure. The US Army and the industry wanted the System of Systems, but criticisms increased, particularly from the political sphere.

The end point of the Future Combat Systems project

The ending of the Future Combat Systems programme, shown in figure 17, followed a speech by the Secretary of Defense, Robert Gates, on April 6, 2009 (Pernin et al, 2012, p. 48). Some of the reasons given in the speech were still unanswered issues about vehicle design, the unsolved question of how to compensate for less armour with lower than traditional weight, better fuel efficiency, and better information awareness. The new vehicles constructed to encounter the threats in the ongoing conflicts at a cost of 25 billion dollars were not a part of the Future Combat Systems project and the increasing costs of the project. The speech effectively cancelled the Future Combat Systems project and the formal cancellation occurred on June 23, 2009 by the Defense Acquisition Executive (DAE). The name Future Combat Systems was also later changed in a memorandum on September 25, 2009 (Pernin et al, 2012).

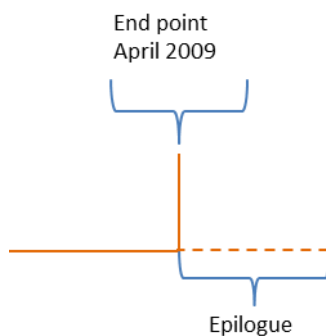


Figure 17: End point of the Future Combat Systems project.

Already in July 2009, the US Army wanted to reallocate funds in order to start the design of a new combat vehicle because no real new vehicles had resulted from Future Combat Systems and older legacy vehicles were aging. It was also considered that none of the five different programmes started during 20 years was finished. With the beginning of February 2010, a new programme was started by the US Army, named Ground Combat Vehicle. In August 2010, the requirements and the aim of the development were expressed to specifically use mature technologies and thus minimise the project and development risk (Erwin, 2011). The repeated changes and different interventions throughout the lifetime of the Future Combat Systems project created disturbances to the project. It was struggling with complexity, concurrent activities dependent on each other, and changed demands

and specifications forcing it to undergo multiple adjustments and restructuring, which led to updates and contract changes. All of the changes lead to inefficiencies that resulted in, for instance, constantly changed targets (Pernin et al, 2012, p. 152).

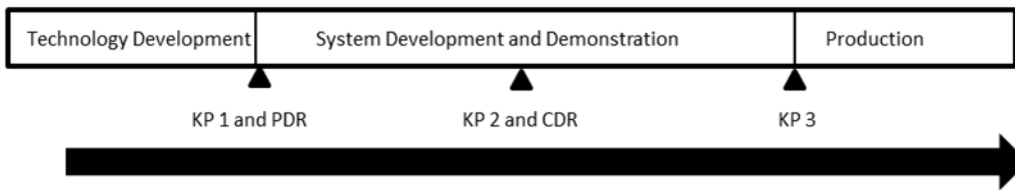
Changes due to ongoing conflicts

The recurrent changes creating turbulence within the Future Combat Systems project were caused by the ambition to acquire completely new technologies and integrate them in a new concept at the same time. The project did not manage to solve this complex task since it was, at the same time, very large, very complex, completely new and had a very short time frame that was further shortened during its life span. During the project, new requirements were developed, causing more turbulence when project management and technologies needed to adjust considerable parts of the project in retrospect. Future Combat Systems underwent changes several times after project milestone B, which all added to the complexity of the project and difficulty in understanding it. Twice, there were considerable changes made to the mega project including changed contract types and addition of so-called spin-outs, adding even more to the project complexity. Changes after Milestone B added complexity to the project, but perhaps more important was the low standard of requirements and in-depth analysis of the requirements before Milestone B given the vast scope and complexity already known. Therefore, the figures and descriptions of project decisions after May 17, 2003 consists of schedule changes and restructuring events illustrated in Table 7 (Erwin, 2011; Pernin et al, 2012, p. 27).

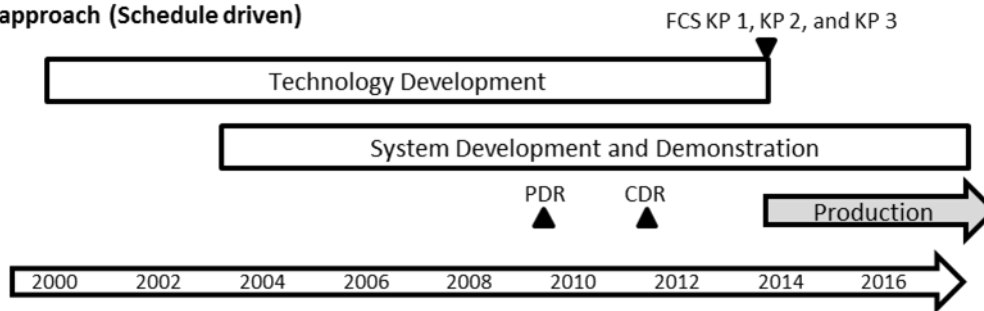
Management

The acquisition strategy of the Future Combat Systems project with its different subsystems was supposed to replace all heavy and interim combat units. The acquisition strategy is said to be evolutionary, which means that the war fighters would have an initial capability sooner and a full capability later. The Future Combat Systems acquisition strategy also mentions a number of different new approaches to make the coming project more effective, taking an incremental block approach including spiral development, Integrated Product Teams (IPT) for collaborating between the user, developer, tester and industry, Concept and Technology Development (CTD), and Lead System Integrator as a main technology integrating actor in the project.

Best practice approach (Knowledge driven)



FCS approach (Schedule driven)



- KP 1: Knowledge point 1; technologies and resource match requirement
- KP 2: Knowledge point 2; design performs as expected
- KP 3: Knowledge point 3; production can meet cost schedule and quality targets
- PDR: Preliminary design review
- CDR: Critical design review

Figure 18: The Future Combat Systems project timeline according to an ex-post view by the US Government Accountability Office and the Center for Strategic & International Studies compared to knowledge-driven project timeline issued in 2008. Source: The United States Government Accountability Office (Francis et al, 2009, p. 21) and Center for Strategic & International Studies (Kaeser, 2009).

In figure 18, the timeline shows the project situation according to the latest schedule in 2009. The Systems Development and Demonstration (SDD) phase began in 2003 and the vast project had a schedule-driven approach, whereas best practice would be to take a more knowledge-driven approach, allowing knowledge to grow in a more planned and controlled manner.

Chronology of the Future Combat Systems project

Time	Character of the development	Programme activities	Changes	Planned combat units
October 1999	Early development phase	Announcement to transform the army from heavy to lighter but agile. The Chief of Staff Gen. Eric Shinseki's speech reveals the intentions of the US Army (Erwin, 2011).	Different DARPA and US Army projects (Pernin et al, 2012).	
February 2000		Four-team competition led by DARPA (Pernin et al, 2012).		
June 2000		Vehicle manufacturers are requested by army officials to come up with Future Combat Systems vehicle designs (Erwin, 2011).		
March 2002		The Boeing Company and Science Applications International Corporation team win the bid to become Future Combat Systems Lead System Integrator (Erwin, 2011).		
May 2002		Officials in the army begin to have problems deciding what the industry is to build (Erwin, 2011).		
July 2002		The GAO starts to review the Future Combat Systems programme before the project milestone B, in May 2003 (Erwin, 2011).		
August 2002		Contractors are confused by the army's lack of clear acquisition strategy (Erwin, 2011).		

September 2002		Design of Future Combat Systems is only done on computers instead of also creating real size mock-ups (Erwin, 2011).		
January 2003		Budget and size of the technical challenges start to be concerns. At the same time, the matter of whether to make a wheel-only system or a mixed wheel and track system is still not decided (Erwin, 2011).		
May 2003	Scope reduction	Approval to start with the project milestone B and transition of the programme from DARPA to the US Army (Pernin et al, 2012). The war in Iraq starts a debate about whether Future Combat Systems is heading in the right direction. Politicians in Congress are hesitating about the Future Combat Systems and Defence Minister Donald Rumsfeld appoints an independent review of the Future Combat Systems programme (Erwin, 2011).	13+1+1 systems	2 Brigade Combat Teams (BCT) planned per year
September 2003		Increased oversight by the Pentagon. The programme receives extra funding since it is now entering Milestone B, which is described as "the most complex thing that OSD had ever seen come across its table to decide" by a senior official in the programme (Erwin, 2011).		
December 2003		Future Combat Systems is to change its goals to better fit the ongoing wars in Iraq and Afghanistan and deliver technologies as soon as possible. The marketing strategy changes according to this (Erwin, 2011).		

April 2004		Future Combat Systems is at "significant risk of not delivering required capability within budgeted resources" according to the GAO (Erwin, 2011).		
July 2004		SECARMY/CSA Shinseki announces programme extension follow-up (Pernin et al, 2012).		
October 2004		Army's top acquisition official, Lt. Gen. Joseph L Yakovac, acknowledges that much uncertainty remains as to whether the project can deliver what it promises. Reality begins to set in that the Future Combat Systems is a pipe dream. "We haven't found magic armour," said a program official. The Future Combat Systems estimated cost rises from 90 billion to 115 billion dollars (Erwin, 2011).		
December 2004		The Future Combat Systems cost estimate reaches 200 billion dollars. Meanwhile, the price tag for replacing war equipment keeps rising. The army is directed to work on a "single investment strategy" that addresses the needs of the current and future force (Erwin, 2011).		
April 2005		The weight of the Future Combat Systems threatens to overwhelm the programme. The Boeing-SAIC team submits two concepts for the main combat vehicle, but neither meets the 18-ton weight goal (Erwin, 2011).		
October 2005		The war in Iraq, where thousands of US troops are being killed by roadside bombs, diminishes the Pentagon's confidence in		

		high-tech weapons. Army leaders are questioning whether the Future Combat Systems can produce a "survivable" vehicle. Congress begins to sour on the Future Combat Systems after having stood behind it for three years. The House proposes cutting 400 million dollars from the 3.4 billion dollars Future Combat Systems budget for 2006 (Erwin, 2011).		
November 2005		The army does away with the C-130 transportability requirement and instead stipulates that three Future Combat Systems vehicles must fit in a C-17 heavy lift cargo aircraft. This allows for 24-ton vehicles in the Future Combat Systems (Erwin, 2011).		
April 2006		The complex technology and the aim to fit it into 17 families of networked vehicles is raising questions about whether it is possible (Erwin, 2011).		
May 2006	The spin-out and extension phase	Decisions at the Defense Acquisition Board on Spin-Out 1 approach (Pernin et al, 2012).	18+1+1 systems Restored all systems Added four spin-outs (Pernin et al, 2012).	1.5 Brigade Combat Teams planned per year
June 2006		Approval of the spin-out (Pernin et al, 2012).		
2007	Adjustment Down	"Negotiations" to reduce scope (Pernin et al, 2012).		
July 2007		For four years the US Congress has been criticising the Future Combat Systems budget. The reality in the ongoing wars still requiring something else than light armoured networked vehicles. Supporters of	14+1+1 systems Consolidated to three spin-outs (Pernin et al, 2012)	1 Brigade Combat Team planned per year

		the Future Combat Systems must hope that the wars are soon over (Erwin, 2011).		
November 2007		Appropriations reflect 229 million dollar cut to Future Combat Systems (Pernin et al, 2012).		
June 2008		Spin-outs to IBCTs instead of HBCTs (Pernin et al, 2012).		
July 2008		A feeling is spreading within the army, that too many eggs have been put in the same basket with the Future Combat Systems, instead of equipping the forces with more urgent needs. Defense Secretary Robert Gates says that the Future Combat Systems is suffering from a “next war-itis”. Three years earlier than planned, the army is intending to equip infantry brigades with the Future Combat Systems technologies.		
June 2009	Restructuring of the development	The Future Combat Systems is officially stopped and four major systems are cancelled (Pernin et al, 2012). Defense Secretary Robert Gates announces in April the end of the Future Combat Systems program, signed by Undersecretary of Defense for Acquisition, Ashton Carter. The memorandum also directs the army to use all technologies developed in the Future Combat Systems programme in any follow-on ground combat vehicle programme (Erwin, 2011).		

July 2009		The army wants to present a case to the Secretary of Defense to reallocate the Future Combat Systems funds in order to start designing a new combat vehicle. The vehicle is planned on the drawing board, which is the same problem that the Future Combat Systems had (Erwin, 2011).		
August 2009		The fleet of vehicles in the US Army is ageing and of the five programmes started by the US Army during 20 years, none is finished (Erwin, 2011).		
February 2010		A new programme is launched, the Ground Combat Vehicle, by the army. Competing are a SAIC-led team with Boeing and Krauss-Maffei Wegmann, a BAE-Northrop team and a team led by General Dynamics Land Systems including Lockheed Martin and Raytheon (Erwin, 2011).		
August 2010		The request for proposals is cancelled. Requirements and acquisition strategy have been changed to avoid the same mistakes seen with the Future Combat Systems. Strategy is that mature technologies have to be used to minimise risk (Erwin, 2011).		
July 2011		The plan to develop and produce a new Ground Combat Vehicle is approved by the Defense Acquisition Board with a seven-year timeline. Teams led by BAE Systems, SAIC and General Dynamics submit a second round of bids to compete in the "technology development phase." Concerns are		

		raised regarding budget cuts that could also affect the GCV programme (Erwin, 2011).		
August 2011		BAE Systems and General Dynamics win a research contract of almost 900 million dollars for the army's GCV, approved by the Defense Department acquisition executive Ashton Carter (Erwin, 2011).		

Table 5: Ex-post chronology of the Future Combat Systems development according to Erwin (2011) and Perring et al (2012, p. 27).

The design concept created the different kinds of requirements, which were very difficult to meet. The concept had rigid demands concerning weight but kept protection features by literally replacing armour with a network system. The protection features, with armour, were to be compensated for with almost perfect knowledge about the adversary using sensor and network systems combined with precision engagement. Stricter requirements on the system were the network that was necessary for combat effectiveness, lethality and survivability. High reliability, maintainability and sustainability were difficult to balance with the overall technology demands. If, for instance, the sensor fusion were not working well, the system as a whole would be unsatisfactory and could not perform its intended task according to requirements. Thirty-one such technologies existed which if not working would cause serious degradation of the entire Unit of Action.

In late 2004, the US Army was directed to work on a “single investment strategy” aiming at the then ongoing conflicts in Iraq and Afghanistan. Financial support was strained due to the new conflicts, which demanded other kind of equipment than what Future Combat Systems could offer. At the same time, the cost for the Future Combat Systems project was increasing. In October 2005, the House proposed “cutting 400 million dollars from the 3.4 billion dollars the Future Combat Systems budget for 2006” (Erwin, 2011).

The chronology of the US Army’s search for a new combat vehicle started with Future Combat Systems and continued with the Ground Combat Vehicle project illustrated in Table 5 (Erwin, 2011; Pernin, 2012). In the magazine National Defence, Sandra Erwin described the Future Combat Systems project from the initial announcement in 1999 until the outcome after the project was cancelled. The

description of the project includes the criticisms of the project before Milestone B but also how concerns were raised and became louder with the continuation of the project. The project was criticised before the start and before Milestone B, but issues and criticisms seemed to accumulate after Milestone B since the project was then supposed to be realised, and ideas and concepts met reality. There were other important events later on in the project, such as the spin-outs beginning in 2006 and the reductions to the scope of the project in 2007, mentioned by Pernin et al (2012), which all caused disturbances in the project when resources needed to be allocated to these changes.

The issues after Milestone B in 2003 were the result of the project continuing despite warnings having been given. High costs kept on increasing due to complex technology, which created obstacles for the project and unsolved transportability problems, and overall high uncertainty about whether the project could be achieved. The synthesis of the criticisms led to the cancellation of the project in 2009, which was decided by Defense Secretary Robert Gates (Erwin, 2011).

The US Government Accountability Office

The United States Government Accountability Office made similar remarks about Future Combat Systems in its testimony of June 16, 2009, as in the report from 2003. The United States Government Accountability Office was also concerned about future projects and their prospects for success, knowing that some of the criticisms had addressed issues like overambitious plans before the project beginning, which leaves not much of a chance of overcoming problems when a project of mega scope has already started. Lack of competence to manage such projects was also considered a possible issue unless the knowledge needed for a project to succeed can be created during such endeavours.

What is new in the United States Government Accountability Office report from 2009 is the possibility to transfer knowledge from the Future Combat Systems to other future projects in order to save as much from the failed project as possible (Francis et al, 2009).

During the mega project, there was a systematic spreading of understanding among involved actors about the increasing problems. It began when some of the US Army officials started to understand the difficulties of the planned Future Combat Systems in May 2002, with additional criticisms in August 2002 regarding the risk of basic technologies not being ready for Milestone B. Concerns shifted between criticisms about the readiness of the involved technologies and doubts about how to

manage different stages of the development in time. When the Future Combat Systems project later was terminated in 2009, there was a continuation in the form of the Ground Combat Vehicle development, which was similar to Future Combat Systems but with a reduced scope and without the technologies for the unmanned systems of Future Combat Systems (Erwin, 2011).

The epilogue of the Future Combat Systems project

The US Secretary of Defence, Robert Gates, took a decision regarding Future Combat Systems in April 2009. The decision resulted in an Acquisition Decision Memorandum (ADM) released on June 23, 2009, that cancelled the Future Combat Systems Brigade Combat Team (FCS BCT) programme and directed the US Army to create plans in order to divide the programme into several different acquisition programmes (U.S. DoD, 2009). The decision was made by the Department of Defence on April 6, 2009, to restructure the Future Combat Systems programme into several different projects. The measures taken according to this decision included keeping the unmanned systems of the programme, adjusting the different manned systems to lessons learned during the recent conflicts, and focusing on building a versatile Ground Combat Vehicle platform. The Manned Ground Vehicle (MGV) was also cancelled with the decision (Feickert & Lucas, 2009).

Selected technologies from Future Combat Systems were taken into the Brigade Combat Team (BCT) in order to take lessons, draw conclusions and keep technology developed during the Future Combat Systems programme. Among the different new programmes, the Ground Combat Vehicle (GCV) and Early Infantry Brigade Combat Team (E-IBCT) were important programmes and inheritors of Future Combat Systems. Those programmes were also given the technologies developed during the Future Combat Systems programme as technology spin-outs (Feickert, 2011). The US Army issued a new Request for Proposal (RFP) on November 30, 2010 with General Dynamics and BAE Systems-Northrop Grumman as the winner of the two development contracts. The former developer SAIC-Boeing lost the contract and on August 23, 2011 protested against the evaluation process, but without success, since the United States Government Accountability Office denied the protest (Feickert, 2012). The search for a ground combat vehicle continued. The estimated cost for the Ground Combat Vehicle programme was approaching the cost of Future Combat Systems. Still, in the Ground Combat Vehicle programme, there were incompatible capabilities in the same platform resulting in an increased risk for cost overrun (Erwin, 2011).

Analysis of the Future Combat Systems project

Concurrent development and immature technologies are both factors that individually can increase project risk if schedule and technology development is not proceeding as thought. The entire Future Combat Systems project was also against basic laws of physics on the transportability issue. If transportation was to be done with C-130 cargo aircraft, there could never be much armour protection on the vehicles. Additionally, every trade-off that was made within the project could affect the future war-fighting ability of the system, which was already expected to answer large demands since it was conceived to change the entire basic way of fighting wars through new technology. To revolutionise the way war is fought with technology is difficult or even impossible, as it is creating an edge impossible for all imaginable enemies to catch up with. However, the later conflicts in Afghanistan and above all Iraq proved assumptions wrong by showing the crucial importance of armour to protect a military force. That development started a series of changes to the Future Combat Systems project that already had problems with vast complexity in development. Continuous change to the mega project led to failure of the development.

Powerful ideas and concepts based on dared expectations were built into the mega project from start

The ideas for the Future Combat Systems development were taken to the US from the Soviet Union during the 1980s. The future winner of conventional wars would be the side with the best organisationally spread communication technology and the ability to combine communication systems with precision weapon systems. Future communication systems would then allow precision weapons to be used and defeat an adversary. The magnitude of effectiveness was claimed to be perhaps even competitive with nuclear weapons. During the 1990s, the idea grew in the US Army that there was a need for modernisation and to create a more effective force. The ideas of Revolution in Military Affairs also meant that it was about armed forces in general. The US Air Force and the US Navy already had their own versions of Network-Centric Warfare technologies and systems for conduct according to network-centric concepts. A transformation of the main part of the US Army was then considered necessary to create the Network-Centric Warfare armed force. Studies to prepare for a future project for transformation of the US Army were started during the second part of the 1990s. The ideas that were created and promised greatly enhanced land combat systems were furthered by powerful actors working for their interests and for the future development of new land combat forces.

New situations made new kinds of notions possible to develop

The US Army was considered to need a modernisation during the 1990s. Not only were ideas from the Soviet Union affecting the assessment of this need; it also came from certain events during the 1990s. The perception was that the 1991 war in Iraq had been managed in an ineffective manner. It had taken too much time to move the forces in the area of operations. During a second event during this period, the US Army felt it was being forced to stand by the side of the bombing campaign in former Yugoslavia in 1998. These events added to the common notion that war was seeing a shift towards communication-intensive forces, using computers to communicate and evaluate actions in a much faster manner than ever before. The notion of future communication technologies was combined with the sensed problems of the past. The solution to the problems was proposed to be the Network-Centric Warfare or System of Systems concepts. The US Army then started different kinds of studies in order to evaluate how the future combat force could be constituted and what kinds of features it would have. The different kinds of austerity events but also the perception that military actions had failed were used to further the studies and development of the new System of Systems. The linkage to the research question why mega projects fail or succeed are the unclear circumstances which resulted in relatively unclear aims, purposes and daring assumptions concerning the emergent development. Such circumstances can apparently lead to very ambitious mega projects that when they confront reality simply are not realisable and lead to complete or partial failure.

The role of the state in defence acquisition in the United States is normally strong because the nature of the business is a natural state concern for several reasons. However, during the studies before the Future Combat Systems project, a new concept of management of defence industrial mega projects emerged. It was motivated by the claimed lack of knowledge and resources in the Department of Defense and the US Army to manage and understand the new kinds of technologies that were emerging. The US Army wanted to understand and then develop the new technologies built as systems. The Boeing Company also claimed to have a history of creating Systems of Systems and one answer as to why The Boeing Company and Science Applications International Corporation eventually won the contract was the promising claimed capability to build the new kinds of System of Systems. The Boeing Company also became the Lead System Integrator (LSI) of the entire Future Combat Systems project and thus at least indirectly the leader of the entire transformation of the US Army. The Department of Defense and the US Army were assessed as lacking the resources to manage the entire project. It is difficult to conclude if there was any real need for a new kind of management, which the Lead System Integrator concept was. What the concept can possibly indicate

is that it was in fact too difficult to manage the entire development at the same time and the Future Combat Systems were doomed to fail or partly fail already before the start. The Lead System Integrator concept can also be seen as an idea created to manage an already daring idea and development. An indication of mega project failure can then be the unclear concept itself.

The chain of events before the mega project started led to failure

Before and during the Future Combat Systems project, the ideas about the technology were contained in descriptions like Revolution in Military Affairs, Network-Centric Warfare and System of System. These descriptions referred to concepts and definitions of how technology would be used in new ways for future military activities. The notion of Revolution in Military Affairs became interesting for high-ranking officers in the United States and Europe when concepts like System of Systems and Network-Centric Warfare claimed to have the ability to disperse the “fog of war”. The ideas were easy to grasp and unproblematic for inducted actors, and spread according to Czarniawska & Joerges (1998, p. 222). To know an armed force’s own and its opponent’s exact activities, capabilities and intentions in war is difficult and perhaps even impossible. This was already concluded in the beginning of the 1900s by Carl von Clausewitz, with the description of war interpreted as “Der Krieg ist das Gebiet der Ungewißheit; drei Viertheile derjenigem Dinge, worauf das handeln im Kriege gebaut wird, liegen im Nebel einer mehr oder weniger großen Ungewißheit”. War is the province of uncertainty: three-fourths of those things upon which action in war must be calculated, are hidden more or less in the clouds of great uncertainty (Clausewitz, Vom Kriege, 1853, p. 49). Especially high-ranking officers belonging to land services would have recognised the potential advantages, with relatively easy to grasp concepts, that new technology could offer. The events leading to unclear and unrealistic ideas furthered by actors is a source of mega project failure already before military mega projects have started. The next part of the chain of events is the introduction of the ideas and motivation to commence mega projects which is done with experts described by (Silverman, 2011, pp. 51-77; Brunsson, 2002). The aim is to create trust among high level decision makers according to Dombrowski & Golz (2006), where relationships mattered as a tool for selling according to Speh (2010, p. 16). The promised perceived quality according to Aaker (1991), was potentially very large.

Another purpose of selling systems as complete solution concepts rather than as several items is that systems selling gives few possibilities for government and politicians to pick and choose among single components of the system. There emerges a situation, real or imagined, that the System of Systems could be severely degraded if sub-components are taken away. The political level of decision making

could, perhaps due to budget reasons or implicit political agenda, otherwise want to choose only some parts of a system. The overall capability of a system could then be argued to have been significantly degraded if the entire system were not acquired. Systems selling as described by Mattsson (1973) is then not only a way to sell more and to create market barriers to entry; systems selling could also be used to influence political decisions regarding acquisition and to prevent politicians from cherry-picking among what to buy from a comprehensive system. This action of selling entire systems becomes a reason for increased mega project risk and thus a reason for failure.

Transformation with a mega project

The Future Combat Systems development was planned to also be a tool for transformation of almost the entire United States Army. The intention to drive a vast organisation transformation with a mega project is with little doubt an almost certain way to not succeed with the mega project and the organisation transformation. The actors furthering the development were neglecting concerns of risk due to overconfidence, or as Flyvbjerg (2017, p. 8) describes it as having an optimism bias, about the future possibilities of the Future Combat System. Two activities implicating vast uncertainty alone would combined become very risk or impossible to manage and reach.

The Boeing Company and SAIC were to manage Future Combat Systems and succeed with the mega project. However, the United States Government Accountability Office in Anderson et al (2003) and also Pavitt (1999) conclude that the development of future technologies is strongly related to uncertainty because it deals with what is to be developed in the future, which is inherently difficult to know about before it occurs. Both Boeing and SAIC must have known this fact. With such a large amount of new and different technologies that were supposed to be integrated into a system with of mega dimensions, the uncertainties and therefore also the risks involved should be very large.

The complete change of almost everything regarding land force technology and its behaviour increases the mega project scope and also increases all dimensions of the mega project risk as well as the risk for the entire transformation. Risk should have been managed twice: once for the mega project and once for the transformation. Moreover, if the Future Combat Systems mega project failed to some extent – as it eventually did – the entire transformation would be at stake.

On some occasions regarding failure of mega projects, the failure itself is sometime not seen as a complete failure. Parts of a failed mega project can be a success or a mega project can be delayed by

several years and still be regarded as being at least partly a success. Eventually, the mega project developing the Systems of Systems is finished.

To combine mega projects with vast organisation transformations would be an almost certain way of failing both the mega project and the transformation.

Obstacles during the project

There are several reasons for mega project failure that can be traced to the ideas and events before a mega project even starts but also to the events concerning selling the development with social contacts. Strong interests influences the initial process to further a start of a mega project with little notion about the conditions of actually succeeding with the development. The expectations and ideas are built into the mega project until either organisation resistance or basic laws of nature stop the development. In the case of the Future Combat Systems resistance from political environments and the fact that the relatively light transport aircraft, C-130 should be able to transport 17 ton vehicles from the United States. Other environments outside the mega project, like the two ongoing conflicts in Iraq and Afghanistan, made the development difficult to motivate and unrealistic plans became impossible obstacles for military mega projects and reasons for failure.

With the continuation of some technologies from the Future Combat Systems project failure can be nuanced as some technologies could be useful in later development. Apart from this nuance, the overwhelming part of the Future combat Systems was a failure.

Chapter 5 - The Ledsys project as a defence acquisition mega project

The development of the Network-Based Defence development in Sweden was implemented by the Ledsys mega project. I discuss the introduction of the concept in Sweden, the timeline for the project, and criticisms of the project. In the end, I discuss reasons for failure and how the fact that the idea did not survive increased international co-operation, despite the concept being taken from the US and the defence industry, which was supposed to deliver the equipment for the project, having been internationalised.

The implementation efforts of a network centric armed force was a transformation, which included the Ledsys mega project that was a part of the Network-Based Defence development. The clearest difference between the two is that the Network-Based Defence development also include activities after the Ledsys project was stopped.

The Ledsys project was divided into four different sub-projects, with the main project being LedsysT, where the focus was on technology for command and control systems. Later on, other issues were to be addressed by the other sub-projects in Ledsys, with LedsysP for Personnel, LedsysO for Organisation and LedsysM for Method. The sub projects LedsysP, LedsysO and LedsysM were started but did not continue or never started at all due to lack of funding. For managing the technology development, an entire specialised authority dealt with technology acquisition but regarding staff, organisation and method, it was up to the armed forces to manage the sub-projects according to interviewed (Nilsson & Nordenberg, 2014).

Background to the Swedish focus on Revolution in Military Affairs

In the years immediately after the Cold War, the Swedish Armed Forces High Command was evaluating how it would plan the development of equipment and the organisation of the armed forces for the future. The traditional planning and activities of the Swedish Armed Forces had during the Cold War been based upon not being a member in any military alliance during peacetime. Officially, the aim was to stay neutral in case of war between the Warsaw Pact and the North Atlantic Treaty Organisation (NATO). The organisation and equipment of the Swedish Armed Forces therefore focused on self-sufficiency. All of this changed with the end of the Cold War. The détente during the 1990s gave the Swedish Armed Forces the possibility to re-evaluate its activities and planning. High-

ranking officers from the Swedish Armed Forces went to the US in order to learn and understand how future conflicts would be fought and what kind of possibilities future technologies could give. The ideas for the change of the Swedish Armed Forces into a Network-Centric force came from the US during the 1990s, emanating from the same basic principles that were developed in the US Army. The ideas which led to the motives for change also in the Swedish Armed Forces emanated from modern societies, which had started to change from industrial-based societies to knowledge-based societies. The increasing density and flow of information was expected to affect how war and conflicts were dealt with. The armed forces were therefore to adapt to the surrounding society. Military leadership and military technology had to follow the rest of society. Mass armies were not expected to exist in the same manner as during the Cold War and trust in the power of new technology and its effects on organisations was high. The dot.com crash, where many early internet firms went bankrupt, had not taken place yet. The idea of “[e]ntrepreneurs and such analogies” were widespread and part of the package of ideas in which the idea of Network-Based Defence existed according to interviewed Swedish officials Nilsson & Nordenberg (2014). Information was thought to be shared in a faster way than before and the flow of decisions should thus become faster. During the mid-1990s, network technologies were at the very start of their development. Ideas about what it was possible to do with the new technologies were on a conceptual level. The prevailing idea in the Swedish Armed Forces during this time was that something had to be done with planning and development concerning both the war planning and the potential use of new technologies, which might change how war would be fought in the future according to Swedish official Nordenberg (2013). In 1996, the Swedish Commander-in-Chief, Ove Wiktorin, took a policy decision aimed at maintaining the armed forces organisation intact, as it was at the time. However, it was understood that something had to be changed in order to create capability for dealing with future security issues. Something completely new had to be implemented, which is also the reason why studies were ordered on how Sweden would fight future wars. Study projects were started to investigate how future conflicts could be managed. The names of the studies were “Dominant Battlespace Awareness” and “Dynamic Engagement”, and would later play an important role in the launch of the development of the Network-Based Defence, which is illustrated in figure 19. Any alternatives to this chosen direction were at that point not considered to be realistic according to Swedish official Nordenberg (2013). At the end of the 1990s and beginning of the 2000s, the largest threat was perceived to be a disintegrating Russia that wanted to retake the Baltic States. There was large political pressure for efficient situation awareness in the Baltic Sea and the Baltics. Therefore, the practical perspective was that a sensor network directed towards the Baltic Sea and the Baltic countries should be developed.

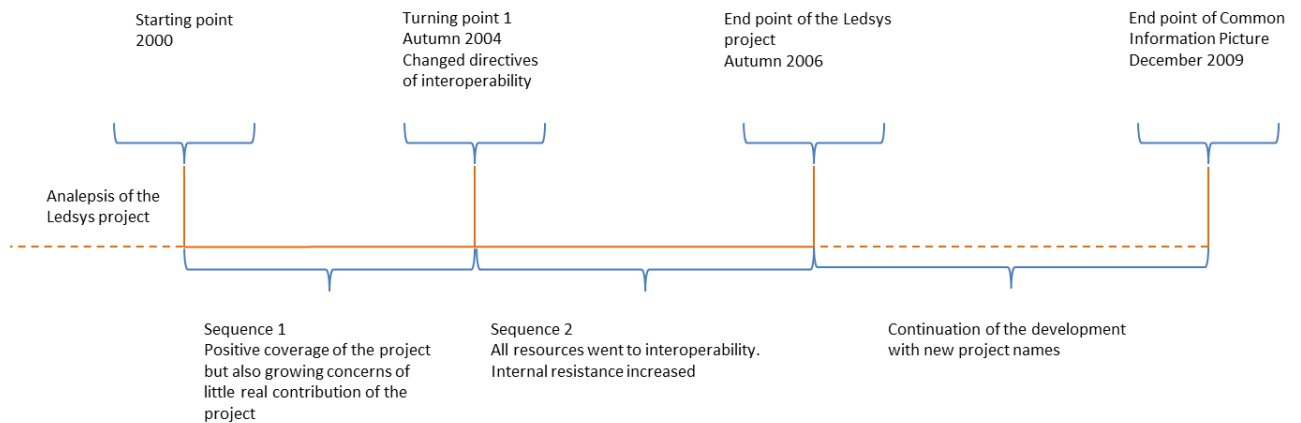


Figure 19: The sequential dynamics of the Swedish Ledsys project.

An additional motive for transformation into Network-Based Defence was economic. Around 1998 and 1999, the armed forces had their budgets reduced annually as illustrated in figure 20. The basic purpose of the armed forces was also questioned. The future was unclear, and the classical adversary was unclear. Financial inflation decreased the effect in each defence bill, which also led to so-called black holes in the defence budget, when the lack of funding became a continuous annual event concerning the armed forces budget. The Swedish Armed Forces needed to look for efficiency improvements.

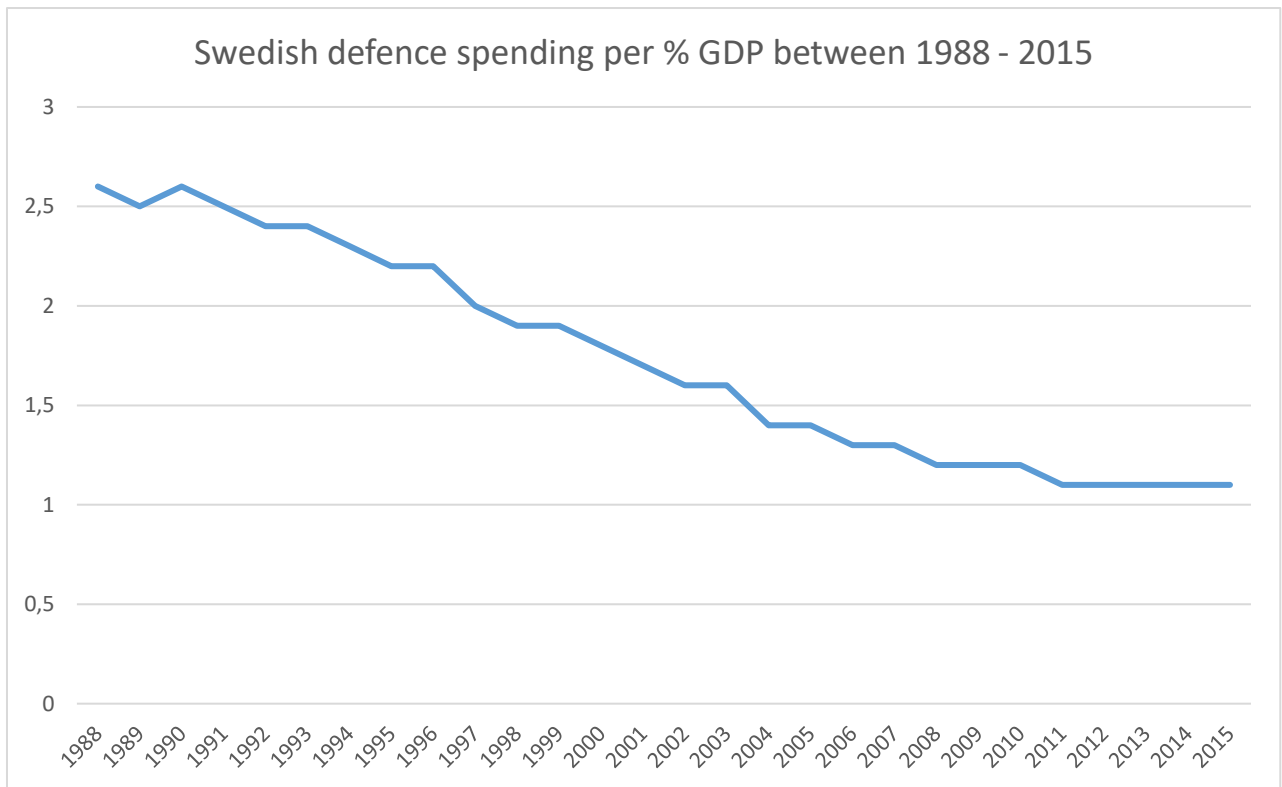


Figure 20: The Swedish defence spending decrease according to Stockholm International Peace Research Institute (2017).

At the same time, information technology development had started in civil society and the new ideas about Network-Based Defence were emphasising information technology, which became the driving force of the change. Network-Based Defence could be the solution to the problems of how to organise the armed forces after the end of the Cold War; it gave direction and created trust in the future. Another idea was that the technology would “promote future recruitment” according to Nilson (2014). To manage the shift towards a different perspective on technology and use of technology, and the possible changes to the organisation of the armed forces and their behaviour in future conflicts, discussions were held with the defence industry (Eriksson, 2013).

From the point of view of the involved parliamentarian Allan Widman, ideas for the project came from the US to Sweden through Swedish officers frequently visiting the US. From his point of view, PowerPoint presentations showed what the project should result in. As the years went by and there were no signs of real and physical result, the PowerPoint presentations disappeared, more critical questions arose and the armed forces and Swedish Defence Materiel Administration spoke less and less about the project (Widman, 2015). The reason for the travelling to the US that began in the mid-1990s was that the Swedish Armed Forces were not considered adapted organisationally or equipped for modern or future conflicts, and interest in what was developed in the US at the same time

therefore arose. In the US, similar thoughts and planning took place. High-ranking Swedish officers were thus travelling to the US in order to be informed and understand the new ways in which war would be fought according to Swedish officials Nilsson & Nordenberg (2014) at the Swedish Armed Forces and the Swedish Defence Materiel Administration.

Later on, better interoperability capability became an important driver for Network-Based Defence. It was claimed that technology would enable much higher effectiveness and thus save taxpayers' money. All those arguments were sales arguments according to an official responsible for the development of a combat command and control system (Neppelberg, 2013).

The actors within and around the Ledsys Project

In Sweden, the intermediate acquiring authority is the Swedish Defence Materiel Administration, which acquires defence systems for the Swedish Armed Forces. However, a difference in the Ledsys project is that the Swedish Defence Materiel Administration was responsible for the technical part of the project. The Swedish Defence Materiel Administration, the Swedish Defence Research Agency (FOI) and the defence industry consortium then did the implementation work. The other parts focused on organisation staff and concepts were supposed to be implemented by the Swedish Armed Forces. The Swedish Armed Forces had never before performed such tasks.

The consortium of the domestic defence firms SAAB Technologies and Ericsson did the work on the technology for the Ledsys mega project together with The Boeing Company and IBM. One can claim that the consortium SAAB Ericsson NBD innovation AB made the selling of the Swedish Network-Based Defence development. However, the consortium got the contract based upon the idea that the domestic defence industries SAAB Technologies and Ericsson should be the main contractors and The Boeing Company and IBM should be tied to the consortium in order to share information with the ongoing mega project in the US, Future combat Systems.

As in the US, there are in Sweden other actors involved in defence acquisition who are neither armed forces, defence industry nor politicians taking decisions to buy specific developments or technology systems. Two different audit authorities have been involved in reviewing the Swedish Network-Based Defence development and the Ledsys project. The Swedish Agency for Public Management and the

Swedish National Audit Office started the reviewing the Ledsys project when the development went from planning to real systems development.

The Swedish Network-Based Defence development had growing external groups of individuals belonging to other armed services of the Swedish Armed Forces seen from the main Ledsys project and the later continuation of the development. A clear similarity with the other two projects does not exist because the Network-Based Defence development eventually went over the armed service boundaries.

Analepsis of the Ledsys project and reports by Science Applications International Corporation (SAIC)

In order to evaluate how the Swedish Armed Forces would fight in future conflicts, studies were done in cooperation between the Swedish Armed Forces and foreign consultant firms such as Science Applications International Corporation. Three different reports were completed on the theme of future armed conflict and Revolution in Military Affairs, and in what direction the Swedish Armed Forces would transform. The reports which were the result of pre-studies composing the concept of Revolution in Military Affairs started with two of the three main important issues within Revolution in Military Affairs. These were the concept areas of command and control (C2) and dynamic engagement. The consequences of an implementation would be a complete change of the Swedish Armed Forces (Science Applications International Corporation, 2000, pp. ES 1-5).

The high command of the Swedish Armed Forces planned for creating so-called dynamic engagement capabilities in the late 1990s. Science Applications International Corporation were given the task of writing three documents for the Swedish Armed Forces aiming at how armed forces would plan to fight future conflicts in the area close to Sweden. The documents included a so-called dynamic engagement vision, which concerned the vision of dynamic engagement for the Swedish Armed Forces until 2020, a “DE Conceptual Framework” and different capabilities which were also named “DE design principles” which were necessary to create a structure of the armed forces with capacity to manage dynamic engagement operations (Science Applications International Corporation, 2000, pp. ES 1). Together with the mentioned documents and other documents and reports, the dynamic engagement study group from Science Applications International Corporation consisted of a Senior Review Group, three Expert Panels and Core Integration Team. The Senior Review Group consisted of five former joint Chief-of-Staff in the US Armed Forces and one world-famous researcher regarding Revolution in Military Affairs (Science Applications International Corporation, 2000, pp. ES 2).

One of the reports from Science Applications International Corporation, “The Swedish Armed Forces Dynamic Engagement Study”, from September 1998 describes activities for the future Swedish Armed Forces which include practising global dominance and deterrence including how adversaries would be defeated and could be reached in future armed conflicts. Political and military influence was claimed to be possible to practice on local, regional and global levels but also increased capability to support civilian security challenges. The highly educated population and high-technology defence industry in Sweden would also benefit from the Swedish Revolution in Military Affairs. It was argued that not only the armed forces but the entire nation would benefit from the development (Eriksson, 2013, pp. 38-39).

The report also describes how a study group with different panels worked on the pre-study and implemented four different future scenarios with a vision for the dynamic engagement, conceptual framework and design principles. The reports on the visions, concepts and design principles led to the conclusion that the Swedish Armed Forces were to be fundamentally changed to be able to manage so-called dynamic engagement operations. A transformation of the Swedish Armed Forces according to the new concepts would then add considerable efficiency and an increased range of possible tasks able to be performed by the armed forces (Science Applications International Corporation, 2000, pp. ES 4-6).

The Swedish Armed Forces Dynamic Engagement Study referred to a number of factors by which future conflicts could be characterised, but also what kind of impact modern technology would have. This included the impact of Revolution in Military Affairs in a Swedish context. Descriptions included what future conflicts would demand from a fighting force in order to win. To reach a balance for the Swedish Armed Forces Revolution in Military Affairs, the organisation and equipment that created the capabilities would be constituted according to three different components: command and control, information, and engagement, according to figure 21.

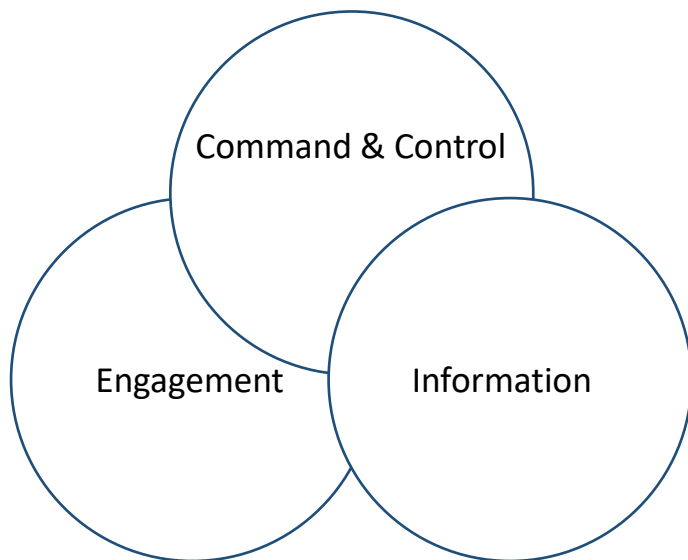


Figure 21: The future balance of RMA components according to Science Application International Corporation (2000, pp. 12).

The next step after Network Centric Warfare had been implemented in the Swedish Armed Forces, according to the Swedish Armed Forces Dynamic Engagement Study, would be the development of dynamic engagement. Measures had been taken to implement the Information and the command and control components in the report “Perspective Study Dominant Battle Space Awareness 2020”, also from 1998. The report from 1999 “Command and Control Study” had also been addressed and had a decisive impact on the planning of the Swedish Armed Forces command and control and decision support capabilities. The Swedish Armed Forces Dynamic Engagement Study further claimed that the Swedish Armed Forces were ready for development of dynamic engagement capabilities, which was considered the central component of the Swedish Revolution in Military Affairs. In order for the new (transformed) Armed Forces to be useful, dynamic engagement was vital because this was where the capability to use force would be placed.

The dynamic engagement report was thereby claimed to be the core factor in the Swedish Revolution in Military Affairs, and the most important part of the entire Revolution in Military Affairs because without dynamic engagement, opponents would be impossible to defeat.

The report describes the geopolitical situation for Sweden at the end of the 1990s. A summary of the situation during that era includes the globalisation and information revolution but also the difficulties for governments to control the flow and use of information (Science Applications International Corporation, 2000, pp. 3-1). The report corresponds with what the officials Nilsson & Nordenberg

(2014) claimed to be the background to and motives for the Network-Based Defence project. Moreover, a range of different potential future threats were assessed as likely at the time with a disintegrating Eastern Europe combined with a calm environment that the detente created and technology trends with large proportions of common technologies that would be available for all. The way in which the report is composed indicates that a model of the report should exist with its most probable origin in the US. This indicates that the spreading of ideas was taken directly from other actors rather than first being adapted to Swedish circumstances.

The concept for how future technology could facilitate superior military operations was described with text and colour pictures describing different kinds of information and physical presumptions for an armed force to gain superiority over an opponent. Ways of dealing with information and organisation in order to manage complex and diversified military tasks were described as becoming very efficient in the new Network-Based Defence. The report promised technologies that would disperse the uncertainty in war and other conflicts, similar to what has been described before as “...woraus das handeln im Kriege gebaut wird, liegen im Nebel einer mehr oder weniger großen Ungewißheit” (Clausewitz, Vom Kriege, 1853, p. 49). As in the Future Combat Systems project underway at the same time in the US, the idea was to use technology to disperse the “fog of war” (Science Applications International Corporation, 2000).

However, reports were later written concluding that Network Centric Warfare was not the big thing that would win future wars. Network-Based systems and organisations can be detected and defeated with both active and passive measures according to Falk (2005). On a theoretical level, thinking regarding for instance the introduction of the new systems was not about the introduction of the systems as such but about how rapidly and broadly the concept was introduced (Adamsky, 2010, p. 33).

Critique of the Network-Based Defence development

Branch-specific media and daily news media have been investigated regarding the Network-Based Defence project. The media articles were mainly positive about the project in its beginning but changed to take a more critical attitude when the development indicated different kinds of mismanagement. In addition, blogs have been investigated in order to find out how the development unfolded. Blogs became an important way for actors to put forward their point of view on the

development, and to point out dissent and potential mismanagement. The creation of internet blogs started with anonymous blogs where informed authors wrote mainly about problems regarding technology systems used by the armed forces or those developed for later implementation. Two blogs of this kind were *Wisemanswisdoms* and *Chefsingenjören* where common issues were mentioned but also issues regarding Network-Based Defence (Wiseman's Wisdoms, 2015; Chefsingenjören, 2015). Later, *Svenska Dagbladet* was another blog in which the armed forces' shortcomings with technology systems were dealt with from time to time. Several commented on the former responsible leader of Network-Based Defence, Johan Kihl, and others, when they confessed the failure of the development in an article on the *Svenska Dagbladet* blog on September 26, 2010. Problems that were addressed were the non-existent war planning, lack of relevant exercises and other shortcomings, since too much focus had been on developing Network-Based Defence, allowing other functions to degenerate or to be closed down completely (Kihl, Johansson, & Sundström, 2010). Among them, General Carl Björemán wrote on the blog about the problems that copying the American view of Revolution in Military Affairs had created for the Swedish Armed Forces. He critiqued the fact that Revolution in Military Affairs had confused politicians in Sweden who were not even close to the resources of the US. Instead, more realistic assessments and studies were needed which he claimed had not been done since 1945 (Björemán, 2010). In addition, the parliamentarian Allan Widman commented on the confession of Johan Kihl about the failure of the development with an article on the same blog with a more restrictive attitude. Widman was suspicious about the hidden interests of another change of direction regarding development that would eventually continue with extravagant spending (Widman, 2010).

Branch-specific resistance to the Network-Based Defence transformation

Individuals within the Ledsys project who wanted to connect different communication systems probably did not understand the priorities within the Swedish Air Force. The Swedish Air Force is rather small, and had tried to adapt in order to work together with other air forces at the expense of cooperation capability with, for instance, the Swedish Army. At the same time, management and project management was deficient all the way up in the organisation. The initiative for the project came from Army General Johan Kihl and the project was very loosely controlled. In an organisation like the Swedish Armed Forces, the impact of decisions can affect large parts of the organisation on very loose grounds. However, between the different authorities' communication and cooperation between the Swedish Armed Forces, the Swedish Defence Materiel Administration and the Swedish

Defence Research Agency needs to be better managed and thus laws control the cooperation (Nilson, 2014).

