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Explorations in architectural design at the time of energy transition

Malvina Apostolou

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ÉCOLE DOCTORALE ABBÉ GRÉGOIRE
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Conception

THÈSE

présentée par : **Malvina APOSTOLOU**

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Explorations in architectural design at the time of energy transition

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Affidavit

Je soussignée, Apostolou Malvina, déclare par la présente que le travail présenté dans ce manuscrit est mon propre travail, réalisé sous la direction scientifique de Monsieur François Guéna, dans le respect des principes d'honnêteté, d'intégrité et de responsabilité inhérents à la mission de recherche. Les travaux de recherche et la rédaction de ce manuscrit ont été réalisés dans le respect de la charte nationale de déontologie des métiers de la recherche.

Ce travail n'a pas été précédemment soumis en France ou à l'étranger dans une version identique ou similaire à un organisme examinateur.

Fait à Paris, le 21 juillet 2021

Signature

A handwritten signature in blue ink, appearing to read 'M. Apostolou', with a horizontal line drawn through it.

Affidavit

I, undersigned, Apostolou Malvina, hereby declare that the work presented in this manuscript is my own work, carried out under the scientific direction of François Guéna, in accordance with the principles of honesty, integrity and responsibility inherent to the research mission. The research work and the writing of this manuscript have been carried out in compliance with the French charter for Research Integrity.

This work has not been submitted previously either in France or abroad in the same or in a similar version to any other examination body.

Paris, 21st July 2021

Signature

A handwritten signature in blue ink, appearing to read 'M. Apostolou', with a horizontal line drawn through it.

A mes parents Elena et Paul
A ma sœur Matilda
A ma grand-mère Mathilde

Σὰ βγεῖς στὸν πηγαμὸ γιὰ τὴν Ἰθάκη,
νὰ εὐχεσαι νᾶναι μακρὺς ὁ δρόμος,
γεμάτος περιπέτειες, γεμάτος γνώσεις.

Τοὺς Λαιστρυγῶνας καὶ τοὺς Κύκλωπας,
τὸν θυμωμένο Ποσειδῶνα μὴ φοβᾶσαι,
τέτοια στὸν δρόμο σου ποτέ σου δὲν θὰ βρεῖς,
ἂν μὲν ἡ σκέψις σου ὑψηλὴ, ἂν ἐκλεκτὴ
συγκίνησις τὸ πνεῦμα καὶ τὸ σῶμα σου ἀγγίζει.
(...)

Ἡ Ἰθάκη σ' ἔδωσε τ' ὠραῖο ταξίδι.
Χωρὶς αὐτὴν δὲν θᾶβγαινες στὸν δρόμο.
Ἄλλα δὲν ἔχει νὰ σὲ δώσει πιά.

Κι ἂν πτωχικὴ τὴν βρῆς, ἡ Ἰθάκη δὲν σὲ γέλασε.
Ἔτσι σοφὸς ποὺ ἔγινες, μὲ τόση πείρα,
ἤδη θὰ τὸ κατάλαβες ἡ Ἰθάκης τί σημαίνουν.

Κωνσταντῖνος Π. Καβάφης, Ἰθάκη

Quand tu partiras pour Ithaque,
souhaite que le chemin soit long,
riche en péripéties et en expériences.

Ne crains ni les Lestrygons, ni les Cyclopes,
ni la colère de Neptune.
Tu ne verras rien de pareil sur ta route si tes pensées restent hautes,
si ton corps et ton âme ne se laissent effleurer
que par des émotions sans bassesse.
(...)

Ithaque t'a donné le beau voyage :
sans elle, tu ne te serais pas mis en route.
Elle n'a plus rien d'autre à te donner.

Même si tu la trouves pauvre, Ithaque ne t'a pas trompé.
Sage comme tu l'es devenu à la suite de tant d'expériences,
tu as enfin compris ce que signifient les Ithagues.

Ithaque, poème de Constantin Cavafy. traduction de M. Yourcenar

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En espérant que ce manuscrit n'est pas la fin, mais le début vers de nouveaux mondes et nouvelles péripéties.

Résumé

Cette recherche exploratoire s'intéresse aux manières dont les architectes prennent en compte les questions énergétiques. Plus précisément, elle observe l'implication des considérations énergétiques dans le travail de conception architecturale.

La conception architecturale est soumise aujourd'hui à des programmes incluant des prescriptions environnementales en matière de consommation énergétique. Nous supposons que ce cadre réglementaire exigeant modifie la hiérarchie des enjeux dans les activités et les métiers des acteurs de la ville et conduit à (re)former les savoirs, méthodes, pratiques et modèles de l'architecture¹. Les principales questions qui sont à la base de la recherche sont les suivantes : De quelles manières les questions liées à l'énergie s'impliquent dans la conception architecturale ? Comment influencent-elles le processus de conception d'un projet ?

Pour répondre à cette problématique, l'objectif est d'interroger et d'analyser des activités impliquées dans la conception d'espaces énergétiquement