In Sweden civil and military aircraft share airspace. This fact means that military systems need reliability that is at least as equal to civilian aircraft, in order to be allowed to fly because the military and civilian air traffic needs to be coordinated. A new system would need to function with civil and military rules if any integration could be made. The Ledsys project aiming at the future was based on technology and systems that had not yet been certified according to Nilson (2014). The flight safety and information security was not completed, for instance, computer files and filters did not exist. The use of such system would not have been allowed according to officials (Neppelberg, 2013). The idea of the Network Based Defence was stopped, but if the idea had been followed, the Swedish Air Force could have been forbidden to fly for about five years between 2010 and 2015, because flight safety and information security were not implemented in the new system. On the other hand, StrilC 5.0, the already existing Combat Command & Control management system, was already fully implemented. Results from the project Ledsys that developed the Network Based Defence never showed any real progress or results, such as equipment or technical system according to Neppelberg (2013).

The roles of management of systems ownership, formal rules, culture in the resistance

Technology and technology certifications were used to point out that an implementation could cause severe problems for the air force. This was done correctly to show the resulting implications of an implementation but also as a tool for resistance. The technology behind the communication system Link-16, for instance, is from the 1970s and was acquired by the Swedish Armed Forces in order to become interoperable with NATO forces. It was perceived by the Swedish Air Force that the implementation of a new communication system could result in a wide range of consequences, and this was not appreciated by the air force. That is one reason to refuse the integration of a new system that is not yet functional at the expense of a system that already works (Nilson, 2014). In Sweden, the airspace is shared between civil and military aircrafts. This means that military systems need reliability at least equal to civilian aircrafts in order to be allowed to fly, because the military and civilian air traffic need to be coordinated. A new system would need to function with civil and military rules for any integration to be made. The Ledsys project aiming at the future was based on technology and systems that had not yet been certified according to Nilson (2014). The flight safety and security information were not completed where, for instance, computer files and filter did not exist. The use of such a system would not have been allowed according to officials (Neppelberg, 2013). The idea of Network-Based Defence was stopped, but if the idea had been followed, the

Swedish Air Force in practice could have been forbidden to fly for about five years between 2010 and 2015, because flight safety and security information were not implemented in the new system. StrilC 5.0, the already existing combat command and control management system, was on the other hand already fully implemented. Results from the Ledsys project that developed Network-Based Defence never showed any real progress or results, such as equipment or technical systems (Neppelberg, 2013).

System operations and system ownership struggles

A further concern was the area of command and control, which is different in the way it is dealt with as a normal system but affects everything in the organisation. As one interviewed official put it, “Someone else was supposed to be able to take over your weapon systems. Imagine that revolution for a pilot. He releases, and someone else is shooting” (Nilson, 2014). The different services have their own systems for command and control, which the highest command in different services uses to lead and control the air force, navy and army. But in the concept of Network-Based Defence, which was also the intentions for the Ledsys project, ownership of the different systems for command and control was supposed to be outsourced and delegated to another organisation within the armed forces. The information in the command and control system was then meant to be reproduced, by an external actor, for the respective services in order for them to take decisions. The result was that, to a large extent, high-ranking generals were intended not to control their own budgets or specifications for the command and control system needed to control their forces. This caused resistance. The development aimed at changing everything in the organisation whereby functions could be owned by one part of the organisation but controlled by another (interviewed official)(Nilson, 2014). The government directive to the Swedish Armed Forces in 2010 rejected several equipment acquisitions and equipment updates, among them the system named Central for Common Command and Control This system was pointed out as forbidden to order unless special permission was granted by the Government (Swedish Ministry of Defence, 2009, p. 12). The result of this decision was that the command and control structure went back to what it had been before (interviewed official)(Nilson, 2014).

Cultural mindset and contextual understanding

Technology as such is not an issue but the mindset of people and within the organisations would be subject to change. Specifically, the interoperability and its consequences also would have been crucial in the matter of implementation of Network-Based Defence. Since it was about interoperability with other nations, it was also about changing the mindset of an entire community in an international context, much larger than just Sweden. Nilson (2014) claims that missing the necessity to change the mindset, in Sweden but also internationally, was the biggest failure. Wanting fast results had the effect of turning people against certain wills and intentions. Examples of issues were added requirements on systems without increased financial support for implementation. This in turn resulted in systems fading away due to insufficient funding.

Culture and different ways to manage change

One additional concern has been about thinking regarding war and whether military activity is an art or a science. There is an opinion that the armed forces stand for or own the outermost capability for violence, and are thus not like any other authority. Because of this assumption, routines are not thought possible to implement in the same way as in other authorities. Politicians, on the other hand, view the armed forces like any other authority, according to officials interviewed (Nilson, 2014). The Swedish Armed Forces did not have any management control system for managing such an activity as a complex development project. There was a so-called working order which was used. In practice, this meant that there was no standardised way in which projects were planned and carried out, which could cost money for the armed forces due to inefficiency. As a comparison, the Swedish Defence Materiel Administration had a management control system, which was, and still is, built on the standard ISO 15288. The Swedish Armed Forces had no standard at this time, according to officials interviewed Nilson (2014).

Resistance

The different views and power struggles drove arguments to become dogmatic, and the different sides stopped listening to each other. From the legacy system owners' side, the side of the present system, it became a struggle about closing down the Network-Based Defence programme, and from the side of Network-Based Defence, it was about disposing with older systems that were an obstacle to the Network-Based Defence development (Nilson, 2014).

One situation that illustrated how far away from each other the different sides were, was in 2008, during a course in science of command and control, when the teacher said at the start of a presentation, “If you don’t agree with this, you may as well quit the armed forces” according to officials interviewed (Nilson, 2014). Due to differing opinions created during the project, knowledge was not taken care of as would have been normal. In this context, it also becomes clear that the training, one five-week course and one two-day course, was not enough. The concept of the new ways to planned System of Systems included completely new ways of viewing things with too little time to learn them. Education was then not sufficiently involved in an organisational and technological revolution in several ways that did not work in a conservative organisation. Instead, according to one of the officials interviewed (Nilson 2014), the time frame for a change such as the one supposed to be implemented by the Ledsys project should be much longer and progression should be done in small steps.

Wrong assumptions and management of change

Seen from the start with an ex-post perspective, the strategy used by the armed forces to work towards the implementation of Network-Based Defence was wrong. It was not about buying technology but about other issues, according to Nilson (2014). The defence firm SAAB AB that was an important actor in the Swedish Ledsys project has expressed similar opinions claiming that the Ledsys project was disorganised. Involved in the project was an integrated project team where the Swedish Armed Forces, the Swedish Defence Materiel Administration and the Swedish Defence Research Agency cooperated, but without delivery dates or a framework agreement. Settlements were made continuously and cooperation was more in focus than delivery of products, according to interviewed Svensson (2015). The Swedish Armed Forces were dealing with the domain of command and control in four different areas: technology, method, staff and organisation. Perhaps the most important areas to take into account were method, staff and organisation, and they were also the most difficult since they are more diffuse and difficult to define. All the way through the project, these three areas were underestimated with respect to the consequences. One reason for such problems could be the relationship between the Swedish Armed Forces and the Swedish Defence Materiel Administration, since the latter dealt with technology and technology development. It is a smaller issue to hire consultants that deal with technology and its implementation than to hire the same amount of consultants who deal with methodology regarding such a project. Method, staff and organisation were not a part of the Swedish Defence Materiel Administration’s job to manage. At the same time,

technology was considered 'cooler' to work with, including new technology and future perspectives, where an entire authority was dedicated to developing technology. Few resources were aimed at managing method, staff and organisation (Nilson, 2014).

According to one of the officials interviewed Nilson (2014), there were lots of good ideas in the concept of Network-Based Defence, but in this case it was not only about ideas but also about power. If the change had been done in a different way, it could have worked, since the understanding within the organisations would have been greater about the consequences and change would have happened over a longer time and in much smaller incremental steps; there would have been a basis for the change. Nilson (2014) states, "I believe that in the long run, and then we're speaking about perhaps 30 to 50 years, we will go there, no question about that, we will end up there. It is just that, we don't have that game plan." The need to implement such a change is not necessarily the same in an armed force as in most other organisations. The Swedish Armed Forces would not be closed down if the change was not carried out. A civilian firm needs to earn money, and a change of any kind could be about the survival of the firm. That is not the case in an armed force, where the budget will be set every year anyway. This needs to be understood and how the basis for change should look if a change is going to work (interviewed official) (Nilson, 2014).

In order to increase the possibility for the Ledsys project and thus the Network-Based Defence development to succeed, it would have been necessary to take more time for implementation but also to manage culture and organisational issues together with participation among involved actors. The technology-intensive LedsysT was not the largest issue but instead it was methodology, staff and organisation culture. An entire specialised authority, the Swedish Defence Materiel Administration, existed to manage the acquisition of technology systems included in the LedsysT. The activities through the Ledsys project were mainly going well with standardised ways to manage the development and acquisition by, for instance, the ISO 15288. But dealing with methodology, staff and organisation culture which was to be managed by the LedsysP, LedsysO and LedsysM would mainly have been the responsibility of the armed forces itself. In order to manage those activities, the armed forces had so-called Rules of Procedures, which were considered to be insufficient compared to what would have been necessary for the implementation of completely new technologies in the organisation where also organisation culture and staff were to be involved (interviewed official) (Nilson, 2014).

Spreading of the resistance to politicians in the Parliamentary and the Government

The struggle within the armed forces can be divided into different parts, with the technology and computer system on the one hand, and the organisation on the other. The technology dispute became a simple case to describe including its consequences, and to write about in blogs, in order to get attention from politicians. The parliamentarian Allan Widman noted the disagreements and started to address the problems, which started a debate in the Ministry of Defence. The debate resulted in a request directed to the armed forces to answer some questions (interviewed official) (Nilson, 2014).

One reason for the problems with the development project, according to (interviewed official) Widman (2015), was the very scarce information about the project made available to parliament. However, there was probably also little understanding from the parliamentarians' side when information reached parliament. Another issue that affected the project was Combat Command that could not be integrated in the project due to differing standards and prerequisites regarding, for instance, Rules for Military Air Traffic. The rules would have been difficult and complex to change, even if it were possible. The Swedish Armed Forces had only managed two large projects without the Swedish Defence Materiel Administration, of which one was Network-Based Defence and the other a project called Prio, and neither went well (Widman, 2015).

During the latter years of the Network-Based Defence development, blogs were used for revealing real or imagined irregularities. A result was that the commanding officers started to be careful about how to manage internal criticisms. One of the blogs, *Strilaren*, was closed down. The parliamentarian Allan Widman instead started the blog *Strilaren II* (Arvidsson, 2009c). The background was that interests in the Directorate of the Armed Forces Training had approached the author of *Strilaren* and the Directorate of the Armed Forces Command and Control Training and Procurement, claimed that information from a meeting about a development named Central for Common Picture (GLC) and Network Operating Centre (GLC/NOC) development was secret. Still, no adequate assessment of any detriment was done. The conclusion was then made that the aim of the approach had been to send a signal about being quiet about what was happening (Wiseman, 2015). Because of the events around the closed-down blog, Allan Widman started a debate regarding the communication problems and wanted the armed forces to announce that they were not trying to close the blog and thus free themselves from rumours according to the daily newspaper Svenska Dagbladet (Svensson L. , 2015).

The defence industrial perspective and differing agendas within the consortium

Cooperation within the consortium that managed the technology development also encountered some difficulties in the beginning. Between the four firms - SAAB, Ericsson, The Boeing Company and IBM - there were different agendas. SAAB and Ericsson were used to solve tasks for military applications; IBM had a civilian portfolio of products they wanted to sell in order to solve military problems; Boeing was not considered of much of use for the project because it never wanted to share information about Future Combat Systems in the US according to interviewed Svensson (2015). The agenda of IBM was different from SAAB and Ericsson. Still, the mix of actors was very rewarding regarding knowledge, but cumbersome due to different cultures. This meant that it took about a year for the structures to become established in the project. The cooperation then became more efficient; even though The Boeing Company never wanted to release information about Future Combat Systems, they cooperated well within the project according to interviewed (Svensson K. , 2015).

I have now described the analepsis to the Ledsys project and discussed some criticisms from important actors in the development. I also include the defence industrial perspective at the end of the section, which contain criticisms but also beneficial results for the defence industry. I will now turn to the chronology of the Network-Based Defence development and the Ledsys project.

The timelines of the Ledsys project and the Network-Based Defence development

The Ledsys mega project is a part of the Network-Based Defence development that later continued with other project names. The extent of the Network-Based Defence development concerned the entire Swedish Armed Forces with all different services, and limitation to the Swedish Army was never the idea according to interviewed Swedish official (Bergström, 2016). The start of the development was the Ledsys mega project. The Swedish Defence Materiel Administration has described the timeline of the project LedsysT, which was the largest project within the Network-Based Defence development. The Ledsys project was planned to have four different phases from phase 0 to phase 3 (Arnoldsson, 2010). After having described the actors involved in the mega project and their different specific roles and their implications, the Ledsys project and later development will now be described.

Network-Based Defence development review and the starting point of the Ledsys project

The pre-study for the Ledsys project consisted of different small studies between 1999 and 2003, which was the phase 0, and occurred before the consortium between SAAB, Ericsson, The Boeing Company and IBM existed according to interviewed Svensson (2015). Focus areas during this phase of the development were demonstrations, architecture and technical experiments (SAAB, 2010). The Network-Based Defence development included the Ledsys project but also the episode after the Ledsys project was cancelled, since there was a continuation. The study phase of the Ledsys project that started in 1999 with the reports from Science Applications International Corporation according to interviewed Swedish official (Bergström, 2016).

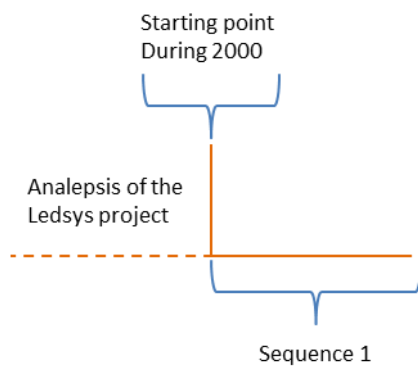


Figure 22: The starting point of the Ledsys project.

However, according to a report from the Swedish Defence Materiel Administration in 2010, the Ledsys project phase 0 started in 2000 as illustrated in figure 22. It was primarily about defining the forthcoming work in phase 1 and additional studies regarding Revolution in Military Affairs and Dominant Battlefield Awareness (Arnoldsson, 2010). The beginning of the Ledsys project was associated with strategic persuasion in order to create acceptance and understanding of the project at the defence committees in the government office. Concerns about the project management can be described by the following: "The difficulty is not to make something new; the difficulty is to stop doing what has been done" according to Swedish officials (Nilsson & Nordenberg, 2014). In order to start the Ledsys project, it was not possible to continue doing what had been done before. Information had to be spread about the novelty that was to come. One example is from the magazine *Framsyn*, produced by the Swedish Defence Research Agency. According to staff members at the Swedish Defence Materiel Administration and the Swedish Armed Forces, articles included

positive information and the idea that the Swedish Armed Forces could not be the largest but instead the best and smartest. The idea was to include not only the armed forces but also the entire society with the civil defence in the development (Askelin, 2003).

Sequence 1 of the Ledsys mega project

Courses about Network-Based Defence were also taught at the Swedish Defence University to spread knowledge in the armed forces according to Swedish officials (Nilsson & Nordenberg, 2014). An important factor to take into account is that the Defence Minister, Björn von Sydow, wanted Network-Based Defence to be strictly national during the early years of the project. Economic means could then be allocated more easily due to that motivation according to interviewed Swedish official Nordenberg (2013).

The planned first phase of the project started before the summer of 2001 and continued until the late autumn of 2002, where the purpose was to gain knowledge about the technology within Network-Based Defence. The design of a framework for the armed forces technical architecture was also started during the first phase (Arnoldsson, 2010).

During the development of Network-Based Defence, different media reported on the project. In addition to the foreseen transformation of the armed forces, there were also potentially large sums of money over the long term that would be used in the transformation into a new armed force. The weekly newspaper covering technology and industrial development in Sweden, *Ny Teknik*, wrote several articles about Network-Based Defence during the lifetime of the project. In the beginning, the articles had a positive tone, for instance briefly describing the principles of the new way in which war would be fought: an armed force based on sensors, computers and networks and fewer weapons (Wallerius, 2002).

The Swedish Agency for Public Management and the Swedish National Audit Office

Two Swedish authorities have continuously undertaken reviews of the Swedish Defence Materiel Administration and equipment projects. The Swedish Agency for Public Management and the Swedish National Audit Office have both dealt with the Network-Based Defence development and the armed forces' ways of acquiring equipment and managing defence budgets.

Since the beginning of the Ledsys project during the end of the study phase in 2002, the Swedish Agency for Public Management had followed and reviewed the project at the request of the Swedish government. Criticisms were made regarding the character of the project whereby it was considered as rather visionary and conceptual and aimed at a number of measures for creating the basis for further work. More specifically, some criticism was about method development, creation of the development environment, training and education and the establishment of design rules. The Swedish Agency for Public Management also wrote that the visionary and conceptual project did little to add to the parallel efforts to create the international activities that the Swedish armed forces had at the time. The mega project was in the beginning characterised by technology optimism, which was considered as a potential source of risk (Swedish Government, 2002, p. 1).

The Swedish Agency for Public Management made reviews of the economy, management and controlling of defence equipment and materiel acquisition for the Swedish Armed Forces and the Swedish Defence Materiel Administration commonly. The Swedish parliament decided in March 2000 on a new equipment strategy. The parliament wanted a more flexible strategy that would be more adaptable to unexpected threats and new requirements for the future armed forces. Better economic adaptability and fewer ties to specific objects or systems were recommendations from the Swedish Agency for Public Management. The recommendations in the report have three main issues to address which are: advice about economic control, control of acquisition planning, and control of international equipment cooperation (Grufberg & Andrén, 2004).

Dager (2007) mentions that technology optimism decreased during the project and the focus of the Swedish Armed Forces became instead the European Battle Group concept within the European Union. The task of being a framework nation within the Battle Group concept made real equipment an issue of focus. It became important to have direct contributions to the European Battle Group concept within short notice (Dager, 2007, p. 11). The unclear goals resulted in problems in reviewing the development of Network-Based Defence. In light of criticism, the armed forces revised the objectives by changing the goals in the documents HKV 100:64336. According to the Swedish Agency for Public Management, focus had been moved towards upcoming deliveries of products aiming at the creation of increased military capabilities, and international commitments. The Swedish Agency for Public Management commented furthermore that the increased focus on products for the next generation transformed the Network-Based Defence development into a means for change of the entire new concept of the armed forces.

Two elements remained a concern for the Swedish Agency for Public Management: information security in the new technology systems, and the increased risk regarding the complexity of the development. The Swedish Armed Forces assessed the risk in the beginning of the project as being moderate. The Swedish Agency for Public Management claimed that the assumption drawn had been wrong and too sweeping, because no ties had been made between goals, plans, and resources (Dager, 2007, p. 11).

The Swedish Agency for Public Management also noted in their report that the conditions for transforming the armed forces with Network-Based Defence changed with the government bill in the autumn of 2004, *Vårt framtida Försvar* (prop.2004/05:5). Network-Based Defence was considered as a tool for changing the Swedish Armed Forces from a large defence force prepared for a very large-scale invasion, to a more prepared armed force capable of carrying out international operations. The Swedish Armed Forces then needed to manage both real results in the near future and long-term development according to Dager (2007).

Ledsys project phase 2

Phase 2 of the Ledsys project began in 2003 and was supposed to be finished in 2007. Basic issues regarding the implementation of the Network-Based Defence concept, design rules and standards were important in this phase. Several outside actors were hired to examine the project during this phase (Arnoldsson, 2010; (interviewed Swedish official) Bergström, 2016). A news agency for the manufacturing industry noted in October 2003 that Ericsson and SAAB, the two large developers in military electronics, had closed a deal with IBM and The Boeing Company and formed the SAAB Ericsson Network-Based Defence Innovation. The ownership was shared between SAAB with 60% and Ericsson with 40% where IBM was supposed to contribute with complex solutions based on information technology. The Boeing Company was meant to contribute with future military technology systems according to Evertiq New Media AB (2003) and Karlberg (2003b). Other branch-specific media such as the *Elektroniktidningen* news service mentioned the cooperation between SAAB, Ericsson, IBM and Boeing some days later. The Swedish Defence Materiel Administration had signed an agreement of 300 million krona with SAAB, Ericsson, IBM and Boeing. At this time, it was already said that so far there had been mostly ideas and visions. An important purpose was to use as much civil technology as possible. The CEO for the new consortium between SAAB, Ericsson, IBM and

The Boeing Company said that IBM and Boeing were going to contribute with experiences from the armed forces in the US.

Management and control of the technology development was to be done with design rules where two main questions needed to be answered: how should the information and services combine, and what should combine in different situations? The purpose of the design rules was to create a basis for later public acquisition of equipment and services (Edström, 2003).

Before the real criticism started regarding the management of Network-Based Defence and the vague visions surrounding it, considerable interest regarding the project existed from other actors. Foreign espionage occurred against Network-Based Defence via Ericsson in the Network Centric Operations Industry Consortium. Potential weaknesses of Network-Based Defence were said to be transmissions being intercepted and even entire systems being turned off by a potential adversary in case of an armed conflict (Karlberg, 2003a). Since an important aim for Network-Based Defence was to become interoperable with different armed forces within NATO, foreign interests of network solutions were also aimed at other NATO countries (Holmström, 2003a).

Network-Based Defence became tied to the overall transformation of the entire Swedish Armed Forces, and thus became a tool for transformation. The risks were also shared between the two events. This became known during 2003 by an investigation made by Jörgen Thulstrup, ordered by the defence committee in the parliament. Swedish preparedness for conflict was much too low in comparison to what the parliament expected. The budget for the Network-Based Defence development and thus the Ledsys project was needed also for other concerns to create a better conflict preparedness (Höjeberg, 2003). The morning paper *Svenska Dagbladet* wrote in an editorial about the investigation, and drew the conclusion that the Swedish Armed Forces' capability to defend Sweden as a nation had become a non-issue. The newspaper concluded that Network-Based Defence was not to be ready until later in the future, and that the previous defence capability was gone. Sweden was practically without any armed force that could defend the sovereignty of the nation (Svenska Dagbladet, 2003). Still, large budget cuts were planned, the scope of which can be visualised better by an investigation within the armed forces claiming that an entire service of the navy or air force would need to be cut. The environment for the Network-Based Defence development would then be easier to realise (Tidningarnas Telegrambyrå, 2003).

The technology newspaper *Ny Teknik* wrote again in October 2003 about other emerging problems regarding the management of Network-Based Defence. The consultant firm Gartner Group released a report about the transformation of the Swedish Armed Forces into a network-centric force. A large and conservative organisation like the armed forces was difficult to change and therefore planned its activities as before without taking the forthcoming and total change into account. The advice from Gartner Group at this stage was, according to *Ny Teknik*, that high-ranking generals should be more determined in order to make progress with the Network-Based Defence development. Politicians were also hesitant about the large change, since there were several sacred cows that did not fit in the new Network-Based Defence (Wallerius, 2003). In 2003, criticisms regarding problems with management of the project also began from the morning newspaper *Svenska Dagbladet*, which had read the report from Gartner Group. The criticism was about increased total risk for the project because goals were not being met as expected. Other examples were decisions that were not followed up, which meant risks for both the Ledsys project and the overall transformation of the armed forces, and lack of competence and focus including the fact that no one in the armed forces was responsible for the comprehensive perspective. The management of the Ledsys project lacked staff, resources and methodology. Before the demonstrator project planned for 2005 and 2006, there was a lack of any unified purpose and aim in the armed forces and at the Ministry of Defence. Among high-ranking officers, other issues were more important, such as their own careers.

Information security was still a big problem, even though two earlier development projects had been stopped due to deficient security according to Holmström (2003b).

In the beginning of 2004, articles in both *Svenska Dagbladet* and *Ny Teknik* mentioned problems with the armed forces' equipment acquisition activity. *Svenska Dagbladet* concluded that there was no strategy for defence acquisition and that the transformation of the armed forces was not visible with respect to acquisition, which remained almost completely the same even though Network-Based Defence was supposed to have changed the way acquisition was practised (Holmström, 2004). In an interview with *Ny Teknik*, the resigning Director General of the Swedish Defence Materiel Administration, Birgitta Böhlin, mentioned important factors regarding defence acquisitions. Network-Based Defence was used as an example of an acquisition project that in the beginning was unclear and not sufficiently defined. The armed forces wanted a Network-Centric System, but did not have any doctrine and thus did not know what to buy or what to use it for (Pröckl, 2004). For the defence industry, the development had progressed to such a degree that the main contractor in the consortium, SAAB, had become a member of the consortium Network-Centric Operations Industry

Consortium (NCOIC). It contained 27 large firms, aiming at creating a unified development of worldwide network environments. The Senior Vice-President of SAAB said that as Sweden like many other countries went towards network-based military operations, the role of SAAB as a European founder of the NCOIC was important.

Firms that became members of the consortium were BAE Systems, Boeing, CACI International, Carrillo Business Technologies, Cisco Systems, EADS, EMC, Ericsson, Factiva, Finmeccanica, General Dynamics, Hewlett-Packard, Honeywell, IBM, Innerwall, L-3 Communications, Lockheed Martin Corporation, Microsoft, Northrop Grumman, Oracle, Raytheon, Rockwell Collins, SAAB, SAIC, Smith's Aerospace, Sun Microsystems and Thales North America, Inc. The firm The Open Group would be the coordinating company. Different kinds of equipment and systems, from different developing firms, would be specified according to open industry standards where minimum requirements for interoperability would be decided by customers (Larsson, 2004). As the only non-American defence firm, SAAB was allowed to be in the management of the NCOIC (Wallerius, 2004).

Different procurement decisions were made during the following year 2004. For instance, Siemens was to deliver telecommunication systems for mobile airfields and new kinds of underwater surveillance, and weapons systems were ordered from SAAB (Karlberg, 2004). *Svenska Dagbladet* wrote in April 2004 about the activities in the development project and the new notion of Network-Centric Warfare solutions and Revolution in Military Affairs in order to meet future threats in a more effective manner. The newspaper also mentioned a number of potential risks regarding for instance the complexity, information security, electric power dependency and cost (Augustsson, 2004). Presumptions changed later in 2004 when the Swedish Armed Forces received new political directions.

The defence bill of September 2004 gave the Swedish Armed Forces new instructions. Interoperability now became the focus, unlike the strictly national focus of before. International operations together with other nations now became the foremost important concern (Swedish Government, 2004).

However, the intentions of interoperability also attracted some of the core criticisms because of the kind of interoperability that was intended. The Network-Based Defence development had a clear focus on land forces. Deep-rooted conceptions from long ago became a foundation for resistance to change. The identity of the Swedish Air Force was created from the other services, the army and the

navy, in the Swedish Armed Forces in 1926. The creation of a new service from the other services was done with rather large efforts, and this event has shaped the identity of the Swedish Air Force. The result has been that the air force was keen not to be organised under the army or navy again. This became a foundation for criticism within the armed forces where there were talks about integrating systems together with other services again as part of the Network-Based Defence development. The Ledsys project had a clear focus on the land forces and therefore on the army side. Due to the history, the Swedish Air Force had always prioritised “combiveness before jointness”, according to one of the interviewed officials interviewed (Nilson, 2014). This resulted in the Swedish Air Force having better capability to, and therefore preferring to, cooperate with other countries’ air forces rather than with the Swedish Army. Interoperability for the Swedish Air Force was rather done with other air forces than with other services in the Swedish Armed Forces. The capability for the Swedish Air Force and the Swedish Army to cooperate was estimated as low (Gustafsson, 2014).

The first sequence of Ledsys was characterised in positive terms in the media and audit authorities started to examine the new project. Sequence 1 does contain increasing concerns from actors outside the project, mainly journalists from daily newspapers and branch-specific technology publications. Any conflict of large scale had not yet been shown at this stage of the project. Most information was positive and although interviews mentioned criticisms from this stage of the Ledsys project, there was no resistance strong and motivated enough to try to stop the development.

Turning point 1

The Battle Group concept had emerged in the European Union. In order to be a part of this development, the Swedish parliament in September 2004 took a decision in which interoperability with other armed forces, and in particular an adaptation to NATO standards, was important. The Swedish Air Force was to acquire systems equal to NATO. In order to integrate the Swedish systems for command and control with the NATO MIDS-terminals, the Swedish Air Force created the concept of Ground Control and Command Facility (GC2F). An interim solution of this was called iGC2F. These systems were supposed to create the capability to later bridge the gap between the different systems in the budget year 2008. The iGC2F started with an estimated cost of 7 million krona but increased first to 70 million and later even to 140 million according to interviewed Swedish official (Neppeberg, 2013). Because of the change of direction of the Swedish Armed Forces, shown in figure 23, a decision, called “C KRI Beslut i stort”, taken in December 2004 to adopt interoperability of the

command and control systems was taken by the General and Chief of War Planning, Mats Nilsson. The decision named a number of different NATO technologies to be acquired and implemented and memberships of working groups which taken together would make the Swedish Armed Forces more interoperable with NATO countries. The Swedish Armed Forces were also applying for memberships in different NATO working groups and organisations. The aim was to work more closely together and become interoperable with NATO. Technology systems were to be adapted to NATO standards, as well as working methods (Swedish Armed Forces, 2004).

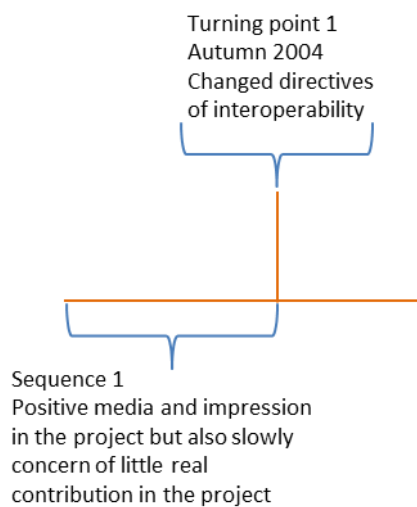


Figure 23: the sequence 1 and turning point 1 of the Ledsys project.

The defence political directive in 2004 redirected the primary aims of the Swedish Armed Forces. Where national defence had been in focus, international operations became the foremost important issue (*Vårt framtida Försvar*, Prop.2004/05:5). The project received new guidelines when the Swedish Armed Forces received new directives and the aim became interoperability with other armed forces (Swedish Armed Forces, 2004).

The development after 2005 aimed at creating interoperability with the Nordic Battle Group, a standby force created for the European Union's security and defence policy. Later, the large expansion of the International Security Assistance Force (ISAF) in Afghanistan became a greater focus for the armed forces. The money that was aimed at long-term equipment planning, e.g. to build sensors and networks, and to change communication systems, was allocated for other purposes, such as the operation in Afghanistan. Since the decision about interoperability was made, the Swedish Armed Forces' aim had been to be interoperable with NATO in terms of technology, standards and organisation.

Sequence 2

Despite the shrinking defence budget, the Network-Based Defence development was prioritised during 2004 but internal opposition between different interests became greater in the armed forces and in the defence industry (von Schultz, 2004). The Network-Based Defence development was used as a motive for both saving defence budget and creating interoperability. The command and control development activity in Enköping was created during this time with an emphasis on systems for the army. The decision on interoperability, "C KRI Beslut i stort", is associated with this according to interviews with official (Neppelberg, 2013).

The shrinking budget and the planned consequences of the interoperability development led to a power struggle between the different services of the armed forces. The owners of the legacy system, such as the air force combat command systems, started a struggle to close down the development of the Network-Based Defence. From the other side, the older systems needed to be closed down in order to create resources for the new systems according to interviewed Swedish official (Nilson, 2014). There was a difference between army officers on one side and air force and navy officers on the other. The army officers wanted to proceed with the project but the air force and navy officers wanted to wait until clear solutions and clear system alternatives existed. The air force and navy already had their Combat Management Systems, StrilC and SESUM, in full operation but in case of a transformation, both the air force and the navy risked being without functioning systems. The decision on interoperability taken by the parliament in 2004 was an important factor because the beginning of the project had no directive to create any interoperability with other nations. Much could be done in the Ledsys project due to loose regulations, but interoperability had been spoken about for a long time without affecting the project. In 2006 and 2007, however, interoperability became very important according to interviewed Swedish official Nilson (2014).

Some of the core early criticisms of Network-Based Defence development concerned the fact that the use of the old system would be phased out before the arrival of the new acquired system, which as an extreme result could have rendered the entire air force forbidden to fly for a period of several years according to interviewed Swedish official (Neppelberg, 2013). The defence industry and the consortium were influenced positively by the decision about interoperability. The development of technologies was made easier for the industry and the consortium since common standards were

followed and thus made engineering easier according to interviewed Swedish official (Svensson, 2015). Within the armed forces, the contradictions had started to grow.

Criticism had now increased and with it, resistance to the development. Still, positive images were spread about the planned Network-Based Defence, the future System of Systems. The technology magazine *Ny Teknik* reported in a positive manner during 2005, about the future way of carrying out war was described i.e. swarms of unmanned vehicles, nanorobots and quantum computers. The technology was described as realistic, with the question of implementation being a financial issue, in the 2005 edition of *Teknisk Prognos*, which was the first technology forecast in ten years. The battlefield of the year 2030 would consist of automation technologies, networking information technologies and invisible nanotechnologies. The great task was said to be the creating and architecting of complex technology systems that would more or less take autonomous decisions and act autonomously (Wallerius, 2005a).

Two months later in November 2005, *Ny Teknik* reported on a review that had been made by the Swedish Agency for Public Management about the development of Network-Based Defence and critical remarks from the authority on the project (Wallerius, 2005b). In addition, the daily newspaper *Svenska Dagbladet* also reported on the review and about the large risks involved when there was still much left of the development, and the project was seen as fuzzy. The cost for Network-Based Defence was not reported. In 2005, there was still no overview of the planned activities beyond 2006 and any concrete result had been difficult to find by the Swedish Agency for Public Management, who also demanded that the Swedish Armed Forces search for possibilities for changing the direction of the project or else terminate the project. The armed forces claimed in response that the project was not to be seen as a limited project but as an experiment. There was no beginning or end; instead, it was a journey, said General Major Christer Lidström (Billger & Holmström, 2005).

A few days later in November 2005, more criticism was formed regarding overconfidence in Network-Based Defence on mainly technological concerns. Humans could easily be left out of the system, according to the behaviourist Björn Johansson (Wallerius, 2005c).

The planned Ledsys project phase 3

Phase 3 of the project was supposed to be started during the winter of 2006/2007 and continue until the spring of 2010. The Ledsys project was however stopped before phase 3 and the aim became

instead to continue with other focus areas of the Network-Based Defence development. In 2007, the mood in the Network-Based Defence development was good and had not yet deteriorated. But when the proposals were made about changing the organisation at the expense of two already functioning units, the opposition became clearer. The Combat Command and Control Battalion of the air force and the Sea Information Battalion of the navy were absolutely not interested in becoming a part of an integrated Information Battalion. Capability to lead the different services was extremely important and not something service commanders wanted to give away to others to manage, or to adapt to others' habits. "It doesn't work like that, there are humans behind." (interviewed Swedish official) (Nilson, 2014) The proposal emerged and disappeared again according to interviewed Swedish official Nilson (2014).

According to officials interviewed, when different specifications from the Ledsys project were to be implemented into other systems outside Ledsys' domain, the result was larger expenses that had to be dealt with by the command and control system owners. The management of the Ledsys project did not consider the increased expenses for others to be their concern. The result was a conflict between the Ledsys project management and the command and control system owners. This is when the controversy started where the air force did not "buy the road of command and control that had been pointed out to be the right way according to Johan Kihl, Christer Lidström and Per Nilson and involved staff in Enköping, around 2006 and 2007". At the same time, the economic problems for the Swedish Armed Forces became more and more apparent according to interviewed Swedish official Nilson (2014).

The sequence 2 of the events in the Ledsys project was characterised by increasing resistance from outside actors belonging to mainly other services that witnessed how the Network Based Defence development started to take resources from other services. The resistance was strengthened because of little real development progression by the Ledsys project.

End point of the Ledsys project

In 2006, the new government after the parliamentary elections of that year suggested stopping the Ledsys project, and in 2007 a decision to stop the development was taken, as shown in figure 24. The project management of Ledsys admitted at this time that things had gone wrong with the project with 2 billion krona spent. In 2007, the government made a decision to finally stop the project, "but

all projects have a tendency to continue but with changed names” according to interviewed Swedish official (Widman, 2015).

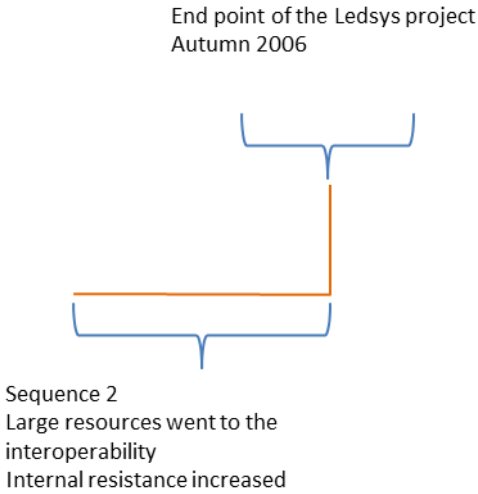


Figure 24: The sequence 2 and the end point of the Ledsys project.

During 2007 and 2008, a comprehensive inquiry was carried out within the command and control sector in the Swedish Armed Forces and the result was the report on Command and Control Systems 2010. Around 2007 and 2008, the Network-Based Defence development were treated with suspicion in the organisation. At the same time, the report “Command and Control Systems 2010” announced that the consequences, if the intended plans presented in the report were carried out, would be that the Air Force could lose its computerised command and control systems according to interviewed Swedish official Nilson (2014).

In 2007 and until the end of the development in 2009, the industry consortium continued with the procurement phase where technical procurement specifications were developed. However, in 2008, new directives to the armed forces changed the conditions where the Swedish Armed Forces were to be made combat-ready in a considerably shorter time than before. The change to shorter-term combat readiness made the long-term project less interesting, since it was aimed at long-term transformation and technology implementation according to interviewed Swedish official (Svensson, 2015).

In April 2008, the department of Integrated Material Management at the Swedish Defence Materiel Administration recommended a change in direction where the projects iGC2F and GC2F were to be stopped in order to use “experiences and achievements from Network-Based Defence” in Enköping.

The solution iGC2F was however not a real part of Network-Based Defence, but a solution for communication between the new versions of the Gripen aircraft that had Link-16 implemented instead of TARAS, which was an older version created for the older versions of the Gripen aircraft. Since Link-16 was partly used for Network-Based Defence to implement and open organisations for the overall change towards Network-Based Defence, iGC2F could also be used as a tool by the Ledsys project management to continue with the Network-Based Defence development (Neppelberg, 2009a).

Due to difficulties in defining a clear goal for the project, the Swedish government decided to end the development at the end of 2008 and change focus. As a distinct development, the Network-Based Defence development ended during the winter of 2008/2009 (Arnoldsson, 2010, p. 4).

In an article in *Svenska Dagbladet*, the head manager of the development of Network-Based Defence, Johan Kihl, and two other authors, Per-Egon Johansson and Dag Sundström, both former active management consultants, wrote an article from a different perspective regarding Network-Based Defence. The article claimed that the Network-Based Defence development had driven the armed forces into having too little of everything. There was nothing left of the former invasion defence as it was composed during the years after the Cold War, and its capacity was too small to send on expeditionary activities, which would not be enough to defend the territory of Sweden. The skills gained in expeditionary activities were also not the skills necessary to defend Sweden (Kihl, Johansson, & Sundström, 2009).

New name but about the same

In 2008, the report on the future Combat Command and Control 2010 came from the Swedish Defence Materiel Administration, and from that report came a proposal about starting a new project to develop a Central for Common Picture (GLC) and Network Operating Centre (NOC), or GLC/NOC. The new expression GLC/NOC indicated that something new was about to be developed. However, it was not new but instead a continuation of what had been the Ledsys project, and therefore also a continuation of the Network-Based Defence development. The Ledsys project had changed name to GLC/NOC, but in reality it was still the same project. With GLC/NOC, the ambition was to control all armed forces services from one geographic point. It has been interpreted as the attempt of the former project management of Ledsys to still implement what had been ordered to be stopped (Nilson, 2014; Neppelberg, 2013). Widman (2015) has expressed concerns that the project could

survive and continue working even though it should have been stopped according to formal decisions.

The idea behind the name change to GLC/NOC and the changed instructions for the projects iGC2F and GC2F was to take money from other systems for GLC/NOC and the Command and Control Battalion, which would be the new unit within the armed forces, leading all forces. However, no real result, such as real usable technology or technology systems, had come from the activity in Enköping where GLC/NOC was developed and where the new Command and Control Battalion forces were supposed to be created. In the demonstrations “DEMO 2007” and “DEMO 2008”, the new concept was supposed to be tested, but none of the practical solutions were really new. The Swedish Air Force already had a system, StriC 5.0, operational according to Neppelberg (2013). During 2007 and 2008, the armed forces military headquarters was reorganised due to an order from Commander-in-Chief Johan Hederstedt. One result was that a new department was created, the Directorate of the Armed Forces Command and Control Training and Procurement, to work with the command and control development. The different services of the air force, navy and army were only supposed to focus on their respective systems (Neppelberg, 2013).

A little later, the Ministry of Defence wanted an explanation from the armed forces about what Common Information Picture (GLI) was, and how it should be implemented. The Ledsys project and the Network-Based Defence development had changed name again from GLC/NOC to GLI in order to open for a continuation of the development, according to one of the officials interviewed (Neppelberg, 2010). As Widman (2015) put it in an interview, “When a project goes into the wall, it tends to change name”. Eventually, the project management changed their minds and gave up on continuing the project. The command and control centres Bålsta and Hästveda, which were built into the mountains, were kept. The tensions between the different interests of the project management and the opponents of the project were at the end of the project rather strong, as shown by the arguments for closing down the command and control centres. It was according to Widman (2015) motivated by such issues as lack of windows inside the centres which were situated deep in the granite of the mountains.

During a large part of the development project, there had also been considerable parts of the armed forces that protested, either openly or more discreetly, against the development. Large parts of the organisation including two of the four services - the air force and the navy - had been severely

threatened by the potential impact of an implementation of Network-Based Defence, according to both interviewed Swedish officials Nilson (2014) and Neppelberg (2013).

One additional matter regarding decisions and leadership was that high-ranking officers thought they could simply tell their subordinates to do things and be obeyed without being questioned. By using possibly the wrong kind of leadership and management, a resistance to the changes started. It was the kind of leadership where someone just “stands up and says, this is how it is” according to interviewed Swedish official Nilson (2014), and everyone obeys. “I don’t know how many times the chief of military operations came down and talked about that, now we had decided to take this way with GLC/NOC, and now it is just to do it“, according to interviewed Swedish official (Nilson, 2014).

End point of Common Information Picture

In an article in the news paper Svenska Dagbladet on December 19, 2009, the Supreme Commander of the Swedish Armed Forces wrote that along with some other changes, GLC/NOC would be closed down due to too few gains in terms of intended military effect illustrated in figure 25 (Göransson, 2009). According to interviewed Swedish official Nilson (2014), everything related to GLC/NOC was stopped in 2009. After that, at least four more requests came from the Ministry of Defence regarding command and control systems issues during 2009. At this stage, the Ministry of Defence’s trust in other issues had turned into distrust regarding the armed forces generally. The number of requests from the Ministry was a sign of this distrust, according to interviewed Swedish official Nilson (2014). Requests were also sent to the Swedish Defence Material Administration regarding command and control systems concerns. The Ministry of Defence believed that the armed forces had not thought things through properly, that they had prioritised incorrectly and therefore had taken the wrong strategic decisions. Though strategic decisions by the armed forces are normally taken in consultation with the Ministry of Defence, this was not done regarding the command and control systems according to interviewed Swedish official (Nilson, 2014).

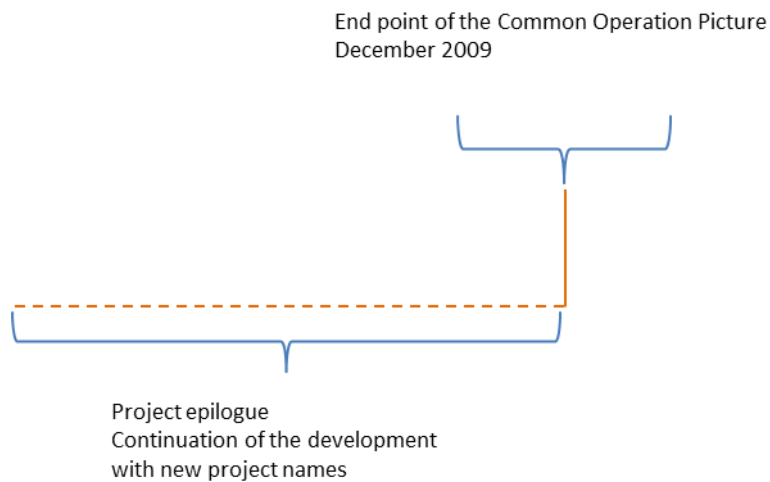


Figure 25: The continuation, and epilogue, of the Network-Based Defence development and the end point of the Common Information Picture development.

At this time, the Swedish Armed Forces suffered from large financial problems and one of the reasons for this was the Network-Based Defence development. It had proposed changes that were unwanted by the air force and the navy and had created shortage of staff which nearly resulted in system collapse at the Air Force Combat Command, according to (Arvidsson, 2009c); (Arvidsson, 2009a); (Arvidsson, 2009b). Still, in 2009 the GLC/NOC project had changed name to GLI, which meant Common Information Picture, and continued. According to Neppelberg (2009a), the Defence Minister Sten Tolgfors had been persuaded to implement the new concept of combat command. At this point, the Swedish Defence Materiel Administration had started to be more critical of the project, advising that present systems would be upgraded instead of a complete change of systems, which would probably have resulted in a future ban to fly for the Swedish Air Force. Peter Neppelberg had at this stage been writing to the Defence Minister, the Supreme Commander and the defence committee in the parliament in order to make them pay attention to the situation. The arguments with the politicians were about the potential risks of having an air force without a command and control system for several years during the shift from StriC to GLC/NOC. The result was that the politicians understood the problems with the Network-Based Defence development as having made it a “castle in the air”, according to interviewed Swedish official (Neppelberg, 2013).

A concern raised in the report “Systemstöd GLC/NOC 40748/2009” (System support GLC/NOC 40748/2009) from the Swedish Defence Materiel Administration was that financial resources had been taken from two other necessary systems in order to be used for development of GLC/NOC. These systems were GC2F and Marin Infoledning, which were aimed at upgrading the air force aircraft system and the navy information management, respectively. Due to lack of basic information

regarding the project from the Swedish Armed Forces, the Swedish Defence Material Administration had no calculations and no assessments had been done regarding costs. Neppelberg (2009b) also claims that Swedish Defence Material Administration report "Systemstöd GLC/NOC 40748/2009" (System support GLC/NOC 40748/2009) still did not show any real calculations of cost, content and purpose of GLC/NOC made by the Swedish Armed Forces (Neppelberg, 2009b). The armed forces still wanted to continue with the development of Network-Based Defence due to the invested means in the development, but the result of the distrust was that politicians wanted to close down the development completely. Additional writings from different blogs, true or not, combined with the distrust made Network-Based Defence impossible. "To go down to the Defence Department and talk about Network-Based Defence was like shooting yourself" according to interviewed Swedish official (Nilson, 2014). The defence industry did however gain from the development.

The events from the planning of the Ledsys project from 1999 until the final development was stopped in 2011 is illustrated in table 6 showing the main events in the Ledsys project and the following projects including the entire Network Based Defence development.

Chronology of the Ledsys project and the Network-Based Defence development

Time	Programme activities
Autumn 1999	The notion of Ledsys was established during the end of 1999.
Spring 2000	A definition phase (phase 0) of Ledsys was initiated. This phase resulted in study reports but also in proposals for tenders for the next project phase (1) with the industry. The working methods were successively erasing the the previously sharp boundaries between studies, research and technology development and acquisition.
Summer 2001	Phase 1 of the project was divided into five different parts. The development methodology led to rapidly changing requirements and ability to adapt according to new circumstances. At the same time, the development was considered to be experimental with increased pressure of taking risks that could lead to failure (Arnoldsson, 2010).
End of 2002	The phase 1 of the project ended.
2003	The main task in phase 2 was to prepare the implementation of Network-Based Defence and build knowledge to develop the technological parts of it. LedsysT was to be just a subset of the total architecture and architecture framework. During phase 2, a constructive level of dialogue was only maintained in some areas. As a consequence, the requirements for an implementation of Network-Based Defence were incomplete. The LedsysT project therefore became similar to an isolated island. The project results, aim and purpose were not understood.
Spring 2007	Towards the end of phase 2, the assumption was that the Swedish technology development was at the forefront of development internationally.
Spring 2007	Parallel to the end of phase 2, phase 3 started.
Spring 2008	Large parts of the staff were changed due to a new development partner being chosen. At the same time, a new kind of architecture

	framework, the Ministry of Defence Architecture Framework (MODAF) was chosen. As a result, the entire concept development had to be restarted. During the spring of 2008, NATO headquarters wanted to adopt Swedish design rules.
Autumn 2008	The Swedish government decided to stop a number of defence development projects. One of the stopped projects was LedsysT.
Winter 2008/2009	In practice, the development had been stopped.
End of 2009	LedsysT was formally stopped (Arnoldsson, 2010).
October 2009	The new project GLC/NOC was claimed to contain numerous risks in a report from the Swedish Defence Materiel Administration (Arvidsson, 2009c).
December 2009	Those responsible for the report had been replaced and given a new narrower aim of considering only cost issues and nothing else. Still, the new planned development was risky and could jeopardise Swedish Air Force flight activities. The close contacts between the defence industry and individuals from the Swedish Armed Forces involved with the development are also considered as a potential problem (Neppelberg, 2009b); (Neppelberg, 2013).
February 2011	The costs for the development project, now under a new name (GLI), were increasing. It could rather be described for what it was not, than for what it was, according to the blog <i>Strilaren 2</i> . There was also criticism of the vague descriptions of the fast-increasing costs for a development which was supposed to be ended (Widman, 2011).

Table 6: Ex-post chronology of the Network-Based Defence development.

In 2009, it was decided that Sweden was not supposed to lead development but instead follow and adapt according to developments in other countries (SAAB, 2010). However, according to interviewed Swedish official Svensson (2015), SAAB built much of the core functionality between 2008 and 2010/2011, based on what was done in the project. From the Ledsys project, the flexibility,

mobility, interoperability and cost-effectiveness have now been solved. Due to the work done by SAAB, Sweden is now at the forefront in technologies and concepts for Network-Enabled Capabilities in NATO (NNEC). SAAB is perhaps the only actor continuing today with the technologies and concepts. The ambition of SAAB has been to create functionality of the sold systems and not to connect and integrate an entire armed force, which they estimate is probably not what will happen. The core competence will always be in the country that buys the systems. The Ledsys project put SAAB at the forefront of development of network technologies according to interviewed Swedish official (Svensson, 2015).

A driving force for the development in 2009-2010 was a budget saving of three billion krona that was to be made in the domain of command and control systems. This was possible because Network-Based Defence was no longer a prioritised development project. The Supreme Commander of the Swedish Armed Forces and the Director Generals of the Swedish Defence Materiel Administration and the Swedish Defence Research Agency had then approved the saving. The result was the report on command and control systems from 2010, but also the emergence of blogs that questioned and reacted to plans to abolish well-functioning command and control systems with no, or very unclear, substitutes. The debate became larger than the armed forces itself. At this time, but starting already around 2006 to 2007, the armed forces already knew that there was a need for budget cuts, although an Information Battalion needed to be created to reach the goals of a networked armed force. In order to do this, components and resources needed to be taken from older systems in the armed forces in order to enable the transformation since no other clear option existed. There were two armed forces units that could contribute parts, components and systems - the Combat Command and Control Battalion of the air force and the Sea Information battalion of the navy. Only these units had the budget and the staff to enable the creation of an Information Battalion.

A development connected to Network-Based Defence but with main important events occurring after the Ledsys project, GLC/NOC and GLI, was the development in Afghanistan, where the International Security and Assistance Force (ISAF) commanders were concerned about the number of deaths of NATO and allied soldiers. This was said to occur due to too little and inefficient communication between the involved countries in the mission according to interviewed Swedish official Ivarsson (2014). The ISAF General Stanley McChrystal gave an order in 2010 for coalition information sharing in a single network. In 2011, 48 nations within NATO and partners to NATO used the Afghan Mission Network (AMN) according the Rand Corporation (Serena et al, 2014, p. xii) and one of the officials interviewed (Ivarsson, 2014). The continuation of the AMN developed into Federated Mission

Networking (FMN) in NATO. Roughly, the AMN and then the FMN were based on the ideas of Network-Based Defence according to interviewed Swedish official Ivarsson (2014).

The end point of the Common Information picture development project was nothing else than an extension of the already stopped Ledsys project only that the development then started to take resources from other services. With the continuation, the struggle continued like before with the same actors putting up resistance. The politicians understood that the project management of the Network Based Defence development that belonged to the Armed Forces had been disobedient and had not stopped what the politicians wanted to stop.

Analysis of the Ledsys project

Ideas and concepts about a network based defence were borrowed and built into the mega project

The ideas for Network-Based Defence came during the 1990s from mainly the United States. High-ranking Swedish officers went to the United States in order to understand how future wars and conflicts would be fought but also to borrow ideas invented in the United States and start similar development in Sweden. The ideas were uncritically taken and only slightly adapted to Swedish conditions. Study projects were started during the late 1990s with the help of consultant firms from the United States. The ideas of Revolution in Military Affairs and Network Centric Warfare were closely connected to the new concepts of how Sweden should defend itself in a future conflict. The reasons why later the Ledsys project became communication-intensive and aimed at dealing with other functionalities like engagement can be found in the communication-intensive Swedish industry, which was world-leading during this time. The ideas were first connected to the basic Swedish perspective of standing outside any defence alliance. Hope and expectations of what the new networked system would become became a fashion as described by Brunsson (2006). The ideas about the technology were immature and expectations were unrealistic, plans were initiated, and conflicting requirements were built into the mega projects. All these factors contributed to failure later on.

The times of austerity and the perceived ineffectiveness of the Swedish Armed Forces made it possible to introduce new notions

In the Swedish case, the ideas were taken directly from the United States. The ideas were adapted to better fit into a Swedish context and were claimed to create a better and more effective armed force. Similar notions like the United States' Network Centric Warfare and System of Systems were introduced to the Swedish Armed Forces by high ranking Swedish and American generals with help from consultants and defence industries like SAIC and the Boeing company.

Transformation with a mega project over service branch borders

The Ledsys project whose aim was Network-Based Defence emphasised communication systems development. Perhaps due to that fact, the idea was constantly to connect all different services of the Swedish Armed Forces. This was the aim for the development, which also meant that no specific

combat force was in focus as being the network-centric force. Instead, everything would be connected into one communication system in order to allow for everyone and all components of the System of Systems to communicate with everyone. This kind of approach created two large concerns leading to failure. One was the starting of the development with possibly the most difficult part of the development, the communication system. The second concern was the possibly hidden organisation conflict that arose when attempting to integrate the entire Swedish Armed Forces.

Both those concerns to start with the most difficult part and attempt to integrate the entire Swedish Armed Forces and not only the Swedish Army led to failure of the mega project. Future technologies and conceptual work on how they would be interconnected and operating together were clearly in the study phase. The absence of a real aim of the project is one reason why Ledsys was criticised and accused of having little concrete contribution for a long period of the project developing the future System of Systems. However, the vague aim, daring plans and the ignoring of risks indicate an optimism bias described by Flyvbjerg (2017, p. 8) about what could be possible to develop similar to the Future Combat Systems project. Ultimately, the vague aim led to failure of the mega project.

Obstacles during the Ledsys project

Around the middle of the Ledsys project directives were changed which meant a change from pure defence of Sweden to expeditionary tasks. This change became a source for increased organisational resistance to the Ledsys project when the project started to take resources from other service branches of the Swedish Armed Forces.

The transformation attempts of the Ledsys project and the subsequent projects GLC/NOC and GLI show the strength in the transformation, with both attempts to take over existing and functioning systems and close them down in order to allow the new unproven systems to exist. The projects that followed the Ledsys project had more limited aims but the transformation attempt was still real. The change of name of the original project was also understood as a deception and as hiding the transformation that was continued at the expense of the air force and the navy. The resistance can be traced to the intentions of the Ledsys project to integrate the command and control function in the different services to one single function and geographic place. The resistance led to the failure of the mega project. The mega project and the transformation were stopped and failed due to growing resistance and repeated changes to the project.

The result of the transformation attempts is an armed force, which has not been changed concerning technology, organisation, method or staff, and a complete failure was the result.

Chapter 6 - The French Scorpion project

The French Scorpion programme, *Synergie du contact renforcée par la polyvalence et l'infovalorisation* or Scorpion, is the equivalent to the Future Combat Systems project for the US Army and the Network-Based Defence development for the Swedish Armed Forces. There are obvious differences in scope regarding the different projects, but there are also similarities between the new technologies involved. The Scorpion project, however, was initiated several years after the other projects, using a somewhat different approach. The project included implementing technologies into already existing systems and later on employing completely new systems. The Scorpion project, in this way, also resembles a normal development process of the entire French land force and does not necessarily need to be viewed as a project with a start and an ending.

Background to the Scorpion programme and Revolution in Military Affairs of the French Army

In the mid-1990s, the US Army had started to evaluate new alternatives for the future through the pre-project Army After Next, and high-ranking Swedish officers travelled to US to take away impressions of possible future issues in military strategic thinking and activity. French affairs at that time were about to conclude development steps from during the Cold War. For instance, France was during the mid-1990s involved in the last steps of its nuclear weapon development test programme, according to the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) (2015). The tests aimed at development of the new warhead TN75 and creation of a computer simulation programme for later development of other nuclear warheads according to Flam (1995). However, aside from that concentrated action, the French Armed Forces experienced similar events to most other armed forces after the Cold War, with a decreasing defence budget. When the pre-project Army After Next, before the Future Combat Systems, started in the US and the preparations for the Network-Based Defence in Sweden occurred in the mid-1990s, the French Armed Forces had not yet started any activities on the matter of Revolution in Military Affairs. However, the notion of new information technology and the potential for digital technology to make military operations more effective had developed and studies and developments had also started in France.

The origin of the Scorpion mega project was the study project Digitisation of the Battlespace (NEB) that started in the year 2000. The aim was to start studying the impact of digitisation in military affairs, according to officials (Maudre, 2014). That project was and still is a study about communication systems and the integration of those systems into the French Armed Forces. The NEB project describes how the battlespace was to be digitised and how the new kind of digitised French Armed Forces should act and be constituted in the future (Centre de Doctrine d'Emploi des Forces, 2013).

With NEB, the defence firms Thales, Nexter and Sagem had their decided share of the project. A subsequent project, Air-Land Operational Bubble (BOA) started in 2005 when Thales, Nexter and Sagem received 100 million euro for the evaluation by the Directorate General of Armaments (DGA). One part of the project was about System of Systems Engineering, with experiments that explored new technologies and concepts. Half of the studies were supposed to be outsourced. The BOA project resulted in proposal of offers from the studies that the DGA wanted to implement. Thales, Nexter and Sagem were an integrated project management team but a clear supervisor did not exist and all involved firms had casting vote regarding unwanted decisions. The cooperation was considered a mess, but the cooperation was a demonstration aimed at winning the later Scorpion project. With BOA, the architecture of the Scorpion project was given to the same three firms Thales, Nexter and Sagem, or TNS Mars. technology development was considered acceptable but the management by the temporary joint venture was very confused, which is not wanted again according to interviewed officials (Maudre, 2014). The NEB and BOA projects are a part of the analepsis, before the Scorpion project started. The Scorpion project sequence is illustrated in figure 26.

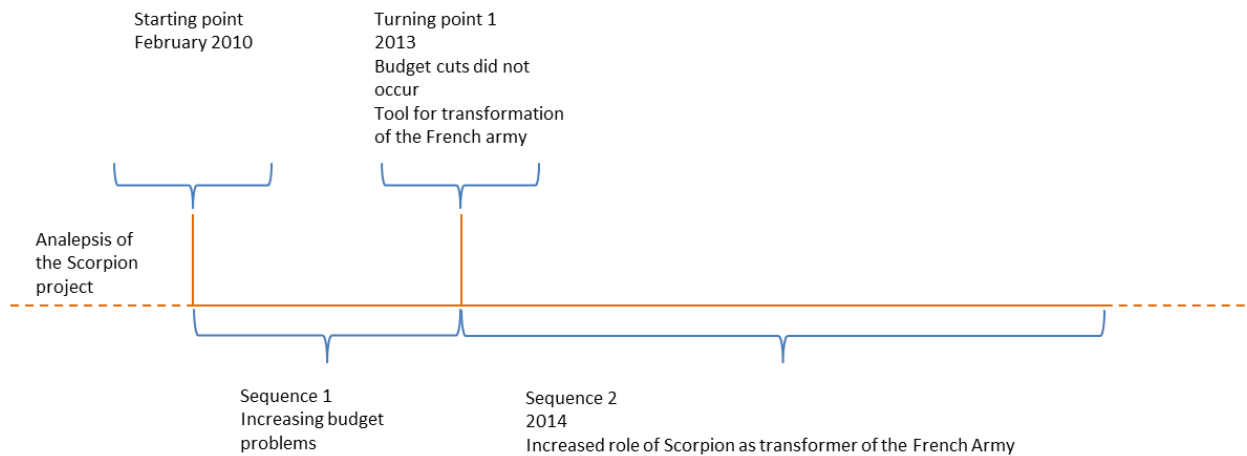


Figure 26: The sequential dynamics of the Scorpion project.

As in the cases of the other projects studied, the French Armed Forces endured a long period of decreasing of its defence budget after the Cold War. In addition, the decrease in defence spending as illustrated in figure 27 eventually would have started to have an impact concerning modernisation and capability to manage large and complex development activities.

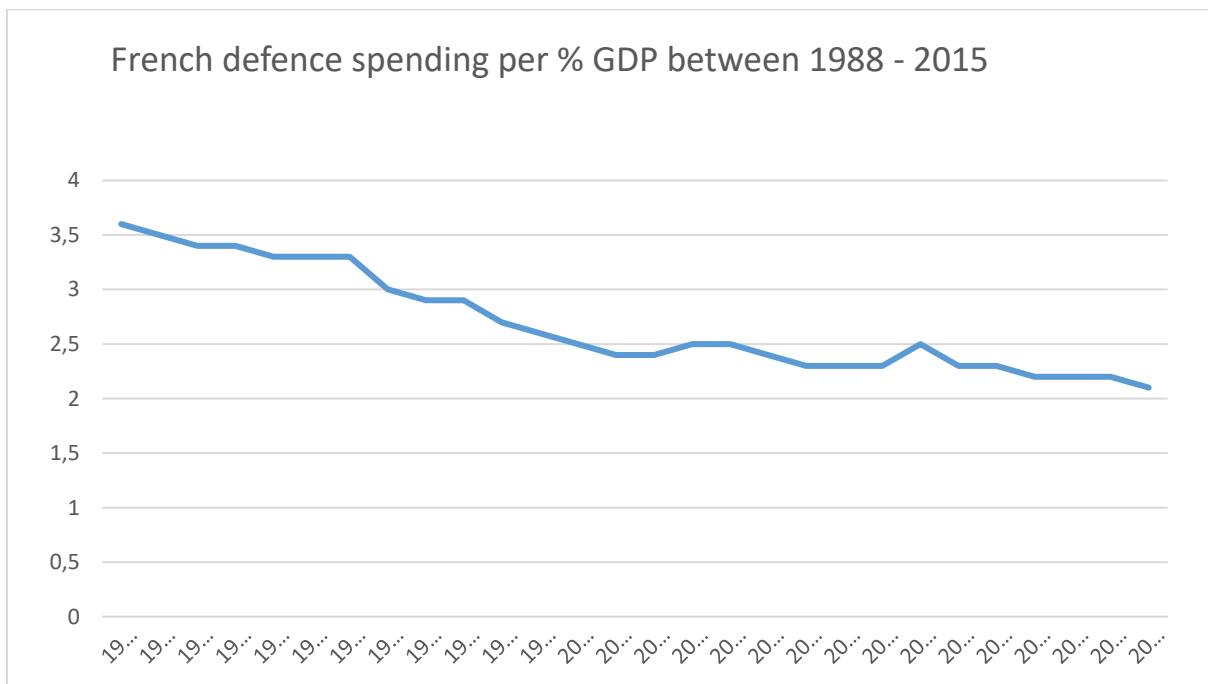


Figure 27: The French defence spending decrease according to Stockholm International Peace Research Institute (2017).

The development and acquisition of defence equipment in France is done similarly to Sweden with a specialised intermediate authority. The composition of actors in the Scorpion project, however, looks different.

The actors within and around the Scorpion project

The buyer of defence technology and technology systems for the French Armed Forces including the land force is the intermediate authority, the General Directorate of Armaments (DGA). Together, the French Land Forces and the DGA decide what the requirements are for the French Land Forces.

In the case of the Scorpion project, the role of selling defence technology systems belonged to Thales, Nexter and Sagem as the consortium TNS Mars which was created in order to manage the vast task of developing a completely new armed forces formation, the *groupement tactique interarmes* (GTIA). For the acquisition of technology systems, the French defence industry is contracted for each system and it is not necessarily one consortium managing one entire holistic system development.

Other actors involved in the French acquisition of the GTIA are from neither the armed forces nor the defence industry, but belong to the Ministry of Defence. The Ministerial Committee of Investments (CMI), for example, audits the Scorpion project.

The apparent aim for the French project management controlled by the DGA is to keep clear control of the project progression with, at least initially, no consortium of defence industries responsible for the creation of the entire GTIA. It is also meant to have responsible politicians for different stages of the Scorpion project. This measure differs compared to the Future Combat Systems project and the Ledsys project and should influence the actors.

Analepsis of the Scorpion project

The first steps in the French transformation towards Network-Centric Warfare started with the project Digitisation of the Battlespace (NEB). The notion of a revolution of the battle space, “la numérisation de l'espace de bataille”, which the Digitisation of the Battlespace is called in France according to Zecchini (2005), had arisen in the French Armed Forces headquarters, where technology

proliferation and information technology were considered to allow military activity to be much faster than before. The impression had been taken mainly from the US but also from other European countries, according to (Moussu & Estrate, 2004). The change was, like in the other cases, affected by developments in civil society, where increased use and development of modern communication technologies became more important in entire societies, giving everyone access to information each individual needed. The properties of the new technologies and systems that needed to be standardised were also considered to enable greater interoperability, which became increasingly important. The notion of “plug-and-play” to connect different technical devices in a simple manner had spread from computer games to the military establishment.

The transformation of the armed forces since the Cold War and thus the implementation of the new Network-Centric Warfare concept went fast, with little analysis of what was happening. The transformation aims corresponded to the dream of military strategists: flexible, more lightweight and faster forces to deploy combined with all the information needed regarding allies and enemies.

Like the importance of nuclear weapons during the Cold War, Network-Centric Warfare has been considered the next important concern in the development of armed forces in the era of the Internet and communication. The French Armed Forces also took notice of the large investments in US development of Network-Centric Warfare programmes of planned 200 billion dollars. The French version would be a “digitisation of the battlefield” with the name Regimental Information System (SIR), according to (Zecchini, 2005). The deal for the different firms was that Thales would develop the vehicle electronics, Nexter would develop the hull of the vehicle and Renault Trucks would develop the driveline and the engine. The core capability would be the electronics, since this was how one could build families of vehicles aimed for the entire French Armed Forces (Zecchini, 2005).

The reform of the French armed forces

As in the cases of Future Combat Systems in the US and Network-Based Defence in Sweden, a transformation of the French Armed Forces was planned in the late 1990s and during the 2000s. Two laws, the military programme law of 1997 – 2002 (Ministère de la Défense, 2015a) and the military planning law of 2003 – 2008 were put through the National Assembly (Assemblée nationale, 2015). The military programme law of 1997 – 2002 aimed at reforming the French Armed Forces with a number of objectives including: creation of a professional armed force, modernisation the

equipment while strengthening the industrial and technology base, and creation of a European defence policy. The military planning law of 2003 – 2008 aimed at accelerating the modernisation and acquisition of a number of different equipment systems, which also corresponds to the Network-Centric Warfare concepts, with sensor systems, command and control systems and long-range weapon systems. The law also aimed at contributing and constructing European defence by creating the capability for France to become a “framework nation” for conflict management. The final aim was the realisation of “Le modèle d'armée 2015”. The idea of the armed force of 2015 was the reaction to a strategic analysis from the 1990s, when the trends at the time included no direct military threat close to French borders, but instability could quickly emerge around the world. The armed forces would in the future be professional, more compact, better equipped and better operationally outside the national territory. Those priorities were the same in both the military programme law of 1997 – 2002 and the military planning law of 2003 – 2008, according to the Directorate of Legal and Administrative Information (DILA) (Direction de l'information légale et administrative, 2004).

The 2015 army transformation (le modèle d'armée 2015)

From the 1990s, the security environment had changed since after the Cold War into an absence of direct threat to the French territory but with a risk for potential conflicts to suddenly emerge, including other threats than traditional military conflicts between nations. Because of the perceived realities and future development, the 1994 defence policy document renewed a model for the future French Army. Certain acquisition priorities became important due to the document, such as intelligence resources, command capabilities and strategic mobility. Commonly, the intentions were to create a force better equipped to achieve military tasks outside France. In the defence planning laws of 2003 – 2008, the intentions from the earlier defence planning law was to be accelerated but with the same priorities. The modernisation pace of the French Army would then be increased, with specific emphasis on situation awareness by launching reconnaissance satellites, developing observation drones and expeditionary command systems. Increased research regarding different kinds of new threats was also to be commenced according to the DILA (Direction de l'information légale et administrative, 2011).

Lessons from other similar projects

The aim of the Scorpion project to develop the GTIA was defined several years after other countries went into their respective developments. Lessons were taken from the Future Combat Systems project when planning the Scorpion programme. For instance, short timelines and integration of several components at the same time would be avoided. Competence within the acquiring authorities would also be kept in order to manage the development of Scorpion according to interviewed official Meaudre (2014). Additionally, the development of the Stryker brigade for the US Army as an interim solution for the closed down Future Combat Systems could be viewed as a success, since it became the spearhead of the US Army equipment modernisation. The Scorpion programme as it was planned, conducted and implemented has been considered a success (Goya, 2014). The measures that have been taken by the DGA in order to reach the programme aims constituted an incremental approach to the project. This was done to reduce the risk, which otherwise would be high, if the entire programme would be reliant on small numbers of very important events along the project timeline. Systems Engineering built on an architecture approach has achieved project reliability and optimisation and systematic industrial integration was done during the entire programme. All costs from the beginning of the programme to the end, including the support, should be taken into account. Eighteen digitalised and networked battle groups were planned to be created by the Scorpion programme between 2014 and 2020 according to the DGA (Direction Générale de l'Armement, 2012). The end of the Scorpion programme is planned for 2021 and aims at producing almost thousands of multi-role combat infantry vehicles, 70 armoured reconnaissance vehicles, a renovation of the Leclerc tank and the Scorpion Information and Combat System (SICS) (Foss, 2016).

Different kinds of complexity

The current organisation of the Scorpion project was created in 2005 with a matrix approach. Technology experts could then work using their expertise in different areas of the French Armed Forces - air, land and sea. For instance, radar experts could be working on air, land and sea radar technologies. This also coincided with the term and specification of System of Systems, which emerged in 2005 (Dohet, 2014). The entire development consists of 130 projects with 130 project managers and 235 different systems where contracts first were given for architecture. The architecture would then lead to requirements, which would then be followed by an integrator

contract. The development of the GTIA is thereby implemented in steps and incrementally due to budget limitations, which prohibit the development to be done any faster. But the pace of change, or life time, for different technology types is different where, for instance, communication systems are considered to be changed every four years and vehicles every 20 years. There is also a potential issue with the incremental acquisition when the Armed Forces will own the System of Systems. The ownership of an integrated System of Systems can be complex with potential different owners within the same equipment system. It is not yet known what this will lead to and what, for instance, computer software development will result in regarding the system flexibility. The concept of System of Systems indicates that it would be flexible but at the same time, development of communication systems is a slow activity. When the oldest vehicle, the véhicule de l'avant blindé (VAB), was new in 1976, there were no software concerns at all. Today, much more is dependent on communication systems, which can result in greater system sensibility. For instance, can a single system be delayed and configured successfully, or not (Dohet, 2014).

After the pre-project BOA a new contract for the Scorpion project is meant to be signed but with a joint venture since the project is too large and complex to manage for only one industry. Especially ground systems together with communication systems are difficult to develop. The DGA also needs to be critical and keep control over the project since there is a joint venture of defence industries possibly defending their different interests. With the BOA project, there was an actual exchange between the government and the industry but the risk of having firms involved needs to be addressed. The DGA also see to the military perspective and ensure that the future user of the systems would get effective equipment. It is aiming at a basic approach with applications that can undergo improvements continuously and the armed forces themselves can develop applications. There is not much direct willingness to experiment with different solutions, but rather to adapt the context and use past experience, according to officials (Dohet, 2014). There are considered to be further differences between development of complex System of Systems and normal developments.

There is a financial distinction between ordinary development programmes with project phases with single technology systems, and programmes consisting of System of Systems. A System of Systems cannot be cut financially because then the System of Systems will have critical faults related to the nature of System of Systems according to French officials (Dohet, 2014).

The overall design authority will be controlled by the DGA and other parts could, for instance, be bought off-the-shelf. The example of a submarine can be used where there is an architect for the

submarine with programme managers for missiles and communication and so on according to interviewed official (Dohet, 2014). For instance, the French Air Force used to call the fighter aircraft Rafale a System of Systems where missiles and other components are considered as being subsystems. However, official Dohet (2014) disagrees with this definition, since a System of Systems should be distributed geographically in order to qualify. For instance, the capability for fire support or protection, in a military context, could be a System of Systems if the capability is a distributed function. In this context, Network-Centric Warfare is a special case of System of Systems, according to French officials (Dohet, 2014).

Regarding the management of System of Systems, there is a clear view of not wanting any Lead System Integrator like what was practised with Future Combat Systems whereby the industry develops the concept and leads the development. In the Scorpion project, the DGA wanted to keep control over the development. However, in this case the industry takes part in selecting the best architecture and then helps with the requirements for the systems. Then the DGA takes over and gives contracts, which will allow the government to keep full control (interviewed official) (Dohet, 2014). Concerning the architecture of the System of Systems and the suppliers, there are problems about knowing who is responsible for what. The problem regarded in this view is significant including ownership issues, responsibility issues and project complexity. For instance, at one stage, the three different firms of Thales, Nexter and Sagem in the consortium were working in 11 different functional lines with the architecture according to interviewed French official Luzeaux (2014).

One tool to manage and control the development of System of Systems and thus the development of the system of the GTIA is the Technical and Operational Laboratory (LTO) at the DGA. The purpose was to save resources and acquire resources that were needed in order to accomplish the tasks of the Scorpion project, according to interviewed French official Dohet (2014). The task of the LTO is to manage the different needs, constraints, possibilities, limitations, alternatives and potential future military activities. An important means for solving this task is by using modelling and simulation, according to Hamel (2015).

Still, the complexity of the Scorpion project is manageable where modelling according to NATO Architecture Framework (NAF) is practised. Different relationships between different subsystems are known and how they are interconnected practically with, for example, which vehicle will replace another both in combat and when replaced for other new vehicles, interviewed French official Luzeaux (2014).

The System of Systems approach in the Scorpion project is revolutionary, which means continuous transformation using a computerised database. A concern complicating the System of Systems approach with this kind of continuous work is the military routine of having staff stationed for only three years. The short time for each staff member to stay creates difficulties to maintain competence and capability to run complex projects over time, interviewed French official Luzeaux (2014).

There are technical challenges with the System of Systems, as it is not an exact science or always clear. When Scorpion was launched, it was said that the Americans had started a similar project (with Future Combat Systems), so the French should succeed. The difficulty with System of Systems is that the human is capitalised. Out of ten ideas, nine can be tried and abandoned. It can take a lot of time to learn and comprise things, interviewed French official Meaudre (2014).

What is new regarding development of System of Systems compared to Systems Engineering is the industrial production. There are contract issues when the DGA and the industry are cooperating. The System of Systems is the link to the architecture and the requirements at all levels and traceability comes out of Systems Engineering and the importance of simulation comes from Systems of Systems. Due to these differences between the System of Systems and Systems Engineering, the market system will be slightly different for the two types of system. As a comparison, the Control and Command System for Aerial Operations (SCCOA) is for “automated global management capability for air operations, both within mainland France and in overseas operational theatres” according to ThalesRaytheonSystems (TRS) (2015), but according to French official Dohet (2014), the SCCOA is a question of inheritance and would moreover not be a system for renewal during the Scorpion project interviewed French official (Dohet, 2014).

French official Meaudre (2014) does not think there will be a collapse of the Scorpion project like that experienced by Future Combat Systems. The information system for the Scorpion development is divided: there is the Scorpion Information and Combat System for basic levels and another system for command and control at higher levels. The development is also spread out in time so the French Armed Forces will have vehicles and radios, and from this perspective, Scorpion will be successful anyway. Possibly though, vehicles might not have all capabilities, radios might be less interoperable than expected and other promised capabilities will perhaps not be there, but it will be better than the present technologies according to interviewed French official (Meaudre, 2014).

Architecture, system development and system integration is not as simple as it sounds with distinct project phases. The approach is incremental and architecture evolves over time, in this case which makes it more complicated than what would have been normal. With these dimensions, the Scorpion project is the first of the kind. An example can be the VAB that needs to be changed. Integration of the new vehicle needs to be done where some technologies will have to be automatic and improvement of communication and miniaturisation of technology has allowed much more electronics to be put into the vehicles. One idea is also to reduce the number of platform types in the French Army, where many different vehicle types will become two types. There was according to interviewed French official Dohet (2014) a legend that there is no longer a single type of VAB in the French Army that is identical. For the first time, an ambitious scope can be handled as a System of Systems in increments, knowing that the old types of vehicles will be used some time in the future.

Unmanned systems will also be developed during the Scorpion project but there are some concerns regarding unmanned technology connected to confidence in the technology. In some areas, unmanned technology such as remote controlled mine clearing vehicles have existed for many years. However, in other areas, walking mules create much noise, which land forces do not like. Still, different technologies can need more or less time in order to mature and be adapted according to interviewed French official (Dohet, 2014).

In order to be interconnected and even interoperable, the forces need to be constituted as a System of Systems. Still, the campaign against Libya in 2011, for example, was carried out exactly like for a system and not a System of Systems according to interviewed French official (Dohet, 2014).

Regarding international cooperation, there have been attempts at standardisation for unified vehicle technologies but there are few examples of international cooperation regarding System of Systems. In addition, the Scorpion project started with already existing vehicles and systems, so initially there would be little industrial impact and little cooperation. On the other side, NATO wants to have interoperability with other development projects like the Ballistic Missile Defence in the United States.

International cooperation means that the System of Systems must be able to function together with other countries. Therefore, there is a need for control with use of standards, other concepts, joint studies and joint technology development. It has been done with Germany, for instance, and helps to develop standards so that combat concepts do not diverge and to identify technologies possible to

share. Germany does not have any clear equivalent to Scorpion, but works with linking vehicles electronically. The difference is that Germany does not have any System of Systems approach. There are just a few countries that have taken such an approach: the US Army, the UK and Sweden according to interviewed French official (Dohet, 2014). When it comes to the European Defence Agency, there are only concepts, but when there has been cooperation on vehicle design and acquisition and later production there has been little that worked due to industrial interests. Financially, there would not be any problem with economics of scale, but industrial interests have made cooperation impossible and armed forces in different countries want their own specifications and requirements, which can result in systems becoming too complicated. The opposite can also happen where systems become too cheap and simple to export according to interviewed French official (Dohet, 2014). The European Defence Agency serves as a platform for the spreading of ideas about System of Systems, concepts and technologies. There has been little outcome from common technologies due to little interest in any common defence. On the other hand, the European Defence Agency makes it possible to find partners regarding development of common technologies according to interviewed French official (Dohet, 2014).

Scorpion as a defence acquisition mega project

The Scorpion programme came several years after both the Future Combat Systems project for the US Army and the Ledsys project with the development of the Network-Based Defence for the Swedish Armed Forces. Some factors that were perceived as relevant in the late 1990s would not be understood similarly in the mid-2000s when the Scorpion programme was initiated. Technologies that were still unexplored had been developed and matured, civilian communication systems had been developed throughout societies. The project Scorpion does not start in a vacuum but took impressions from earlier project of similar kind, including both the Future Combat Systems project and the Ledsys project. The importance of having the government keeping clear control over the development and acquisition process has also been identified. Separating the different steps of the project and within the joint venture, the TNS Mars defence industry consortium would also be important in order to reduce the project risk. TNS Mars was also only active to assist the project management of Scorpion.

The DGA controls the development of the Scorpion project as a System of Systems and the development authority must not be delegated to any firm. TNS Mars has the role of project

management assistant. In Future Combat Systems, the Boeing Company and SAIC had the responsibility of both architecting and integration, according to interviewed French official Meaudre (2014). In the Scorpion project the different project steps were divided with, for instance, the DGA which also decided to not start with tenders, for the integration of the Scorpion project and the included systems, until 2017.

The DGA as the key element for eventually creating better operational efficiency for the land forces divided the project into milestones, with each milestone is being evaluated separately. In a progressive manner, new capabilities would then be acquired and implemented into the French Army by the DGA. The architecture work for the entire Scorpion programme was done by TNS Mars commissioned by the DGA in close cooperation with the Armed Forces headquarters and the French Army. The implementation phase of the programme would also include an additional evaluation of the architecture where contractor firms can be selected depending on what kind of construction they are developing according to interviewed French official (Luzeaux et al, 2014).

The preparation of the Scorpion programme has been conducted since 2005, with the pre-study project Air-Land Operational Bubble (BOA), which studied functional analysis of future technical and financial compromises. The development timeline and capacity to carry out the programme was also evaluated during BOA according to the French Ministry of Defence, Ministère de la Défense. The pre-study project was also one of the largest undertakings made by the DGA and went on for seven years, according to interviewed French official Dohet (2014).

Because of BOA, an announcement was made in 2008 regarding the need for a larger land force transformation, which is illustrated in figure 28, with the different projects as parts of the defence transformation. But the very contract of the up to 2,000 armoured vehicles for the Scorpion system was presented and given to the defence consortium by the Defence Minister Jean-Yves Le Drian in 2014 (defense-aerospace, 2014; Thalesgroup, 2014).

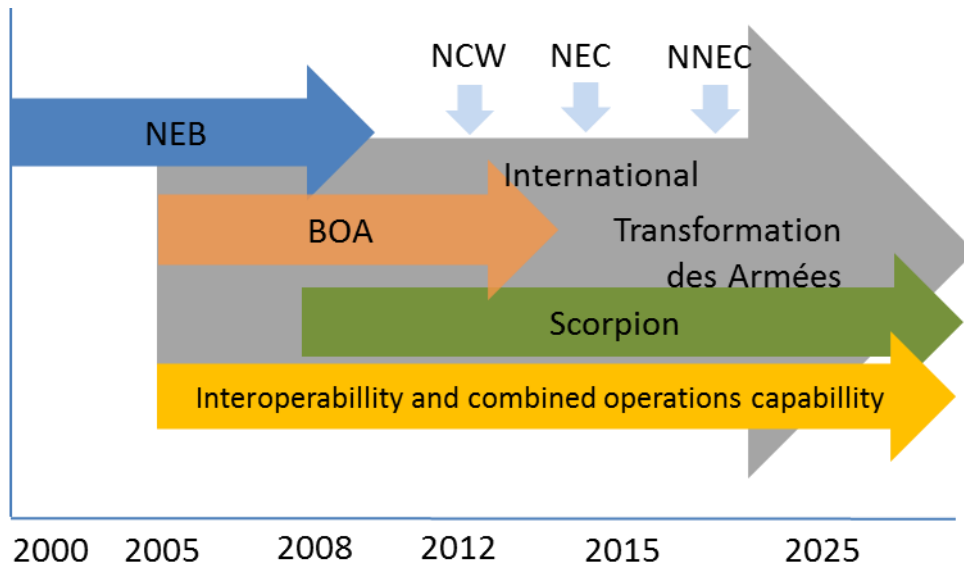


Figure 28: The context of the Scorpion project according to French official Meaudre (2014).

The basic concept of the Scorpion programme is to create a better and more effective combat capability of units named *groupement tactique interarmes* (GTIA). Compared to armed forces in earlier times, increased effectiveness would be based on enhanced protection, mobility, autonomy and tactical speed. When the properties protection, mobility, autonomy and tactical speed are combined, the efficiency of overall military operations is supposed to increase including military readiness level. The way in which the Scorpion project is supposed to be carried out is to start with renovation of the existing vehicles in the French Army inventory. Twelve vehicle types are meant to be exchanged for two main types of vehicles, the *véhicule blindé multi rôle* (VBMR) and *engin blindé de reconnaissance et de combat* (EBRC). At the same time, the main battle tank Leclerc would have maintained capability to control the costs that otherwise could be too high if all acquisition and renovation were done at the same time (Ministère de la Défense, 2015b). However, renovation of the main battle tank Leclerc is planned and included in the Scorpion project, since the Leclerc will also be a part of the GTIA (defense-aerospace, 2015). All platforms and soldier systems in the GTIA are then supposed to function and work with one combat information and communication system (SICS) to allow immediate information sharing, which is supposed to result in increased speed and enhanced readiness and thus more effective combat activities. At both lower and higher organisational level than the GTIA, other types of units of organisation will exist as shown in figure 29. The support system is also developed to become modular, aimed at reducing the logistic footprint, which gives additional advantages when executing military operations to and within different military theatres of operations (Ministère de la Défense, 2015b).

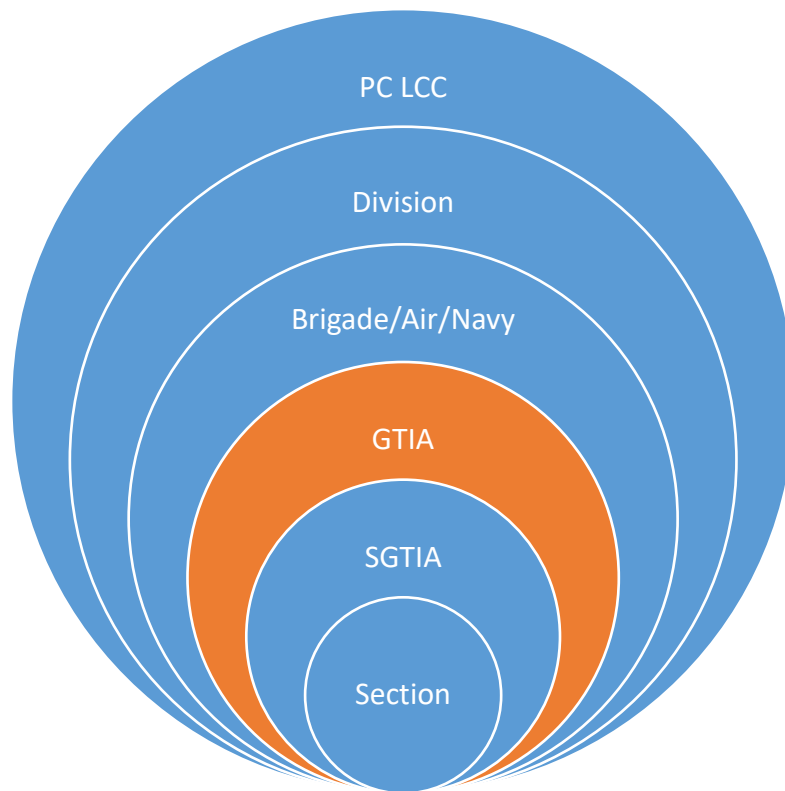


Figure 29: The concept of GTIA and the intended interconnections and delimitations according to the Ministère des Armées (2015).

In order to manage the undertaking of the Scorpion mega project, the French defence industry has been tendered as a consortium or joint venture. The project is considered too large for one industry to manage and like with the other mega projects, the French defence industry was intended to cooperate with the development.

Thales, Nexter and Sagem proposed for a joint venture with the DGA, with the motivation that the unique management should save costs, creating both independence and transparency. The study project Digitisation of the Battlespace (NEB) had led to conflicts with managers who discovered that the software that had been developed was indeed chaotic according to interviewed French official Maudre (2014). The same three firms later won the bidding. Staff at the DGA reasoned that Thales, Nexter and Sagem already knew the development, possibilities and involved costs. One important motive for contracting the same defence firms was that the three firms had their intellectual properties tied to the joint venture and it was assessed to create fewer problems than if the entire matter had to be dealt with again. The joint venture was created on July 15, 2010 as an AG3 firm. The

firm president came from Nexter and the shares between the three firms were 37.5% for Thales, 37.5% for Nexter and 25% for Sagem. The joint venture was not easy to manage for the DGA. It is important that nobody else than the DGA is has the role of managing and architecting the joint venture because the architect has strong power according to interviewed French official Maudre (2014). The role of Thales is additionally to develop the radio system for communication between the other services, the air force and the navy.

Scorpion aims

The aim for the joint venture TNS Mars has a clear goal, which is the creation of the combat unit GTIA for the army. The combat unit is the smallest kind of land combat unit, which France intends to use in combat. However, each of the firms Thales, Nexter and Sagem saw the joint venture as a potential competitor. If, for instance, the joint venture wanted to apply for a tender, it needed agreement from the shareholders of the three firms, which could create problems according to interviewed French official Maudre (2014). According to the responsible authority of the Scorpion development, the DGA, Scorpion is of a structural form aiming at renovating and improving the entire land forces component of the French armed forces. Eventually, the Scorpion programme should also include a change of the French Army from being based on regiments to being based on battle groups, *groupements tactiques interarmes* (GTIA), as standard land combat formation. Land vehicles acquired from the 1970s to the 1990s will be upgraded and new vehicles will be acquired. Vehicles integrated into the GTIA will not only be armoured platforms but will become parts in a complete combat system, integrating soldiers and weapon systems in a networked computerised communication system. Therefore, in addition to vehicles, protection and different kinds of soldier systems are also included as well as computer communication networks to connect the different components in the combat force (Goya, 2014). The way in which the programme Scorpion is marketed and motivated is also via the French armed forces information channels using the Internet, describing how the French Army would transform into a more modern force better able to meet new threats, unlike the more static situation during the Cold War (Armée de Terre, 2016). The French Army is however not the main body responsible to carry out the development of the GTIA. The DGA is the main responsible project manager in cooperation with the French Armed Forces.

Directorate General of Armaments

The main responsible authority for the development of Scorpion is the government defence procurement and technology agency, the DGA. Its tasks include design, acquisition and evaluation of equipment, systems and defence programs for the French Armed Forces including the Scorpion programme (Direction générale de l'armement, 2012). There are three strong parts of the DGA: the vehicle part, the communication part and the information security according to interviewed French official Maudre (2014).

There are different units of management which have the financial resources in the DGA called Directeur Unité de Management (DUM), divided according to different areas like helicopters, nuclear etc. One of the units is Land and was directed by Dominique Luzeaux, and is involved in the project Scorpion. The change of the organisation to develop System of Systems is a fundamental change, which is considered important to succeed with the implementation of the Scorpion project. It is not easy to understand what a System of Systems really is, but the future developed GTIA should be considered a System of Systems and is also the smallest type of land force the French Army would use in conflicts according to interviewed French official (Meaudre, 2014).

The new manner in which development should be dealt with in order to develop System of Systems will also affect how the legislation is composed. The new law called 1516 describes how the Defence Department should manage the arming activity. It will also affect how the future staff, purchasing and specifications are implemented by the DGA, and how the armed forces are used according to interviewed French official Meaudre (2014). It will create the new standard of how equipment procurement should be conducted. A new process, divided into six stages, has thereby been introduced covering the study and development of an equipment system until the removal from service of an equipment system. Unlike before, it should be possible for systematic intervention of the ministerial committee of investments (CMI) to review the stages and project milestones. With the new standard, each stage of development should also get a supervisor, either from the Chief of Staff of the Armed Forces (CEMA) or a representative from the Senate (Senat, 2016).

Differences between the Scorpion project and Future Combat Systems

There is a very important difference between how the architecture of Scorpion is implemented and how the architecture of Future Combat Systems was implemented. The Scorpion project is first done

as an architecting work and then there will be a pause for several years before starting again with an integration phase. There is furthermore a stronger governmental involvement than with the Future Combat Systems project. With Future Combat Systems, the US Army work was done symbiotically with The Boeing Company and SAIC. When dealing System of Systems, it is necessary to work very closely with the armed forces. Therefore, the role of the DGA is to guarantee that the interests of the manufacturers will not guide the suggested solutions. In the pre-project BOA, the state had a strong role and the contribution of TNS Mars was well-defined, according to interviewed French official (Meaudre, 2014). In the Scorpion project, there is an architect from the DGA opposite an architect from the defence industry. The architect from the DGA asks a question and the architect from the industry answers. The architect from the DGA turns to a person responsible for vehicles at the DGA and makes a bid. The joint venture works as a support for the project management. Legally, it would have been very big problem if any kind of influence on the cooperation had occurred. The CEO of the joint venture also spread this information in order to explain how important it was that no pressures of any kind should exist on this issue. In the end, it worked well even with staff from three different and competing firms involved. Moreover, the development of the new System of Systems concept was made with no margin for the defence industry because it was considered being of strategic interest for structuring for future markets. The development of the System of Systems should not be trusted and left to a firm because the state needs to keep control. Therefore, the DGA controls the Scorpion project and TNS Mars is just the Project Management Assistance. The Future Combat Systems project of the US Army was entrusted to The Boeing Company and SAIC, who were both at the same time involved in the architecture and integration. The DGA has separated the two. TNS Mars contributed to the architecture phase and in 2017, there will be a tender for integration according to interviewed French official (Meaudre, 2014). However, According to interviewed French official Dohet (2014), there is however, an example where there have been more freedoms given to the industry with the project Control and Command System for Aerial Operations (SCCOA) described by the Direction Générale de l'Armement (2014). The control was lost in that project and the result was loss of competition. Additionally, the SCCOA project also changed in increments. In order to keep the control, the architecture should be controlled by the Direction Générale de l'Armement, and thus the Scorpion project was created in order to allow the Direction Générale de l'Armement to keep control. For instance, sudden emerging issues regarding the architecture could force closer cooperation with the defence industry and lead to increased dependency on the defence industry. In the end, more information and responsibility than what was initially intended have been given to the industry according to interviewed French official Dohet (2014).

Timeline of the Scorpion programme

The project “Synergy of contact reinforced by versatility and infovalidation” (Scorpion) phase 0 occurred in 2008 (starting point) according to interviewed French official Meaudre (2014). TNS Mars won the bidding for the development phase of the Scorpion project in 2010 (Guisnel, 2012). The initiating contract was signed on December 5, 2014 and included two different vehicle prototypes with the first deliveries of vehicles planned for 2018 (Thalesgroup, 2014). The signed contract includes the first 318 of the Griffon vehicle type with a total of 1,722 Griffon vehicles planned to be produced by 2033. The other vehicle, a Jaguar, is planned to be acquired in a batch of 110 during the first stage of the project until 2020 with 248 vehicles produced by 2032. The first stage of the Scorpion project is to be finished in 2020, and in 2021 the first GTIA is planned to be deployed outside France. Two kinds of vehicles in a total of six variants will be developed. Stage two of the project is planned to be started in 2023. By then, the first brigade is planned to be ready, which will consist of three GTIA. Two brigades are planned for 2025. Stage two of the Scorpion project will last until 2035 (de Larrinaga, 2016).

The French Armed Forces staff was originally to be cut down in 2008 from 50,000 to 30,000 men and women. The conclusion was that the same thing with fewer resources could not be done. Instead, things would have to be done better with different uses of armed forces units and combined elements of the different services. Therefore, a large and comprehensive programme named Scorpion was to be launched in order to modernise the equipment of the army and give the involved forces better versatility and use of information. The programme Scorpion was planned to be part of a large defence reform where large cuts to the French Armed Forces were also planned. It was concluded by the Chief of Staff of the Army, General Elrick Irastorza, in a speech on July 24, 2008 that the French Army would be given fewer resources and would then have to accept having decreased possibilities to act due to the shrinking budget (Guisnel, 2008a). The programme corresponded to what had already been done in US with the Future Combat Systems, led by Boeing and in the UK with the Future Rapid Effects System, led by Thales UK. According to Guisnel (2008b), the Scorpion programme was also motivated by an argument that if France wanted to keep on playing with the big players (Guisnel, 2008b), the investment of 10 billion euro over at least 10 years in Scorpion would be a necessity, as claimed in the speech by Elrick Irastorza.

Another goal mentioned in the speech was to avoid the problems of earlier projects of the same kind. Additionally, and in order to decrease the amount of expensive testing and training, a battle lab (LTO) and a demonstrator (TACTIC) would be created. Cooperation with a German equivalent of Scorpion was planned for 2009 to test the interoperability between their different command and control systems (Kenyon, 2008).

In 2009, the DGA made a proposal for the Scorpion architecture to the defence industry. It was aimed for a long development time and the DGA had a budget of 5 to 10 billion euro and project times of 10 to 15 years for a modernisation of the army. The agreement was first done with Nexter/Cassidian, but suddenly the coalition changed and the cooperation was agreed between Nexter and Sagem with Thales as leader of the joint venture instead. Together the joint venture of Thales, Nexter and Sagem are creating the GTIA and all the technology for combat and contact with an enemy, with different heavy and lighter vehicles, information systems and weapons. The defence firm Cassidian is also involved with mainly command and control computers.

In the alliance of firms, there has also been cooperation between Sagem and Boeing, though Sagem cut the cooperation when Thales and Nexter became concerned about too much involvement of other external firms. Sagem wanted a piece of the deal of the Scorpion project, but Thales and Nexter refused. In order to enhance its negotiating position, Sagem then turned to Boeing, and could then offer the cooperation with Boeing in the deal. Thales and Nexter were afraid of Boeing but at the same time the DGA were happy to have the experience from Boeing. In this way, the DGA has also intervened in the deal according to interviewed French official Meaudre (2014).

One of the aims of the DGA is to acquire equipment off-the-shelf (Guisnel, 2009). In the competition for the Scorpion programme, the DGA does not intend to acquire from anywhere else than the French industry. The first main component of the Scorpion programme would be the computerised communication network SICS, which would connect all components in the land combat force GTIA, the second main component of the programme, according to Guisnel (2009). In 2010, the French government budget was decreased and so was the defence budget, resulting in a decreased scope of the Scorpion programme. According to Pineau (2010), some components of the planned Scorpion programme were to be stopped due to the planned budget savings. The consortium of Safran, Thales and Nexter competed against the European/American consortium EADS/SAIC (Pineau, 2010).

Description of the Scorpion programme

At first, the issue was to make clear the different levels in the GTIA that would need to be taken into account and the development of the communication network accordingly. There have been technical issues with the communication network, concerning the interoperability between the different services and ingoing parts within the GTIA. The next step would be to replace the old vehicles, like the VAB, with VBMR and EBRC. The different subsystems and vehicles are to be standard equipment in order to reduce costs but also ease interoperability, changeability and operational flexibility. A System of Systems perspective is practised to avoid addressing one issue at a time. An approach addressing capability is pursued and unlike the American Future Combat Systems, the French Scorpion project is done in incremental steps where each step is compared to a capability output. Some problems are occurring with encryption, for example, since the French Army is applying a slightly different use of it than the US Army, with the French Army avoiding too much encryption at lower unit levels, which decreases some requirements on the technology according to interviewed French officials (Luzeaux et al, 2014).

Starting point of the Scorpion project

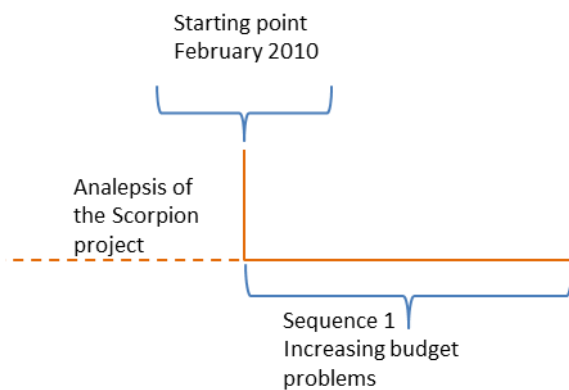


Figure 30: Starting point and sequence 1 of the Scorpion project.

The starting point of the development phase, shown in figure 30, was in 2010, with an announcement on February 22, 2010 by the ministerial committee of investments (CMI). The design phase was intended to continue until 2012 with the initial phase of the project running until 2020 with an estimated cost of 5 billion euro. The entire programme aims at being finished in 2025, with an estimated cost of 10 billion euro. The Scorpion programme aims at creating “18 fully integrated

and digitised Scorpion combined tactical combat groups, equipped with combat information networks, related digitalisation kits, infantry combat vehicles and the Félin future soldier programme” (army-technology, 2010). The aim for this stage of the project was to finish the details of the architecture and technical alternatives for the system components. Industrial alternatives and contracts were also to be finished during this stage. According to Guisnel (2012), the project phase was to end in 2013. The implementation phase was planned to begin at the end of the development phase in 2013 with a delivery of equipment concentrated to the period 2015-2020. Within this period, different vehicles would be replaced by new vehicles including a renovation of the Leclerc tank and implementation of the first version of the command and control system SICS. The Scorpion programme is planned to be finished in 2021 according to the DGA (2012). A probable review of the programme was however promised and the future of the programme was claimed to be far from guaranteed (Guisnel, 2012). The contract for the development was planned to be given to Thales, Nexter and Sagem in November 2011 (AFP, 2010). The created industrial consortium group, TNS Mars, was claimed to be independent from the respective firms Thales, Nexter and Sagem in its work on defining the architecture of Scorpion according to AFP (2011). The first vehicles of the Scorpion programme, when delivered, had already been delayed several times (Guisnel, 2013).

Sequence 1 of the Scorpion project

The aim of this stage of the project was to finish the details of the architecture and technical alternatives of the system components. Industrial alternatives and contracts were also to be finished during this stage of the project. According to Guisnel (2012) the project phase was to end in 2013. The implementation phase was planned to begin at the end of the development phase in 2013 with a delivery of equipment concentrated to the period 2015-2020. Within this period different vehicles would be replaced by new vehicles including a renovation of the Leclerc tank and implementation of the first version of the command and control system, système d'information et de combat de Scorpion (SICS). The programme Scorpion is planned to be finished in 2021 according to the Direction Générale de l'Armement (2012). A probable review of the programme was promised though and the future of the programme was claimed to be far from guaranteed (Guisnel, 2012). The contract for the development was planned to be given to Thales, Nexter and Sagem in November 2011 according to AFP (2010). The created industrial consortium group, tns-Mars, was claimed to be independent from the respective firms Thales, Nexter and Sagem in its work on defining the architecture of the Scorpion according to AFP (2011).

The first sequence of the Scorpion project consisted of much the same stage as the planned project stage. Growing concerns of planned decrease of the French defence budget could have stopped the mega project but the planning continued.

Turning point 1

During 2013, considerable cuts to the defence budget were made. The Scorpion programme was according to Vignal (2013) considered to be delayed or even stopped as an undertaking of renovating and modernising the French Army. The planned large cuts to the armed forces budget also resulted in clear differences in interests between the defence industry and the armed forces. Jean-François Lafore, the general delegate of the Association of the French Defence Industries (Gicat), said in spring 2013 that concerns are increasing over acquisition orders which never happened and the Chief of Staff of the Army wanting to cut the equipment programmes including Scorpion in order to save army units that otherwise would be subject to closing (Vignal, 2013). Due to the budget cuts, the Scorpion programme was one of several large defence development and acquisition programmes that became subject to decreased ambitions or were deleted. The trend regarding French defence spending can also be seen in figure 27 according to Guisnel (2013). The decreasing budget became an immediate risk for the project to be stopped due to insufficient funding. The Scorpion project was however not cancelled but got an extended role. The Scorpion project that developed defence equipment and created the new kind of combat unit GTIA was probably too important to stop, thus it would have been like stopping the equipment renovation and acquisition for the French Army. The first turning point in the Scorpion project is the change from declining budget and possible end of the just-started mega project and transformation, to the status of being the renovation and modernisation transformation tool for the French Army.

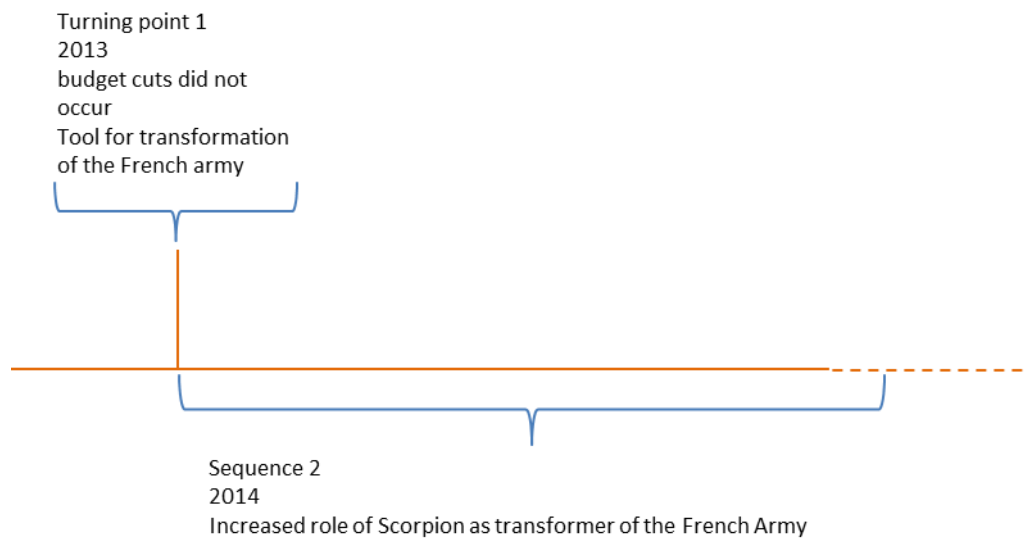


Figure 31: Turning point 1 and sequence 2 of the Scorpion project.

Ahead of 2014, the Scorpion project was given the role of the moderniser of the entire French land force when the French Defence Minister Jean-Yves Le Drain, illustrated in figure 31 announced at a meeting at the 27th Mountain Brigade (Leroux, 2014). The brigade would be the first land force unit to become user of the new battle group the GTIA and have it implemented (Ministère de la Défense, 2015b). The contract to build the vehicle EBMR within the Scorpion project went to the temporary consortium GME consisting of Nexter Systems, Renault Trucks and Thales According to Thales, the contract would shape the consortium and create jobs in Nexter Systems, Renault Trucks and Thales including the industrial sub-suppliers during the development and production phase (Thalesgroup, 2014). According to the Defence Journal *Jane's Defence Weekly* the contract was worth 752 million euro and included two main types of vehicle, the VBMR and the EBRC. The vehicles will also be built in several different types for different combat tasks. The development, acquisition, maintenance and training equipment necessary for the vehicles will also be included (Lert, 2014).

Chronology of the Scorpion project

Period	Program activities
July 24, 2008	Announcement by Elrick Irastorza of starting the Scorpion project because of an overall need to modernise the French Army (Guisnel, 2012).
2009	Directorate General of Armaments (DGA) were to acquire equipment off-the-shelf. Any other than French contractors would not be considered for the contract. The aim is to modernise the French Army (Guisnel, 2009).
February, 22 2010	TNS Mars won the bidding for the development phase of the Scorpion project (Guisnel, 2012). The announcement was made by the Ministerial Committee of Investments (CMI) (army-technology, 2010). This phase of the project was to continue until 2013 (Guisnel, 2012).
During 2013	The French Armed Forces were subject to large budget cuts with the Scorpion programme possible to be cut (Vignal, 2013; Guisnel, 2013).
December 5, 2014	Two initial design prototypes were contracted and chosen with the first delivery planned for 2018. The announcement was made by the French Defence Minister Jean-Yves Le Drian and the Scorpion programme was announced as the future moderniser of the French Army (Leroux, 2014).
During 2016	Vehicles, which will be parts of the future GTIA, are at the prototype stage.

Table 7: Ex-post chronology of the Scorpion project.

When it comes to the System of Systems perspective, there can be concerns due to the necessity to accept that a true System of Systems will never be ready-made. The overall system will always be degraded compared to a traditional system of subsystems. This also means that any optimisation cannot occur in a traditional manner. Thus, to operate a System of Systems means accepting a degraded system and not an optimised System of Systems. But still the System of Systems means much work and also work with little output with including scenarios used for development of the System of Systems. Still, there are limitations for which scenarios can be used. The operation serval

in Mali 2013 and 2014 would, for instance, not have been included as a scenario due to its geographical dispersion according to interviewed French official (Luzeaux, Baracco, Dufourd-Moretti, & Leca, 2014).

As of 2016, the Scorpion project continues with different vehicle systems planned, procured or renovated to fit into the Scorpion system as exemplified by three different kinds of vehicles that are newly developed, such as a smaller vehicle (Barreira, 2016, p. 16). An extensive renovation of the legacy Leclerc main battle tank will also start and later be integrated into the GTIA. The Scorpion project is progressing forward with different kinds of substantial parts of the claimed future System of Systems. Different kinds of new vehicles and communication systems are developed and acquired by the French Army illustrated in table 7. The systems are also developed according to modularity which has been an important concern for all of the different sub-projects (Foss C. F., 2016; de Larrinaga N., 2016).

The turning point 1 of the scorpion project was a clear sign that the French Army and politicians consider the development important. The Scorpion project is a modernisation activity involving all kinds of new but also old systems that are to be modernised.

Analysis of the Scorpion project

The ideas for the Scorpion mega projects had been proven and evaluated

The idea for the Scorpion project comes from the same ideas as for the other projects, Future Combat Systems and Network-Based Defence, with its origin in the ideas around Revolution in Military Affairs. The ideas have been motivated in about the same manner but perhaps supplemented by the importance for France to continue to be one of the large actors in security politics. Revolution in Military Affairs is also a component of the ideas and conclusions about how conditions for future wars constituted have been studied in the pre-projects to the Scorpion project. The Network-Centric Warfare concept on which the Future System of Systems would base much of its utility and thus win future wars had also been thoroughly studied before the Scorpion project with a pre-project started in 2000 with Digitisation of the Battlespace (NEB). In 2005, the studies continued with the Air-Land Operational Bubble (BOA), which is roughly when the first issues and problems with the new network communication systems had started to mature. Nevertheless, without a modernisation project like Scorpion, there were concerns that France would not have been able to continue to cooperate with the larger allies within NATO and the European Union. Some events coincided in time that affected the development of the French project differently. The ideas from the US coincided with the rather urgent need to renovate and modify the equipment of the French Army. The motive for the transformation was not only taken from pure ideas of how future wars would be fought but also the real need to modernise the French Army. The ideas also coincided with the development of the European concept of battle groups and the French equivalent, the *groupement tactique interarmes* (GTIA).

The non-existing project

Firstly, a project is defined as having a start and an ending. The Scorpion project does not have an ending yet for natural reasons. The project is not supposed to be finished with the first stage of implementation until 2020, and the second stage is not planned to be finished until 2033. The project is in the beginning of its existence and can thus not be defined as a project yet.

Secondly, because a project is defined as having a starting point and an ending point, it could be questioned whether the Scorpion project is a real project if the implementation stages and milestones become a part of an emerging transformation or rather an activity in the line activity of

the French Armed Forces. The French Armed Forces and here the French Army will always need to renovate and acquire equipment and equipment systems, which means constant technological change, like all armed forces. The constant change will vary in pace depending on individual technologies and type of system. It has been said that the Scorpion project is also a transformation activity for transforming the French land forces if the transformation continues and develops the French land forces with its number of comprehensive System of Systems embodied in GTIA.

It would be the line activities and management that would use smaller development and implementation technology and organisation projects to push the emergence and development of the Systems of Systems in specific directions and thus also the entire French land force.

The Scorpion project can therefore be understood as both a project and not a project, since it is difficult to define whether it meets the definition of a project. However, Scorpion may still be considered a project because it has a starting point and an intended ending point, which has not yet been reached.

The French understanding on what the role of the government should be and the degree of influence and control firms can or should have in the activities of government military systems and arms deals affects its posture in defence acquisition. The concepts and different kinds of evaluations of the kind of utility in France of any military system are mainly the activity of the DGA but also the Chief of Staff of the Army. The end user of the battle groups or the System of Systems, by this organisation of technology acquisition, keeps control of what kind of technology is acquired but also ensures that the cost for the systems is not increasing uncontrollably. The concern of keeping control is however real because the complexity of the project is hard to follow consistently and thus the project complexity could get out of hand. The French government is claimed to have control over the Scorpion project and can decrease the pace of the project if the budget is putting up limitations. Control is also upheld by the DGA according to the law 1516 - to exercise control of the acquisition activities in order to save the budget. There is also the possibility for the Ministerial Committee of Investments to intervene into projects to review the project stages and possibly change milestones, if considered necessary.

Consequently, the French manner in dealing with the Scorpion project concerning government control would have a good probability to result in a battle group and thus a System of Systems better adapted to what the end user requires. The degree of control is an element that indicates a future

possible success of the mega project. The efforts to keep the Scorpion project as simple as possible, with a few vehicles and a few communication systems and is managed in one stage at a time in order to avoid unnecessary complexity is also an element of success. The control have been kept although a System of Systems have been claimed to be necessary to be bought as a whole and not in parts without risking severe degradation of the overall System of Systems. Instead of offering specific single systems and vehicles and so on, decision makers have been offered to buy a comprehensive System of Systems. When budget cuts are decided upon and thus parts of the procurement list are also evaluated for cuts, one could claim that the decision makers risk degrading the System of Systems severely because if a System of System is bought only to a limited extent the entire advantage of the System of Systems is lost. In the end, the project Scorpion does have clear goals and project stages are also understood in terms of vehicles and their respective equipment, which makes results clear and palpable. The principles for vehicles and communication systems are also technically rather easy to comprehend as physical items and components which are planned to compose the future end goal of the GTIA as a System of Systems. In the Scorpion project, Institutional ideas described by Furusten (2013) and, for instance, ideas of pushing technological boundaries using technology development as a motive for its own sake according to Frick (2008) is not strong within the Scorpion project.

The later start of the Scorpion project compared to the other two studied projects enabled the management of Scorpion to consider causes of failure of other projects. Some other issues had also come further along in the developments. The first promising technologies from the first new communication development had matured when the NEB and BOA pre-projects started. The Scorpion project could start with more mature technologies and ideas connected to the technologies.

Preparations before the mega project start

By starting the implementations step of the Scorpion project in 2014 instead of earlier, it probably avoided obstacles difficult to otherwise foresee. In the two earlier projects not only powerful ideas were affecting the agenda, much technology was also immature. The Scorpion project still has the implementation of the GTIA as its main goal but also the transformation of the French Army with few a new technology systems and renovation as important ingredient of the mega project. The Scorpion project is a tool for the transformation and modernisation of the French Army. But keeping to a few chosen technologies and keeping the complexity low the Scorpion project that has rather few

vehicles and communication platforms and maintains a regular pace with project steps taken one at the time. The development of the System of Systems is complex and the technology involved is high technology, though the Scorpion project is intentionally aimed at consisting of few system components like vehicles and communication systems using a flexible time and scope of the development. The planning and management of the Scorpion project would then also have a manageable level of risk regarding achieving intended development of the GTIA.

The Scorpion project can be claimed to be a transformation but in that case implemented little by little over a long period of time in order to lower risks and decrease uncertainty according to Ansar et al (2017); Atkinson (2011). There is no overconfidence as described by Flyvbjerg (2017) about the possibilities to develop the GTIA and the development is being implemented gradually.

Any clear obstacles have also not occurred in the Scorpion project like what occurred in the other two mega projects.

I have now made an analysis of the Scorpion project and earlier about the other two mega projects. Each mega project has been analysed compared to the literature. I will now turn to the analysis of the comparison between the different mega projects where I will compare the different contents.

Comparing the similarities and differences between the turning points and sequences

The limitations of the discussion and the conclusions lead to some possibilities of augmenting the understanding of mega projects. The scope and magnitude of mega projects needs to be compared with the nation concerned and its armed force budget in order to create a reference for a mega project. In that context, the mega project budget and the time for the development need to be properly understood. There are differences and similarities between the different ingoing parts of the projects with some general differences and similarities presented in table 8 displaying the respective mega projects next to each other.

Mega Project	The Future Combat Systems	The Ledsys	The Scorpion
Ideas	<p>Revolution in Military Affairs with Network Centric Warfare that was understood to be completely new.</p> <p>Interconnected System of Systems developed with the emerging communication technology.</p>	<p>Revolution in Military Affairs with Network Centric Warfare that was understood to be completely new.</p> <p>Interconnected System of Systems developed with the emerging communication technology.</p>	<p>Revolution in Military Affairs with Network Centric Warfare that is understood to be a part of an ongoing modernisation.</p> <p>Interconnected System of Systems developed with new but mature technologies.</p>
Transformation aim of mega project.	<p>Complete radical change of land force with somewhat unclear aim.</p> <p>Built-in incongruous requirements from project start.</p>	<p>Complete radical change of armed force with Command & Control (C²) focus with unclear aim.</p> <p>Built-in incongruous aims of interconnecting different services from project start.</p>	<p>Complete incremental land force renovation and renewal.</p> <p>Renovation and new development of few vehicle systems to start with.</p>
Obstacles during the mega project.	<p>Strong and increasing pressure of becoming useful in the ongoing conflicts. Started in 2001 and increased until the project was stopped in 2009.</p> <p>Transformation shifting in mid-term due to spin-outs to the ongoing conflicts.</p> <p>Incompatible requirements.</p>	<p>Two defence bills in 2000 and in 2004. The first pointed out the Ledsys project as a transformation tool. In 2004, the transformation was changed to also include interoperability. After the interoperability decision Parliament politicians are informed about problems</p>	<p>No dramatical obstacle affecting the Scorpion mega project.</p>

		with the ongoing development. Transformation of combined services with C ² / shifting in mid-term due to new aim of becoming interoperable.	
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Table 8: Differences and similarities concerning ideas aims and obstacles affecting the outcome of the mega projects.

The development before, during and after the respective project is displayed in table 9 with the main sequential events for the respective mega projects showing the respective analepsis, start points, turning points, sequences, end points and the events after two of the projects were stopped. The first two projects have endings because they have been finished, but the Scorpion project does not yet have an ending. The Scorpion project was also rather recently started compared to the other two projects and measures have been claimed to be taken to avoid mistakes made in the previous projects. The overall idea for the Scorpion project compared to the other two earlier projects is about the same. However, the times were different in 1999 - 2000 compared to 2010, when the Scorpion project started.

Mega project	The Future Combat Systems project	The Ledsys project	The Scorpion project
Analepsis /Actors involvement	During the 1990s with studies / with high-ranking US Army officers and defence industry Boeing and SAIC.	During the 1990s / high ranking Swedish Army officers wanted a new force and wanted to transform the old invasion defence and were influenced by the US studies.	During 2000s with studies / driven by the French army and the Direction Générale de l'Armement. The development in other countries were studied.
Starting points /Actors involvement	In 1999 after the studies and after perceived need of a new type of force. Two conflicts, Iraq War in 1991 and Kosovo in 1998 were important drivers. The Boeing Company and SAIC were leading from the	In 1999 / 2000 after SAIC studies. Project management was mainly from the Swedish Armed Forces and Swedish Defence Materiel Administration.	In 2010 followed by a speech by the French Defence Minister Jean Yves Le Drain / Direction Générale de l'Armement keeps strong control over the project.

	defence industry. The LSI concept made the defence industry very strong.		
Sequence 1 /Actor involvement	Speeding up the project. The US Army and The Boeing Company and SAIC are the main actors and The Boeing Company and SAIC lead development.	Speeding up the project but slowly increasing concerns of little real content beyond the PowerPoint presentations. The project management from the Swedish Army starts the development.	Initial economic difficulties.
Turning point 1 /Actor involvement	In 2003 new requirements were added in order to adapt the Future Combat Systems for the ongoing conflicts.	In 2004 with the decision about making the Swedish Armed Forces interoperable which meant changed requirements and accelerated resistance from external services. The consortium starts with SAAB, Ericsson, the Boeing Company and IBM.	In 2013, the Scorpion project becomes the transformation tool for the modernisation of the French Army. The French army wanted the Scorpion and the French defence industry was concerned due to few defence orders. The Direction Générale de l'Armement manages the Scorpion project with tns-Mars as a joint-venture with the defence industry.
Sequence 2 /Actor involvement	Adaptation to the ongoing conflicts. The spin-outs decided by the US Army took resources from the main project.	Technical progression but the planning for interoperability with other services created problems. The project starts to decline in this sequence with increasing resistance from other armed services. Politicians in the Swedish Parliament are informed about critical legal issues	The French Defence Minister Jean-Yves Le Drain announced the Scorpion project as a modernisation tool for the French Army. The Scorpion project received a stable role in the renovation and development of the French Army.

		about the change and transformation.	
Turning point 2 /Actor involvement	In November 2005, the US Army changed the transportation requirements. It did not want to but was forced to due to intense political pressure. The number of planned vehicles was increased in May 2006 with more complicated technologies implemented. New resource demanding replanning.		
Sequence 3 /Actor involvement	Increased criticism from the United States Congress about the inability to adapt the Future combat Systems to the ongoing conflicts.		
Turning point 3 /Actor involvement	In summer 2007 the number of planned vehicles was changed in the Future Combat Systems with new resource demanding replanning.		
Sequence 4 /Actor involvement	Decreasing budget and increased mistrust from politicians.		
End points /Actor involvement	In April 2009 followed by decision by the Defense Secretary Robert Gates.	In 2006, the Swedish Government ordered the development to stop.	

<p>Epilogues</p> <p>/Actor involvement</p>	<p>After the project ended in 2009 the development of some technologies has continued due to the needs of the US Army, which stood without any new combat system. New tenders have been made after the project ending with other defence industry firms.</p>	<p>After 2006, the project Ledsys changed name and continued with the same development. The actors leading this development were the same that managed the Ledsys project. In 2009, the Swedish government ordered the development stopped.</p>	
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Table 9: The different mega projects main sequential events.

The Analepsis

The Analepsis of all the projects are similar, as illustrated in figure 32. The ideas and motives are all the same. New information and communication technologies were assessed during the 1990s to be developed in the future and the development would be through civilian society, unlike what had been normal before in the military development and defence industries. For both the first two mega projects, Future Combat Systems and the Ledsys project in the Network-Based Defence development, austerity was a fact during the 1990s. Large and comprehensive development of entire armed forces could be done with fewer resources locked in large and costly armed forces, but development activities could be more comprehensive and thus also include the transformation of entire armed forces. The ideas to start comprehensive transformations were spread from the US to Sweden but also to the armed forces throughout the entire Western world including France. The ideas evolved from high-ranking officers and consultants in the US. In all countries, those ideas were then presented to the political community and became integrated into the national concept of future equipment and systems acquisitions. The beginning of such activity is to study and develop concepts around new ideas.

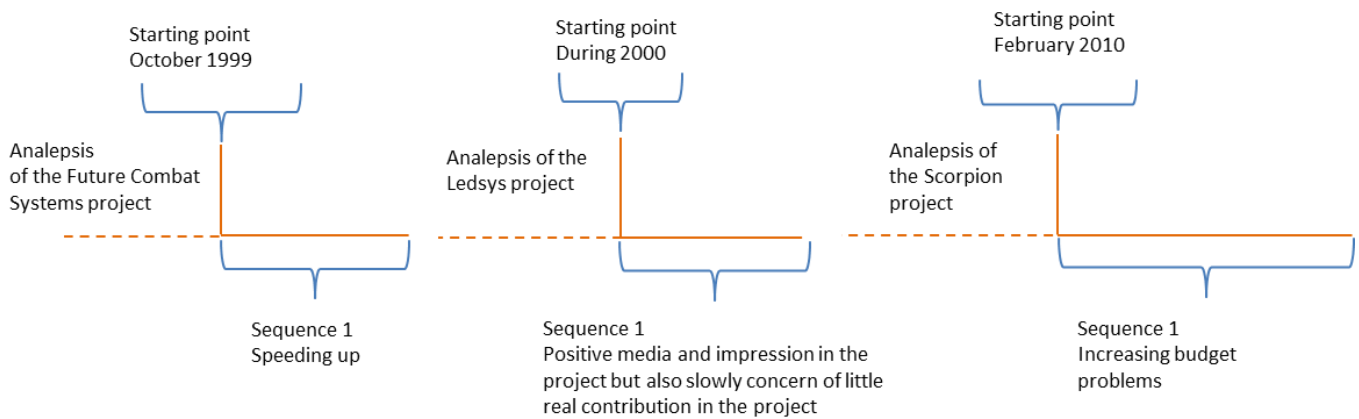


Figure 32: The different starting points of the Future Combat Systems, Ledsys and Scorpion projects.

The first two projects were motivated by new technologies and the potential of such technological System of Systems if communication technologies were interconnected. Future Combat Systems took inspiration from ideas that came to the US during the 1980s and 1990s from the Soviet Union and the Swedish inspiration for the Network-Based Defence development came from the United States. High-ranking Swedish officers went to the United States and wanted to know and learn about the planned developments in the US Army. The belief in the future was apparent, with project risk assessments put at least partly to the side, resulting in daring project plans. The Swedish development did not clearly try to avoid mistakes made in the Future Combat Systems project because both of the developments were running parallel which would have made serious error prevention difficult. The Future Combat Systems development was to a large extent kept secret so any clear view of the development was possibly difficult to discover due to secrecy and the resulting lack of information. The analysis of the Scorpion project also overlaps in time with the entire project implementation of the Future Combat Systems and Ledsys projects. Similar basic technological developments were used to motivate the Scorpion project. However, unlike the earlier projects Scorpion started with knowledge taken from other similar projects when the modernisation of the French Army was to be commenced.

Those concepts started with studies in late 1990s and continued as development projects in the US with the Future Combat Systems project and in Sweden with the Ledsys project. France also started a study around the same time, NEB, in order to evaluate how digital communication would affect the future French Armed Forces. The impressions and lessons have been drawn and the short timeline and parallel activities have shown to be important reasons why the Future Combat Systems did not succeed according to the French project management. The idea was there for the French Armed

Forces and was studied, but was not on the way to becoming implemented until a decade later with the Scorpion project. The first two projects were also strongly dependent on each other, with the Ledsys project apparently being considerably more dependent on Future Combat Systems than the other way round. Still, the Network-Based Defence development in Sweden was also looked at as an additional test platform, which would use the Swedish communication industry. All projects have been influenced by the other projects but adapted to the respective armed forces' main requirements.

The starting points

The starting points of the different projects are during the same period for Future Combat systems and Network-Based Defence, during the internet and communication technology revolution. The projects had been prepared for by studies during some years and in a development view, it was suitable to start the projects and transformations when the studies had been completed. It was also considered the right time due to the overall military and relaxed political security situation that had been ongoing for almost a decade since the Cold War. Due to austerity, the defence industries would also at this time have been in need of some kind of procurement if jobs were not to be affected. The overall aim for the development was to transform the respective armed forces according to new ideas but also to modernise the considered old armies or armed forces.

The starting point of the Scorpion project is different, since it started almost a decade later. France had other concerns during the mid-1990s, but the ideas of a network-based army started to grow eventually because the French Army with its ageing equipment needed to be modernised. The modernisation was also considered necessary in order not to risk losing some of the capability to be interoperable with its allies.

The French Defence Minister also gave this general reason when the plans to begin with the Scorpion project were revealed. The French Army needed the new communication technology implemented. Modernisation was planned to be implemented by a transformational project with a possible additional reason that if the French transformation was not implemented, France would not be able to take part in modern military activities in the future.

The start of the projects came from military wishes to transform the armies into more modern forces using modern and future communication technologies which the defence industry would not be able

to lead in the understood future. The dominant development of communication technologies would instead be implemented and led by civilian society. In this way, the starting points of all the different projects are similar due to the motives for starting them, even though the French project was started a decade later. Modernisation was considered necessary in order to manage future conflicts and be able to cooperate with the armed forces of other nations and use modern communication systems.

The first sequences

The first parts of the different projects include the respective first sequences, which have the common features of being characterised by enthusiasm. All three projects had their critics, but decisions to give control to joint venture firms to start working were taken or about to be taken. During the first sequence of the Scorpion project, however, the criticisms were rather about hesitation to start the project and modernisation efforts. For the earlier two projects, the criticisms were more about the large and daring undertakings and the risks that could be involved. All projects were also audited by other authorities because of the extensive use of public means and large parts of the armed forces budgets. In the Scorpion case, there is also one responsible external either high-ranking officer or politician for each project step, which was clearly not the case for the Future Combat Systems project or the Ledsys project. The two earlier projects had similarities with increased pace of development and positive media attention. The defence industry consortium developing the technology for the Ledsys project started to work with the project during the late part of the first sequence. Although the interactions between the Future Combat Systems had existed between high-ranking officers before with two American defence firms involved in the consortium, the information flow from the US project did not work as expected by the Swedish counterparts SAAB and Ericsson. However, other emerging concerns were also starting to arise. Little real results came out of either project, with much of the development made in computers with no real test systems. The lack of acquisition strategy of the US Army was also given attention. For the Ledsys project, not much more than PowerPoint presentations was produced. Outside both of the projects, concerns were raised about the technical difficulties involved.

A comparison with the French project, a decade later, shows economic difficulties during the first sequence of Scorpion. However, one important difference is that Scorpion has a focus on modernising the French Army with less complex or complicated technology systems. This was made possible through the experiences and failures of other earlier similar projects such as Future Combat Systems.

The first turning points

The first turning points of the respective projects are different, but consist in the two earlier projects of changed requirements, which forced both projects to adapt to new directions, shown in figure 33. Future Combat Systems had new technical requirements to create technologies that would be better adapted to the ongoing conflicts at the time. The first real problem was regarding the weight requirement of all vehicles, which then became even more difficult to solve. Additionally, the new requirements meant different and changed kinds of vehicle design. The first turning point for the Swedish Ledsys project was also changed requirements of technical, management and conceptual kinds. The Swedish Armed Forces were ordered to become interoperable to a much higher degree than before. NATO standards were supposed to be implemented throughout all parts of the Swedish Armed Forces even if there were better specific Swedish technologies. The System of Systems that was about to be developed should also adapt to the new European battle group concept and become interoperable. The Ledsys project had to adapt according to the new directives.

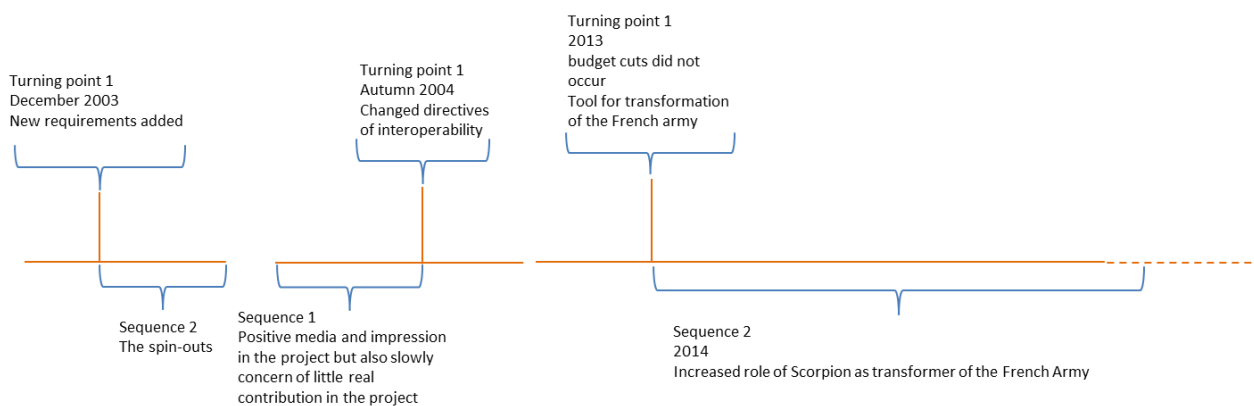


Figure 33: The first turning points of the Future Combat Systems, Ledsys and the Scorpion projects.

The turning points in the Future Combat Systems and Ledsys projects have similarities of mainly technical origin. Around ten years later, the Scorpion project had its first turning point, when the project's economic issues were solved without budget cuts. The first turning point for the Scorpion project was about the decision to survive and then become the tool for the modernisation and transformation of the entire French Army. The Network-Based Defence interoperability decision meant new concerns that had not been managed before. That decision however came from the intentions of the Swedish government that wanted the Swedish Armed Forces to become

interoperable. One of the tools for achieving interoperability was the Network-Based Defence development with the included transformation, which makes the projects similar.

The differences between the turning points of the Future Combat Systems project and the Ledsys project are however not only about technology. The implementation of interoperability and adaptation towards NATO standards would have been a relatively larger task to manage, which went outside the Ledsys project. The basic manner in which a land force is to be constituted is the same in the US and in France. But in the Swedish case, the turning point also meant a shift towards a way of managing military affairs which had never before been done, at the same time that the transformation towards Network-Based Defence was ongoing.

All three of the projects had or have aims to transform and develop the respective armed forces to more modern forces. The differences are still that the progression regarding the Scorpion project seemed positive at the first turning point, due to increased budget, but regarding the Future Combat Systems and the Ledsys project, the progression seemed negative due to emerging technical and conceptual problems which would need considerable efforts to manage.

The second sequences

The second sequences of the projects show increasing budget concerns in both the Future Combat Systems project and the Ledsys project, shown in figure 34. The Future Combat Systems had the so-called Spinouts for technology aimed at the ongoing conflicts that resulted in fewer resources for the main part of the project. Additional changes to the number of planned systems caused loss of focus in the Future Combat Systems project. The sequence consisted of mainly technical concerns and decisions with technical results.

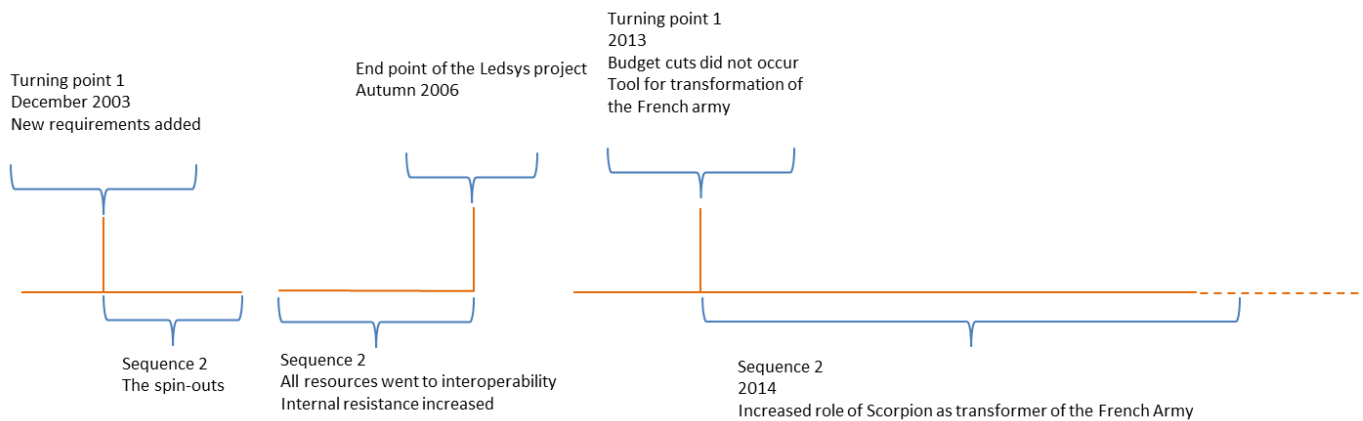


Figure 34: The second sequences of the Future Combat Systems, Ledsys and Scorpion projects.

The Ledsys project also had increasing problems with the implementation of interoperability, which technologically progressed but created problems in connection to other services within the Swedish Armed Forces. Because the Ledsys project was aiming at implementing Network-Based Defence in the entire Swedish Armed Forces, an emerging power struggle and internal resistance of influence between different armed services began.

The Ledsys project can be understood as declining from the second sequence until the ending of the project in 2006, which was decided by the Swedish government. Nevertheless, the project can also be understood as the attempt to create a network-based force independent from a specific project name. If so, the project continued with the new name Central for Common Picture/Network Operating Centre (GLC/NOC) and later with the name Common Information Picture (GLI). Nevertheless, the development had an ever-decreasing budget and tried to take budget from other similar systems in the Swedish Armed Forces command and control centres. In the comparison of the mega projects, the attempt to make the development survive over other activities and other services occurred only in the Network-Based Defence development. Such developments in the second sequence or in any other sequence have not occurred in Future Combat Systems or in the Scorpion project.

The Scorpion project has reached only sequence 2 compared to how much time had gone since the turning point in 2013 but also compared to how long it would be necessary to reach a potential turning point 2. The second sequence of the Scorpion project is characterised by vehicle and communication systems development and production as a transformation tool for the French Army.

The end of the Scorpion project cannot be stated since the project has not occurred in its entirety. However, no apparent obstacle in the project has occurred.

The second turning point of Future Combat Systems

The second turning point is therefore not clear for the Scorpion project, but for the Future Combat Systems this event meant more so-called spin-out technologies and a changed number of planned included vehicles. A very important technical requirement was also removed - the request for transportation capability with the cargo plane C-130, which had shown to be unable to lift Future Combat Systems. The vehicles could then be allowed to be heavier and thus could be produced which had before been practically impossible with clearly conflicting requirements. This decision was forced because any alternative was not possible, especially not with the ongoing conflicts at the time. With the removal of the transportation requirement, the Future Combat Systems project could be used to develop systems for current conflicts.

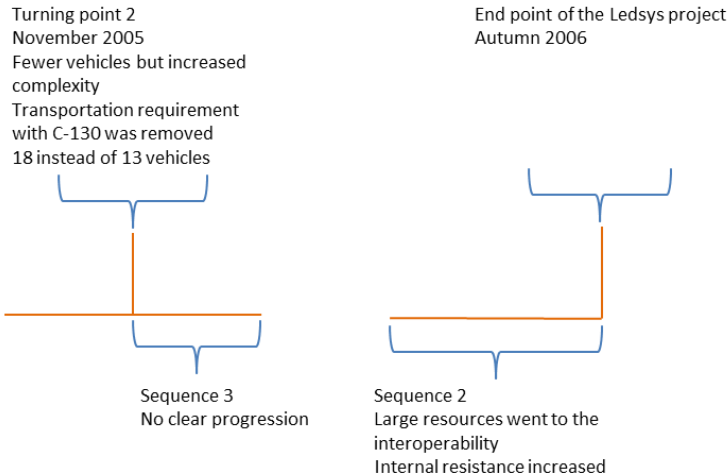


Figure 35: Future Combat Systems turning point 2 compared to the end point of the Ledsys project.

A comparison with the other projects in terms of any second turning point is not apparent since there are no clear other turning points. The Ledsys sequence 2 would be the same as the end point and thus the project termination. The Network-Based Defence development was however not stopped completely, but instead the name was changed and the project continued. A comparison can then be made between the continuation GLC/NOC project and the Future Combat Systems, as

illustrated in figure 35. In that situation, the end point of Ledsys can be seen as the second turning point, including a change of project name from Ledsys to GLC/NOC, but also a change of financial situation where GLC/NOC became more of a modernisation of the entire command and control system belonging to the Swedish Armed Forces. The development became a competition between financial support for the existing systems owners and the new planned system. This development has not existed in either the Future Combat Systems project or the Scorpion project.

The third sequences

Sequence three of Future Combat Systems was characterised by what was decided on during the second turning point: spin-outs and technology changes of the project, but also easier development due to the removal of the C-130 transportation ability requirement. The US Congress became more critical of the project due to increasing conflict regarding the outcome of the project and the inability for the project to contribute with technologies for the ongoing wars.

The third turning points

The third turning point of Future Combat Systems was another change of number of vehicles to be included in the System of Systems. The result meant resource-demanding re-planning and consequence evaluations.

During the last half of the project, but also after it had ended, the so-called spin-outs were created in order to save lessons and technologies for the conflicts in Afghanistan and Iraq.

The fourth sequences

The fourth sequence of Future Combat Systems is similar to the second sequence of the Ledsys project, with decreasing budget and increased mistrust in the project. Unlike Ledsys project the Future Combat Systems had development technologies that had been adapted for other systems and ongoing conflicts. Parts of the technologies for Future Combat Systems had been taken care of with the technology spin-outs in order to save chosen technologies. For Network-Based Defence, technologies had been developed by the defence industry but never came to the Swedish Armed Forces to share. The Swedish Defence budget at the time was not adequate to go ahead with any controlled acquisition of the technologies developed by the Ledsys project. As claimed, the other

parts of Network-Based Defence regarding methodology, organisation and staff were never really started compared to the technology part of the project.

The end point of the Future Combat Systems and Ledsys projects

The Future Combat Systems and Ledsys project end points were the result of political decisions, as illustrated in figure 36. In the US, the Defence Minister concluded the ending of Future Combat Systems. The end point of the Ledsys project was decided by the Swedish government. Both decisions originated in a gradually growing political mistrust of the respective development projects' ability to reach their aims. However, things were not ended completely.

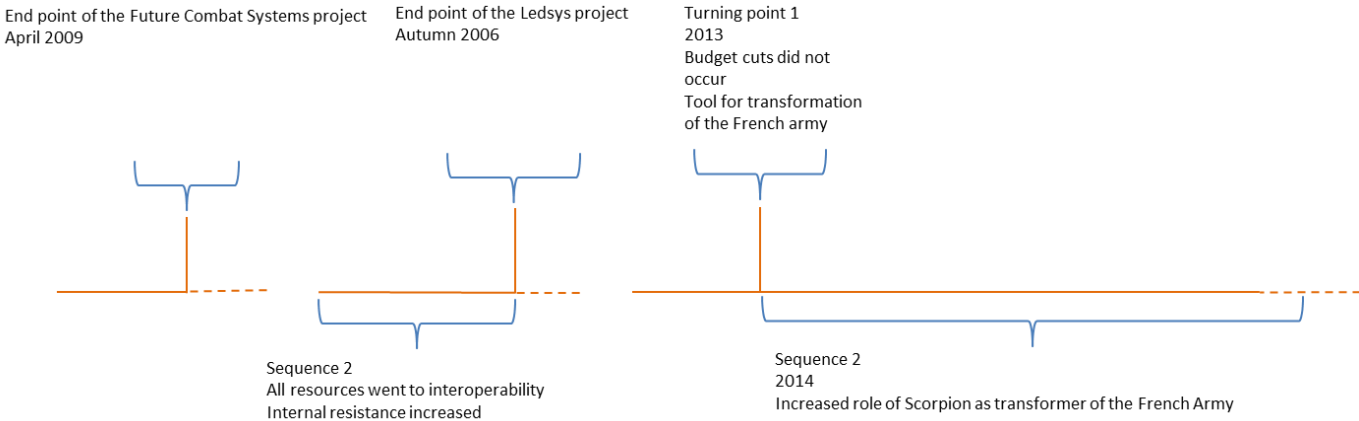


Figure 36: End points of the Future Combat Systems and Ledsys projects and turning point 1 of the Scorpion project.

Towards the end of the Future Combat Systems project and after it had been stopped, technologies were taken to the Brigade Combat Team (BCT) development. Other sub-programmes within Future Combat Systems were saving technologies and resources were aimed at creating combat formations instead of focusing on the stopped Future Combat Systems. The Ground Combat Vehicle (GCV) and Early Infantry Brigade Combat Team (E-IBCT) were created.

Similar events also occurred in the Network-Based Defence development when it was not stopped. However, it was done in a different manner. When Future Combat Systems could take technologies and recover them into other systems, Network-Based Defence development continued without really having the authority of the Parliament. Both mega projects had continuations but in two different ways: one was organised in order to save technologies for a possible partial or complete failure of

the Future Combat Systems project, while the Network-Based Defence development continued without saving any technologies.

There is no end point for the French Scorpion project, so end points can only be compared between the Future Combat Systems project and the Ledsys project or possibly the Network-Based Defence development ending with the Common Information Picture illustrated in figure 39. Regarding their vast difference in scope and budget, the end points appear to have occurred for similar reasons, with failure over a long period to show much of the intended objectives being met. Conflicts and growing numbers of hesitating actors were also seen in the projects, but especially during their final years.

The project epilogues

The development of large parts of both Future Combat Systems and the Swedish Ledsys project did continue after they were formally stopped. It is not possible to comment clearly on the French Scorpion project regarding this subject, as the project has not yet stopped and is in its middle stage or in its beginning, depending on how the end date is viewed in 2020. For the Future Combat Systems and the Ledsys project, the respective end points did not result in a clear ending to the projects or development of considerable parts of the System of Systems, illustrated in figure 37 and figure 38. For the Future Combat Systems project, the name of the project was changed after the project was stopped. Almost all of the vehicles originally planned had been abolished and other reliable vehicles had come to replace the riskier completely new types of manned and unmanned vehicles. It also became clear that what was to be developed were brigade combat teams of different kinds, such as the Heavy Brigade Combat Team. The word 'system' in the earlier Future Combat Systems project was removed. This development is similar to the Swedish Ledsys project, which was stopped and underwent a name change to GLC/NOC and later GLI. Both the new abbreviations indicated that the development was about command and control systems development and easier to introduce into the ordinary ongoing development and maintenance of the existing systems. It then also became possible to use other funding aimed for already existing command and control systems at the expense of the existing systems, essentially starving them. In this manner, with a name change, other funding and different strained motivations for closing the existing systems, the development of the stopped Ledsys project could continue.

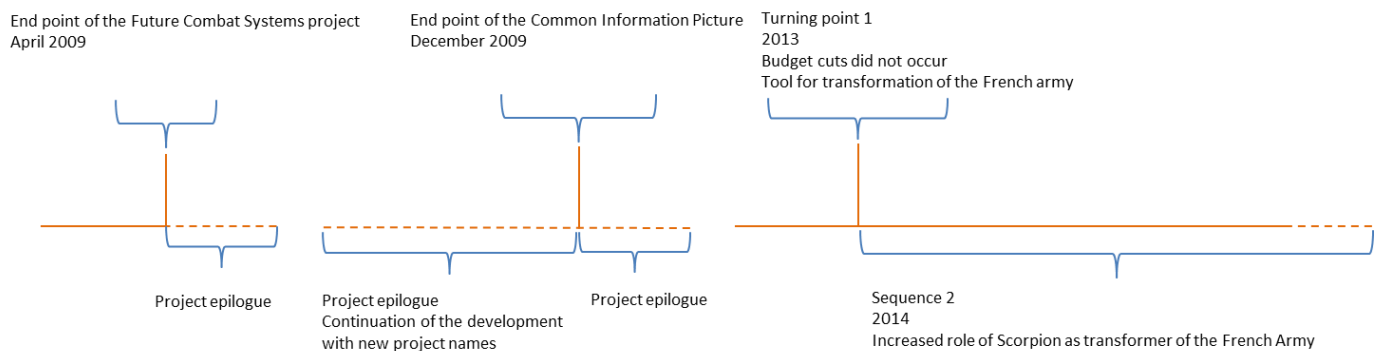


Figure 37: End points of the Future Combat Systems project and of the Network-Based Defence development and turning point 1 of the Scorpion project.

However, the difference between the epilogues of the projects is that the US Army Future Combat Systems was stopped but changed name due to changed aims and requirements of the planned vehicles for the future brigades. The parts that were stopped were stopped completely and other parts of the development were developed further. Something other than Future Combat Systems was developed with changed requirements, what would later become different brigade combat teams. Deliberately during the project, technologies from the Future Combat Systems development were taken to other development activities in order to make use of what had been created.

The Ledsys project was stopped, but the Network-Based Defence development was not really stopped. The management of the development instead changed the project name and altered the way in which the development of Network-Based Defence was funded and motivated as an ingoing part of the ordinary defence acquisition plan. Deliberately, the armed forces project management continued the development of Network-Based Defence in order to build what was planned from the start.

The Scorpion project does have similar aims as the other two development projects: to modernise the French Army with new and also renovated older systems. Some of those activities have been implemented and other systems are about to be developed with additional systems to be finished later. At the same time, the Scorpion project is planned to continue for many years to come including a second project phase from 2023 and into the 2030s. Given the planned progression of the project and the aim of being the moderniser of the French Army, but also comparing with the other two projects, any clear ending to the Scorpion project would be difficult to imagine. It would require the French Army to discontinue its modernisation. A project of mega scope with aims similar to the

ordinary line activities would easily grow into the line activities due to the project scope, which comprises considerable parts of the efforts of the organisation. All the projects have been planned and executed over a long period and the projects have become essential part of the acquisition for the respective armed forces and acquisition authorities.

The mega scope of the projects does not only make them very large and complex, but also essential for the organisations, that is, the end users who acquire the systems, which is the end goal of such mega projects. The result or part of the result would be that from both the end user point of view and the political point of view, the content of such projects could be critical for the activities and functionalities of an armed force.

With so many resources at risk and with clearly noticeable parts competing with other resources from an armed force, mega projects can easily push out other essential activities and thus become a drain for an armed force organisation. However, the organisation managing the mega project would not stop existing. Instead, the mega project with time can become a part of the line organisation. One could argue that a mega project actually already starts to become a part of the line organisation as soon as resources, technologies and knowledge are taken out from the project and used for additional tasks and aims, and the two different organisational parts become more and more dependent on each other.

For the ongoing Scorpion project, an end point could occur, but a large part of the project aim is in practice the same as the aim of the line activities of the French Armed Forces and the DGA - to maintain old systems, develop new systems, develop concepts and plan for continuous equipment maintenance. The other two projects were aiming at new technology and not to implement any of the new technology into the existing equipment and systems inventories. The Scorpion project aims at implementing new technologies into the existing and future inventories of technologies and systems, which will make the development and implementation of new network-centric technologies a part of the line organisation activity.

The narrative epilogue

The development of the two first mega projects, the Future Combat Systems and Ledsys projects, continued after the formal ending of the respective projects with sub-projects cut out from the stopped main project. The name was changed for each and the development was continued with a

similar purpose. The Future Combat Systems project was formally ended in 2009, but the development of the technology continued and was aimed at being implemented in other systems. Similarly, the Swedish Ledsys project was stopped but changed name and continued twice before the development was finally stopped. As mentioned in the methodology, there is a defined stage in the narrative concerning the pre-history to the projects, the analepsis. From the start, during and until the end, there exists a structure to help in understanding the dynamics of the mega projects. However, when mega projects are claimed to have been stopped, the actual development of the project is not always stopped but may continue to develop what has already been done, sometimes with small changes and under a different name. The narrative template does not include such an after-project-ending component. An additional part of the narrative is therefore needed to describe the events and dynamics even after the formal ending of a mega project. Such an additional part would be an epilogue for the events and dynamics after the formal ending of a military mega project. During the epilogue of a mega project, the possible successes of the development can be placed in an attempt to allow, for instance, specific technology to survive. Parts of projects can then be saved for different reasons, of which one is to save necessary technology in order to create whatever is possible with what is left. Another reason to save parts of projects after a project formally ends can be to serve the interests of specific groups. If not an entire mega project, crucial parts and results of a mega project could be successful if transferred to external activities. Moreover, if an epilogue is added to a narrative inquiry, it can be possible to create a better picture of the dynamics and the extent to which a mega project can be claimed to be a failure or a success. Without an epilogue, it can be easy to claim a mega project has been a failure, if the mega project is not finished in time. If an epilogue is added, it can be easier to see the belonging parts of system but also continuation of the project containing parts of the actual mega project. With an epilogue added to the narrative sequence, a certain failure can be understood as rather a partial failure with some successes. An epilogue also provides yet another possibility for an ex-post understanding of the dynamics inside and around a mega project.

The Epilogue can contribute to and possibly clarify if a mega project really is a pure mega project or is it an actual part of the overall defence equipment strategy and acquisition plan. A mega project has many subprojects and an equipment strategy has many subprojects to acquire defence systems for an armed force. The difference between an independent mega project and a defence equipment strategy and acquisition plan can be great but also very small. An epilogue would contain the rest of a mega project and could contribute to deciding whether subparts of a former mega project should be considered failures or successes and nuance the results of a mega project development. A mega

project epilogue does not only visualise what components of technology or systems continue to be developed or not. An epilogue can contribute to the visualisation of power struggles within and around a mega project. When the project resources become scarce the different actors feel pressured and can use methods otherwise considered inappropriate.

Chapter 7 – The discussion of the dynamics in the three mega projects

Introduction to discussion

The decision to plan, initiate and implement mega projects is not only about project management or technology management. It is about what can be defined as a development culture. It is a shared overconfident, global, and unclear discourse, which has characteristics that are reminiscent of what is usually perceived as ideology, as described by Gil, Lundrigan, & Pinto (2017, p. 50, 81 & 107-109), leading to overconfident, overly global, and rather unclear management and implementation of the project as described by Sahlin-Andersson (1992, p. 76). It has also been concluded that the organisation supposed to deliver a mega project frequently does not know how to implement it (Flyvbjerg, 2017, p. 12-13). In a context of deep technological and economic uncertainty, the development culture protects what a group of actors thinks should be created. The debate is about whether to be pro or con an “ideological” movement rather than be pro or con a technological development. As the decision to launch a mega project is not merely a scientific and technological decision, but looks like a decision that involves conflict between political and ideological positions, Levitt and Scott (2017) have suggested using Swidler’s political and cultural model of this kind of conflict to understand the starting and the development of mega technological projects. Swidler (1986) focuses on cultural competition in sociological environments such as social systems. However, the type of cultural struggle Swidler analyses has some similarity to struggles about the launching and development of mega projects. The model explains the competition of cultures which affects action, where one type of culture tends to preserve and is not too prone to change and another type promotes major change. Decisions based on values is a central concern mentioned by Swidler (1986) and this is also the case for mega projects. However, Swidler’s model is rather static. When trying to study the development of mega projects, more dynamic analytical tools are needed, and the study of changes in culture led me to use the notion of epiphanies, which allows me to investigate moments in the mega projects when actors’ discourse and actions change. As mentioned before, the development culture that favours the decision to launch a mega project is overconfident, global, and unclear. When the project develops, it encounters concrete difficulties with technological setbacks and organisational resistance. Thus, a change in culture becomes necessary. This occurs through an epiphany (Denzin, 1989; Dumez, 2016) that affects discourse and practice simultaneously. Epiphanies do not occur in an uncontrolled environment. They are the result of a conflict between competing

cultures involved in the development of the mega project. Pragmatic reasons can be behind changes of discourse and practices when, for instance, a new technology is either to be chosen or not chosen. However, technology development is deeply uncertain and characterised by values and controversies. So the decisive factor for the triggering of epiphanies is related to power. Clegg (2017) has insisted upon the role of power in the dynamics of mega projects. He relies on Lukes' analysis of power. According to Lukes (2005) power affects what actors can do and is further closely related to development culture.

To be able to affect the development of a mega project, power has been included. Power is mobilised to explain the way epiphanies occur. Lukes (2005) describes three different faces of power that could be utilised in mega project contexts. The first face of power is the ability to enforce some people's will over someone else's will, whilst the second face of power is the ability to keep issues away from the agenda and divert issues from becoming subject to decision. The third face of power is the ability to define reality and affect people's aims.

The relationships between development culture, epiphanies and power need an explanation because the links between these phenomena are important for understanding dynamics in mega projects and sorting the links between development culture, epiphanies and power.

To reiterate, development culture is at the very beginning overconfident and fuzzy. These characteristics help make the decision of launching mega projects. But when mega projects begin to develop, concrete problems occur and controversies develop. A change in culture is needed. Epiphanies, as changes of discourse and practice, are crucial to study to understand the dynamics of development of mega projects. But to understand how epiphanies occur, we need to study power relationships among actors.

In this chapter of discussion, I will study the relationships between culture, dynamics (epiphanies) and power as the quoted authors have formulated them and as they explain the three cases presented.

The competition between cultures for change

Levitt and Scott (2017) suggest that Swidler's model for political and cultural struggle could form the basis for analysis of development of mega projects. First of all, we must explain why Levitt and Scott

went to look for a model that deals with the evolution of cultures in society to think about the development of mega projects, although there seems to be no link between both.

The reason to use Swidler (1986) is that Levitt and Scott (2017) argue that mega projects involve extensive social interaction between actors resembling the environment between cultures and shared understanding of the social world of cultures. The social interaction, based on regulations, norms and cultural cognition combined with activities and resources, provides social stability and meaning for the institution in such environments. Ideas create and craft the structure around concepts and mutual identities of actors, which fosters cooperation between actors. Indeed, mega projects are highly heterogeneous with differing understanding by actors with subjective opinions, perceptions and interpretations just as the rest of society.

What Swidler (1986) has done is to create a model that shows how culture affects action in a context of deep social transformation and of less social transformation. In times of social transformation, during unsettled times, culture affects action by ideologies that need to be followed by actors wanting action. In times of no social transformation, during settled times, culture affects action more independently from ideology, which means that resources are given for people to construct diverse courses of action. For an ideology based culture to succeed with intended action, structural opportunities for that action determine if an ideology based culture will succeed or fail. That means that the action needs to be successful in order for the ideologically based culture to survive.

According to Swidler (1986, p. 284) culture shapes and constrains action by values that grow from habits and skills of actors and shape how to act and interact with the social structure that varies with time. With the model Swidler (1986) explains how competition between cultures works between a settled culture and an unsettled culture, settled cultures constraining action over time and unsettled cultures competing through action with other cultural views. Settled culture encapsulates action over time resulting in little impulse or need to change.

Swidler (1986) applies the model to analyse dynamics in society. Society is broadly defined and Swidler (1986) deals with cultural dynamics in societal context. A clearly more delimited and culturally narrow context is mega projects that nevertheless contain large parts of socially constructed dynamics including culturally influenced change and power. Following Levitt and Scott, I argue that Swidler's model could be used to analyse the dynamics of actors in mega projects and it should work due to the extensive elements of dynamics of actors in mega project that have similarities to those of society at large.

To use Swidler (1986), however, requires an adaptation of the model because the culture model does not explicitly deal with mega projects but with sociology in society. Here is the way she presents her model:

	Characteristics	Short-Term Effects	Long-Term Effects
Settled Culture (traditions and common sense)	Low coherence, Encapsulates	Weak-direct control over action Refines and reinforces skills, habits, modes of experience	Provides resources for constructing strategies of action Creates continuities on style or ethos, and especially in organisation of strategies of action
Unsettled Culture (ideology)	High coherence Competes with other cultural views	Strong control over action Teaches new modes of action	Creates new strategies of action, but long-term influence depends on structural opportunities for survival of competing ideologies

Table 10: Two Models of culture according to Swidler (1986, p. 282)

The onset and implementation of mega projects is a change regarding cultures and in mega project terms, the settled and the unsettled culture can be illustrated as being two sides also in the competition of change in mega projects. Swidler’s model is useful for understanding the decision to initiate or not initiate mega projects, but also to understand the development of mega projects. I will first explain the question of the initial decision using Swidler’s model (1986) and then the question of the dynamics of mega projects, once they have been commenced.

The advocates for slow or no change represent the settled culture and the advocates for profound change represent the unsettled culture. The settled culture is the culture involving actors that do not want change, stand for stability and continuous activities, and manage line activities. Any change that occurs should be stepwise and carefully implemented. The control over action is weak in the settled

culture also with respect to mega projects and long-term work aims at creating long-term continuity including resources for ethos and rules for acting.

The unsettled culture in the context of mega projects is the culture involving actors that want comprehensive change, action and further change. An unsettled culture in mega project contexts would want the mega project to be initiated and implemented. The unsettled culture implies action and is characterised by cultural products like symbols, mythic lore and ritual practices. It wants drastic change and challenges the settled culture that wants to preserve and does not contain cultural products like the unsettled culture does. The attempts for change embodied by a mega project are a struggle between an unsettled and a settled culture.

The clash between the different cultures occurs due to the difference in opinions about whether a mega project should be initiated at all and how such an endeavor should be implemented. The basic differences are the change culture's competitiveness-based subjective ideology and the logic-based preservative culture's focus on efficient long-term continuity. The unsettled culture is competitive whereas the settled culture is preservative.

The unsettled change culture is characterised by relatively unclear aims and a desire for fast change, thereby competing with the settled culture. To oppose an unsettled culture is difficult because actors that do not further their individual careers and belong to the unsettled culture or are directly involved in that kind of environment can be *personae non gratae*. There is, however, a difference between opposing an unsettled culture when it is vivid and strong and when it has experienced resistance. Opposition is not acknowledged in the beginning when an unsettled culture is vivid and strong and the settled culture is weak. When the unsettled culture becomes weaker and the settled culture stronger, opposition becomes easier.

The control over action is strong in an unsettled culture and has impact with short-term effect. It affects the development in the way that a path is communicated where actors involved should adjust according to the mega project. The long-term effects of an unsettled culture are that strategies for action, the path, are created but the long-term effect is dependent on how the unsettled culture survives in competition with the settled culture.

Differences between Swidler's model and mega projects

I mentioned that Swidler's model cannot be applied as it is but needs to be modified because it does not explicitly deal with mega projects. A modification needs to be made to the model to fit mega projects which I have done in Table 11. Similarities and differences between Swidler's model need to be compared to how mega projects fit with the model. On a principal level, it is similar; the difference is about competition between two cultures both in cultures in society and in cultures in mega projects. In both contexts an unsettled culture wants to create change. The unsettled change culture wants to affect the daily habits, thoughts and ways of behaving by promising new ideas. An already existing and relatively static culture is represented by the already existing daily habits, thoughts and ways of behaving. In the beginning the already existing culture does not question the new and competing growing change culture unless, or before, it becomes threatened. Small changes can occur from the static culture's view but not intentionally drastic changes.

The main difference between Swidler's model for culture struggle in society and mega projects is what it is that defines a project. A mega project is a resource and time limited development of technological and organisational systems. It means that although a mega project in a military context can have different aims and purposes, it has an initiation and an ending. The initiation of a mega project is an event in time with a planned intended change and with an intended ending. The competition between cultures mainly occurs between the start and the ending of mega projects. The competition culminates during the lifetime of the mega project.

If I begin with the characteristics of the unsettled culture, as I illustrate in Table 11, it is competitive and wants to introduce new habits, thoughts and knowledge. When it comes to society, it may be just that, but mega projects have aims to introduce new habits, thoughts and knowledge with comprehensive technology and organisational change and development.

On the contrary a settled culture in mega projects is about retaining habits, thoughts and knowledge already acquired. Intensive technology development is not understood by a settled culture as anything clearly necessary, and existing technology is defended.

When resisting a development, a settled culture in a mega project does not necessarily comply with Swidler's model regarding weak control over action. Instead, a settled culture can make clear resistance by actions and take measures to defend the static environment.

Development mega project culture	Characteristics	Short-Term Effects	Long-Term Effects
Settled	Low coherence, Encapsulates. Conservative oriented, manages organisation	Weak-direct control over action. Refines and reinforces skills, habits, modes of experience	Provides resources for constructing strategies of action. Stands for continuities on style or ethos, rules, behaviour including, organisational adaptation and limitation of the mega project
Unsettled	Competing with other views and oriented towards comprehensive change	Strong control over action Teaches new modes of action Initiation of the mega project	Creates new strategies of action, but long-term influence depends on structural opportunities for survival of competing ideologies Survival of the mega project depends on how the settled culture survives

Table 11: adaptation of Swidler’s model to mega projects

The short- and long-term effects of cultures in society and in mega projects are similar. Swidler (1986) claims that the short-term effects of change culture in society launch new kinds of action and have strong control over action. That coincides well with how unsettled culture works also in mega projects as illustrated in Table 11. For an unsettled culture absence of refining skills, habits and experience are also clear in mega projects as well as in unsettled culture in society. Swidler’s model also demonstrates the same phenomenon in settled cultures in mega projects.

In Table 11, I have also illustrated the long-term effects of an unsettled culture in society that, according to Swidler (1986), are new change strategies. This is also true for a mega project with the possible addition that also long-term aims, though possibly unclear, should be included. The long-term influence depends on the success of the unsettled culture being implemented, and its ability to replace the settled culture. Swidler (1986) also indicates that an unsettled culture could facilitate mega project success. The change culture is relatively unclear and has unclear aims but is measured in clearly measurable terms like, for instance, project milestones. With time, it may become clear

that the development that the unsettled culture stands for does not hold much real content, the unsettled culture therefore loses credibility, and instead the settled culture gains credibility.

The long-term effects for the settled culture are continuity regarding rules, behaviour and organisational adaptation. This also applies to mega projects but if cultures in society means unsettled and settled culture competition, mega projects are driven more by an unsettled culture and a settled culture mainly belongs to the environment surrounding the mega project. It is the organisational order, rules and behaviour of settled culture that can be disturbed by a change oriented unsettled culture.

The difference in long-term effects between culture in society and mega projects is that Swidler's model allows interplay between unsettled and settled cultures. In a mega project context the interplay is a mega project that is initiated based on a change oriented unsettled culture that wants to implement comprehensive change. The settled culture that is subject to the change, does not want the comprehensive change implemented by the mega project. The adapted model for mega projects based on Swidler (1986) is illustrated in Table 11.

To sum up the differences between Swidler's model of culture in society compared to cultures in mega projects: the main difference between culture struggle in society and mega projects lies in the long-term effects to initiate comprehensive change. However, in mega project contexts the mega project is the unsettled culture realised as a tool for driving the intended change.

The unsettled culture consists of actors wanting comprehensive change and thus drives, or influences, the implementation of the mega project. It consists of actors who believe that their service needs revolutionary changes, not small incremental ones. The settled culture is mainly the surrounding environment affected by the mega project and consists of actors protecting themselves from effects on the services they belong to. The settled culture also exists among politicians that eventually become concerned about the financial situation when the mega project does not reach the intended aims. The unsettled culture tries to implement the mega project, and the settled culture tries to stop the development, interact via meetings and decisions related to the mega project. The main area for the conflict occurs in and around the mega project. The settled culture has its own armed forces service as a place to grow and the unsettled culture has the mega project as a safe place to grow, or decrease due to external influence.

The implication of Swidler's model of culture on the three compared mega projects

I have shown Swidler's model for mega projects in general but the model needs to be applied to the compared mega projects. Table 12 and Table 13 show how Swidler (1986) would be represented in a mega project context with the three compared mega projects represented. I present the respective characteristics and the short-term and the long-term effects for each kind of mega project culture.

I will use Swidler's model on the Future Combat Systems mega project and show how the model is useful to explain that case. After that, I will use Swidler's model on the Ledsys mega project and show how the model is useful to explain that case. Lastly, I will use Swidler's model on the Scorpion mega project and show how the model is useful to explain that case.

I show the respective cultural characteristics of each mega project with the proportions of settled respectively unsettled culture and then the short-term and long-term effects of the development culture in each mega project.

The short-term and long-term effects on each of the mega projects' development culture leads to an additional result in the explanation. The short-term effects, illustrated in Table 12, and long-term effects, of the culture illustrated in Table 13, become a concern about the initiation and the continuation of a mega project respectively. It means that the development culture around mega projects has characteristics with two important events, the initiation and the continuation.

I will begin with the Future Combat Systems mega project and the character of the development culture around the development. The environment around a development project of a very large scope is well-tried in the United States Armed Forces. Development of the order of magnitude reaching mega project scope has occurred before on several occasions, which also means that a comprehensive project is also relatively easy to initiate. It is seen as a normal means and is not necessarily understood as something extraordinary, unlike the situation in Sweden or France. That means that a change culture is a relative notion and should be understood in relation to how common very large development projects are. The reason for that is that the development actions of mega project scope are a part of the normal activities in the United States Armed Forces, which also makes the Future Combat Systems partly an ingredient of the normal settled culture. The ideas for the development are not necessarily something that only comes from an unsettled culture.

The development around the Future Combat Systems is unsettled and a settled culture is unclear or weak. Weak because the objection to the planned development of the Future Combat Systems exists before and in the beginning of the project even though the unsettled culture is strong. Only later

during the mega project the complaints become louder, more common and originate from political environments that was not the case in the beginning. The development culture around the Future Combat Systems mega project is mainly unsettled but the habit of comprehensive development activities makes it an unsettled culture with elements of a settled culture.

Compared to the other mega projects with comprehensive change plans, the Ledsys mega project can seem to have clear similarities to Swidler's model. The change culture around the Future Combat Systems project does not need to be unilaterally a change culture, compared to the Ledsys project where such change attempt would be the result of a more lateral cultural development.

The environment around the Ledsys project is unaccustomed to and inexperienced about comprehensive development projects. The Ledsys mega project is then a result of a more pure unsettled culture compared to the Future Combat Systems.

The other mega project in the comparison with predominantly unsettled cultures is the Ledsys mega project and the associated Network Based Development. The cultural environment around this mega project has more of an unsettled culture character. The different balance of culture compared to the Future Combat Systems can possibly be understood with the fact that comprehensive development projects are rare events in the Swedish Armed Forces. It is something new and perceived to be something more revolutionary than compared to the Future Combat Systems project. In the Ledsys mega project the unsettled culture is relatively stronger and the settled culture is weaker compared to the Future Combat Systems.

In general the Scorpion mega project differs clearly from the other two mega projects, also in the character of the culture. The Scorpion mega project is carefully managed, aimed at clearly defined problems and is clearly delimited. The project is not fast-paced and is aimed at keeping competence. The mega project is not an activity emerging from an unsettled development culture. Around the Scorpion mega project, the culture is settled and ideas and plans are results of normal changes of technology and organisation within the framework of a settled development culture. The Scorpion mega project has been created on the lessons from the culturally unsettled mega projects compared earlier with clearly similar aims but without the unsettled culture environment that the Future Combat Systems and Ledsys mega projects emerged from. The characteristics point to a settled culture around this mega project with little to no unsettled culture.

Comparing the cultural characteristics among the three mega projects, the Future Combat Systems involves a predominantly unsettled culture with elements of settled culture because of the historical experience and custom of comprehensive projects and developments. The Ledsys mega project is a

clearly predominantly unsettled culture with little or no settled culture in the beginning of the project. The Scorpion mega project involves a clearly settled culture with little or no unsettled cultural ingredients.

The short-term implications

Continuing from Swidler’s model, and the short-term perspective of effects from the culture it can be concluded that all of the mega projects have been initiated. Two of the mega project initiations can be related to the unsettled development culture that pushed hard to initiate the Future Combat Systems and the Ledsys mega project as illustrated in Table 11. In both of these mega projects unsettled cultures worked to initiate the development furthering action that was considered necessary.

Mega project	Development culture	Characteristics	Short-Term Effects
The Future Combat Systems	Settled culture: Initially weak and unclear Unsettled culture: Initially strong	High coherence Competes with other cultural views (Competing and oriented towards comprehensive change)	Strong control over action Teaches new modes of action (Initiation of the mega project)
Ledsys mega project	Settled culture: Initially weak Unsettled culture: Initially strong	High coherence Competes with other cultural views (Competing and oriented towards	Strong control over action Teaches new modes of action (Initiation of the mega project)

		comprehensive change)	
Scorpion mega projects	Settled culture: Initially strong Unsettled culture: Unclear	Low coherence, Encapsulates (Conservative oriented, manages organisation)	Weak-direct control over action Refines and reinforces skills, habits, modes of experience

Table 11: model of the short-term effects from the culture, based on Swidler (1986), on the compared mega projects

Unsettled cultures work to achieve action and vast change is not the case considering the Scorpion mega project, which was carefully planned and initiated. However, that development was considered necessary to maintain the capability of the French Army [Armée de Terre]. The delimited development can be considered to be hosted within a settled culture.

The short-term effects are similarly independent if the culture can be understood to be unsettled or settled. All of the mega projects have been initiated but it is the kind of initiation that differs. The difference in the initiation lies in the cultural differences but can be difficult to see using Swidler’s model. The Future Combat Systems and the Ledsys mega projects are initiated but with ideas and plans emphasising just action and less caution for potential negative development or setbacks that were clearly not taken into account. The Scorpion mega project is initiated with the intention of keeping skills and experience and avoiding risks. Action in the Scorpion mega project is important but action is balanced against the potential consequences.

I have now described the initiation of the respective mega project cultural characters. Swidler (1986) also shows the long-term effects from culture and I will now describe the long-term effects on mega projects from a cultural point of view.

The long-term implications

The long-term effects of the culture are again similar to the short-term effects, when looking at the Future Combat Systems illustrated in Table 12. The Future Combat Systems have an unsettled culture that in the long-term encounters problems and resistance when politicians questions the entire idea and the developments. The aim of the mega project is, however, rather clear and that can indicate a

mix of a settled culture helping to keep the ideas and plans realistic and delimited. Critical political concerns erode the credibility of the unsettled culture with an increased credibility of the settled culture that the critics support. In the end the unsettled culture is not able to withstand the growing resistance that comes foremost from politicians and the media. It leads to large credibility problems and finally to the termination of the entire Future Combat Systems mega project and an ending of the unsettled culture that wanted comprehensive change.

The development for the unsettled culture in the Future Combat Systems is also similar to the Ledsys mega project. Some differences are central, though. The long-term effects of the unsettled culture development in the Ledsys mega project are illustrated in Table 12. The Ledsys mega project is aimed at completely changing the entire Swedish Armed Forces. The combination of being both relatively unclear and having all the armed forces' services involved shows a strong unsettled culture and an initially weak settled culture. Other services are also culturally strong and an intensive resistance to the development begins. In the beginning of the development and before any severe problems have occurred the cultural competition is small or non-existent because other culturally strong services are strong but still unaffected. With intensified involvement of these services, the resistance increases. The ideas and plans facilitated by the unsettled culture gradually lose credibility and when the development is stopped the second time the unsettled culture finally loses to the settled culture.

Mega project	Development culture	Characteristics	Long-Term Effects
The Future Combat Systems	Settled culture: Initially weak and unclear Unsettled culture: Initially strong	High coherence Competes with other cultural views (Competing and oriented towards comprehensive change)	Creates new strategies for action, but long-term influence depends on structural opportunities for survival of competing ideologies,

			(and survival of the mega project)
Ledsys mega project	Settled culture: Initially weak Unsettled culture: Initially strong	High coherence Competes with other cultural views (Competing and oriented towards comprehensive change)	Creates new strategies of action, but long-term influence depends on structural opportunities for survival of competing ideologies, (and survival of the mega project)
Scorpion mega projects	Settled culture: Initially strong Unsettled culture: None or very weak	Low coherence, Encapsulates (Conservatively oriented, manages organisation)	Provides resources for constructing strategies of action Creates continuities on style or ethos, and especially in organisation of strategies of action, (that includes rules, behaviour, organisational

			adaptation and limitation of the mega project)
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Table 12 model of long-term effects from the culture, based on Swidler (1986), on the compared mega projects

Concerning the Scorpion mega project, there is not much of any clear unsettled culture. Instead, the culture around the mega project is rather settled and the development that is implemented is vigorously delimited and can be hosted in what can be understood as normal technology and organisational changes. The long-term cultural effects of the Scorpion project are therefore that the settled culture fosters rules, behaviours and competence. There is no clear sign of an unsettled culture aiming at comprehensive change at a fast pace.

The Future Combat Systems and the Ledsys mega projects have similar long-term effects. The Future Combat Systems has clearer aims and the surroundings are more used to events like mega projects compared to the Ledsys mega project, resulting in the Future Combat Systems having an unsettled culture but also elements of a settled culture. The Ledsys mega project is more unclear than the Future Combat Systems indicating that the Ledsys mega project does not have any or very little settled culture in the beginning. For both the Future Combat Systems and the Ledsys mega projects the settled culture that prevailed after the competition with the unsettled culture was similar to the initial settled culture. The Scorpion mega project does not have any clear unsettled culture but has a culturally settled development.

Swidler's model shows that cultures can stand against each other in society, but can also stand against each other in mega projects for which the model can also be used to understand the dynamics in such environments. Mega projects are characterised by opinions, ideas and plans that provide conditions for implementation. Swidler's model, after adaptation, fits to understand cultural character, effects on short-term and effects on long-term mega projects.

Swidler's model shows the dynamics through an explanation model built on cultural struggle. It illustrates mega projects well because these kinds of processes are to a great extent a struggle between ideas and culture. Swidler (1986) illustrates the cultural struggle but that is not enough to show changes of critical events and turning points in mega projects. The dynamics of actors in mega projects with shifting interactions and specific mega project turning points need to be researched closely in more detail.

Epiphanies change the paradigm

I have described the clashes between competing cultures but they do not contain much dynamics. Different cultural opponents are active and competition occurs. This means that the dynamics between actors need to be described. In order to do that the dynamics in mega project turning points in the chain of events need to be addressed. When a mega project for some reason changes course, which in mega projects commonly depends on actors, turning points create the course change. However, the notion of turning point needs to be unraveled to distinguish what is meant by a turning point.

A turning point is a general notion about expected and unexpected course changes when mega project activity changes to a different path than the one the activity had earlier. Changes in mega projects can, for instance, be planned and presented as milestones that form steps along the intended path of development towards the mega project aim. In the best case, the aim of mega projects is to reach all the milestones.

It is, however, not possible to only rely on intended and implemented changes and use, for instance, project milestones to understand the entire course of events.

Unplanned change can possibly occur if the management of a mega project takes unplanned decisions and the involved actors follow the new directives based upon a clear view about what has to be done. These would be turning points without any epiphany and little dynamics between actors.

Mega projects are, however, frequently changed through turning points of another kind, not with planned and intended changes, when actors change their thoughts and actions. From initiation of a mega project, new emerging concerns are added and this affects the development. Events of external or internal kind occur that change how actors act which gives rise to changes in mega projects. Changes caused by dynamics between actors that change their thinking and acting are epiphanies. This kind of turning point involves epiphany.

I will do something that has rarely been done before and mobilise epiphanies to understand the dynamics and allow analysis of actors' unplanned turning points when changed thinking and acting affect the outcome of mega projects.

Clegg et al (2017, pp. 238-258) describes aspects of interaction between stakeholders but not the dynamics of the interaction between actors in a clear manner with the impact of epiphanies.

Some part of the dynamics can be understood because moments when actors change thinking and acting and experience an epiphany can depend on the respective actors' interpretation according to Denzin (1989, p. 37); Dumez (2016, p. 128).

Why actors change their thinking and acting does not, however, depend on a sudden event seemingly emerging from nowhere. There can be numerous potential reasons for why setbacks emerge in the process of development, like overconfident mega project management or plans that are too global and unclear. The combination of daring ideas, neglected concerns and actors with strong wills gathered in different development cultures leads to shifting dynamics with different kinds of epiphanies.

I am using epiphanies for the reason that turning points in mega projects have occurred due to different kinds of insights that have changed discourse and actions of the actors and lead to a changed development path of mega projects. The insights have occurred in different ways having all resulted in changed thinking and acting by actors and have resulted in changed development paths.

What implications do epiphanies have in mega projects

Following the notion of epiphany involves a series of ideas where Denzin (1989, p. 37); Dumez (2016, p. 128) describe different kinds of epiphanies such as the cumulative, the major, the minor and the relived ones.

A cumulative epiphany may be the result of a series of events causing a buildup of dissatisfaction that is ultimately released causing change in thinking and acting by actors. Repeated setbacks in mega projects with failed progression as a consequence could possibly be an example of a cumulative epiphany. If different promising future technologies are supposed to be constructed together with the aim of functioning very efficiently, several forms and layers of risks and also uncertainties are present. With repeated setbacks caused by individual technology development failures, tensions are built up among actors that want the development to be successful. With failures, some actors lose confidence and the mega project becomes more difficult to motivate to the outside world. The tension is ultimately released as a cumulative epiphany.

A major epiphany is said to "shatter a person's life" with Raskolnikov's murder in Crime and Punishment as an example. The result of a major epiphany would be a comprehensive and complete change of the perception of what would be needed. A possible example of such an epiphany leading

to comprehensive and complete change in a mega project context could perhaps be a situation when what is considered necessary to construct is shown to be something completely else late in the process of construction. It could, for instance, be about an investigation pointing towards a need for an airport but well into the construction process the need for an airport no longer exists due to changed passenger travel patterns. When the signals reach actors in such circumstances it can lead to major changes in thinking and acting.

The minor epiphany can be difficult to detect but can lead to major changes in thinking and acting as underlying tensions are revealed to actors. An example of such an epiphany in a mega project context could possibly be a small fact being interpreted differently than it used to be interpreted or the small fact being given a new meaning, leading to a major change in thinking and acting. An unforeseen technology could be shown to be impossible to develop physically if the construction principle goes against the laws of nature. Furthermore, another example could be if a military mega project is based upon the principle that constant communication in the future system is necessary. If the constant communicating turns out to be easy for any adversary to detect and consequently combat, a minor epiphany can lead to large changes in thinking and acting by actors in the mega project.

A relived epiphany is to relive something that has happened before once more. It may work as a reminder of events that go well but also events that do not go well. As a reminder of something bad, a relived epiphany also weakens the credibility of an unsettled culture.

I have now explained what epiphanies are and put epiphanies in a context of mega projects. I will now continue to the comparison of epiphanies of the mega projects.

The epiphanies found in the compared mega projects

What I will do now is to show what kinds of epiphanies have been discovered in the respective mega projects but also which mega projects do not have different kinds of epiphanies. The comparisons can be made because the respective cumulative, major and minor epiphanies have the characteristics that Denzin (1989) describes epiphanies as having. However, factors leading to the different epiphanies are not the same but the epiphanies can still be identified and compared.

I will make the comparison in the following order: first the cumulative epiphany that after several repeated emergencies of a smaller kind eventually results in comprehensive consequences. After the cumulative epiphany, I will continue to the major epiphany that results in comprehensive

consequences after one main change of thinking and acting by the involved actors. The minor epiphany will also be shown in the comparison between the mega projects, where a neglect of critical facts eventually results in a complete change or stop of development activity. I will shortly mention the relived epiphany for the reason that the cumulative epiphanies are very similar if seen as reminders of concerns intimately connected to daring ideas, plans and decisions. Besides the epiphanies that have occurred I will also bring attention to the absence of epiphanies.

The cumulative epiphany

In both the Future Combat System (FCS) and the Ledsys mega projects, cumulative epiphanies have been identified. Below, I will explain and compare each epiphany starting from the Future Combat System mega project and then continue with the Ledsys mega project. Lastly, I will explain and compare the mega project that does not have any clear epiphany, the Scorpion mega project.

Regarding the FCS case, the politicians became increasingly critical during the ongoing wars, described on pages 145-157. It is clear that the ongoing conflicts created urgent needs not fulfilled by the Future Combat Systems' development. The repeated signals of need for change and resistance to the Future Combat System project came mainly from politicians and not from internal stakeholders belonging to other services. The previous mutual understanding that has been described by Levitt & Scott (2017, p. 102) eroded. Erwin (2011) indicates that the course of events in the mega project is clearly changed by turning points, like epiphanies, powerful enough to overturn entire mega projects. This has to do with how actors change their mind and start acting differently than they used to and is not the same as, for instance, project milestones, which are planned moments when certain project aims are supposed to be reached.

There are mainly two reasons for the signals leading to epiphanies in the Future Combat Systems mega project. The origin of the signals is firstly one odd requirement that makes any real progression impossible and results in an inability to progress with the mega project until the requirement is removed. The requirement is expressed in a way that it is also a part of the definition of the perceived very important new kind of military capability, the massive air transport capability. The other reason is the inability for the Future Combat Systems to meet the expectations from the ongoing conflict at the time. The entire mega project is based on very bold assumptions of what is possible to do in armed conflict. Even the perceived new kinds of conflict that emerge are shown to be completely wrong for the planned Future Combat Systems under development. Both the daring

requirements and the comprehensive technology systems development, whose technological readiness is immature, lead to unfulfilled expectations.

The result is therefore that the Future Combat Systems have seen a cumulative epiphany with cumulative negative signals about its development. The cumulative signals lead to disappointment and frustration because the ongoing development does not meet the requirements that have emerged during the ongoing conflicts. The entire mega project aim consists of using relatively light vehicles, which was not relevant in the ongoing conflicts.

Leading actors in the mega project want swift and comprehensive change. Setbacks caused by absence of project progression combined with the development which is not adapted to the then ongoing wars cause cumulative epiphanies to emerge for the actors. The signals emerge repeatedly and affect the thinking that the development is not as easy as had earlier been claimed. The acting in this case is the acting by actors to implement repeated changes of milestones, how many subsystems and what kind of technologies are supposed to be developed. For every cumulative epiphany caused by setbacks and complaints from politicians the thought process turns into saving what can be saved from the development and adapting the implementation before an eventual termination of the mega project (Erwin, 2011). What the cumulative epiphany means is that there are constant reminders of an impossible obstacle that creates constant small cumulative signals that one of the main tasks of the development is impossible. The result of the cumulative epiphanies is a settled culture that is similar to the one that existed before the development.

The cumulative epiphany in the Ledsys mega project happened because of the absence of progression with the mega project and the growing resistance that was a result from that development. The resistance to the development also grew due to stakeholders who understood that they were threatened but also from politicians who had been made aware that the Ledsys project was not succeeding as planned. The intended changes themselves gave rise to a major epiphany because of the resulting changed relationships between actors. It is a major epiphany due to the change of relationships created by the directives. The intended changes emerged from changed directives well into the development and made the mega project affect previously not involved armed forces services. A minor epiphany became the result because the basic rules for flying military aircraft would have been threaten had the mega project continued on the intended course.

Actors, belonging other services than the Swedish Army, the Swedish Air force and Swedish Navy, would later change their mind about the development were initially passive because they were not

clearly threatened by the mega project. In the early stage of the development absence of progression was still considered normal. It was intended to let the development go on as usual. In the Ledsys projects different actors influenced each other as described on pages 17, 184 and 189, which led to the creation of increasing organisational resistance, which entailed refusal to implement the plans of the mega project and a gathering of other actors to bolster the resistance. This was a form of cumulative epiphany because there were repeated signals of discord among the actors. The fear from other armed forces services was that considerable parts of the Swedish Armed Forces were threatened by changes for the worse. The main sources for the signals were other services than the Swedish Army. They perceived the Ledsys project as a potential threat and its technology as a threat to the already existing systems.

Eventually, absence of progression and changes in the development aim made sensemaking about the ideas useless. The ideas could no longer be utilised to further the mega project and development. It can even be counterproductive to talk about the ideas for the involved actors, as I described on page 191. The previously shared understanding, according to Levitt & Scott (2017, p. 102), about what is about to be developed, had at that stage been shattered and left only as small islands among the actors. The mutual understanding among actors was changed by cumulative epiphanies with series of small signals about the development not going in the right direction.

Gradually the resistance in and around the Ledsys project grew with a growing insight into the problems and project final aim and the project management lost its credibility and influence. The change of the culture around the ideas for the new kind of future military systems changed gradually with the cumulative epiphany. The signals leading to the cumulative epiphany were the absence of progression in the project resulting in resistance.

Actors belonging to the mega project management did not change their minds and did everything possible to continue the development but the positive thinking about the development was eventually impossible to maintain. The resisting actors from the Swedish Air force did everything possible to stop the development, refusing to implement project plans, warning politicians and spreading the resistance to other actors. Cumulative epiphany changed thinking and acting mainly by the resisting actors whilst project management changed their acting but not necessarily their thinking. The result after the cumulative epiphanies was the victory of a settled culture resulting in a situation similar to what that which existed before the development was initiated.

The last initiated mega project, the Scorpion mega project, had no cumulative epiphany because that development is delimited and does not have the cultural driving forces that the Future Combat

Systems and the Ledsys mega projects have. The involved actors in the Scorpion mega project have a realistic attitude and have not changed their thinking and acting either before or during the development.

Comparison of the cumulative epiphanies

The cumulative epiphany is a series of repeated signals that works as reminders of, in the discovered cases, perceived anomalies. That description goes for the cumulative epiphanies in the Future Combat Systems and the Ledsys mega projects, which were initiated first. Why cumulative epiphanies have occurred in the Future Combat Systems and the Ledsys mega projects has to do with repeated setbacks. The setbacks have origin in the vague, too global ideas and aims that in principle did not have any clear limitations and resulted in technological setbacks, repeated replanning and organisational resistance in both mega projects. The mega projects had unrealistic expectations and a management that believed in the expectations for cultural reasons and therefore neglected important information. The involved actors that furthered the developments did not want to see or could not see the problems arising.

The difference in epiphanies resulted in differences in development of the respective different cultures. It meant that a cumulative epiphany affects the culture gradually and erodes the credibility of the unsettled culture that initiates and manages the development. One reason why the mega project is still continued is the absence of attention to the critical problems that give rise to the cumulative epiphany. High ranking officers i.e. decision makers that initiates the mega project and management, neglect problems which results in cumulative epiphanies for, e.g., engineers and resisting actors. The decision makers and management, themselves experience a minor epiphany. A minor epiphany is more easily neglected compared to a cumulative epiphany. This means that the development culture can be protected for a longer time because the minor epiphany does not result in immediate change of thinking and acting.

The major epiphany

A major epiphany means that actors change thinking and acting by one sudden profound event or insight. The major epiphanies I discovered have occurred in the Future Combat Systems and the Ledsys mega projects and I shall start with the Future Combat Systems.

The major epiphanies have been the impossible requirements that have been integrated from the initiation and the new and sudden project directives respectively. The fact that the Future Combat Systems were impossible to continue unless the requirements were removed resulted in a major epiphany that continuously reminded stakeholders that the development had critical flaws. Such requirements were added because some influential actors believed, or wanted to believe, that there was a possible solution. The thinking before the epiphany was that the development aim was possible to achieve and the development activity was to continue without any changes.

The air lifting, though, is probably only partly a major epiphany. The reactions to the incapability to airlift the Future Combat Systems would probably be understood differently depending on what actors in the development are involved. Engineers, for instance, would soon understand that the problem is impossible to solve but the project management could be unaware of the problem for a longer time due to neglecting technical air lifting problems. This means that among engineers a major epiphany could be the case at hand because insight should be made about the impossible task. The actors planning the mega project involved in the idea creation can experience a minor epiphany when neglecting basic technical properties. It requires that those involved in the planning and idea creation truly believe in the ideas and plans. It would be a minor epiphany due to the crucial fact that the planned airplane type for transport could never lift the entire Future Combat Systems and that actors neglected the information.

After removing the air lifting requirement the ability to make use of the technology parts that can be saved from the development is the priority for the actors. The goal is to start saving what can be saved from the development. This means that the major epiphany in the Future Combat Systems case is a change of thinking and acting when the requirement is removed in November 2, 2005.

The major epiphany in the Ledsys mega project is when the project has new changed directives according to “the decision on interoperability” that I described on page 183. The changed project directives turned the development into a threat to stakeholders that previously had not been threatened so much (Neppelberg, 2013). Before the changed project directives, the development continued as a separate development project. Actors continued their respective activities in accordance with their previous way of thinking. The changed project directives (the decision on interoperability) taken in December of 2004, started the change in thinking and acting by the actors that eventually led to the termination of the development.

The greater threat resulted in stakeholders being more involved than they had earlier been including stronger organisational resistance as a consequence. The main reason for the resulting resistance was the increased impact on them from the mega project Ledsys.

The increasing resistance against the planned changes made actors start to resist using channels to other actors and stakeholders that had not previously been used, and thus put pressure on the mega project management. The mega project management tried to silence the resisting stakeholders who had changed their minds about the mega project. The resisting stakeholders' influence on other actors eventually led to the termination of the mega project.

I have not observed any major epiphany in the Scorpion mega project. Furthermore, no development directives or prerequisites have been changed regarding the Scorpion mega project. Although major epiphanies occurred in the two earlier mega projects none of the built-in requirements resulting in the epiphanies have been observed in the Scorpion mega project. The actors involved in the Scorpion mega project have not changed their thinking and acting about the development.

Comparison of the major epiphanies

The major epiphanies of the Future Combat Systems and the Ledsys mega project differ. One major epiphany occurred due to a requirement that was impossible to solve until the requirement was removed. The removal caused a change in thinking and acting by actors in the Future Combat Systems mega project. The other major epiphany followed the changed project directives introduced in the middle of the Ledsys mega project. When the aims changed then the epiphanies were experienced among actors. They are not small changes but the times before the major epiphany and the times after are clearly different in both mega projects.

The major epiphany caused change the moment it emerged but the project was not terminated but it changed the prerequisites. The single critical problem that causes a major epiphany also becomes a turning point for the unsettled culture. From when the major epiphany happens, the main cause of events is no longer in complete control by the unsettled culture. The major epiphany has a similar impact on both of the mega projects even though the projects are different.

What I have discovered about major epiphanies in the compared mega projects is that they are at least partly connected to technology requirements in the planned developments. The requirements have initially been both unrealistic and unclear. The major epiphanies have caused the development to regress to realistic and clear development aims.

This does not exclude experiencing a major epiphany for other reasons, but it is not something discovered in the compared mega projects.

Because the compared mega projects with the experienced epiphanies have unrealistic and unclear planning based on ideas about technology it is close at hand to think that major epiphanies will occur due to anomalies emerging from some of the technology requirements. Inaccuracies caused by technical characteristics and legal regulations that presume certain technical characteristics have ultimately become impossible to avoid. It is possible that major epiphanies can more easily arise if technical prerequisites are first neglected but are later revealed when technical barriers for the development are revealed and imply absolute obstacles that actors cannot influence. Actors have let the development continue outside what is technologically and legally possible which has created absolute obstacles for progression without adaptation. That has created the major epiphanies.

The minor epiphany

The minor epiphany in the Future Combat Systems mega project is about neglecting the critical fact about the impossible air transportation requirements. That concern becomes a critical issue and affects the unsettled culture. The decision to remove the critical requirement is, however, taken in the middle of the project lifetime so the potential tension does not become as high. The US Armed Forces are used to large development endeavours and are not as affected by experiencing epiphanies and perceive them as a normal part of the process.

The minor epiphany in the Ledsys mega project is the insight that if the mega project continues it will lead to the Swedish Air Force being forbidden to use the aircraft. The mega project intends to introduce new technologies for air traffic activities and that requires new rules in order to be allowed to use any of the aircraft in the Swedish Air Force. The mega project is continued in spite of the fact that if the new system is introduced all flying will be forbidden. The neglecting of basic rules for flying is a perceived small issue but critical and is a minor epiphany with completely profound consequences. It makes any continuation of the development practically impossible but it also makes the unsettled culture irrelevant. To continue the unsettled culture after that insight renders actors being irrelevant themselves.

The Scorpion mega project did not have a minor epiphany. There are no clear signs about hidden or fuzzy requirements or actions in the Scorpion development that could develop into a minor epiphany.

Comparison of the minor epiphanies

The minor epiphany has an impact on the unsettled culture when it is revealed that it makes the unsettled culture less credible. The minor epiphany is a subtle development not discovered or apparently neglected. The mega projects contain two different but yet similar minor epiphanies. Critical facts are neglected or possibly not understood as being critical and this is a profound obstacle for development progression. In the Future Combat Systems the air transport requirement results in a minor epiphany because the requirement is neglected. The neglecting of the problem effectively prohibits significant development until the requirement is removed.

The minor epiphany in the Ledsys mega project is the attempt to make the mega project develop a system completely dependent on new rules for flying aircraft that turn out to be impossible. Neglected requirements resulted in a minor epiphany with profound consequences for the development. The epiphany was that the development had no prerequisites for success.

The relived epiphany

Lastly, I mention that a relived epiphany is to relive something again that has happened before. It is because the epiphanies in the failed mega projects have the characteristic of being similar to each other in the respective Future Combat Systems and Ledsys, like repeated reminders of unsolved problems. The epiphanies emerge repeatedly as reminders of concerns that are not, or cannot be, dealt with. In that sense, similar kinds of epiphanies were repeatedly emerging and relived in both mega projects. During the course of the developments, epiphanies tend to be similar and remind the actors about same or similar problems that are not properly addressed and systematically erode the strength of the unsettled culture that tries to implement the mega projects.

The absence of epiphanies and cultural competition in the Scorpion mega project

The mega project Scorpion that I have compared with the two other mega projects does not show any clear epiphany. One reason is probably that the project is not finished. That highlights an issue that epiphanies can be more easily found ex-post when the development has stopped and actors as well as researcher can sum up what happened. However, the mega project also does not involve the same total change of armed forces like the other mega projects. It is more carefully managed which

means that it is implemented part by part compared to the other mega projects where all changes are to be implemented practically simultaneously. In that way the Scorpion mega project works as one piece of many different equipment projects of an armed forces which does not require any special development culture other than a settled culture. It is a mega project but a part of the equipment system plan and does not have the daring comprehensive ambitions compared to the earlier mega projects.

The difference between the first two mega projects and the Scorpion mega projects raises question of how Scorpion is a mega project and why is there a difference. It can be divided into systems and how the interplay between actors works in the development.

What makes Scorpion to a mega project is the three systems that is developed and other older systems that is renovated. It can seem to be much but is not compared to the other mega projects. The new planned systems is further limited to one radio system and two vehicle systems which is clear and can easily be understood. The other compared mega projects aims at create everything new and are unclear, and are too general, of what is to be developed with even management themselves unsure about what exactly should be developed. The Scorpion mega project is not a mega project in the sense of being unclear and aims at develop everything at once. The Scorpion is a mega project regarding the total amount of work to be made and be developed. It is not a mega project regarding the amount of completely novel systems to be developed and not a mega project regarding the simultaneous involved developments and not seen to its clear aim.

As a result of the interplay between actors, both the two earlier mega projects endured considerable changes of the developments during the implementation phases with actors trying to further their different agendas. The Scorpion does not contain any clear interplay between actors that results in repeated changes of the development or shifting agendas among actors. The repeated changes in the two earlier mega projects occurred because the unclear and too general ideas eventually did not lead to any useful results. No such problems have occurred in the Scorpion mega project. The Scorpion have, in contrast to, the earlier mega project, no specific unsettled development culture and no clear epiphanies. In the sense that mega projects involves large amount of actors that have differing ideas of what should be developed the Scorpion mega project is not a clear mega project.

Possible answers to this differences is that it can be more difficult to find epiphanies ex-post but the most likely interpretation of the Scorpion mega project compared to the difficulties of finding epiphanies is that the project is scaled down to avoid problems, including unwanted epiphanies.

The management of having a clearly low development risk and absence of clear mega project characteristics can be why the Scorpion mega project seems to lack the kind of shared understanding and dynamics otherwise related to mega projects. There is also no clear minor or major disagreement between stakeholders in the Scorpion project. The project is not involved with any major change of directives or obstacles like in the other compared mega projects. Any other clear reason for sudden or continuous change (weak or major), is not visible. The reason for the absence of clear epiphanies in the Scorpion mega project is probably because the development is not finished and probably because it is implemented carefully without the strong cultural positions between actors and stakeholders in the development.

The Scorpion mega project does not have any clear epiphanies but also no clear culture competition because the development does not have such characteristics. One explanation is that absence of cultural competition means absence of epiphanies. The Scorpion mega project is planned and managed to avoid culturally affected development where daring project plans, development aims and insufficient delimitation are not tolerated. The culture in the Scorpion mega project is what can be expected in a normal development project strictly controlled by authorities with little room for any daring new steps of unknown innovation. The development is focused on reachable incremental aims that include new but not completely unknown technologies combined with renovated systems. That means that the Scorpion mega project is a part of the equipment plan of the French Army [Armée de Terre], which will always exist as long as the French Army exists. That means in turn that the ending of the Scorpion mega project can be difficult to perceive because it can grow together with the general equipment plan for the French Army. Why? Because the renovation of the French Army will always continue and the potential subsystems that have been decided to be a part of the Scorpion mega project can probably become unclear and will probably also have consequences on the type of culture.

The culture in the Scorpion mega project follows a similar pattern: no completely unknown technologies are furthered by new ideas because a settled development culture exists. In the earlier mega projects, the technologies are unknown and the ideas are completely new because those mega projects are driven by unsettled development cultures. To develop technology, which is in clear reach, does not require any unsettled culture that lives on promising ideas. The settled culture in the Scorpion mega project is characterised by the environments of an engineering project with little room for daring ideas of promising technologies.

The absence of daring ideas and completely unknown technologies makes different kinds of surprises such as epiphanies less likely. Epiphanies containing cumulated insights, neglected uncomfortable facts or drastic development changes do not exist.

There can still be a situation with an unsettled culture with a weak resisting settled culture though no such development with epiphanies has been discovered. The probability for such development is, however, not very likely because it lies in the nature of an unsettled culture to implement a thought development at a fast pace. The Scorpion development is slow and clearly managed with low risk as a stated intention. The absence of cultural competition limits the possibilities of making daring and ill thought through ideas from becoming reality.

The general implications of epiphanies on the culture in mega project context

What I have done is to analyse epiphanies as contributing to the dynamics in mega projects which Clegg et al (2017, pp. 238-258) does not clearly describe but stays with a rather static view on relationships and sensemaking in mega projects. Culture competition contributes to the understanding of mega projects and the dynamics between actors but does not give a clear picture about how the dynamics between actors unfolds. Epiphanies complete culture competition because turning points in mega projects are dependent on actors changing their thinking and acting during the course of the development. I propose that epiphanies can show the dynamics in mega project turning points and cause the ruling culture to lose in a competition against another culture.

The signals leading to epiphanies in mega projects become a force that influences the thinking and acting of stakeholders. In that way, epiphanies are a phenomenon that changes the course of mega projects but also weakens the unsettled culture especially if the initiation is made with unclear ultimate objectives. Epiphanies are fruitful to use in order to understand dynamics in mega projects but epiphanies also change cultural paradigms. In the cases I have discovered, it is the unsettled cultures wanting profound change that are stopped and the settled cultures that regain their former power when the competition between cultures is over. The settled cultures are initially weak because of the strong support from powerful actors belonging to unsettled cultures. Even though it might be unlikely, the losing side is eventually the unsettled cultures and not the settled cultures.

Conclusions on dynamics in mega projects

Turning points in mega projects can be planned or unplanned. Planned turning points follow the intended development and lead to the end when the tasks are finished. Unplanned turning points in mega projects are common and can be deliberate to implement necessary adaptation. When actors come to new realisations during a mega project and due to the changed thinking also change acting it gives rise to turning points in mega projects caused by sometimes sudden and uncontrolled directions of mega projects. The dynamics caused by epiphanies have origin in culture competition that involves unrealistic implementation attempts from the start. To understand dynamics in mega projects epiphanies can be mobilised in order to recognise types of turning points and kinds of dynamics.

Cumulative epiphany occurs when a perceived continuous problem is not removed but development can to some extent be continued allowing the driving actors to keep believing in the main aim. Cumulative epiphanies create dynamics empowering other actors who want to create something else than what the mega project aims for.

The cumulative epiphanies affects the perception of mega projects which results in eroding credibility for the developments. Because of the close relation between the unsettled culture and the development led by that culture the credibility also erodes the unsettled culture. The settled culture is the alternative that is left when the cumulative epiphanies makes the credibility erode for the unsettled culture and actors tend to return to the settled culture after the competition.

Major epiphany occurs when an unsurpassable obstacle is at hand and no development will succeed without removing the obstacle. There is no other way to take than altering the rules for the development so that the obstacle is removed. For the development to succeed it is necessary to create clearer aims and simplify the development. Dynamics created by the major epiphany are about actors wanting something else but it is also about the very fundamentals of the development with requirements too difficult to manage. The ideas for the difficult requirements come from the unsettled culture that once came up with daring and unrealistic ideas. The discovered major epiphanies in the mega projects occurred because the requirements are impossible to reach, technologically or legally. A question arises about the origin and the decision leading to the major epiphany and the reasons, driving forces and knowledge of actors involved. Because it can be about too little understanding of how risky a mega project can be but it can also be about unspoken additional plans for a development that ultimately is a question about power and possibly deception.

Minor epiphany can, for instance, be caused by neglect, or possibly incompetence due to inability to understand specific potential concerns. Actors may know but hide the fact that there are crucial concerns that potentially can stop or create obstacles for the development. Dynamics created by the minor epiphanies are about actors hiding, neglecting or missing critical information to further the mega project because if the information is known the credibility for the management would be lost. Hiding or even neglecting information is probably not done without intention and if there is a minor epiphany it can possibly be mobilised to discover hidden intentions in the power interplay in mega projects.

The origin of and reason why different epiphanies emerge is because epiphanies give information about kinds of decisions and different driving forces and interests. What are the roots of such epiphanies and how do they appear?

In this environment with planned and unplanned turning points, some ostensible unplanned turning points can be unspoken planned aims that are impossible to reach. Can epiphanies be mobilised to discover and understand the differences between such turning points?

Epiphanies as turning points caused by actors changing thinking and acting can be used to understand dynamics in mega projects. I have mainly used three different kinds of epiphanies for use on the dynamics of mega projects: cumulative, major and minor epiphanies. I have also described the relived epiphany because it is similar to the cumulative epiphany in the dynamics among actors because it could probably be possible to use on mega project. Epiphanies can be used to understand different kinds of dynamics between actors unfolding specific reasons for how and why actors are acting.

Something that can reach the dynamic between actors and how to affect others to act is still needed. I have identified different kinds of epiphanies as turning points in the chain of events but epiphanies (as unplanned turning points) alone are not enough to describe how actors act or avoid acting. I have shown that mega projects can exist without any clear cumulative, major or minor epiphany. I have also shown mega projects based on ideologically similar ideas with considerable planned and initiated comprehensive change resulting in different kinds of epiphanies. Epiphanies that finally lead to termination and failure of entire mega projects.

If culture competition illustrates a general struggle between culture and epiphanies illustrates changed thinking and acting by actors, the conscious affecting of actors by other actors with different means needs something else to explain that phenomenon. Because the organisational resistance I discovered is a sign of comprehensive change attempts.

How shall I now explain how the cultural competition, the differences in epiphanies, change attempts and organisational resistance interact? I will mobilise the notion of power. Because power is needed to implement daring decisions or to resist change.

The interplay of power between project management and stakeholders in mega projects

The management of mega-projects is characterised by cultural struggle. However, to understand how cultural struggles develop, the concept of power must be mobilized, which Clegg (2017) and Lukes (2005) have proposed. This concept of power allows explaining how turning points occur in the dynamics of mega-project management. Power is the state of an asymmetric relationship between actors, in which the actor with power is able to make a second actor carry out the first's will.

An unsettled culture wants to implement comprehensive change whereas a settled culture wants to preserve the order. I have shown that dynamics in mega projects can be understood if turning points are highlighted and used. Turning points involving dynamics imply unplanned changes, which mean epiphanies occur when actors change their way of thinking and acting. The changed thinking and acting results in changed cultures in mega projects and the orientation of entire mega projects.

How is it possible for epiphanies to create real change in mega projects? The answer has to do with power. While actors can change their individual thinking, coordinated action is only created when power plays a role in the dynamics of mega projects.

First, I will explain why power according to Lukes' (2005) can be used in the mega project context. Then I will describe the three faces of power that can be used internally and externally in relation to mega projects when considering why they either change aim or are stopped. Lukes (2005) studied power usage in public administration that deals with management and policies of government organisation and programs; he also examined the behavior of involved officials. Mega projects in a defence context involve government management of temporary development activities involving interacting actors. As the similarities between public administration and mega projects in the defence context are numerous, Lukes' (2005) conclusions about power can be applied to mega projects.

The first face of power, a straightforward form of power, is about how to make actors obey another actor's will. It means that one actor can directly make another actor act and take action according to the first actor's will (Lukes, 2005, pp. 16-17). An actor B is told to do something by actor A and actor B does exactly that.

The second face of power is the ability to, for instance, keep issues away from the agenda and favour those actions and processes that further a specific idea or plan. An actor A furthers the agenda that furthers actor A. Non-decision making also belongs to the second face of power when concerns can be kept covered or silenced before any question has been raised (Lukes, 2005, pp. 20-25). An example of this type of power could possibly be to alter activities in a schedule according to what fits a specific actor. A non-decision could be to postpone or hide a concern that is subject to decision to avoid having to take a poor and disadvantageous decision.

The third face of power is the ability to define the reality and affect the wishes and wants of the actors internally and externally to public administration and politics (Lukes, 2005, pp. 135-136). Examples of how affecting others' wants is by controlling information, mass media and socialisation but also by creating ideological kinds of aspirations of the actors. The aspirations work together with other actors' aspirations and the third face of power becomes the power altering perception and wills of actors. The third face of power connects to the change culture. This was evident in the first two mega projects which both included actors wanting to change to the new future and it is the same wants that is important for the unsettled culture in the two first mega projects. The change culture helps to gather actors around the ideas which make the change activities more powerful by strengthening the credibility of the ideas.

The two first faces of power and culture competition does not appear in the Scorpion mega project because that development is not based on completely new ideas that are presented for politicians and to other powerful actors in order to obtain exceptional authorisation. There is no change culture emerging due to any promising future development. The actors involved in the development are involved because it is a normal well-defined task and a small change to an already existing organisation meaning that only directly involved staff are needed. It is not a complete change where actors are gathering around a relatively unclear aim.

These types of power have been exercised in the mega projects reviewed, most clearly in the Ledsys mega project and the subsequent Network Based Defence development. The different faces of power interact to different degrees in each case.

The relationship between power and the mega projects

The use of power by the actors in mega projects is visible during the project when stakeholders start to become more concerned about whether the project is possible to achieve.

The first face of power is used throughout a mega project but is clearly visible in the initiation and is used towards the end of the development. The initiation requires actors making other actors start the development. Towards the end of mega projects, the struggle between cultures leaves actors with only that option of power 'as other actors are unwilling to act according to the mega project management. Finally, when the end of the mega project eventually occurs, it is the first face of power that is in use. It can become a competition between obeying or refusing orders but eventually the final cessation of the mega project is made by formal endings that can be achieved because one side has lost the competition. The order to stop is the first face of power exercised when the former leading side in the competition has lost credibility.

When mega projects start to show problems, replanning is done because actors start to doubt the development. Replanning is apparently a means of adjusting the project but also a means of making the activity look better and a demonstration that action is being taken. It is a version of administrative power, i.e. the second face of power. Another way of using the second face of power is to describe the mega project differently or change the name of the development so that it seems to be something else. This occurred with the Ledsys project when it should have been terminated. Instead, the project management of the Ledsys mega project tried to use other developments. The result was a changed name but continued like before despite that the fact that it should have been terminated.

A different form of power to use can be of a personal kind when actors belonging to the project management threaten individuals with potential prosecution. Evidence of this can be found at the end of the Network Based Defence development when the project management used the threat of prosecution to try to silence resistance. Both examples of the second face of power had the result of attempting to alter the agenda and make resisting actors change their behavior.

The third face of power is the power similar to ideology using the wishes and wants of the actors. It has a strong connection to the ideas and culture surrounding the mega project. The third face power is what motivates and makes actors work to initiate and implement the mega project. This kind of power is probably the most suitable for mega projects because actors will work for themselves and will make project management easier. With different kinds of setbacks and organisational resistance, this kind of power erodes first of the three faces of power. It happens because the culture and beliefs similar to ideology related to the ideas of the mega project lose credibility when the idea is put to the test but does not meet the expectations.

Power, according to Lukes (2005), has been used in public organisations and political environments. It is very similar to the context of mega projects in the defence context. The difference is that mega projects in the defence context create an environment that has mainly political implications on a national level rather than a general political implication.

The faces of power in my cases

I will now describe how power interacts with examples from the investigated mega projects. The third face of power is created and exercised by actors' by affecting the wishes and wants among other actors and could be regarded as being similar to ideology. It is this type of power that the unsettled culture uses to spread ideas and to initiate and implement the mega project. This face of power is one reason why the first two mega projects were initiated. The culture that has been created around the ideas of change makes actors positive about transformation. High-ranking officers met with politicians and industry leaders who were convinced by the new ideas. Initiation of the developments were ordered. The ordered development could commence due to high-ranking officers convincing politicians and later ordering the development in the US Army and the Swedish Armed Forces.

The will to change the entire US Army with the Future Combat Systems and the Swedish Armed Forces with the Ledsys mega projects can be motivated. High-ranking officers in both of the armed forces spread the ideas and created a culture that made other actors (politicians and officers) follow and think in the desired manner required for sensemaking and acceptance of the ideas. Power, according to the third face of power, was practiced by the high-ranking officers after introducing the tempting new thoughts and ideas. Later in the development, the third face of power was affected negatively and lost its effect with repeated and increased setbacks in the mega projects. These were brought about when the ideas were shown not to work and credibility was lost incrementally during the mega projects.

The third face of power

In the Future Combat Systems' mega project the third face of power is visible when high-ranking officers belonging to the US Army were behind the initiation and development. It was possible to initiate because there was an understanding that the perceived new times in military development had to be used to develop new systems. It also opened up opportunities amongst actors wanting

change when normal routines were under scrutiny and questioned. High-ranking officers who wanted change, used the opportunity when more traditional actors and practices were questioned. The power to change came from political authorization after request from the US Army. Resistance at this early stage before any problems appear is not present. Normally such development would be made incrementally, not comprehensively with everything at once. The comprehensive development was possible due to the third face of power because that face of power is based on ideas and promising plans and not solely in traditional hierarchy.

The project management then introduced spin-outs to save technologies generated in the development phase and make those technologies useful in the ongoing conflicts indicating that the development was not unconditional but preparations were made in case the development failed. This shows that the third face of power was weak and no longer reached out with ideologically similar ideas and therefore actors were hesitant about the development.

In the Ledsys mega project, the third face of power is visible during the initiation and during the development when offering completely new solutions to military problems. It was used by high-ranking officers belonging to mainly the Swedish Army and practiced first in conjunction with the initial positive sense-making and promised future development that answered well-known and long-standing problems. The long-standing military problems were the motives for the change. Similar to the Future Combat Systems mega project, high-ranking officers convinced politicians about a need for a comprehensive change, and as advocates attained the power to initiate the comprehensive cultural change. The Armed Forces were generally receptive to the changes because the planned changes were perceived as positive and politicians had been convinced that the change was good. Before any problems had emerged or other actors felt threatened, there was no resistance.

Ideas and a will to initiate the development came from culturally based thoughts and created shared understanding among actors. With the setbacks and absence of progression, the shared understanding eroded resulting in the unsettled culture and the weak third face of power weak which could not support the projects. With repeated and increased setbacks the third face of power lost credibility for the actors. The development was managed so that there were no alternative ways of managing the setbacks and no clear pragmatic solution was used to save parts of the development, thus indicating that the third face of power was rather unconditional.

The Ledsys mega project was more affected by the third face of power compared to the Future Combat Systems. The third face of power can be understood as conditional or unconditional in a mega project context. It is visible when management creates ways of saving parts of the

development (conditional) when spin-outs are used such as in the Future Combat Systems mega project or when there are no measures taken to save parts of the development (unconditional) illustrated by no real results in the Ledsys mega project. This means that the motivation and will to change was nuanced when the Future Combat System was implemented as there were actions taken to save parts of the development. The Ledsys mega project instead did not have any actions taken to save parts of the development and was unconditional with respect to the development and the lack of preparations taken to save parts of the development. The plan for the Ledsys mega project was to not have a way to go back. There was only one way forward, which makes that development unconditional. Because the third face of power is dependent on actors' wills and thoughts the third face of power is not applicable when the ideas and thoughts upholding the activity have changed and are not perceived as relevant anymore.

The development of the Scorpion mega project did not involve the actors' free will, thus the third face of power was not involved and there was no creation of culture and ideologically similar power. The ideas were old and not perceived as fashionable anymore when the initiation of the mega project started which made it difficult to use the third face of power a part of the motive for the development. The power relationships in the Scorpion mega project were traditionally hierarchal. There were no specific different asymmetric relationships.

However; there were high-ranking officers that gave orders regarding developing systems after specific needs. Such relationships and developments do not involve special ideas and daring plans that would require special explanations for politicians and industry.

The second face of power

The second face of power is when actors affect the agenda of what is to be created and developed. This face of power is most clear when problems arise in mega projects. Planning of activity and repeated change in schedules and timelines are some examples of this power becoming visible, and used to make the development adjusted to reach the intended aims.

The Future Combat Systems mega project had this sort of power visible and it was utilized through repeated replanning of parts or the entire development by the project management and the US Army when setbacks arose. One way of doing the replanning was, for instance, by "spin-outs" to save technologies and spread risk as I described on pages 138 and 146. Replanning does have a natural condition to change the project development into a better development. The spin-outs had the

function of endeavoring to make the development useful in the ongoing wars and to dampen the increasing criticism of politicians, as the development was losing credibility among these individuals.

In the Ledsys mega project, the growing resistance from the Swedish Air force made the project management take action in order to avoid concerns and critical questions about the development. The project management tried to alter the agenda and continue the development regardless. For examples, the project reemerged with a new name, GLC/NOC, in order decrease attention to the development and continue it like before but now at the expense of the Swedish Air Force. It was carried out by the former project management of Ledsys in order to continue the development that earlier had been ordered to be stopped by politicians. The project management had too little power to continue formally; however, they had enough power to try to hide the development with another name and the use of resources belonging to other services, mainly the Swedish Air Force. The latter started intensive resistance, which the project management eventually could not overcome. To use the previous name became impossible because of ever-decreasing credibility and loss of power to the Air force. Other actions taken by the project management were to threaten actors belonging to the resistance and thus hope to change the development. The change of name and the threats are a sign of the project management losing power and the Swedish Air force gaining power.

The second face of power is not clearly visible in the Scorpion mega project with no clear usage of altered agenda or other operation.

The first face of power

The first face of power is when an actor can affect another actor against that actor's will but also with that actor's will. This occurred in all of the mega projects. Because other faces of power are more visible initially and during the development, the first face of power becomes most clear when the other faces of power are not effective anymore. But it is not necessarily clear when a mega project is initiated and therefore the first face of power can be difficult to apply as a tool.

The first face of power in the Future Combat Systems mega project was seen in specific moments of decision during replanning and when the development was terminated. The project management and the US Army controlled those moments. There was no clear resistance in the development but the threat was that politicians had lost faith in the development, and terminated the development. This indicates that the power competition in the Future Combat Systems mega project occurred between the project management and the US Army on one side and the politicians on the other.

The first face of power in the Ledsys mega project was visible with the management's inability to make actors carry out and control the development. The two different endings of the development, the ending of the Ledsys and the ending of the GLC/NOC, were also due to the first face of power. The ending of the Ledsys project was ordered by politicians but was not followed completely by the project management that decided to continue the development as the renamed GLC/NOC development. The second termination (of the renamed GLC/NOC development) was ordered by the Supreme Commander and was eventually followed. But until then orders from politicians and the Supreme Commander were not followed by the project management, indicating a powerful project management, even late in the development. It also indicates the far-reaching difficulties facing the project management due to culture competition, when for example the resisting actors, mainly the Swedish Air Force, had spread information to politicians, and claimed that the project would have severe consequences for the Swedish Air Force.

The Scorpion mega project was clearly a start and continuation without any clear ideological means or agendas for manipulating actors. The visible kind of power in the Scorpion mega project is exercised with the traditional settled culture and stable hierarchy. The project was initiated and managed without a new ideologically similar cultural change, and without comprehensive change attempts. The initiative to start the development was made by high-ranking officers, and the development was tied to the already existing organisation and system development.

Comparison of power in the mega projects

I will now compare the interactions between actors and what role power plays in the different mega projects. I will commence the comparison as a sequence then continue with the implementation and subsequently finish with how power is constituted and used in the terminations of the mega projects. The first two mega projects, Future Combat Systems and Ledsys, were clearly affected by a daring unsettled development culture. That development culture emerged due to high-ranking officers introducing new ideas to politicians and the defence industry making it possible to motivate and initiate comprehensive changes in both countries' Armed Forces. Power that was given to the high-ranking officers was the third face of power, which works to make the affected actors desire the change and to be a part of it.

The wills and ideas that thrived in the unsettled cultures also facilitated the third face of power among the actors who wanted to clear the table about what should be developed. It should not be

anything of the old left that could be turning back to. The unsettled culture is made up of actors wanting to change and the third face of power is based on the same principle of wanting change.

This development was not the case for the Scorpion mega project that was not initiated with ideologically similar and daring ideas as the basis for the development. There was also no unsettled culture for any third face of power. The third face of power was used in the two first mega projects because the unsettled culture encompasses a general understanding and support of the intended development being considered necessary. That was not the case in the Scorpion mega project that instead was managed by a traditional hierarchy whereby high-ranking officers requested politicians to develop some additional systems to integrate into the already existing organisation. That is the first face of power.

There are some differences within the Future Combat Systems and the Ledsys mega projects regarding the relationship between actors with and without power. It is the habit in the United States to implement very large projects and it is a normal activity for the US Armed Forces' development. That leads to the unsettled culture in Future Combat Systems differing from that in Ledsys in that it more pragmatic in the first and less pragmatic in the latter. High-ranking officers in the US Army would more easily be allowed to initiate and implement Future Combat Systems. This is reflected in the interactions between the actors allowing project management to repeat replanning later in the development and salvage parts of the development and thus prepare for a termination of the development.

The Future Combat Systems project

The culture for change associated with the Future Combat Systems mega project emerged due to a wish to change the US Army into something completely different. The actors belonging to the unsettled change culture in the beginning of the mega project were high-ranking officers but also the Defence industry, Boeing and SAIC. Any clear actor belonging to a settled culture was not clear in the beginning of the mega project. Politicians were rather easily convinced about the plans and therefore it was easy to acquire political authorisation for the project initiation. The power was given from politicians to the US Army and the project management who consisted of the defence industry, Boeing and SAIC.

During the development two wars were started, in Iraq and Afghanistan. This created other requirements on the development that resulted in cumulative epiphanies among actors when the development did not fulfill the new requirements. This development with new information caused politicians to be critical of the mega project. The US Army also started to become critical of the

project. The change culture became weaker and started to lose credibility with the absence of perceived relevant progress of the development. A settled culture emerged that wanted the mega project to adapt to the conflicts. When former positive politicians and some high-ranking Army officers became more or completely critical, the change culture started to erode. This also caused actors to start to mistrust the development and change their minds about the development. Thus, the supporters became fewer and made the power of the unsettled culture weaker. The new requirements which had emerged from the two conflicts created a shift with a weaker unsettled culture and a stronger emerging settled culture. The influence of the unsettled culture and the belonging actors, project management and some high-ranking officers in the US Army weakened. In order to adapt the development so that it could continue, repeated changes were made to the project plan. The repeated changes represented a form of the second face of power with changes to the agenda. Critical politicians and high-ranking officers gained power. During the development, there was also a requirement that received a special role in the interaction between actors. The requirement of airlifting the entire Future Combat Systems effectively stopped all realistic progress of the development. That requirement was in the beginning avoided by the actors belonging to the unsettled culture to avoid critics. The project management removed the requirement when the critics became too loud. The requirement removal was a major epiphany, which indicated that the project management had been wrong earlier', and the epiphany changed the prerequisites for the development when progress could continue. The project management had by this minor epiphany, been forced to admit that the development was built on wrong assumptions. It was a neglected critical change of thinking and acting. The growing settled culture, which included critical politicians, gained power with these events. It was not easy at this stage to continue the development when the credibility was low and a growing number of actors lost confidence in the development. During the mega project, the power associated with the project management became increasingly weak with fewer actors wanting the development and being motivated to work with what they did.

The ending of the Future Combat Systems mega project was when the Secretary of Defence terminated the development. At that time, the unsettled culture no longer existed and the settled culture dominated. The project management did not have any strong power at that time and the power itself was not situated in the wants of the actors but in clear orders that was obeyed.

The Network Based Defence development

The culture for change associated with the Ledsys mega project emerged due to a wish to change the Swedish Armed Forces into a Network Centric System of Systems. The actors belonging to the unsettled change culture at the beginning of the mega project were high-ranking officers in the

Swedish Army. Clear actors belonging to a settled culture did not exist at the beginning of the mega project. Politicians were also rather easily convinced about the plans and it was easy to acquire political authorisation for initiation. The power was given from politicians to the project management which consisted of the Swedish Armed Forces and the Swedish Defence Material Administration.

During the development, it slowly became apparent that there was not much progress though the mega project continued. It was a cumulative epiphany due to this absence of progress that caused politicians to be critical to the development. A settled culture started to emerge but it was initially weak; the unsettled culture continued to dominate with a strong project management. In the middle of the project, the Swedish Armed Forces took a decision to become interoperable with other countries. That decision meant that the development was ordered to be integrated with other services in the armed forces and share the development resources. That gave rise to a major epiphany and the competition between the unsettled culture and the settled culture became at once intense. The unsettled culture was the project management and the settled culture was the Swedish Air force. The power belonging to the project management was influential and the development appealed to actors. Orders from the project management were, however, neglected or refused implementation by the Swedish Air Force. The change of name of the development was a means of power to make the development continue. That attempt was, however, discovered by the Swedish Air Force and politicians. At that stage, the project management had lost much of the power and credibility that were strong earlier. The unsettled culture also lost influence due to the credibility loss and the growing strength of the settled culture in the Air Force. A minor epiphany was the termination of the Network Based Defence development. It meant that if the requirement was implemented the result would be that the entire Swedish Air Force would be forbidden from flying for several years due to legal reasons. That epiphany made it impossible for the project management to continue and it was not possible anymore to use power because it was not obeyed. The settled culture was the strongest with very little of unsettled culture left.

The endings of the Ledsys mega project and the Network Based Defence development occurred when the supreme commander of the Swedish Armed Forces terminated the development. At that time, the unsettled culture did not have any influence and the settled culture dominated, similar to the situation before the development started. The project management did not have any strong power at that time and the power itself was not about the wants of the actors.

The Scorpion mega project

There is no clear specific change culture associated with the Scorpion mega project. The actors belonging to the settled culture are high-ranking officers in the French Army. The means to execute the implementation of the Scorpion mega project is to use the Direction Générale pour de l'Armement which is the project manager. There is political authorisation for the implementation of the development that consists of both a new developed system and renovated systems. The power is clearly in the hands of actors belonging to a settled culture without any clear competition from an unsettled change culture wanting comprehensive change. The change is being implemented relatively slowly and incrementally. Furthermore, there is no clear epiphany in the Scorpion mega project. The power remains at the project management at the Direction Générale pour de l'Armement and the project management is not led by ideas of quick change or any special kind of management.

Though project is not yet finished, there is no clear sign that power in which actors' wills are affected, like Lukes' third face of power, is being used because the project is based on and managed with a common relatively clear idea and shared understanding.

I have now referred to Swidler (1986) on culture in mega projects, Denzin (1989, p. 37) and Dumez (2016, p. 128) on epiphanies in mega projects and lastly Lukes (2005) to explain power in mega projects. First, I explained that culture affects mega projects but also how the competition between different cultures unfolds when actors take part in different cultures. The culture competition is affected by epiphanies that I use to explain how unplanned changes emerge when actors change their thinking and acting. Lastly, I used power that is needed to create organised change and illustrated how power affects outcomes and orientation of mega projects. In each section, I also compared each mega project. I will now continue to compare the culture, epiphanies and power of the mega projects.

Contribution

I use Lukes' (2005) third face of power as I expected to see some power connected to the mega projects although Clegg et al (2017) does not clearly mention power used internally in mega projects or changes of power usage during mega projects. I did not, however, expect to see the third face of power so apparent in especially the Ledsys mega project and that it was similar to culture and ideology when affecting actors' wishes and wants.

I will now compare culture, epiphanies and power in the different mega projects.

The interplay between culture, epiphanies and power in mega projects

Culture and power are described in the Oxford Handbook of Mega Project Management by Levitt & Scott (2017) and Clegg et al (2017), respectively. The descriptions are not exhaustive but rather brief and the areas can be developed further. To give a better picture of culture competition in mega projects Swidler (1986) is applied as having a model that can potentially work to understand cultural competition in mega projects. Clegg et al (2017) mentions Swidler's (1986) theories as potentially fruitful to use in investigating mega projects. Swidler (1986) has, however, not typically been used to understand mega projects but rather to understand cultural systems in societies. Though Swidler (1986) has not been used previously to understand mega project, it still should be suitable for understanding and analysing the cultural dimensions in mega projects. However, Swidler's (1986) model has weaknesses if the original model is used. The model should be complemented with dimensions from the studied mega projects. In order to analyse mega projects where cultural competition, power and epiphanies are apparent, I started with the model of Swidler (1986) and formulated a general analytic model.

In mega project contexts, decisions based on cultural dimensions that are taken have, or can have, an ideological character leading to critical obstacles being ignored. Obstacles can be ignored, or are not understood, based on the obstacles not correlating to the kind of development ideological vision that change advocates have. Critical flaws are built in mega projects with the leadership being enthusiastic and simultaneously unable, and unwilling, to see critical flaws. Flaws that later, during the course of a mega project, will be encountered and in many cases similar to someone surprised by an unknown and sudden event changing the prerequisites negatively, a peripeteia, an abrupt change with negative consequences. Because of this, epiphanies are included in the model.

The change cultures seen in the Future Combat Systems mega project and the Ledsys mega project are similar but not identical. The difference lies in how familiar the respective organisation was with managing very large project. The US Army is rather used to such development activities but the Swedish Armed Forces is not at all used to implementing very large development projects. These levels of familiarity make a difference in the change culture. The Future Combat Systems mega project had ways and means to discontinue a development if needed, whereas the Ledsys mega project had no ready mechanism to undo the development.

But the similarities are more numerous regarding the change culture that results from high-ranking officers perceiving flaws in their army. The ideas around the perceived flaws were similar in the two mega projects and the actors gathered around similar forms of problems with a desire to create Network Centric armed forces. Those officers contacted politicians and received authorisation to plan and initiate comprehensive change of the US Army and the entire Swedish Armed Forces. With authorisation and the promising aims a change culture started to grow that was beneficial to belong to and even feed from for defence industry but also for individual actors in their respective armed forces. The change culture and the extra power the project management had from politicians to implement comprehensive change was not questioned at the beginning of the respective developments because there were no clear problems. Because of the wish to complete change and the authorisation from politicians, the Future Combat Systems and the Ledsys respective project managements had exceptional power compared to normal for implementation of their ambitious aims.

The aim of Future Combat Systems was to change the equipment and organisation in the entire US Army and be able to airlift everything with relatively small transport airplanes.

The aim of Ledsys was to create a complete network centric connection across the entire Swedish Armed Forces.

Those aims gave rise to different kinds of cumulative, major and minor epiphanies. The epiphanies worked to change the unsettled change culture negatively so that the change culture lost influence and the settled culture instead gained later influence. The cumulative epiphanies in the Future Combat Systems mega project were the fact that the development did not answer the needs created by the two ongoing conflicts in Iraq and Afghanistan at the same time. It was a reaction to the absence of relevant progress. The cumulative epiphany in the Ledsys project were the absence of progress. Both of the cumulative epiphanies made politicians more critical to the respective developments and decreased the credibility of the respective project management.

The major epiphany in the Future Combat Systems mega project was the reaction to the removal of the airlifting capability requirement. From that point the development could be used for other means than Future Combat Systems and the development could continue, though with more actors showing mistrust of the development. The major epiphany in the Ledsys mega project was the decision to integrate all services in one communication network. That started an even more intense competition between the unsettled and settled cultures with actors refusing to talk to each other and do what they were ordered to do. The power started to shift to the settled culture and the Swedish Air Force.

The minor epiphany in the Future Combat Systems mega project was the neglected airlift requirement that made the entire mega project impossible to continue until the requirement was taken away. It was a clear loss of credibility and showed the unrealistic aims of that mega project and the unsettled culture connected to it, but it was not a clear loss of power for project management.

The minor epiphany in the Ledsys mega project was the reaction by the Swedish Air Force to the requirement to introduce an unproven system into the air traffic control system. This reaction led to the termination of the Network Based Defence development by the supreme commander.

The epiphanies allowed a settled culture to start gaining influence in both mega projects. When an unsettled culture loses influence, the project management cannot use the same power anymore because actors start to change their minds about the developments. With fewer actors wanting the same as the project management, it became difficult to control the projects in both the Future Combat Systems and the Ledsys mega projects. A project cannot use the influence of promising future development when actors do not believe in it. The weaker change culture no longer supported the project management which made the influential part of power, the third face of power, weaker and allowed the settled culture to grow in influence in both mega projects. The settled culture in the Future Combat Systems mega project consisted mainly of politicians but also high-ranking officers in the US Army. The settled culture in the Ledsys mega projects consisted mainly of officers in the Swedish Air Force.

With the weaker power the respective project managements used other means; for example, they manipulated the agendas in the attempt to make the respective mega project work.

Future Combat Systems was repeatedly replanned in order to adjust the development and make it appear better. Technologies were taken out from the development, signaling the preparation to salvage parts of the development.

The Ledsys project management tried to change name of the development to GLC/NOC in order to continue the development after the termination of Ledsys. The second face of power can be found with the project management in both Future Combat Systems and Ledsys.

This kind of development has not occurred in the Scorpion mega project. It seems due to the fact that there is no specific change culture in which the project management acquires any special authorisation to implement comprehensive change. The will for comprehensive change is not present among high-ranking officers in the French army. There are also no clear signs of epiphanies like in the Future Combat Systems and the Ledsys mega projects.

When a stable settled culture gains power and supporters and the change cultures loses credibility, actors in and outside the mega projects lose their commitment. It becomes more frequent to disobey orders, as seen in the GLC/NOC development when actors in the Swedish Air Force did not want to do what they had been ordered to. In both the GLC/NOC and the Future Combat Systems developments it was difficult to get anything meaningful accomplished at this stage. The orders in both mega projects were barely obeyed and management did not have much influence or power over actors' thoughts and motivations.

The Secretary of Defence in United States terminated Future Combat Systems with an order in 2009 and the supreme commander in the Swedish Armed Forces terminated the Network Based Defence development in 2009. The first face of power answers how the termination was done. With the termination, the change cultures dissipated and the settled cultures returned to what they had been before the change attempts started.

The Scorpion mega project has been started on an initiative from high-ranking officers that turned to Direction Générale pour de l'Armement which manages the main part of the development. Political involvement has given permission to modernise the French Army with a small number of new systems. The development is a normal acquisition of systems for the French Army and it does not involve thoughts of a complete change. The Scorpion mega project cannot be analysed with Lukes' (2005) third face of power, because the power follows from the normal hierarchy with no special power acquired to implement comprehensive change. The development aims are specific and give little room for interpretation. There is no special development culture involved with actors who want to change everything quickly. No unplanned changes, which could give rise to epiphanies, have occurred.

A culture advocating change combined with culturally dependent power can easily lead a development towards failure with few actors being able to stop the chain of events. Ideological elements in developments with ideological thinking make decision makers discover obstacles too late, leading to potentially profound consequences. The power, which is ideologically influenced and has an impact on stakeholders, cannot be initially contradicted and as long as the ideas are lively and strong the development shows success. Competition between the advocates for the respective culture will determine if stakeholders standing for preservation can oppose the ideas and development.

It is the impact of epiphanies that tends to be of greater significance if ideological visions have affected the development. Ideologically impinged development cultures create overconfident

stakeholders an environment of unclear discourse. That leads to overly global and unclear ideas being passed through to a management integrated in the same environment. Epiphanies in such environments have greater impact than epiphanies in controlled environments without an ideologically impinged culture. The culturally influenced power does not have a traditional approach whereby an actor can order another actor to do something. Because of the unusually strong involvement from other actors, like politicians and industry, the asymmetry approach is more distinct and gives the project management power to be freer than otherwise would be possible.

The power used in mega projects with elements of ideological visions and intentions has ideological similarities and affects wills, and the good will, of actors. Other dimensions of power exist as well and increase in impact with the decreasing influence of the ideological power that is dependent on the ideological influence in the mega project.

Conclusion of the discussion

The conclusions I draw from the discussion are that mega projects have a clear tendency to involve special change cultures that want to develop something completely new and remove as much as possible of what already exists. But mega projects and well as change cultures of this kind have not emerged from nothing but are created by actors as an answer to a perceived need in combination with the actors' recruitment of additional actors who are influential and powerful. In two of the mega projects I have been studying, the actors creating the culture were high-ranking officers, who wanted complete a change of their respective armed forces. Those actors succeeded in recruiting other officers and convincing politicians that the ideas had to be implemented in order to meet the perceived need. Despite the ideas being unclear and unusually risky to develop, the actors acquired authorisation to begin development because the involved actors thought it was necessary to initiate the new plans and go further with the development as soon as possible.

The development acquired high priority, which in combination with the political authorisation, gave the project management great power to initiate and begin implementation of the developments. The change culture emerged into an environment where the actors gathered and kept out other critical actors who did not belong to the change culture. It was necessary for the change culture to keep critical thoughts out because the change culture did not have any clear critical component and would probably not survive if critics were allowed. The growing change culture led to unrealistic mega project with no, or very small, real prerequisites for success. The change culture worked to influence the beliefs and thoughts among actors. That combined with the exceptional power that made actors want to be a part of the development, which was initiated without normal evaluations and room for critics. The mega project did not adapt very effectively to any new emerging requirement and the high priority of the mega projects resulted in resistance when actors belonging to other activities outside the mega project were affected. At this stage, it became a clear competition between cultures. The critics and resistance increased further when epiphanies emerged due to flaws during the mega projects.

Epiphanies with different characters show the dynamics that emerge in the competition between the involved actors that initiated the mega project and the actors resisting the development. The initially powerful and strong change culture that the change enforcing actors stands for is diminished and weakened by the epiphanies. At the cost of the change culture, a more critical and change careful culture, supported by the resisting actors, acquires influence and trust. The change culture loses influence and credibility by epiphanies, which makes the power of project management weaker

because fewer actors believe what the project management tries to say and do. Mega projects cannot be managed effectively if the involved and affected actors start to lose confidence in what they do.

I have shown that power can have other dimensions than just the normal asymmetric way of an actor orders another actor to do something. The two failed mega project also contained power similar to ideology which means that actors want to do and follow the project management. In the beginning of a mega project of these kinds of orders are not necessary to give because actors have bought into the project and complete tasks anyway. This third face of power does, however, erode with increasing obstacles and eroding credibility of the mega project. I have also shown that power can be used in mega projects to tamper with the agenda in order for the project management to achieve what they want when the development does not go according to plan. This is the second face of power in mega projects.

When the third and second face of power eventually erode and actors do not obey that kind of power, what is left of the power is the project management behavior to give orders, which eventually does not work because resisting actors do not obey orders anymore. This is the first face of power in the mega project. Eventually the development is terminated by another powerful actor; the high political leadership or highest military ranked officer gives orders to finish the development.

What I have shown is that the dynamics of mega projects can be analysed with culture competition, epiphanies and power between actors.

In particular failure of mega projects can also be explained with culture competition, epiphanies and power.

I conclude that two of the three studied mega projects can be explained with culture competition, epiphanies and power, which have also strongly contributed to their failure. The culture competition emerged because the ideas involved ideological similar thoughts that powerful actors gathered around. The change culture that initiated the change did not involve normal manner for such development but claimed that exceptional development was needed. It claimed that everything was of great need to implement and needed to be dealt with in a special manner that requires special resources thus normal critical evaluations became less important. The epiphanies were the reactions and unplanned changes of thoughts and actions, that emerged among actors because the change culture involved unready and unclear plans and actions in the development. The exceptional power was the authority of the project management to implement complete change and make the surrounding uncritical to wanting the change.

The Scorpion mega project does not contain culture change, epiphanies or exceptional authorized power

The Scorpion mega project, though, cannot be clearly explained with culture competition, epiphanies and power because it practically does not exist in that development. The Scorpion mega project was not initiated based on any change culture that created competition with any other culture. The actors in the Scorpion mega project did not build their development on daring, unclear and partly unrealistic plans which was the case in the Future Combat Systems and Ledsys mega projects. The absence of unrealistic and unclear plans diminishes the emergence of epiphanies because there are no apparent critical flaws discovered during the development. The project management in the Scorpion mega project also does not have exceptional power acquired from politicians to implement complete change. The power is limited to the development of a few systems and does not at all include complete change at high pace. This means that power is used to implement the Scorpion project but not to intrude on other powerful actors' activities.

The Scorpion mega project has also planned to renovate the older equipment of the French Army, which makes it a part of the normal equipment plan and does not purely develop completely new systems but does also deal with less novel systems with little uncertainty involved.

The absence of culture competition, epiphanies and exceptional and influential power means that the Scorpion mega project has a good chance to succeed. The mega projects in which culture competition, epiphanies and exceptional power have existed have a high risk of failing. In the context of mega projects, culture competition, epiphanies and exceptional power are clearly destructive.

Chapter 8 - Conclusions

The comparison of the three different military mega projects with the help of the literature and methodology has led to the conclusions drawn from the similarities and differences determined between the projects.

The limitations of the comparison and the conclusions

The study of the mega projects has been done based on what kind of literature, methodology and empirical information I have used. The discussion of the mega projects, the comparison between the mega projects as well as the conclusions drawn about the three mega projects should be understood based upon the fact that the literature material and the empirical material is heterogeneous. It means that the discussion and the conclusions about the mega projects and the comparison between the mega projects contain possible explanations. Explanations that can be considered plausible given the three mega projects that have been investigated with the literature, methodology and the empirical material I have used. The discussion and the conclusions are furthermore not necessarily the only explanations and the answers to the research questions do not necessarily need be the only existing answers. What it shows is the most plausible explanations based upon my literature, methodology and the empirical material and me as organiser and interpreter of the cumulative material. There can be other parallel explanations not discovered in the examination of each mega project.

I started this thesis by studying the largest of the three mega projects I chose to examine, Future Combat Systems which I arranged in a structured narrative. The other two mega projects, Ledsys and Scorpion followed and were presented in a similar manner. I did that to each mega project to make events and dynamics in the mega projects comparable. Parallel with that, I started to study how industrial marketing works in relation to the mega projects, because the project has been marketed for important actors, in order to be initiated. I continued to study technology management and how that has developed. I continued to study System of Systems and management of mega projects parallel to the next mega project, Ledsys. I realised that mechanisms other than normal are involved in mega projects and realised that the management of mega projects can be different or claimed to be different compared to normal projects. There had been other mechanisms involved because the mega projects had far-reaching and unclear aims. While I studied organisation transformation,

culture became one part of that I understood to be important in progressing mega projects, which had been important for the development in two of the three compared mega projects. That power has had a clear influence makes sense but power has also played a role by influencing actors' opinions and by that made different actors want the mega projects and in turn promote them. There are parallels between development and cultural signs and to belong to the mega project meant that one belonged to a special community. The special dynamic emerging in the mega projects did that to a large extent due to unconsidered and rather autocratic behavior from project management with great power and influence. That behavior gave rise to changeable actors when the project rapidly acquired resistance and developed against key actors' interests. These were unplanned changes in the form of epiphanies, when actors changed their thinking and acting about the mega projects.

In addition to the turning points that every mega project has, failed mega projects also contain epiphanies when actors revealed shortcomings and even impossibilities. These were evident in the Future Combat Systems and Ledsys mega projects. The epiphanies were also points when the change culture and its power for each epiphany incrementally lost influence and credibility. This development finally led to politicians and a supreme commander ordering the end of the developments.

The Scorpion mega project does not show this development because that development is implemented like a normal technology development project with clear control from the authorities. There is no clear special change culture or exceptional power that could create a hotbed for unthoughtful ideologically similar decisions. Because of that, there are also no epiphanies when actors change their thinking and acting.

The question is how complex mega projects emerge and if there are different types of management of these projects. I have showed how a perceived very important military development of Revolution in Military Affairs created a will to develop a System of Systems to enable Network Centric Warfare that were supposed to revolutionise military activities. This will to change led to the emergence of a belief and change culture aimed at changing all military activities with mega projects. Promising ideas in combination with actors wanting the change made change culture develop and the project management become very powerful in combination with authorisation from politicians. This is a description of the emergence of a failing mega project.

But a mega project does not need to include actors that gather and eventually create a culture which competes with another culture in order to implement comprehensive change using exceptional authorised power. I have also shown that mega projects that lack the exceptional power and culturally aimed change have clearly better prerequisites to succeed.

There is no special type of management needed for mega projects that make those kinds of developments more successful. Rather a special kind of management should be a sign of a future failing mega project because it can be a sign of unthoughtful management and too daring plans that include culture influenced change attempts.

I also posed the question of why mega projects sometimes fail and why do they sometimes succeed. An answer to that question can be formed based on my three cases of the mega projects. Two mega projects failed due to unclear and overly general ideas and aims of the developments as well as the emergence of other priorities when the developments were underway. The unclear ideas and aims could be accepted due to several powerful actors consisting of politicians, high-ranking officers and the defence industry and together approved the plans with little or no consequence analysis. This acceptance led to the initiation of tempting projects that answered the actors' long standing problems. A change culture started to develop with powerful actors and powerful project management. Because of the aim to develop everything at the same time in combination with unclear ideas and aims and a growing resistance from threatened actors, epiphanies started to emerge among actors. The epiphanies worked against the mega projects and the management of them.

One answer to why mega project sometimes fail is the existence of special change cultures and exceptional acquired power that further ideas and plans with little prerequisites to succeed. Those change cultures are closed to other possible critical actors that cannot see or do much at all in the beginning of a mega project. Successful mega projects do not have any special change culture and do not have an exceptional acquired power and little reason for involved actors to experience epiphanies.

The two questions posed lead to a reflection about how the emergence of a mega project can be controlled. The dynamics include powerful actors closely involved in the project who together with powerful actors outside the project create a change culture in which the management is backed up by politicians. That weakens the normal control mechanisms that would exist in ordinary development projects.

I believe that to control the emergence of mega project there has to be a legal dimension involved that are mostly in place in normal projects. If the risk of failure was taken into account more systematically for mega projects, the project management and involved politicians would need to consider legal concerns or risk legal action. As all of the involved actors use public resources, a change culture can be understood as nothing more than a number of individuals involved in inattentive usage of public resources.

The epilogue of the structured narrative

The conclusions have theoretical dimensions because of the difference between the literature and the mega projects when the mega projects have shown phenomena which I have not discovered in the literature. I have discovered the need for an epilogue of the structured timeline concerning the methodology. An epilogue is needed for a successful study of mega projects because those kinds of developments tend to continue well beyond the finish decided upon. Notable parts of the technology development and dynamics of the actors are visible, or more visible, during the time after the main development. It is also possible to notice what emerges from a mega project after the main development. With events in an epilogue understanding partial successes could be easier, which would add to the discussion about mega project success or failure.

Suggestions for further research

From my point of view, there are three main especially interesting research directions. The first can be divided into three different domains, and it is to continue searching for the consequences of my results in the military domain, the defence industry domain and the security political domain. In at least two armed forces we have seen the mechanisms of ideas spreading and the ability of ideas to influence the start of profound change of development activities. Development activities in such organisations are normally adapted to act or react to how the needs of such organisations are perceived and implemented incrementally. The ideas are by definition the first to precede the start of planning for a mega project and transformation. Management becomes a part of such change and is formed after the development idea has emerged and a mega project is very difficult to change after its start. The first started mega projects failed completely or partially and no mega project was able to deal with new emergent events - how conflicts were shown to develop in the security, political and technological domains. All main actors: the military end users, the political decision makers and the defence industries were involved in the commencing of the mega project that turned out to be impossible to adapt according to new security developments and new requirements.

The second research direction is partially connected to the first research direction. The conditions for mega projects are set already at the beginning of a mega project's existence. Some mega project aim to transform and are implemented in a relatively short period of time and require large amounts of resources from the implementing organisations. On the other hand, if the mega project is implemented over a longer period of time, it starts to resemble a normal planned implementation of new equipment, an acquisition plan. The development and project risk decreases and the ability to adapt the development to surrounding changes can be managed more easily. Initiation of a mega project with several high risk components is instead made of a less risky ordinary implementation. The ideas leading to the planning of mega projects and decision makers being influenced by the driving forces of the main actors need to be further researched. A part of this research direction is to investigate how ideas and development cultures can be managed and can management be effectively executed if the existence of management is based upon ideas aiming at complete change.

My third research direction is about further researching the outcome of a mega project involving the events after a mega project is formally stopped. In what sense can the narrative epilogue, the events after a mega project is formally ended, contribute to the understanding of an entire mega project? For mega projects about to fail or partly fail, much of the residual parts of the activity continue after

the formal ending. What continues after the formal ending can have several reasons. If a gradation can be made between failure and success of a mega project the events and residue in the narrative epilogue are important.

Managerial advice

Management of mega projects encounters important and possibly dramatic decisions during idea creation and already before any real project exists. The stakes are immense and different forces of wills can be very powerful. General recommendations for a comprehensive development in military affairs tend to be a kind of preaching to the converted hence much advice relates to already known facts about before, during and after project implementation. Technological, economic and knowledge conditions can be unclear and unknown, which means that the conditions for managing and implementing military mega projects can be unknown. A question management should ask is what are the conditions managing a mega project containing unknown uncertainty, contradictory requirements and the resulting mega risks?

Military mega projects aimed at acquisition of systems for parts of, or entire, armed forces have, or can easily have aim and purpose aspiring to transform parts of, or the entire, armed forces. A controlled defence equipment strategy can almost replace mega projects with the difference that risk and uncertainty can be lowered significantly. Are then such transformations necessary, given that armed forces adapt anyway according to how the surrounding world is constituted concerning technological, economic possibilities and threats?

A development needs to be realistic with respect to assessed knowledge growth, technology maturity, development scope and available time. If a development is to be made in a comprehensive manner, sub activities and sub projects should be easily divisible. A mega project should be able to sustain external changes. How is a mega project, which probably will endure internal and external changes, created in order to manage such events and how can obsolete subparts of the mega project be cut out without damaging the overall mega project?

Some of the difficulties concerning mega projects can lie in vague aims and approaches not yet realisable. When objections are raised they are not taken into account. However, for individuals to object in such an environment can be impossible or often career damaging. This means that the planning and management of a mega project can be overly optimistic with serious concerns ignored

or swept under the carpet and hence developments that are doomed to fail partially or completely are started.

The contribution this study makes to the field

The literature on mega projects, to which Bent Flyvbjerg is perhaps the most eminent contributor, is vast. My contribution to the literature on mega projects is my investigation of the struggle between various actors within mega projects. I use Swidler's (1986) model, which was recommended for further investigation by Clegg et al (2017), in the application of analysing mega projects. Specifically, my contribution adds the dimension of cultural struggle between actors and groups of actors and how it can have a clear impact on the path of mega projects.

The literature on power in mega projects and foremost the third phase of power, which is power when actors' own wishes and wants are affected, is shown by my work to be a tool with which to instigate mega projects. My development beyond Clegg et al (2017) is that I use Luke's (2005) different phases of power applied to mega projects. More specifically, the main contribution of my work is that it clearly illustrates the impact of power interplay involving different phases of power throughout mega projects.

The major part of the change in belief and acting among actors in mega projects, and thus the direction of an entire mega project, is made by epiphanies that change the actors' thinking about the mega project as well as the acting according to Dumez (2016). My contribution to the literature is that I apply epiphanies to mega projects. Epiphanies consist of actors changing their thinking and acting, and they can result in altering the path of entire mega projects.

My study shows that mega projects can be analysed using literature on cultural struggle, power and epiphanies. These disciplines are found in cultural studies, sociology, anthropology and social science but also psychology, thus making mega projects possible to analyse with literature from those fields. A more nuanced picture of the interplay between actors in mega projects should then be possible to create.

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List of Abbreviations

BOA	Air-Land Operational Bubble
BCT	Brigade Combat Team
DoD	Department of Defence
FCS	Future Combat Systems
FMV	Swedish Defence Material Administration
FOI	Swedish Defence Research Agency
GAO	The United States Government Accountability Office
DGA	Direction General of Armaments
GLC/NOC	Central for Common Picture/Network Operating Centre
GLI	Common Information Picture
GTIA	Groupement tactique interarmes
ISAF	International Security Assistance Force
Ledsys	Command and Control systems project
MTR	Military Technology Revolution
NBD	Network Based Defence
NCW	Network Centric Warfare
NEB	Digitisation of the Battlespace
RMA	Revolution in Military Affairs
SAIC	Science Applications International Corporation
Scorpion	Synergy of contact reinforced by versatility and infovalidation
SICS	Système d'information et de combat de Scorpion
SoS	System of Systems
StriC	Combat Command & Control System
TNS Mars	Joint venture between Thales, Nexter, Sagem

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Résumé

Cette thèse est une étude comparative de trois méga projets militaires menés aux Etats-Unis, en France et en Suède, dans le domaine du *network centric warfare* ou *guerre réseaucentrique*.

L'objectif de cette étude est d'observer les similitudes et différences dans le développement et la gestion de ces projets, de comprendre les raisons de certains choix stratégiques puis d'évaluer l'ampleur de leur réussite ou échec.

L'idée des méga projets vit le jour avant la fin de la guerre froide, tandis que l'industrie de la défense connaissait une période de stabilité dans toute l'Europe. Et dans une grande partie du monde, les besoins en équipements, les projets quant à leurs développements futurs et remplacements étaient relativement définis et planifiés par les forces armées. Cette stabilité permettait aux différentes forces de d'envisager leurs technologies, doctrines, tactiques et stratégies selon leurs propres visions et ambitions. Cependant ces évolutions suivaient peut-être aussi les positionnements des adversaires, leurs doctrines, tactiques, stratégies et avancées technologiques.

Après la fin de la guerre froide, le besoin en équipement de défense décrut considérablement et les budgets alloués aux forces armées furent réduits. Au même moment, de nouvelles problématiques apparurent et les missions de maintien de la paix devinrent un sujet de préoccupation majeur, surtout pour le monde occidental. Débuta alors un temps d'austérité durant lequel la disponibilité opérationnelle des forces armées fut réduite et les budgets de défense diminués.

C'est également à partir de cette époque qu'émergèrent de nouvelles théories quant à de nouveaux types de conflits possibles et leurs évolutions potentielles. Si un conflit devait surgir en Europe, par exemple, il s'agissait principalement de savoir comment combattre un ennemi technologiquement avancé à l'aide d'armes équipées de capteurs reliés à des réseaux informatiques. Mais ce n'est qu'à partir des années 90 qu'il devint possible de créer un *centric network*, un système en réseau ou système dans le système ; en effet, l'absence de tensions depuis la fin de la guerre froide permit un tournant dans la conduite des affaires militaires.

Par ailleurs, les développements technologiques dans la société civile influencèrent de plus en plus l'industrie militaire, ces derniers évoluant désormais beaucoup plus rapidement que la durée de vie

moyenne des systèmes de communication et des autres systèmes militaires. L'armée suivrait maintenant les évolutions de la société civile en la matière.

Les plus fervents défenseurs de ces nouvelles idées et adaptations étaient principalement les leaders des armées de terre aux Etats-Unis et en Europe de l'Ouest, qui avaient pu mesurer l'apport de ces technologies aux armées de l'air et de mer, qui utilisaient déjà des systèmes en réseau pour leurs munitions à guidage de précision.

On pensait qu'il était maintenant possible de dissiper le « brouillard de la guerre », qui avait été un problème récurrent pour les armées et leurs commandants depuis des temps anciens et les plus hauts décideurs plaidaient pour que les armées terrestres puissent bénéficier des mêmes avancées.

Ces débats donnèrent lieu à des projets d'équipements d'un genre nouveau, qui seraient capables de combattre un ennemi à l'aide d'un système de réseau informatisé, cela avant même que ce dernier n'ait lui-même eu le temps de localiser le système du système sur le terrain. Et pour mener ces combats d'un genre nouveau, il devint alors nécessaire de concevoir des véhicules suffisamment légers pour être transportables par les airs.

L'impact de ces changements sera profond. Presque toute l'armée américaine, ainsi que les forces armées suédoises durent par exemple revoir leurs plans et stratégies. Les forces terrestres devraient être organisées à partir de systèmes de communication informatiques dont la vitesse d'évolution suivrait celle de la société civile. S'y ajouteront aussi de nouveaux types de véhicules automatisés et organisés en sous-réseaux. La planification de ces projets complexes débuta au milieu des années 90 et se poursuivit jusqu'à la fin de cette décennie.

Ces programmes étaient particulièrement ambitieux puisqu'une grande partie de la technologie répondant à ces besoins n'existait pas encore et certains impératifs techniques étaient proprement incompatibles. Pour répondre à ces exigences, la création de nouveaux matériaux était une première étape préalable à toute implémentation à des systèmes existants, comme ce fut le cas pour les projets américain et suédois. Le projet français débuta une décennie plus tard mais partageait les mêmes ambitions d'interconnexion des forces terrestres, qui rendrait l'armée plus efficace. Et à l'instar des Etats-Unis et de la Suède, la France annonça qu'il s'agissait du point de départ de la modernisation et de la transformation de son armée.

Ces trois méga projets militaires ont été analysés de façon qualitative. L'objectif principal a été de rechercher les dynamiques et événements majeurs en œuvre avant, pendant et après le développement de ces projets. Une étude comparative a permis d'en évaluer les points de rapprochement et différences, afin de mieux appréhender les issues et résultats.

La thèse a été constituée grâce à des documents empiriques tels que rapports, articles, articles de presse et entretiens réalisés avec différents acteurs proches de ces méga projets ou ayant participé à leur développement. En parallèle, un panorama de la littérature existante sera proposé, incluant des domaines tels que le marketing industriel, le management et ingénierie des réseaux et des systèmes des systèmes, ou encore les changements et transformations des organisations et management des technologies.

L'étude de cas et la comparaison des méga projets sont présentées sous une forme narrative. Le résultat en est la description des trois méga projets militaires reproduisant les dynamiques internes et externes à l'œuvre pour deux des trois projets. Le projet français a été décrit jusqu'à l'étape de développement actuel, le déploiement du projet étant prévu jusqu'au milieu des années 2030.

Cette comparaison des méga projets militaires a montré que de vastes programmes peuvent être gérés comme des projets de moindre envergure. Il n'y a pas de méthode de management spécifique et ils peuvent être appréhendés selon de nouvelles méthodes de management, c'est le choix qu'a fait l'armée américaine pour son *Future Combat System*, ou selon des approches plus traditionnelles, comme l'armée de terre française avec le projet *Scorpion*. Ces projets néanmoins complexes requièrent des ressources considérables, imputées aux budgets de défense, et peuvent aussi nécessiter des moyens financiers supplémentaires. Ils impliquent également des idées qui sont à l'origine du développement de projet, et des obstacles, envisagés ou non, avant et pendant le développement. Ceux-ci peuvent s'avérer impossible à gérer, causant alors à l'échec du projet. Mais avant même toute planification et mise en œuvre, il convient de savoir si le projet répond à une évolution simple ou s'il est source de révolution technologique. Cela aura en effet des conséquences sur, par exemple, la rapidité de développement du projet, les besoins présumés en nouvelles technologies et la nécessaire adaptation des organisations à ces nouveaux concepts. S'il s'agit plutôt de répondre à des évolutions naturelles, une approche opposée sera alors privilégiée. La durée de développement sera plus longue et moins de nouvelles technologies seront incluses dans des systèmes déjà existants et plus anciens. Les changements importants de

technologies impliquent de plus gros développements et donc une plus grande prise de risque. D'autres facteurs jouant un rôle dans la réussite ou l'échec d'un tel projet est le temps mis à atteindre un seuil de développement visible, mais aussi l'environnement et la période durant laquelle le projet est initié. Pour un projet au développement long, les pouvoirs politiques peuvent manquer de patience et décider de mobiliser les ressources sur d'autres sujets leur paraissant plus urgents et dont l'impact se mesure plus rapidement. Il existe aussi un risque que des développements technologiques prévus sur du long terme et envisagés pour un certain type de conflit ne soit pas, ou peu, adaptés à de nouveaux impératifs de sécurité qui pourraient survenir soudainement.

Les trois méga-projets comparés ont conduit à une transformation organisationnelle conséquente au sein de nombreux départements des forces armées. Ces deux facteurs déterminants, méga-projet et transformation des organisations, ont considérablement augmenté la complexité des projets et des risques possibles, comportant des considérations technologiques, humains et organisationnels. Dans ce contexte des méga projets, il est important de considérer les événements et dynamiques à l'œuvre après que ces projets ont été menés à bien. Ils tendent à continuer à évoluer dans le temps, que cela soit un choix délibéré ou seulement en partie, sous des noms de projets différents mais qui restent proches des objectifs initialement fixés. Une étude de cas narrative doit prendre cela en compte afin de permettre une compréhension plus profonde de la façon dont les acteurs internes et externes à ces projets et les différentes dynamiques autour de ces projets interagissent.

Introduction

Il est fréquent que les développements de technologies et de programmes militaires soient complexes et certains d'entre eux peuvent être considérés comme des méga-projets. L'étendue de ces programmes est souvent telle qu'ils peuvent représenter une part importante du budget de la défense, allant parfois jusqu'à nécessiter des financements complémentaires pour leur mise en œuvre. À si grande échelle, les démarches essentielles pour initier et mettre en place des méga-projets peuvent être facilement divisées en sous-ensembles ou sous-projets, restant eux-mêmes toutefois de grande envergure. L'ampleur de ces projets rend aussi les enjeux plus importants et, outre les facteurs risque et incertitude, les intérêts de types technologiques, économiques, bureaucratiques et stratégiques jouent également un rôle décisif. La planification de projets, dont les résultats ne peuvent se mesurer que sur le long terme, équivaut à essayer de prédire l'avenir alors que les futures formes d'intelligences et de menaces restent encore pour partie inconnues ou floues. Ainsi, les décisions en matière de développement de projets de grande envergure peuvent être

parfois faciles à prendre, mais celles-ci doivent être prises tenant compte d'un fort degré d'incertitude. La conception de certains de ces programmes débuta après la guerre froide et, dans ce contexte, certains acteurs avaient pour but la transformation des forces armées grâce à ces méga-projets.

Qu'est-ce qu'un méga-projet ?

Un méga-projet représente un investissement très important ; il est bien souvent porté à la connaissance du public ou du politique pour son impact direct ou indirect sur la communauté, l'environnement et en raison des budgets alloués conséquents. Ils sont aussi souvent associés à un certain niveau de compétences et d'attention, indispensables à leur bonne conduite. Le contexte de développement d'un méga-projet est également important. Par exemple, un projet à moins d'un milliard de dollars sera considéré comme un méga-projet pour un acheteur plus petit, bien que l'envergure du projet en lui-même ne suffise pas pour le qualifier de méga-projet.

Cette thèse porte sur les développements et acquisitions de systèmes technologiques militaires dans le contexte des méga-projets. Nous verrons aussi l'origine des premières idées et comment la planification, le lancement et la mise en œuvre de ces méga-projets sont gérés par les différents acteurs. Nous traiterons également des systèmes technologiques complexes, bien que la complexité ne soit pas seulement d'ordre technologique mais tient également dans la relation entre les acteurs et à l'ampleur du projet lui-même. Ainsi, cette thèse se concentrera sur le management des méga-projets dans un contexte militaire, et sur les raisons de leur succès ou échec. Avec l'étude comparative, notre objectif sera d'élargir notre compréhension des méga-projets et leurs échecs. Celle-ci sera réalisée à l'aune des événements et des nouvelles technologies émergentes, étant donné que les objectifs des méga-projets étaient le développement et l'intégration de nouvelles technologies au sein de nouveaux systèmes en réseau. Le but de cette comparaison est d'établir les similitudes et différences entre ces programmes, de les analyser, puis de déterminer si ces projets ont échoué, pour quelles raisons et dans quelle mesure. En conséquence, deux questions se sont posées, guidant ainsi notre recherche.

Questions de recherche

Comment les méga-projets prennent-ils naissance et existe-t-il différentes formes de management de ces projets ?

Quels sont les facteurs de réussite ou d'échec de ces méga-projets complexes ?

Structure de la thèse

Trois méga-projets différents mais présentant certaines similitudes et liés à l'industrie de la défense ont été étudiés. Les champs d'application de ces projets couvraient l'ensemble des armées des pays étudiés et intégraient des concepts de Systèmes de Systèmes, soit un grand nombre de systèmes de communication informatisés. Le développement des Systèmes de Systèmes était également synonyme de nouveaux types de planification des organisations et de leur comportement. Avec les méga-projets, une transformation totale des différentes forces armées était programmée. Des projets spécifiques, pouvant présenter des similitudes ou non (si l'on compare la dimension et le budget de chacune des forces armées) ont été conduits et menés à terme aux États-Unis et en Suède, ou débuté et toujours en cours en France.

Ces trois cas ont été retenus en raison de certaines de leurs similitudes et singularités. Ces projets sont comparables si l'on observe les systèmes technologiques de communication utilisés, aussi parce que plus spécifiquement envisagés pour les armées de terre. Tous ces projets sont ou ont été élaborés à partir des théories de « Révolution dans la conduite des affaires militaires et des forces armées » et d'intégration de Systèmes de systèmes. Une différence notable cependant : les ressources disponibles pour chacune des forces armées. Les programmes, achevés aux États-Unis et en Suède, n'ont pas été des succès, tandis que la mise en place du projet français est prévue sur le long terme et est toujours en cours. Les méga-projets américain et français avaient pour objectif l'implémentation du Système de Systèmes au sein de leurs seules forces terrestres. Quant au projet suédois, l'ambition était d'intégrer les différentes forces armées – terrestres, aériennes et navales- à un seul Système de Systèmes.

Chapitre 1

Si de grands projets de développements militaires ont déjà été menés auparavant, l'objectif avec les méga-projets était la création d'un Système de Systèmes ; cette idée fit son apparition à la même période, dans plusieurs pays. Il était prévu que ces dispositifs complets soient interconnectés et leurs fonctionnements basés sur de nouveaux concepts reposant sur des systèmes automatisés.

Au cours des années 1990, les forces terrestres de nombreux pays voulurent engager des développements de programmes de grande envergure, à l'instar de ceux déjà existants au sein des forces aériennes et navales. En effet, dans le passé, les forces terrestres s'étaient souvent vu attribuer des équipements dont les systèmes étaient déjà dépassés, alors que le besoin de nouveaux équipements se faisait de plus en plus pressant. De plus, les systèmes étaient bien souvent remplacés au fur et à mesure. L'objectif était désormais la transformation entière des forces terrestres grâce à des systèmes interconnectés.

Après la guerre froide, la période de détente fut suivie dans les années 1990 par un temps d'austérité. De nouvelles théories virent le jour et une volonté s'affichait de changer ce qui semblait inefficace au sein des forces terrestres aux États-Unis et en Europe. Ces courants d'idées s'appuyaient sur les développements de technologies de communication émergentes, principalement initiés par la société civile. A cette époque, il devenait également clair que le rythme accru des avancées technologiques ne serait plus à l'initiative du militaire, et que celui-ci s'en inspirerait même désormais. Ces nouveaux principes relataient des événements qui devaient révolutionner le développement militaire, et plus spécifiquement la technologie militaire, et son impact sur la façon d'aborder les affaires militaires. Ils furent décrits sous forme de concepts portant les noms de « Révolution des affaires militaires », « Guerre réseautique » et « Système de Systèmes ». Bien que les ressources se trouvèrent réduites du fait de l'austérité, la volonté d'affirmer l'efficacité des forces de terre grâce à ces nouveaux concepts permit la mise à l'étude de vastes projets ayant pour objectif la mise en œuvre d'une transformation de la défense avec le soutien des industries de hautes technologies, par l'intégration d'un Système de Systèmes réseautique d'un genre nouveau. Cette transformation devait être mise en œuvre de façon radicale par l'armée américaine.

Nouveaux temps et émergence de nouvelles idées

Les scénarios quant aux futurs conflits possibles étaient en grande partie théoriques et basés sur des stratégies potentielles face à un ennemi technologiquement équipé d'armes de précision munies de capteurs interconnectés grâce à des réseaux informatiques automatisés. Les hauts officiers de l'armée soviétique avaient déjà posé les prémices de ces concepts durant les années 1970-1980. Au cours des années 1990, il devint possible de donner vie au concept de guerre réseautique, avec un autre concept nommé Système de Systèmes ; la guerre froide terminée et l'absence de tension rendirent en effet possible un changement dans la conduite des affaires militaires. Ce que les

dignitaires soviétiques appelaient la « Révolution technologique militaire » devint dès lors la notion de « Révolution des affaires militaires ». A cette même période, le développement de la technologie commune devenait de plus en plus souvent le fait de la société civile. Les développements de solutions de haute technologie en matière de systèmes de communication seraient moins initiés par les acquisitions des forces de terre auprès de l'industrie de la défense que par les firmes commerciales civiles qui prenaient désormais le leadership sur ces développements.

Ces théories donnèrent lieu à des projets d'équipements de défense d'un tout nouveau genre, qui seraient capables de combattre en intégrant des réseaux de communication informatisés et capables de combattre un ennemi avant que celui-ci n'ait même découvert le Système de Systèmes.

Une exigence perçue comme une nécessité précipita la demande de nouveaux systèmes de combat : le besoin de pouvoir transporter des forces de terre entièrement par les airs, ce qui nécessitait des véhicules légers. Toutes les nouvelles technologies incluaient des systèmes entiers ; en découlait également des nouveaux concepts organisationnels qui devaient être regardés à travers le cadre de vastes projets globaux et transversaux.

Les conséquences de ces projets de développement seraient considérables. Par exemple, presque toute l'armée américaine et toute l'armée suédoise devaient être impactées par ces bouleversements prévus.

Une grande partie des technologies envisagées étaient encore immatures ou non encore développées, et il semblait impossible de pouvoir répondre à certains des pré-requis techniques. De nouveaux matériaux devaient donc être développés avant toute intégration, afin de répondre au besoin d'accroître la rapidité de réponse face à tout ennemi, et d'éliminer l'éventualité d'un « brouillard de guerre ». Les étapes de mise en œuvre de ces projets comptaient sur l'utilisation de nouveaux composants dont une grande partie n'étaient pas encore développés ou issus de technologies encore inconnues, et qui devaient être déployés à un rythme soutenu.

Différentes méthodes de conception et de développement de nouvelles technologies de défenses

Le développement militaire d'une technologie peut se faire selon deux méthodes différentes. La première approche consiste à mobiliser un grand nombre de ressources et d'énergies dans le développement afin d'atteindre une percée majeure durant cette phase. De telles innovations,

radicales, incluent parfois une partie ou la totalité de technologies complètement nouvelles, générées à partir de chaque génération de technologie ou système. La seconde approche est d'allouer moins de ressources et d'axer le développement sur des composants plus spécifiques, faisant par exemple partie d'un système. Il s'agit dans ce cas d'un développement évolutif, où la technologie est développée et implémentée par étapes (Srinivasan et al., 2002). Dans le cadre de considérations militaires, un développement radical de technologie peut potentiellement créer un énorme avantage face à un adversaire qui ne posséderait pas la même technologie, ou par l'utilisation soudaine d'une technologie nouvelle contre un adversaire non préparé. Du point de vue de l'industrie de la défense, un développement radical, mobilisant plus de ressources, permet le maintien des activités de développement technologiques, ce qui n'est pas toujours le cas dans le cadre d'un développement évolutif, qui, par comparaison, en requiert moins.

Intérêts des différents acteurs

Les différents acteurs sont principalement l'industrie de la défense, les décideurs gouvernementaux et les forces armées du pays dans lequel se trouve cette industrie. Les circonstances déterminant les décisions et actions de ces derniers diffèrent de la plupart des autres secteurs commerciaux et gouvernementaux. Les intérêts et motivations sont dictées par les questions de politiques de sécurité nationale et internationale, les intérêts industriels et commerciaux, les préoccupations liées à l'emploi et les connaissances industrielles. Les questions et politiques de sécurité, ainsi que la grande dépendance aux acquisitions gouvernementales, rendent les acquisitions liées à la défense différentes de celles d'autres secteurs commerciaux.

Les différents acteurs peuvent être divisés en trois grands groupes aux intérêts et objectifs tantôt similaires, tantôt divergents, qui présentent parfois des différences internes. Ces principaux groupes d'acteurs peuvent intervenir sur différents aspects des développements et acquisitions des systèmes technologiques militaires.

L'industrie de la défense

Cet acteur de la défense, par ailleurs acteur économique ayant également un ascendant en matière de politique étrangère, peut interférer sur la capacité de défense de son pays d'origine et de celle des pays lui achetant des technologies de défense. Autour de cette industrie de la défense, la société est elle aussi fortement influencée, tant sur les différentes questions directement liés aux sujets de

défense que sur les questions relevant de la capacité même à constituer et maintenir des forces armées (Heidenkamp, Louth & Taylor, 2011). Cette question de l'influence se manifeste également par le jeu des relations qui se nouent avec les forces armées et les décideurs.

L'utilisateur final

Ce changement fondamental de vision des affaires militaires a également modifié l'idée que les forces armées ont besoin d'objectifs autres que les objectifs militaires traditionnels. L'attente de l'utilisateur final, au regard de la complexité de la technologie militaire, consisterait principalement en une technologie pouvant s'adapter à tout type d'activité militaire, selon les directives du politique. La finalité serait alors l'acquisition de haute technologie et d'équipements selon les besoins et objectifs de l'utilisateur final, en tenant compte de son environnement organisationnel et de ses équipes. La technologie requise pour une mise en application effective des activités militaires ne consiste pas nécessairement en un système de technologie précis déjà vendu par l'industrie, il peut aussi s'agir d'une technologie à développer. Les accomplissements technologiques militaires n'ont pas forcément donné lieu à un changement radical et les circonstances militaires de base restaient en grande partie les mêmes. De plus, des prévisions hâtives ou prédictions peu solides dans l'appréhension de la « Révolution des affaires militaires » auraient pu être évitées grâce à un minimum de connaissances des difficultés liées aux questions technologiques (O'Hanlon, 2009, p.171). Un autre acteur important dans le processus de développement et d'acquisitions des systèmes militaires est le pouvoir politique.

L'acteur politique

Les questions d'emploi, de création de compétences, de maintien et d'essor de l'industrie militaire, ainsi que les politiques de sécurité en matière de politique étrangère sont parmi les préoccupations majeures de l'industrie de la défense.

La dimension de politique étrangère est corrélée à la politique de sécurité décidée par le pays d'origine.

Parce que les évolutions en matière de politique étrangère peuvent sembler incertaines, un État peut décider de préserver son industrie de la défense et sa capacité à développer tout ou partie de sa force de défense au niveau local. Maintenir une force militaire ou une capacité militaire permet en

effet d'éviter la dépendance envers d'autres pays, ou de la diminuer. La dimension de politique de sécurité peut en outre permettre d'utiliser les technologies de défense comme un outil dans la création de relations entre les États, pouvant même démultiplier l'importance de certains d'entre eux sur la scène internationale. Cela constitue un gage de sécurité pour un pays détenant cette technologie (Heidenkamp, Louth & Taylor, 2011). L'industrie de la défense assure par ailleurs le maintien de nombreux emplois, dont ceux d'ingénieurs qualifiés, emplois qui peuvent être perdus si l'industrie ne signe pas de contrats. Cela créerait alors un manque en matière de production de connaissances et diminuerait la possibilité de maintenir l'existence d'une branche militaire liée aux questions de politiques de sécurité (Gholz & Sapolsky, 1999) and (Guay, 1997). Pour que l'industrie de la défense puissent vendre des systèmes technologiques de défense, il peut être important d'influencer les politiques. Et les forces armées peuvent, quant à elles être amenées à favoriser des systèmes technologiques spécifiques, ce qui requiert également de pouvoir influencer sur le politique. Il peut donc être important d'avoir conscience de l'utilisation de l'outil de communication comme stratégie marketing au sein des environnements politiques, et de la connexion entre le marketing, la communication politique et les lobbys (Andrews, 1996).

Les différents acteurs dans les cas de guerres réseaucentriques

Le développement et l'acquisition d'équipements de défense et de systèmes d'équipements impliquent l'intervention de plusieurs types d'acteurs. Les acheteurs de systèmes de technologies militaires sont en général les forces armées, ce qui est le cas pour les pays étudiés dans le cadre de cette thèse. Selon la façon dont sont organisés le politique et les autorités, un intermédiaire supplémentaire spécialisé et dédié à la gestion des développements et acquisitions peut exister. En incarnant ce rôle d'acheteur de systèmes technologiques pour le compte des forces armées, ce type d'autorité peut être envisagé comme la part opérationnelle, technique et managériale des forces armées. Aux États-Unis, l'autorité en charge des acquisitions et qui achète des systèmes de défense pour l'armée américaine est le Department of Defense (DoD). En France, c'est la Direction générale de l'armement (DGA) qui acquiert les systèmes de défense pour les forces françaises et, dans le cas étudié ici, pour l'armée de Terre. En Suède, la Swedish Defense Materiel Administration (FMV) acquiert les systèmes de défense pour le compte des forces armées suédoises. Dans ces pays, les systèmes de défense sont donc passés en revue et les décisions finales quant à l'achat des systèmes de technologies pour les forces armées sont prises par les différentes strates des gouvernements politiques.

Cela revient à dire que les acheteurs des systèmes de défense ne sont pas seulement les forces armées et les autorités intermédiaires, mais également les politiciens de premiers plans des pays concernés. Les ventes d'équipements de défense et de technologies de défense sont principalement réalisées par les industries de la défense des pays d'origine. Tous les pays étudiés dans le cadre de ces projets ont eu, et ont toujours, une industrie de la défense plutôt solide, capable de développer et produire des technologies répondant aux projets de développement initiés. Les industries étrangères de la défense peuvent malgré tout vendre des systèmes technologiques à d'autres pays, mais s'il existe une industrie de la défense locale, elles tendent alors à recevoir des commandes relatives à leur savoir-faire précis en matière de développements d'équipements et de systèmes de défense. Aux États-Unis, dans le cas qui a été étudié, les acteurs principaux sont The Boeing Company et la Science Applications International Corporation (SAIC). Ces sociétés ont coopéré afin de vendre et développer le Future Combat Systems pour le compte de l'armée américaine. En France, la vente de systèmes technologiques de défense est liée aux firmes Thales, Nexter et Sagem. Celles-ci font partie d'un consortium nommé TNS-Mars, dont la vaste tâche est de développer une formation totalement nouvelle au sein des forces armées, le Groupement Tactique interarmes (GTIA). Le GTIA est la version française des Future Combat Systems de l'armée américaine. La vente du système en réseau pour l'armée suédoise a été principalement réalisée par des firmes nationales, soutenues par The Boeing Company et IBM, partenaires du consortium SAAB Ericsson NBD Innovation AB. L'ordre dans lequel les acteurs et vendeurs interviennent est le suivant : les acheteurs précisent leurs besoins en technologies et en systèmes technologiques. Ceux-ci sont normalement basés sur le remplacement de systèmes vieillissants et le développement de ceux dont ils ont besoin pour faire face de façon efficace aux conflits présents ou futurs. Ajoutons au besoin de remplacement des systèmes vieillissants et au besoin d'adaptation aux conflits émergents les développements de systèmes de technologies encore inconnus devant répondre à des besoins liés à des conflits futurs non identifiés, qui peuvent devenir des développements indépendants. Cela veut dire que le développement de systèmes technologiques ne répond pas toujours à un objectif précis, comme nous pouvons le voir avec les développements de technologies pour des forces armées. Les buts et objectifs sont analysés, les plannings et méthodes validés et les failles potentielles normalement envisagées à un stade précoce de développement.

D'autres acteurs sont également impliqués dans l'acquisition de technologies de défense, au-delà des forces armées, de l'industrie et des politiciens prenant les décisions d'acheter technologies et systèmes spécifiques. Des autorités d'audit peuvent jouer un rôle, comme The United States Government Accountability Office (GAO) aux États-Unis, qui a supervisé le développement du Future

Combat Systems. Le GAO commença à suivre le projet lorsque celui-ci passa de l'étape théorique à la mise en œuvre concrète avec des composants réels, jusqu'à son aboutissement. Le Comité ministériel des investissements (CMI) examina, quant à lui, le projet Scorpion en France. Deux autorités d'audit différentes ont évalué le développement du système de défense centré réseau suédois : la Swedish Agency for Public Management et le Swedish National Audit Office qui, comme pour le Future Combat Systems américain, commença à superviser le projet lorsque celui-ci passa de l'étape de planification à l'étape concrète de développement. Les autorités d'audit influencent un projet par le biais de rapports écrits. Cependant, d'autres acteurs influençant ou susceptibles d'influencer un méga-projet ont également été étudiés. Dans le cadre du projet suédois principalement, des groupes d'individus externes à celui-ci, quoiqu'appartenant à d'autres services des forces armées suédoises ayant notamment contribué au projet Ledsys, pesèrent sur le projet en s'opposant aux changements futurs prévus. Il n'existe pas de similitude évidente avec les deux autres projets, car celui-ci en vint à être étendu au-delà du cadre des forces armées, contrairement aux deux autres programmes, destinés aux forces terrestres seulement.

Les développements et acquisitions de systèmes et technologies de défense ont été décrits en détail, ainsi que les événements et changements après la guerre froide qui ont donné lieu à la naissance de vastes méga-projets. Nous avons également abordé la façon dont un produit tel qu'une technologie de défense, si spécifique, peut influencer sur les relations et interactions entre les différents acteurs et sur la conduite des méga-projets technologiques militaires. Afin de répondre aux questions faisant l'objet de cette recherche, je présente des chapitres de littérature, regroupés en 5 parties :

- Environnement institutionnel et pouvoir au sein des groupes et chez les individus
- Le marketing industriel de la défense,
- Le management des ingénieries systèmes et du Système de Systèmes,
- Changement et transformations des organisations et technologies,
- Le management de projet.

Un tel choix de chapitre permet, me semble-t-il, une observation des cas étudiés selon différentes perspectives, et rend possible la compréhension des dynamiques et interactions complexes, à l'intérieur et à l'extérieur des différents développements, mais aussi avant, pendant et après la mise en œuvre des méga-projets.

Chapitre 2 : Littérature et cadre théorique

Ce choix de chapitres est motivé par la possibilité qu'il offre de présenter différents points et d'observer les événements et dynamiques à l'œuvre dans les différents cas étudiés. L'introduction à cette littérature met également en relief certains points qui seront développés dans chaque chapitre. C'est la notion même d'idée qui peut créer, et qui créa les conditions et la base des concepts de nouvelles technologies et systèmes de technologies qui surent convaincre les acteurs. En s'appuyant sur des constructions de pensées, perçues comme rationnelles, et d'autres stimulus, des groupes et individus peuvent agir de plusieurs façons possibles, influant sur la manière dont les arguments, commandes, artefacts et idées, sont appréhendés et transmis au cours du temps. Une idée peut par exemple être rejetée, modifiée, détournée ou encore utilisée à des fins malhonnêtes, mais une idée a besoin d'individus pour être diffusée, sinon elle disparaît... car les idées gardées dans des livres ne voyagent pas. Les idées étaient ce qui suscitait l'intérêt des acteurs, qui influencèrent et imposèrent ensuite l'amorce d'études de nouveaux concepts pour les méga-projets. Les chapitres de littérature décriront la notion de diffusion des idées et comment elles forment un élément essentiel du point de vue de la littérature. Les chapitres de littérature débutent par le marketing des systèmes de technologies et montrent comment ceux-ci ont été décrits comme un Système de Systèmes, nouveau genre de systèmes de combat réseaucentré, puis se poursuivent avec la transformation de l'organisation, requise pour la création et l'implémentation du Système des Systèmes. Le dernier chapitre concerne l'outil de création et de transformation du Système des Systèmes, le management des technologies et des méga-projets. Un dénominateur commun important : les idées sont la force motrice derrière la technologie et le développement de concepts.

Pour que les idées et concepts puissent être exécutés, les acteurs ont besoin d'être coordonnés et les intérêts partagés quant à la compréhension de la nécessité de ce qui doit être fait et développé. Dans certains cas, le pouvoir peut être un facteur important puisque certains aspects du pouvoir présentent des similitudes avec l'influence des idées.

Idées et pouvoir au sein des groupes et chez les individus

Selon Lukes (2005, p.27), il s'agit du troisième pouvoir : la manière dont les individus et les groupes peuvent être influencés alors qu'ils pensent agir selon leur propre volonté, et la capacité à influencer la réalité telle qu'elle est perçue, et donc agir sur les désirs et volontés des autres. L'idéologie peut

être vue comme un parallèle à la compréhension du fonctionnement de ce type de troisième pouvoir, en ce sens que son but est de changer les valeurs et les perceptions des actions considérées pour la prise de décision. Du fait des jeux d'influences, ce type de pouvoir permet aussi d'éviter les conflits ouverts, puisque l'acteur influencé a les mêmes volontés et désirs que celui qui influence les autres (Lukes, 2005). Ce dernier type de pouvoir a un lien avec les idées et la forme d'influence sur les individus et les groupes, leurs perceptions de la réalité et de ce qu'ils désirent.

Selon les types d'individus et groupes, leurs volontés respectives et objectifs propres, différents types d'attitudes rationnelles peuvent être observés.

Le management d'ingénierie des systèmes et du Système des Systèmes

Des officiers haut gradés, à l'instar de l'industrie de la défense, ont activement soutenu les concepts de Système de Systèmes et de guerre réseaucentrée auprès des politiques en position de prendre les décisions d'acquiescer les nouveaux systèmes technologiques. Les systèmes et le Système de Systèmes peuvent être vus comme des outils d'ingénierie servant à développer des systèmes technologiques de défense, mais peuvent aussi être pensés comme des concepts ou idées favorisant la promotion et la vente de projets réels de développements rendant possible une transformation de la défense, impulsée par la technologie. Une méthode de marketing a été utilisée avec des idées de nouveaux types de Systèmes de Systèmes. Les forces armées voulaient acquiescer le Système de Systèmes dans le but d'améliorer leur capacité au combat. L'industrie de la défense, elle, pensait que le Système des systèmes lui permettrait d'améliorer ses positions sur le marché, tandis que les politiciens voulaient le Système des systèmes après avoir été convaincus par les hauts officiers.

Changement et transformation des organisations

Le changement et la transformation des organisations impliquent des prises de décisions par différents acteurs individuels aux intérêts et croyances divers ; ces décisions peuvent donc être rationnelles et irrationnelles, si l'on compare les différentes raisons et objectifs du changement. Les attentes, motivations et engagements constituent des moteurs importants, qui témoignent de la croyance des individus et groupes en ce qu'ils font, et de l'attitude qu'ils adoptent ensuite. La perception individuelle est aussi importante pour comprendre comment les idées sont présentées et diffusées. Elle peut encore être sélective, et cela doit aussi être observé si l'on veut rendre compte de la façon dont les organisations, et les systèmes sur lesquels elles s'appuient, agissent. Les idées

liées aux systèmes technologiques, leurs apparences physiques et leurs activités peuvent être à la source de chaînes de suppositions qui n'ont nullement besoin d'être rationnelles et basées sur une expérience pratique, mais pouvant au contraire s'appuyer sur des projections. Conjointement aux idées et individus qui les propagent, le rythme de transformation des organisations et de la technologie a également son importance. Une transformation à la fois technologique et organisationnelle peut être mise en application par étapes successives et suivre un développement de type évolutionnaire. La différence entre les deux approches est significative, certains acteurs optant pour des changements radicaux quand d'autres préfèrent une transformation graduelle.

Management des technologies et management des méga-projets

Les projets de type développement technologique peuvent échouer en raison du peu de connaissance disponible, d'un optimisme excessif ou d'une sous-estimation du budget ou du temps nécessaire pour atteindre les objectifs.

Le management technologique est piloté par les équipes sur le terrain, dont les stratégies se concentrent sur la technologie, avec comme éléments essentiels le développement technologique et l'innovation, utilisés comme un avantage concurrentiel dans les stratégies d'entreprises. Le développement technologique s'est révélé être une stratégie efficace permettant de s'assurer une position de leadership sur le marché. De façon similaire, le leadership militaire voulait utiliser la technologie afin de créer un avantage sur des adversaires potentiels. Le développement technologique est cependant entouré d'un grand nombre d'inconnues : la complexité des technologies futures et non encore développées, la complexité administrative causée par des réseaux technologiques devant apprendre à fonctionner ensemble dans le cadre de vastes projets... autant de facteurs qui peuvent représenter de véritables défis.

Management du risque dans les méga-projets

Le grand nombre de technologies complètement nouvelles, inconnues et futures, ainsi que les événements émergeant durant la mise en œuvre des méga-projets rendent la capacité à prédire l'aboutissement de ces derniers très difficile. Le facteur d'incertitude peut être élevé, dû au grand nombre de technologies inconnues et interdépendantes, ainsi qu'aux différents acteurs interagissant et dont les intérêts et influences peuvent diverger, auxquels il convient également d'ajouter les événements futurs possibles, non prévus et les développements (Kerzner, 2013, PP 873-874).

Les conséquences d'événements non souhaités dans un contexte de méga-projet seraient plus considérables, si on les compare à des projets d'envergures plus classiques. Un autre élément corrélé à la dimension des méga-projets est le facteur de risque permanent. Cependant, avant le démarrage d'un méga-projet dont le facteur risque assez élevé peut être facilement négligé, la transformation et l'objectif des méga-projets sont parfois considérés comme plus importants que le plus grand des risques.

Chapitre 3 : Méthodologie

Le choix de l'étude de cas comme méthodologie est motivé par l'objectif premier de la recherche, qui est l'étude des différentes dynamiques à l'œuvre au sein et autour des méga-projets. Les dynamiques dans les trois différents méga-projets ont donc été examinées en utilisant une enquête narrative structurée identifiant non seulement les dynamiques entre les individus, mais aussi entre les groupes d'acteurs au sein et autour des méga-projets (Eisenhardt, 1989).

J'ai recherché les dynamiques et les idées qui pouvaient influencer sur les décisions et les comportements des individus et des groupes. Un élément important n'est pas tant le nombre de décisions prises, celles-ci peuvent être considérées comme parfaitement motivées et rationnelles, que l'observation des actions et des différentes dynamiques s'étendant sur le temps (Piore, 2006).

En parallèle aux questions de recherche, la méthode de l'étude de cas a été considérée comme la plus appropriée, du fait du grand nombre de variables possibles à l'intérieur et à l'extérieur des méga-projets (Yin, 2014, p.17).

Tous les cas ont été étudiés en utilisant une structure narrative qui inclut des analyses séquentielles, nous permettant d'organiser les données et de créer des questions autour des différents cas, selon M. Dumez (2016, p.125). L'étude de cas multiple, associé à une trame narrative, structure l'information pour une meilleure compréhension et une prise en compte plus précise des différents points de vue et facteurs.

Le plus vaste projet des trois étudiés est le Future Combat Systems, qui constitue un cas de référence.

Les projets cités ont été choisis en raison de leurs étendues et objectifs, et pour leurs similitudes et différences. La rédaction en trois narrations structurées autorise une vue d'ensemble de chaque méga-projet et facilite ainsi leur comparaison.

Matériau

Le matériau est largement constitué de rapports de différents types et d'interviews d'acteurs liés aux projets Ledsys et Scorpion, pour compléter notre étude. Afin d'établir des constatations et observations à travers l'étude de tout le matériau, toutes les combinaisons ont été analysées : les rapports seuls, les rapports et entretiens réalisés, et enfin les seuls entretiens.

Les données empiriques sont constituées de rapports d'autorités officielles, d'articles issus de la presse quotidienne et professionnelle, de blogs et d'interviews réalisées pour compléter les matériaux rassemblés.

Chapitre 4 : L'émergence du méga-projet Future Combat Systems

L'origine du projet Future Combat Systems remonte à l'Union Soviétique des années 1970 et se poursuit jusqu'après 2009, date de fin de mise en œuvre du programme. Après 2009, celui-ci évolua vers une version automatisée du programme, ainsi qu'en différentes parties pilotées humainement, comme le programme Brigade Combat Team (BCT), le projet Ground Combat Vehicle (GCV) et le Early Infantry Brigade Combat Team (E-IBCT).

L'armée américaine initia le projet Future Combat Systems en 1999, avec pour objectif l'acquisition pour l'armée de systèmes technologiques complètement nouveaux. L'idée était de changer potentiellement tous les systèmes technologiques existants et d'acquérir de nouveaux véhicules, ordinateurs, radios et armes et de s'adapter à des développements de technologies modernes. La transformation s'inspirait d'idées issues de la guerre froide et la période d'austérité des années 1990 fut jugée comme étant un bon moment pour la mise en œuvre d'un méga-projet visant à la transformation de l'armée américaine toute entière. Peu après le début du projet, de nouveaux conflits émergèrent en Afghanistan et en Iraq, créant le besoin de nouveaux moyens qui sauraient répondre aux préoccupations majeures. En raison des conflits, des restrictions budgétaires affectèrent le projet Future Combat Systems, tandis que les politiques, préoccupés par les menaces

grandissantes que représentaient ces conflits, demandaient la mise en place rapide de mesures de protection sur le terrain.

Les méga-projets échouèrent à atteindre leurs objectifs principaux, mais certaines technologies furent utilisées durant les développements du projet. Les affrontements en Afghanistan et Iraq, les problèmes non résolus en matière de technologies de la communication, ainsi que l'exigence d'un transport aérien des équipements reposant sur un modèle d'avion trop petit, exigence retirée trop tardivement, furent des obstacles majeurs à la progression du projet.

Chapitre 5 : Le méga-projet Ledsys

Le développement d'un système de défense basé en réseau en Suède a été déployé via le méga-projet Ledsys. La volonté était de transformer et moderniser les forces armées suédoises. Les ambitions et objectifs étaient les mêmes que celles affichées par le projet Future Combat Systems, les hauts officiers suédois se rendirent d'ailleurs aux États-Unis pour en observer le développement et étudier l'approche américaine en matière de technologie et de gestion de conflits.

Le méga-projet Ledsys débuta en 2000, avec pour objectif de moderniser l'ensemble des forces armées, et pas seulement l'armée suédoise. L'objectif principal au début de ce méga-projet était de rendre les forces armées plus efficaces pour protéger la Suède. Plus tard, durant la progression du projet, cet objectif changea : il ne s'agissait désormais plus que de gérer les conflits extérieurs et de devenir interopérable avec les pays de l'OTAN. Dès le départ, le projet n'était pas clair et cela se confirma durant toute la durée de son développement. Le projet commença également à interférer avec d'autres systèmes importants déjà existants, donnant naissance à une résistance organisationnelle.

Des problèmes identiques au projet Future Combat Systems quant aux questions non résolues en matière de technologies de la communication, des objectifs peu clairs et des changements de finalité visant désormais à une interopérabilité... tous ces éléments aggravèrent la résistance organisationnelle. Au même moment, les forces armées suédoises virent leur budget décroître de manière continue. Les facteurs résumés plus haut causèrent finalement l'arrêt du projet Ledsys par les politiques suédois au parlement d'abord en 2006, puis plus tard, des derniers développements résiduels, par le commandant suprême suédois en 2009.

Chapitre 6 : Le projet Scorpion français

Le programme français est l'équivalent du méga-projet Future combat Systems aux États-Unis et du projet Ledsys des forces armées suédoises. Celui-ci n'a pas débuté à la même période que les autres projets, mais près d'une décennie plus tard, ce qui permet d'éviter certaines pressions institutionnelles poussant à la finalisation rapide d'un programme totalement nouveau, avec ce que cela comporte de risques et d'incertitudes. Cependant, le projet Scorpion, a été abordé comme le sont les vastes projets en général, c'est-à-dire avec prudence quant aux risques et incertitudes dans le développement.

Au début du projet en 2010, seules les forces de terre étaient concernées par le programme, qui se concentrait sur quelques nouvelles technologies principales destinées à deux nouveaux systèmes pour véhicules, ainsi qu'à un système de communication. Une autre partie du projet était dédiée à la modernisation et à la modification de systèmes d'équipements déjà existants, dans le but de les intégrer au GTIA, groupement des différentes armes de l'armée de terre française. Contrairement aux méga-projets précédents, le Scorpion est clairement défini et est mis place progressivement, et il n'a pas pour but la transformation complète de l'armée française.

Le méga-projet Scorpion est similaire à d'autres programmes de renouvellement et d'amélioration des activités des systèmes d'équipements et le type de management appliqué est assez similaire au type de management classique que l'on peut constater lors d'acquisitions d'équipements.

Chapitre 7 : Similitudes et différences durant les tournants décisifs et différentes séquences

Chaque méga-projet doit être envisagé selon le contexte de chaque force armée et sa dimension. Ce peut être des services entiers ou les forces armées dans leur ensemble qui peuvent être bouleversés radicalement ou par étapes. De ce point de vue, les idées majeures en faveur du changement sont identiques mais le décalage temporel au moment du démarrage du projet a été un point important. Ainsi, un méga-projet initié à la fin des années 1990 devait être synonyme de changement radical et de transformation. Une décennie plus tard, des idées similaires conduisaient maintenant à un choix de management de projet prudent et à un changement graduel, afin de minimiser le risque au maximum. Les projets Future Combat Systems et Ledsys, débutés plus tôt, avaient été très ambitieux

mais aussi irréalistes au regard de certains points techniques et organisationnels, et ces obstacles se révélèrent impossible à solutionner. Dès leur conception, ces deux méga-projets présentaient certaines spécificités et les problèmes se multiplièrent quand il fut évident que les projets ne semblaient pas progresser comme prévu ; aussi des changements d'objectifs furent décidés au cours de leur développement. Le Future Combat Systems et Ledsys affichent tous deux une phase de lancement positive, suivie d'une phase de résistance grandissante et d'une hésitation politique à propos des objectifs et de la progression dans la mise en œuvre. Il n'en va pas de même pour le projet Scorpion, dont le cadre n'était pas aussi radical. Comparé aux deux autres méga-projets, le Scorpion serait plutôt comparable à un projet de modernisation graduelle de l'armée française, et donc à un projet normal de gestion de la chaîne d'approvisionnement d'équipements.

Les analepses

Les différences entre les analepses sont évidentes si l'on regarde les deux premiers méga-projets d'une part, et le Scorpion d'autre part. Les deux premiers ont été influencés par les perspectives d'un avenir technologique prometteur, qui pourrait permettre de résoudre les problèmes militaires classiques. Ces convictions étaient si fortes qu'elles influencèrent la conception des projets et encouragèrent la présentation de plans audacieux, qui négligèrent cependant le risque de la faisabilité réelle, tant sur le plan organisationnel que technologique.

Tournants décisifs critiques

Le Future Combat Systems et le projet Ledsys connurent tous deux une phase de lancement positive, qui laissa la place à des critiques grandissantes en raison de l'absence de résultats probants et des obstacles émergents durant les développements. Il est à noter que ces critiques ne cessèrent de s'amplifier, ayant pour conséquence l'arrêt des deux projets. Un des impératifs imposés au Future Combat Systems était la transportabilité par les airs dans un avion relativement petit, pour les déplacements hors des États-Unis. En parallèle était l'incapacité à s'adapter aux nouveaux besoins nés des conflits en Iraq et en Afghanistan, et cela rendit la poursuite du méga-projet impossible. Ledsys, quant à lui, avait l'ambition d'être étendu à l'ensemble des forces armées suédoises. Il était aussi destiné à être intégré à des services des forces armées suffisamment autonomes qui, elles, ne souhaitaient pas cette intégration comme cela était prévu par le projet. De plus, le changement d'objectif principal du projet Ledsys, en raison des nouvelles directives stratégiques des forces

armées suédoises, ne permit pas au méga-projet de réaliser des progrès significatifs et celui-ci fut stoppé.

Le projet Scorpion diffère des deux autres projets car il débuta plus tardivement et est toujours en cours de mise en œuvre. Un tournant majeur a été de considérer le projet comme un outil permettant le renouvellement de l'armée française. Contrairement aux autres projets, des mesures ont été prises afin d'abaisser le niveau de risque lié au projet Scorpion.

Les aboutissements

Les décisions de mettre un terme aux deux méga-projets en raison de leur échec ont été prises par les politiques aux États-Unis et en Suède après plusieurs années de méfiance grandissante en raison de l'incapacité à atteindre les objectifs fixés. Le Future Combat System et Ledsys ont tous deux connu des prolongements dans leurs développements après leur finalisation. La poursuite du Future Combat Systems était prévue et préparée avant l'arrêt du projet. Quant au projet Ledsys, il y a eu continuité mais celle-ci n'avait pas été réellement organisée ni préparée. A l'heure actuelle, le projet français Scorpion n'est pas finalisé.

Épilogues

La continuation des développements après la fin des projets constitue l'épilogue. Quand les projets échouèrent et que la décision fut prise de mettre un terme aux méga-projets Future Combat Systems et Ledsys, les besoins de ce qui devait être développé, eux, ne disparurent pas. Les concepts et les technologies qui avaient pu être développées ont été transférés vers d'autres activités de développements portant d'autres appellations, qui ne se seraient pas ouvertement liées aux méga-projets venant d'échouer. Les développements poursuivis après le projet Ledsys en étaient une continuation, mais peu de ce qui a été développé a pu être utilisé.

Comparaison des éléments essentiels concernant les méga-projets

La décision d'initier, de planifier et d'implémenter des méga-projets ne relève pas de la seule gestion de projet ou de la gestion des technologies. Il s'agit en outre de définir une culture de développement. Un discours confus, imprécis et trop assuré... sont des caractéristiques communes qui rappellent ce qui est souvent perçu comme relevant de l'idéologie, conduisant de ce fait à un management et à une mise en œuvre incertaines du projet. Il a aussi pu être observé que

l'organisation devant délivrer le méga-projet ne sait fréquemment pas comment l'implémenter (Flyvberg, 2017, p. 12-13).

Dans un contexte de grande incertitude économique et technologique, la culture du développement protège ce qui, pour certains acteurs, doit être absolument créé. La question devient alors de savoir si l'on se positionne pour ou contre un mouvement "idéologique" plutôt que pour ou contre un développement technologique. Si la décision de lancer un méga-projet ne semble pas fondée sur une seule décision scientifique et technologique mais naît aussi possiblement d'un conflit entre différentes positions politiques et idéologiques, Levitt et Scott (2017) ont suggéré d'utiliser le modèle politique et culturel développé par Swidler de ces types de conflits afin d'analyser les origines et développements des méga-projets technologiques. Si Swidler (1986) se concentre sur les luttes culturelles dans des environnements sociologiques tels que les systèmes sociaux, celles-ci présentent cependant des similitudes avec les luttes observables lors des lancements et développements des méga-projets.

Ce modèle décrit une concurrence entre les cultures et leurs répercussions sur les actions mises en oeuvre, lorsqu'un type de culture tend à vouloir se préserver, devenant donc peu enclin au changement tandis qu'un autre en fait la promotion. Les décisions basées sur des valeurs sont, comme explicité par Swidler (1986), un élément d'importance centrale ; cela est aussi le cas dans les contextes des méga-projets. Le modèle de Swidler reste néanmoins plutôt statique. Si l'on veut étudier le développement des méga-projets, des outils d'analyse plus dynamiques sont nécessaires.

L'étude des transformations de cultures m'a conduit à utiliser la notion "d'épiphanie" ou révélation, vision, me permettant ainsi d'étudier les moments de ruptures dans les discours et les actions des acteurs impliqués dans la conduite des méga-projets. Comme mentionné précédemment, insistons sur le fait que la culture à l'origine de la décision de lancer un méga-projet est présomptueuse, générale et incertaine.

Lors de la phase de développement de projet, des difficultés concrètes sont rencontrées, en raison des revers technologiques et des résistances organisationnelles. C'est alors qu'un changement de culture devient nécessaire, donnant naissance à une épiphanie (Denzin, 1989; Dumez 2016) qui influe à la fois sur le discours et mises en oeuvre. Nous pouvons souligner que celles-ci ne se produisent toutefois pas dans des environnements non contrôlés.

Culture

Elles sont en effet la conséquence d'un conflit des cultures impliquées dans le développement de méga-projets. Des raisons factuelles peuvent être à l'origine des changements dans les discours et pratiques lorsque, par exemple, une nouvelle technologie se voit intégrée ou non.

Mais le développement technologique reste profondément incertain et se caractérise par ses valeurs et controverses. L'événement déclencheur d'une épiphanie est donc lié au pouvoir. Clegg (2017) a insisté sur le rôle du pouvoir dans les dynamiques des méga-projets. Il s'appuie en effet sur l'analyse du pouvoir telle que décrite par Lukes. Selon ce dernier (2005), le pouvoir influe sur les latitudes des acteurs et est étroitement lié à la propagation d'un type de culture de développement.

il est nécessaire d'impliquer le pouvoir pour influencer sur le développement d'un méga-projet. Son analyse permet également d'observer la façon dont les épiphanies surviennent. Lukes (2005) décrit les trois formes de pouvoir pouvant être utilisées dans le cadre des méga-projets.

La première est la capacité à imposer sa volonté aux autres, la seconde est l'habileté à tenir les points de tensions à l'écart de l'agenda et de ne pas les laisser détourner l'attention des décisions à prendre. Enfin, la troisième est le pouvoir de définir la réalité et d'agir sur les objectifs des personnes.

Les relations entre culture de développement, épiphanie et pouvoir demandent à être approfondies car les liens entre ces manifestations sont importants dans la compréhension des dynamiques à l'oeuvre dans les méga-projets mais aussi dans la compréhension de la nature de ces liens.

Répetons ici que la culture de développement est au départ marquée par une grande confiance et trop vague. Ces caractéristiques se trouvent souvent à la base des décisions de lancement des méga-projets. Mais lorsque les ceux-ci débutent, des problèmes concrets et des controverses apparaissent. Un changement de culture devient alors nécessaire. Les épiphanies, comme changements de discours et de pratiques, sont un élément crucial à étudier si l'on veut comprendre les dynamiques de développement des méga-projets. Et afin de comprendre comment celles-ci apparaissent, nous devons étudier les relations de pouvoir entre les différents acteurs.

Dans ce chapitre de discussion, je vais étudier les relations entre les cultures, dynamiques (épiphanies) et pouvoirs, tels que les auteurs précités les ont théorisées, car elles éclairent les trois cas présentés.

Une culture instable consiste en des acteurs en faveur d'un changement global et qui, pour cela, dirigeraient la mise en oeuvre du méga-projet ou tenteraient d'influer sur celle-ci. Il s'agit d'acteurs qui croient que leur environnement nécessite un changement radical, non des changements progressifs.

Dans une culture stable, l'environnement proche est impacté par le méga-projet et les acteurs tentent de se protéger de leurs effets. Ce type de culture existe également au sein des politiques, qui finissent par s'inquiéter de la situation financière d'un méga-projet lorsque celui-ci n'atteint pas les objectifs fixés. Une culture instable tente d'implémenter le méga-projet, tandis que la culture stable tente de stopper le développement lors de réunions et d'influer sur les décisions. C'est principalement au sein et autour des méga-projets que les conflits émergent. La culture stable possède son propre département des forces armées comme lieu d'expansion, tandis que le méga-projet est le lieu d'expansion de la culture instable, ou de décroissement, selon les influences extérieures.

Si l'on compare les caractéristiques culturelles des trois méga-projets, l'on peut constater que le Future Combat System est de culture instable prédominante, comprenant également des éléments de culture stable, de part son histoire et sa tradition de programmes et de développements transversaux. Le méga-projet Ledsys est, au début du projet, clairement de dominante instable, et ne comprend que peu ou aucun éléments de culture stable. Quant au méga-projet Scorpion, il implique une culture clairement stable avec peu ou pas d'éléments de culture instable.

Epiphanie

Les méga-projets sont cependant fréquemment modifiés au cours d'étapes charnières, elles-mêmes conséquences d'autres problématiques. Ces changements ne sont ni planifiés ni envisagés aux moments où les acteurs changent leurs projets et plans d'action. De l'initiation à la mise en oeuvre du méga-projet, de nouvelles inquiétudes émergent et s'ajoutent, affectant le développement. Ces événements de nature interne ou externe peuvent alors changer la façon dont les acteurs agissent et provoquent le changement au sein des méga-projets.

Les changements engendrés par les dynamiques entre les différents acteurs, qui occasionnent un changement de doctrines et de pratiques sont des épiphanies. Ces tournants majeurs types impliquent nécessairement une épiphanie.

Les raisons de ces changements de doctrines et de pratiques ne trouvent cependant pas leur origine dans un événement isolé. Un grand nombre de raisons peuvent potentiellement expliquer l'émergence d'obstacles durant le développement, comme un management faisant preuve d'une trop grande confiance ou un projet trop global et imprécis. Cette combinaison d'ambitions, d'inquiétudes négligées et d'acteurs aux volontés affirmées, associés à différentes cultures de développement conduisent à un déplacement des dynamiques et à différentes épiphanies.

J'utilise le terme d'épiphanie car des tournants majeurs au cours des développements des méga-projets se sont produits en raison de la manifestation de différentes perspectives et visions, qui ont changé les doctrines et directions des acteurs, et donc des développements des méga-projets.

Prolongeant la notion d'épiphanie, Denzin (1989, 37) et Dumez (2016, p.128) développent une série de théories et décrivent plusieurs types d'épiphanies telles que les épiphanies cumulatives, majeures et mineures.

Une épiphanie cumulative peut être le résultat d'une série d'événements ayant accumulé les insatisfactions des acteurs et qui, révélées, ont causé un changement de dogmes et de pratiques. Des obstacles répétés, rencontrés dans les développements des méga-projets qui, en conséquence, échouent dans leur progression, peuvent être un exemple d'épiphanie cumulative. Par exemple, plusieurs formes et couches de risques se créent lorsque différentes technologies prometteuses sont supposées être construites simultanément avec pour but de fonctionner efficacement ensemble, suscitant des d'incertitudes.

Ces obstacles répétés, en raison des échecs des développements individuels de technologies, ont généré des tensions entre les acteurs, déterminés dans leur volonté de réussite. A cause de ces échecs, certains acteurs ont perdu confiance et le méga-projet devient plus difficile à justifier auprès du monde extérieur. La tension est finalement libérée sous la forme d'une épiphanie cumulative.

On dit qu'une épiphanie majeure bouleverse la vie d'une personne, à l'instar du meurtre de Raskolnikov dans *Crime et Châtiment*. Sa conséquence en est un bouleversement total et complet dans la compréhension de ce qui serait nécessaire. Un exemple possible de ce type d'épiphanie dans un contexte de méga-projet serait une situation dans laquelle est ce qui est estimé nécessaire à construire devient finalement tout autre que prévu initialement, ceci étant réalisé tardivement dans le processus de développement. Cela pourrait, par exemple, être une enquête ayant signalé le besoin d'un aéroport et, tandis que sa construction est avancée, ce besoin cesse d'exister en raison d'un changement de comportement des voyageurs. Lorsque des signaux de ce type parviennent aux acteurs, des changements de dogmes et de pratiques majeurs peuvent alors avoir lieu.

Une épiphanie mineure peut être difficile à déceler mais malgré tout conduire à des changements majeurs dans la conduite des projets car les tensions sous-jacentes sont révélées aux acteurs. Un exemple de ce type d'épiphanie dans le contexte d'un méga-projet pourrait être un élément mineur interprété différemment de son sens habituel, ou qu'une nouvelle interprétation soit être faite de ce dernier, donnant lieu à un changement majeur de paradigmes et de directions. Par exemple, une

technologie non anticipée pourrait se trouver être impossible à développer physiquement si son principe de construction va à l'encontre des lois de la nature.

Un autre exemple pourrait être qu'un méga-projet militaire soit basé sur l'idée d'une communication constante nécessaire au sein du nouveau système. Si un tel système de communication devait se révéler être facile à détecter pour un adversaire, et donc facile à combattre, cette épiphanie mineure pourrait alors conduire à de grands changements de plans et de pratiques de la part des acteurs du méga-projet.

Pouvoir

Comment est-il possible que ces épiphanies engendrent de tels changements dans la conduite des méga-projets ? La réponse est liée au pouvoir.

Les acteurs peuvent changer d'intentions, mais que cela ait un réel impact sur le développement témoigne du rôle joué par le pouvoir dans la dynamique des méga-projet ; parce qu'un changement de déploiement sans une réelle volonté et sans réel pouvoir de changement n'aura que peu de chance d'influer sur un développement et d'exercer une pression sur les acteurs des méga-projets.

Sans autorité, il y a en effet peu de chance de parvenir à imposer une transformation des raisonnements et des pratiques.

Je me réfère à la notion de pouvoir car celui-ci est nécessaire pour que la diffusion, le questionnement et la continuité des méga-projets permettent à des épiphanies de générer un changement de culture de développement et de mise en oeuvre.

Je vais maintenant définir plus précisément la notion de pouvoir, telle que théorisée par Lukes (2005). Selon lui, elle existe sous trois formes. Je commencerai par la forme de pouvoir la plus élémentaire, poursuivrai avec la seconde forme, constituant ainsi une progression jusqu'à la troisième et dernière forme de pouvoir, la plus proche de l'idéologie.

La première forme de pouvoir, la plus directe, consiste à imposer sa volonté aux autres acteurs. Un acteur B se voit demandé de faire quelque chose par un acteur A et exécute cette demande.

La seconde forme de pouvoir est, par exemple, la capacité à préserver l'agenda des tensions et favoriser les actions favorisant la poursuite des développements et objectifs initiaux. Un acteur A poursuit l'agenda qui développe les idées de l'acteur A.

Le principe de non-décision est aussi associé à la seconde forme de pouvoir. Une non-décision pourrait être d'ajourner ou taire toute préoccupation nécessitant une décision afin d'éviter d'avoir à prendre une mauvaise décision qui pourrait se révéler désavantageuse.

La troisième forme de pouvoir, la dernière, est l'habileté à définir la réalité afin d'influencer les désirs et demandes des acteurs en interne et à l'extérieur, jusqu'à l'administration publique et aux politiques. Un exemple est le contrôle de l'information, des médias de masse et de la socialisation, en créant des aspirations de type idéologiques auprès des acteurs. En mêlant ses aspirations à celles des autres acteurs, la troisième forme de pouvoir parvient à altérer leurs perceptions et volontés.

Ces types de pouvoir ont été pratiqués au cours des développements des méga-projets, et plus particulièrement dans le cadre du projet Ledsys et son développement de système de défense basé en réseau.

Chapitre 8 : Conclusions

Dans les contextes des méga-projets, les décisions prises en s'appuyant sur des dimensions culturelles contiennent, ou peuvent contenir, des marques idéologiques qui conduisent à des obstacles critiques bien souvent ignorés. Ces derniers, qu'ils soient ignorés ou non compris, sont liés à des obstacles qui ne sont pas liés au types de développements encouragés par les visions idéologiques des avocats du changement. Les failles critiques observables dans les méga-projets proviennent d'un leadership enthousiaste qui refuse en même temps d'en voir les faiblesses critiques.

L'impact des épiphanies tend à être d'une plus grande importance si des visions idéologiques ont influé sur le développement. Des développements imprégnés de cultures idéologiques créent des situations dans lesquelles les parties prenantes sont trop en confiance, celles-ci intervenant dans un cadre directeur peu clair. Des projets confus sont alors annoncés par un management intégré à ce même type d'environnement. Les épiphanies qui se manifestent dans de telles conjonctures ont plus d'impact que les épiphanies survenant dans des environnements contrôlés, sans culture idéologique.

Deux grands types de méga-projets peuvent être considérés. Un type inclut des acteurs qui soutiennent un changement complet, conduit par des objectifs incertains et des idées novatrices, mais comportant un grand risque d'échec ou prenant une direction pouvant conduire à l'échec. L'autre type de méga-projet est un méga-projet géré de façon prudente qui implique un objectif clair, un moindre risque d'échec et des acteurs non impliqués dans des velléités de changement radical ou moins sensibles aux idées en vogue.

La comparaison des trois méga-projets a permis d'établir plusieurs conclusions, à partir de leurs similitudes et différences. La comparaison repose sur des ressources empiriques diverses, proposant plusieurs explications qui sont probablement les plus envisageables, mais d'autres peuvent aussi être tout à fait valables.

Les conclusions peuvent être empiriques et théoriques. Les conclusions empiriques comprennent les réponses aux questions de recherche, à savoir quelle est la complexité des méga-projets émergents et existe-t-il différents managements pour ces types de projets ?

Les méga-projets peuvent être gérés de la même manière que d'autres vastes projets de développement et d'acquisition. Il n'est pas nécessaire d'avoir recours à un type de management spécifique pour la gestion d'un méga-projet. La comparaison comprend différents types de managements, comme cela a été le cas avec le management du Lead System Integrator pour Future Combat Systems. Le projet Ledsys a montré un management légèrement différent du Scorpion, qui lui fait plutôt l'objet d'un contrôle strict. Des consortiums ont pris part à tous les stades des développements pour piloter le grand nombre de tâches mais cela n'indique pas pour autant qu'un nouveau type de management spécifique est nécessaire pour mener un méga-projet militaire vers le succès. Ce qui peut être déduit indirectement de la comparaison est que les méga-projets nécessitent un plus grand contrôle avant, pendant et après leurs différentes phases de développement.

Elle démontre aussi que des objectifs non clairement définis durant la planification du projet et sa mise en œuvre, associés à une volonté de mise en œuvre radicale d'un méga-projet est un facteur d'échec. A l'opposé, des plans clairement établis et une mise en œuvre progressive réduisent le risque inhérent au projet et augmentent les chances de succès d'un méga-projet. Aucune de ces opérations ne sous-tend néanmoins le besoin d'un type de management spécifique pour un méga-projet. La seconde question de recherche est pourquoi les méga-projets échouent ou aboutissent-ils parfois ?

Suggestions de recherches supplémentaires

Selon moi, trois directions de recherches possibles seraient intéressantes à développer. La première peut être divisée en trois différents domaines, il s'agit de continuer les recherches à partir des

conséquences décrites dans les domaines militaires, de l'industrie, de la défense des politiques de sécurité. Au sein d'au moins deux des forces armées, et possiblement la troisième, nous avons pu voir le mécanisme de diffusion des idées et leur capacité à influencer les acteurs qui peuvent initier le début d'un profond changement de développement des activités. Le développement des activités dans de telles organisations intègre généralement la capacité à agir ou réagir sur la perception des besoins et de les mettre en place progressivement.

Les idées précèdent, par définition, la planification d'un méga-projet et la transformation. Le management est acteur du changement et se constitue après que le développement des idées a été mené. Il est très difficile de changer un méga-projet après son commencement.

Les premiers méga-projets initiés furent des échecs complets ou partiels et aucun ne fut capable de gérer les nouveaux événements et conflits émergents et leur progression politique, technologique et de sécurité. Tous les acteurs principaux, c'est-à-dire les utilisateurs finaux du secteur militaire, les décideurs politiques et les industries de la défense ont été impliqués au commencement des méga-projets, qu'il fut par la suite impossible à adapter aux nouveaux développements de sécurité et aux nouvelles exigences.

La seconde direction de recherche est en lien avec la première direction précédemment évoquée. Les modalités des méga-projets sont définies au début de l'existence du méga-projet. Certains méga-projets ont pour but une transformation et sont implémentés sur une période de temps relativement courte et requièrent une grande quantité de ressources de la part des organisations intégrant ces systèmes. D'un autre côté, si le méga-projet est mis en œuvre sur une plus longue période, il devient comparable à un projet d'implantation d'un nouvel équipement, un plan d'acquisition. Dans ce cas, le développement et le risque lié au projet sont moindres et la possibilité d'adapter le développement aux évolutions de l'environnement s'en trouvent facilitée. L'initiative d'un méga-projet comportant plusieurs facteurs à hauts risques est ainsi rendue moins incertaine du fait d'un type de mise en œuvre plus classique. Les concepts conduisant à une planification d'un méga-projet et les décideurs se trouvant influencés par les forces directrices que sont les acteurs principaux doivent être étudiés de façon plus approfondie. Fait également partie de cette direction de recherche l'investigation concernant la prise en compte des idées, la façon dont elles sont gérées puis comment le management peut être mené efficacement si l'existence de ce management est justifiée par ces idées et concepts.

Ma troisième direction porte sur la poursuite de recherches concernant les aboutissements d'un méga-projet, en incluant les événements survenus après son achèvement officiel. Dans quelle mesure l'épilogue narratif et les événements suivant la fin du projet peuvent-ils contribuer à notre compréhension d'un méga-projet dans sa globalité ? Ce qui est poursuivi après l'achèvement du programme peut être motivé par plusieurs raisons. Si l'on devait proposer une échelle de mesure de succès ou d'échec d'un méga-projet, les événements et détails transmis dans l'épilogue narratif sont importants.

Recommandations de gestion

Le management de méga-projet est confronté à des décisions importantes qui peuvent aussi être difficiles durant la phase d'émergence des idées et avant même qu'aucun projet concret n'existe encore. Les enjeux sont immenses et les différentes forces et volontés exprimées peuvent être puissantes. Proposer des recommandations pour un développement complet dans le domaine des affaires militaires serait comme prêcher un convaincu, puisqu'une grande partie des conseils pouvant être donnés se rattachent à des faits déjà connus avant, pendant et après la mise en œuvre du projet. Les conditions technologiques, économiques et de connaissances peuvent être imprécises ou inconnues, ce qui signifie que les conditions de gestion et de mise en œuvre de méga-projets militaires peuvent être elles aussi indéterminées. Une question que devrait se poser le management est la suivante : quelles sont les conditions de gestion d'un méga-projet comportant des incertitudes inconnues, des demandes contradictoires et des méga risques en découlant ?

Les méga-projets militaires ayant pour but l'acquisition de systèmes pour une partie ou pour l'ensemble des forces armées, ont ou peuvent aisément avoir l'aspiration à transformer partie ou l'ensemble de celles-ci. Une stratégie d'équipement de défense contrôlée peut presque remplacer un méga-projet, à la différence que le risque et l'incertitude peuvent être diminués significativement. On peut se demander si de telles transformations sont alors nécessaires, étant donné que les forces armées s'adaptent de toute façon au monde, cela est vrai tant en ce qui concerne les possibles menaces technologiques qu'économiques ?

Un développement doit être réaliste au regard de l'accroissement des connaissances disponibles, de la maturité technologique, du périmètre de développement et du temps imparti. En cas de développement complet, les sous-activités et sous-projets doivent être facilement divisibles. Un méga-projet doit pouvoir tenir compte des changements extérieurs. Comment un méga-projet, qui

sera probablement confronté à des changements internes et externes, est-il élaboré de façon à pouvoir gérer de tels événements et comment des sous-parties obsolètes de ces méga-projets peuvent-elles être mises de côté sans porter atteinte au projet dans son ensemble ?

Certaines des difficultés concernant les méga-projets peuvent être la conséquence d'objectifs peu clairs, et d'approches difficilement réalisables. Lorsque des objections s'élèvent, elles ne sont pas entendues. De plus, faire entendre sa voix dans un tel environnement peut s'avérer impossible, ou peut porter préjudice en matière de carrière professionnelle. Cela veut dire que la planification et le management d'un méga-projet peut s'avérer être trop optimiste, et les inquiétudes majeures évacuées ou ignorées, donnant lieu à des lancements de développements condamnés à échouer, complètement ou partiellement.

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Appendix

Systems Engineering Management and System of Systems

This section on Systems Engineering Management and System of Systems describes the notion of systems and the ideas of System of Systems. Systems are described and the methods for managing systems, known as Systems Engineering. The latter part of the section is about the differences between systems and System of Systems, which is debated. It is important to be aware of the debated differences because it raises questions about System of Systems. Is System of Systems, and with it System of Systems Engineering, something new compared to normal systems or can some of the notion be traced to new ways of selling defence technology? The failure to find something clearly new other than technologies added to the same development project compared to an ordinary system indicates that the notion of System of Systems is simply a new perspective. System of Systems does not say that technology has reached a new level of complexity. What the notion of System of Systems then can indicate is that System of Systems is a notion used to promote development of future technology systems and mega projects.

The actors related to the notion of systems are those who promoted the notion, i.e. high-ranking officers and the defence industry who wanted the new System of Systems. High-ranking officers and the defence industry promoted the concepts of System of Systems and Network-Centric Warfare among politicians who were in the position to take decisions to acquire the new technology systems. Systems and System of Systems can be viewed as an engineering tool to develop defence technology systems, but can also be thought about as an idea to promote and sell real development projects and technology-driven defence transformation.

An important means to sell technology systems has been by promoting the notion of systems and the derivative ideas of systems. There is a beginning of the notion of systems becoming important to further the selling of mega projects. Bertalanffy (1949) introduced systems theory in the 1930s based on research in biology with a focus on organisms as a whole, including their complex organisation and physiological functions. Very rapidly, the notion of systems became popular in different fields: "Systems thinking plays a dominant role in a wide range of fields from industrial enterprise and armaments to esoteric topics of pure science. Innumerable publications, conferences, symposia and courses are devoted to it. Professions and jobs have appeared in recent years which, unknown a short while ago, go under names such as systems design, systems analysis, systems engineering (SE)

and others” (Bertalanffy, 1968, p. 3). Systems theory approaches phenomena as a whole and not as a sum of parts. “It is necessary to study not only parts and processes in isolation, but also to solve the decisive problems found in organisation and order unifying them, resulting from dynamic interaction of parts, and making the behaviour of the parts different when studied in isolation or within the whole...” Bertalanffy (1968, p. 31). In line with Bertalanffy’s works, exemplified by the International Society for the Systems Science (2007), the new scientific field of systems theory emerged. The notion and ideas of systems theory later developed into disciplines for viewing and understanding systems holistically but also managing entire life cycles of technology systems.

Life cycle management of technology systems using Systems Engineering

The development of complicated or complex systems aimed at the armed forces is commonly done through Systems Engineering. Systems Engineering is practiced throughout all stages of a technology system’s life cycle, from concept and development to production and disassembly, and is tied to the Systems Engineering standard 15288. In military development and acquisition of technology systems, Systems Engineering is commonly claimed to be dealing with a single, or a few, technology systems. The acquisition of complex military technology incorporates methodologies and models for handling the complex work of acquiring complex technology for military purposes. Because of the sheer number of units acquired when military organisations obtain technology, projects tend to be technically complicated and large at the same time. In order to manage such tasks, models can be used to manage the acquisition of complex military systems. An example of such a model on managing development, acquisition and evaluation of complex technical systems is the INCOSE Handbook which is based on the international ISO/IEC certified standard 15288 (Haskins, 2007). From a more theoretical point of view, the development, acquisition and evaluation of military technology can be found in the literature on Military Operation Research, which is a methodology in quantitative decision making. Examples of literature address decisions regarding military issues according to Jaiswal (1997) and Loerch (2007) but there are also similar examples within management decision making (Goodwin & Wright, 2004). With such methodologies, influential factors regarding technology systems and how the technologies are being used can be managed in a systematic manner. Examples of usage is to assess possibilities, limitations or the possibility of certain technologies being less necessary or even unnecessary and weigh against its potential use in conflicts. The evaluation of technology can be done in a structured way, creating a rather fair comparison between different technical systems using the ISO standard 15288. The strong suit of the ISO standard 15288 is that it can be used to weigh different characteristics of different technologies

coupled to what the purposes of different technologies are. It is then possible to evaluate an existing or future military technology against its militarily tactical, operational or strategic purpose. This could give indications about a procurement process and ability to analyse the future use of the technology in its military context as being efficient and correct in the meaning of evaluating and later choosing technology for a certain purpose. Indeed, it is, in theory, a very efficient process given the ISO/IEC standard 15288 to ensure an adequate and as efficient acquisition process as possible. The methodological basis for the acquisition process and activities is mainly Systems Engineering, which is dealing with “recognition, appreciation and integration of all aspects of an organisation or a facility” (Badiru, 2014, p. 5) A system is a collection of interrelated elements working together in a synergetic way, creating an output greater than the ingoing parts summed together individually. “A system view of a process facilitates a comprehensive inclusion of all the factors involved in the process” (Badiru, 2014, p. 5).

Systems Engineering

Systems Engineering is frequently understood as a discipline dealing with the design, creation and usage of complex systems made by humans. However, no complex system is constructed by any single individual and therefore Systems Engineering is strongly tied to management. The combination of Systems Engineering and management is termed Systems Engineering Management that also includes organisational concerns and human factors (Sage & Rouse, 2009, p. 117). It has also been concluded that organisation into working teams and effective human cooperation within teams are important with respect to Systems Engineering. The connection between Systems Engineering and the management of projects is therefore strong (Badiru, 2014, pp. 237-243). The difference between Systems Engineering and Systems Engineering Management is however not easy to distinguish. The process of development of systems is about the same concerns, to manage development of systems. Stevens et al. (1998, p. 7) claims however that Systems Engineering has both a managerial and a technical content and role, possibly with focus towards technical concerns. In technology development, technical implications can cause precarious results if things do not go according to plan. I will now turn from Systems Engineering to Systems Engineering Management.

Systems Engineering Management

Systems Engineering Management is about identifying operational needs in combination with disciplines like marketing, business and technology that could lead to the creation of a system answering the need of a customer and military end user. Transformation of an operational need into a description is done through Systems Engineering Management in an iterative process according to figure 38. It involves definition, synthesis, analysis, design, testing and evaluation of technology systems.

Systems Engineering and Systems Engineering Management are disciplines including models for research, development, testing and evaluation, and deal with vast kinds of complex problems and their solutions, regarding technology and other complex organisational tasks and decisions. Different models for efficient engineering activities, such as the waterfall model, V model and incremental including the spiral model and concurrent engineering, are some tools, but also radical methodologies exist within Systems Engineering (Sage & Rouse, 2009, p. 31).

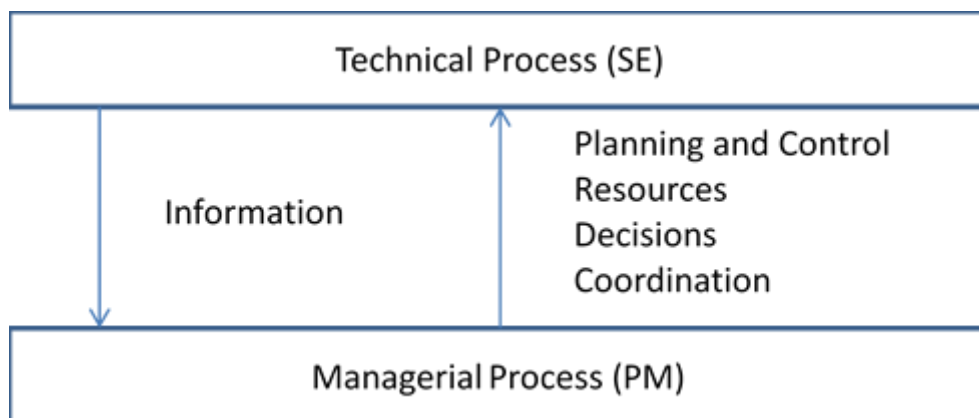


Figure 38: The two iterative processes of Systems Engineering Management according to Sage & Rouse (2009, p. 119).

The beginning of Systems Engineering Management in a process starts with the identification of a need of some kind. There should also exist an opportunity and, if appropriate, technical feasibility. Systems Engineering Management also directs efforts regarding design, development, synthesis and creation of systems, maintaining a holistic view. Technical and managerial decisions need to be taken, which means that Systems Engineering Management also deals with balancing between different experts and economic, social, environmental, and political concerns. Close contact with the customer is also vital for Systems Engineering in order to ensure the need of the customer is met

(Sage & Rouse, 2009, p. 119-120). The numerous kinds of complex problem solving issues that Systems Engineering Management deals with can be divided according to their risks/benefits and be used for decision support.

Depending on the intensity and impact of novelty, technology, complexity and pace of a specific project, there will be different risks/benefits tied to a development project. The novelty dimension of the project stretches from so-called derivative, which means incremental innovation with relatively small changes to existing products like modifications, upgrades and additions. On the other end of the novelty dimension, there is breakthrough, which means completely new products that could change an entire concept or create new products from ideas. The technology dimension has low-tech on one end and high-tech and super-high tech on the other, where low-tech means projects using well-known technologies with equal access for all industries involved. Normally this kind of low-tech project needs to be very large in order to be competitive. Super-high tech projects rely on new technologies, which can be emerging technologies but also still unknown during the start of the project. The complexity dimension, which can also be named the system dimension, scales between the assembly projects which means collection of components into a single component. On the other end of the complexity dimension is the Array, or the System of System, which means immense gathering of systems functioning together in order to reach a given collective purpose. The pace dimension reaches from regular pace where time is not critical, to the blitz, where time is critical as in projects when tasks are necessary to solve as fast as possible (Sage & Rouse, 2009, pp. 127-128). Decisions about the potential character of projects belong to Systems Engineering Management.

Decisions related to Systems Engineering Management and structured methods for quantitative decision support are used to simplify for involved actors, and outside viewers, in order for them to understand the decisions and enable traceability. Information, opinions and preferences can be integrated into the decision-making process. A methodology for quantitative decision analysis can include the following steps: firstly, to specify the objectives that could be reached and the scale that could be used for measuring activities compared to a given task; secondly, to create alternatives that could reach the aim; thirdly, to conclude how each alternative achieves each objective; fourthly, to create a balance between the objectives; and fifthly, to select a balanced alternative that best reaches the objectives with included uncertainties according to Sage & Rouse (2009, p. 1119). There are other examples of methods for measurement related to strategic performance within planning. Aware or unaware of the methodology, most people apply the basic steps which are: create a plan,

do the plan, study the results of the plan and act in the same way or differently in future depending on what has been experienced, according to Badiru (2014, p. 73). From methods of planning and creating systems with different kinds of disciplines like Systems Engineering Management, we will now turn to an important emergent idea, System of Systems, which started to develop along with increasingly complicated technology development.

System of Systems

With the development of computers in the 1960s and 1970s, technological systems became more and more complex. Increasing complexity in combination with the integration of several systems led to the notion of the interaction of parts between systems and their elements, which opened the way for the concept System of Systems in the 1970s. System of Systems is conceived of as a system which is difficult to plan and predict and with a never-before-seen complexity. System of Systems is furthermore constantly emerging and requires continuous architecting. It is the discipline of System of Systems Engineering that is claimed to constantly evolve System of Systems. In an engineering perspective, System of Systems is however still developed with mainly a single systems view used on several systems at the same time, and System of Systems Engineering is in practice Systems Engineering with additional elements of architecting. The question remains as to whether there is anything really new within the new disciplines or whether possibly new technology arrived and added to the complexity and the new notions are just illusory. System of Systems was also used as a new notion, an idea, that would together with the notion of Network-Centric Warfare solve the new problems that arose from the concept of Revolution in Military Affairs.

In economics the notion of System of Systems is used as “the concepts and terms commonly used to talk about systems have not themselves been organised into systems” (Ackoff, 1971, p. 661). In the 1990s, the notion of Systems of Systems spread, defined by Jamshidi (2009, p. 2) as “large-scale integrated systems that are heterogeneous and independently operable on their own, but are networked together for a common goal.” A System of Systems is claimed to exist when a majority of the following five characteristics are present: operational independence, managerial independence, geographic distribution, emergent behaviour, and evolutionary development (Sage & Cuppan, 2001). This notion of System of Systems was used in different fields, especially in the defence industry, but also when dealing with very sophisticated technological systems, such as the Boeing 787. Indeed, Systems of Systems are claimed to improve understanding of complex systems or increase the potential for System of Systems to enhance their effectiveness. However, it gave rise to

controversies. It is System of Systems Engineering that managed the integration of systems into System of Systems. This means that traditional Systems Engineering, managing traditional systems, needs to evolve into System of Systems Engineering in order to manage System of Systems.

Ants, ecosystems, air traffic systems and Future Combat Systems

Examples of Systems of Systems is claimed to be found in nature and in technological systems and can be perceived as a continuum with different degrees of sophistication. Jamshidi (2009, p. 3) argues that in nature, ant colonies can be considered ad-hoc and simple Systems of Systems whereas other biological ecosystems, such as living organisms or human colonies, are examples of Systems of Systems with much more sophistication and complexity. A number of essential principles control natural Systems of Systems, which are synergism or holistic relationships; open interfaces, like permeable boundaries; conservation or least amount of waste; modularity or self-containment and encapsulation; self-governance or self-organisation; emergence, like emerging structure and behaviour; symbiosis or mutual self-rewarding relationships; and reconfigurability, which is the ability to change and adapt. By following these principles, Azani (2009, pp. 25-32) explains that an open System of Systems can be flexible and efficient and can thus survive.

A human-built System of Systems can contain considerable amounts of complex technology, which adds to the complexity compared to a natural System of Systems. The Boeing 787 programme has been claimed to be a System of Systems interconnected in a Network-Centric communication network, which is to enhance the overall performance of the aircraft but also of the entire air traffic system of which the aircraft is a part. The benefits of the e-enabled Boeing 787 aircraft is said by Gosling (2009, p. 22) to be greater efficiency when it comes to maintenance and decreased costs of administration and paper documents. Defining the aircraft as a System of Systems means that technologies and functions are to be connected as a network. This means that passenger technologies, Cabin and Airline Services, Maintenance, Open Networking, Avionics Data and Flight Deck are to be connected. Furthermore, maintenance, materials and other ground functionalities like airlines and the Boeing Company, are connected into one communication network. The system's unit of analysis is the airline but the entire air traffic system belongs to the System of Systems. The aircraft is, in this view, a subsystem within a System of Systems. According to Wilber (2009b), leveraging industrial advances in computing and network technologies were important motives for initiating this project. Using business solutions like network-centric operations and System of

Systems engineering allowed Boeing to reduce costs in production, operations and maintenance (Wilber G, 2009b, pp. 232-233). Calling it the Gold Care Maintenance Solution, the Boeing Company claims to have the ability to offer the best qualified service enabled by network-centric solutions (Wilber G, 2009b, p. 233). There are also examples of land combat systems that can be described as Systems of Systems. These can be as sophisticated technologically but additionally complexity can be included into land combat Systems of Systems due to manned and unmanned vehicles, which are supposed to be interconnected with communication networks. Different kinds of System of Systems can range from relatively simple ant colonies to more complex land combat systems, but it is still not clear whether System of Systems really implies any difference compared to System of Subsystems (Feickert, 2005).

Characteristics of System of Systems

System of Systems became more widespread during the 1990s due to increased interest from military authorities. Sauser (2006) defined this as “System of Systems: a computer architecture term that started in the US Military.” Important reasons for this growing interest were the potential of System of Systems to solve and “reduce the fog and friction of war.” As described by Owens (1996, p. 4), this was done largely by technology. The overall purpose of System of Systems was to acquire improved results with superior effectiveness and performance. A common motive for System of Systems effectiveness is network technology. Indeed, military operations such as 1991’s Desert Storm unveiled the need for better communication between different branches of the US Armed Forces. In order to enable System of Systems to reach its potential and its machine interaction possibilities to perform, the system must be very fast and accurate in its interactions. If instead humans are involved in the interactions with machines to uphold the functionality of the system, the effectiveness of the system will be lower. The opportunities and advantages of System of Systems will then be lost and mistakes can easily be made (Saunders et al, 2005, pp. 2-3).



Figure 39: Illustration of the extreme amounts of data needs to be created, managed and understood with large numbers of variables and physics behind the System of Systems that are too profound or unclear to understand. The interactions between different kinds of connections are intricately coupled that a parametric environment is necessary in order to manage the System of Systems (Jouannet, 2017).

Several differences exist between System of Systems and traditional technological systems of which some are illustrated as examples in figure 39. Firstly, System of Systems focuses on integrating numerous independent complex systems. In that perspective, changing requirements due to new and adaptable environments can result in changing the whole development of the System of Systems while requirements regarding traditional systems are mainly unchanged thanks to the focus on a single system aiming at an end product. Secondly, as a System of Systems changes and adapts to the environment, its architecture becomes a dominating part of its capability development. The adapting and changing System of Systems requires an adapting and changing architecture, the complexity of which makes System of Systems differ from System of Subsystems. In order to adapt to changes in requirements from, for instance, new technologies, System of Systems needs to be able to change and evolve constantly. Thirdly, System of Systems does not have well-defined boundaries, which makes it difficult to manage in a traditional way according to Wells (2009, pp. 46-47).

Further differences between System of Systems and System of Subsystems are the constant changes that would force the System of Systems Engineering activities to adapt the Systems of Systems in a timely manner. The constant changes are done with the Systems of Systems feature architecture and makes architecture of Systems of Systems different compared to System of Subsystems. The architecture of Systems of Systems is about structuring the components in a system and arranging their interrelationship and evolution over time. A dynamic and flexible Systems of Systems creates a requirement for architecting that can be flexible and dynamic during an event and respond to environmental changes. Due to the dynamic and flexible behaviour, Dagli (2009, pp. 77-79) claims that Systems of Systems are very difficult or impossible to long-term plan, using traditional ways of measuring results. Different complex parts within the Systems of Systems have nonlinear relationships, thus dramatic and sudden changes can occur unexpectedly. Short-term forecasting can, however, be done for Systems of Systems, i.e. within short time frames with prediction models. Due to Systems of Systems having the properties of self-arranging order, emergent order and self-organisation, it can according to Dagli (2009, pp. 77-79) be more innovative and more adaptive than complex Systems of Subsystems which are considered less innovative and adaptive since they are mainly focused on one or several less adaptive single systems. Innovation and an ability to adapt are also considered important to measure a Systems of Systems, and for instance its capability, in order to compare with other Systems of Systems or Systems of Subsystems. Architecture is not only managing the properties mentioned above, as we will now discover.

In order to understand how Systems of Systems are affected by the surrounding situation and how organisational learning and proposed new ways of development should be done, architecting is claimed to be the feature to measure the performance of Systems of Systems. Measurement is necessary in order to create an understanding of the performance of a System of Systems. Within the architecting performance, risk, time and cost would be the factors for best measurement of Systems of Systems according to Dagli (2009, pp. 77-79), while performance regarding System of Subsystems can be measured by the result. In addition, assessment of the capacity to learn the architecture and to evolve it are important factors for assessing Systems of Systems. In order to manage Systems of Systems architecting, the learning and modelling of a System of Systems needs to be evolutionary to be able to handle rapid transformations. Different behavioural views must be taken into account when measuring Systems of Systems, as, besides complex technology systems, dynamics due to social and cognitive processes are also involved.

For System of Subsystems, an optimal result made with efficiency, a final product and final solution is mostly the end goal. The dynamic behaviour for a System of Systems will prevent any final solution or any end state and it is therefore difficult and perhaps impossible to find a clear end goal for a Systems of Systems. Instead, Systems of Systems have a greater focus on flexibility, extensibility and run-time interoperability. These characteristics are therefore more important for System of Systems architecting than in System of Subsystems architecting. To manage evolutionary Systems of Systems, Dagli claims that it is important to have an evolutionary environment in order to create evolutionary requirements that are necessary for System of Systems architecting (2009, pp. 97-98). Traditional System Engineering includes controlled planning and a certain set of development steps that need to be followed. This ordered way of System Engineering does not fit System of Systems well since Keating says that Systems of Systems emerge more than they are planned (2009, pp. 172, 188-189). Emergence must therefore be designed for in advance, and can probably not be added in retrospect. Emergence must be a major part of the setting and surprising events must be expected and natural.

When trying to oppose System of Systems and System of Subsystems, some authors have identified five main tensions based on five characteristics of System of Systems. The tensions illustrate the differences between System of Systems and System of Subsystems: autonomy, belonging, connectivity, diversity, and emergence. The characteristics of System of Systems are independent, decentralised, network-centric, heterogeneous and indeterminable, where Systems of subsystems are conforming, centralised, platform-centric, homogeneous and foreseen. The degree of autonomy is high for System of Systems, which is independent, but the degree of autonomy is low for System of Subsystems, which is conforming. The degree of belonging is low for System of Systems, which is decentralised, but high for System of Subsystems, which is centralised. Connectivity is for Systems of Systems focused on network-centricity, but System of Subsystems is focused on platform-centricity. The diversity for System of Systems is high as it is heterogeneous, but diversity is low for System of Subsystems since it is homogeneous. The tension emergence describes the difference between System of Systems that is indeterminable while comparatively System of Subsystems is foreseeable.

There are different views on how the characteristics of Systems of Systems differ from System of Subsystems. This divergence is exemplified by Saunders et al. (2005) shown in Table 13 and Sauser (2009) shown in Table 14. Sauser (2009) also describes the characteristics of System of Subsystems and the tensions that are claimed to exist between the different characteristics.

System of Systems
Operational independence of components
Managerial independence of the components
Evolutionary development where the System of Systems changes over time to adapt to new circumstances
Emergent behaviour
Geographic distribution

Table 13: Characteristics of System of Systems distinguished from System of Subsystems according to Saunders et al. (2005, p. 22).

Tensions between the System of Systems and	System of Systems	System of Subsystems
Autonomy	Independent	Conforming
Belonging	Decentralised	Centralised
Connectivity	Network-centric	Platform-centric
Diversity	Heterogeneous	Homogeneous
Emergence	Indeterminable	Foreseen

Table 14: Differences between System of Systems and System of Subsystems according to Sauser (2009).

Each of these tensions can affect another one in an interdependent manner depending on the characteristics of a specific System of Systems. An example of what Sauser (2009, pp. 205-207) means is that, for instance, a large amount of connectivity can cause a strong belonging, which can affect the way emergence will function. The phenomenon of interdependency creates a challenge to the design of System of Systems. Sauser (2009, pp. 212-214) also says that other challenges of importance for the future are management, measuring capability, and framework for an entire process – technological as well as organisational – of designing System of Systems.

Controversies around System of Systems

Different opinions about what constitutes a System of Systems and whether it displays any real difference from normal Systems of subsystems span from those who believe that nothing new has occurred that motivates a new notion, to others that claim that System of Systems means something new. Maier (1998) claims that Systems of Systems could be understood as a simply more complex Systems of subsystems and the idea of continuum supports that argument. The issue of the differing features of complex systems and System of Systems often involves complex technology in the form of computer networks. It is a debated area and some examples of objections regarding System of

Systems are: “There is no clear line between Systems and SoS”, “There is no difference between SE for systems and SoS...” , “There is simply a need for better requirement management for SoS...” , “Thinking that traditional SE methods/techniques are sufficient for SoS is dangerous...” , “Standard SE applies but requires extensions” , “The only difference is no-one is in control in an SoS...” , “Nothing is new. Any system that has subsystems is a SoS. We have been doing this forever” (Department of Defense, 2006, p. 9). It has been claimed by, for instance, Popper et al. (2004, pp. 6-7) and the Director Systems and Software Engineering at The United States Office of the Undersecretary of Defense that System of Systems is not a new field of research but rather an indication that engineering has lost its way in the sense that, possibly, problems have become more difficult and complex (2006). Instead of speaking of System of Systems, some authors like Holland (2006) prefer to use the notion Complex Adaptive System (CAS), which can potentially be used in understanding different complex systems like global trade, ecosystems, and controlling the Internet with help from computer-based models.

The discipline of engineering System of Systems is represented by System of Systems Engineering (SoSE) which is a discipline that is not yet fully developed. Systems Engineering has not yet been developed into System of Systems Engineering to fully manage System of Systems. Jamshidi argues that System of Systems Engineering is a young discipline on a high conceptual level viewing subsystems as parts of larger systems (2009, pp. 2-3). The differences between System of Systems Engineering and traditional Systems Engineering are several according to Sauser (2006) where System of Systems Engineering is focused on integrating numerous independent complex systems, whereby traditional Systems Engineering deals with single complex systems. System of Systems Engineering needs to adapt and manage System of Systems constantly, in a timely and holistic manner. Wilber (2009a) says that System of Systems Engineering needs the ability to adapt a System of Systems at a shorter notice compared to Systems Engineering, which is mainly unchanged with focus on a single system resulting in an end product.

What are called Systems of Systems are complex interacting systems, taking into consideration that during the 1990s the amount of complex technology increased, and System of Systems often consist of complex networked technologies that are interconnected to a greater degree than before the 1990s. If then complex technology, aiming at connecting an already complex system into a network, is also involved, the complexity increases even more. Problems appear to occur due to ambitious technology developments, which mainly used to mean computerised communication systems. Returning to the example of the Boeing 787 as an air traffic system, we can look at it from both

perspectives. We can consider it a very complex System of Subsystems, its complexity lying in the communication network developed inside the plane and between the plane and the ground facilities, but remaining platform-centric. We can also consider that, when such a sophisticated network system is developed between geographically dispersed subsystems, the nature of the system changes and the system becomes a network-centric System of Systems.

System of Systems either stands for something new - a tool to engage in, for instance, complex defence acquisition; or it constitutes a relabelling of, for instance, a big and complex System of Subsystems, which already exists as a concept. If the argument that System of Systems can be perceived in a continuum with different degrees of sophistication is true, the main question is whether System of Systems really is something new or a continuation of, for instance, a complex System of Subsystems. The failures that System of Systems have experienced in the recent past, such as the unfinished Future Combat Systems developed and abandoned after years of developments and cost overruns for the US Army, can be interpreted in two ways. Either Systems of Systems are something new and we have not discovered ways to manage their development, or Systems of Systems are simply systems too large to be developed efficiently as one cohesive project. In both cases, the choice to engage in the development of Systems of Systems should be done prudently and great care should be taken, since the alternative could entail very large risks.

Either the notion of System of Systems is something new or something that has existed as long as the notion of systems, but as suggested, the creation of systems had become complex and was claimed to require the new notion. System of Systems can also be something other than more complicated or complex systems. System of Systems can be an idea that serves the purpose of making something new more understandable and simple. It could promise better products, like not yet existing systems for future conflicts. System of Systems can be a description of a notion that is understood as simple and futuristic and at the same time is promising a solution to well-known concerns.

Titre : Le management des méga-projets technologiques : le cas de l'industrie de la défense et des projets liés à la guerre réseaucentrique

Mots clés : méga-projets, étude de cas, l'industrie de l'armement, idées, changement de paradigme, pouvoir.

Résumé : Cette thèse est une étude comparative de trois méga-projets militaires menés aux Etats-Unis, en France et en Suède, dans le domaine du network centric warfare ou guerre réseaucentrique. L'objectif de cette étude est d'observer les similitudes et différences dans le développement et la gestion de ces projets, de comprendre les raisons de certains choix stratégiques puis d'évaluer l'ampleur de leur réussite ou échec. Ces programmes étaient particulièrement ambitieux puisqu'une grande partie de la technologie répondant à ces besoins n'existait pas encore et certains impératifs techniques étaient proprement incompatibles. L'étude de cas et la comparaison des méga projets sont présentées sous une forme narrative.

Le résultat en est la description des trois méga projets militaires reproduisant les dynamiques internes et externes à l'oeuvre pour deux des trois projets. Le projet français a été décrit jusqu'à l'étape de développement actuel, le déploiement du projet étant prévu jusqu'au milieu des années 2030. Cette comparaison des méga projets militaires a montré que le type de management appliqué à ces vastes programmes n'est pas différent de ceux mis en oeuvre dans le cadre de projets de moindre envergure. Cela dit, les méga-projets restent extrêmement complexes et ce type de développement doit tenir compte de différents obstacles, déjà connus ou non durant les différentes phases de déploiement, lesquels se trouvant être dans certains cas impossibles à contrôler

Title : Managing Mega technological projects: The case of the defence industry and Network Centric Warfare projects

Keywords : megaprojects, case study, defence industry, ideas, change culture, power

Abstract : This thesis project consists of a comparative work on three different military megaprojects regarding Network Centric Warfare, in three different countries: the United States, France and Sweden. The aim of the comparison is to find similarities and differences with respect to why, and if, the projects failed, or are failing, and if they failed - to what extent. The objectives of the military megaprojects were ambitious and a great deal of the involved technology was not yet developed at the time and the technical requirements were incongruous. For the comparative study a narrative case study methodology has been employed, structuring and analysing the different military megaprojects.

The result is three different descriptions of the military megaprojects reproducing the internal and external dynamics of two of the three projects. One project, the French one, has been reproduced up to its present stage because it is planned to continue to the 2030s. The result of the comparison between the military megaprojects has shown that such vast projects can be managed like normal vast development projects. On the other hand, these kinds of vast projects are comprehensively complex. Such projects do also involve ideas leading to project developments of already known and unknown obstacles before and during the mega project not possible to manage and results in project and development failure.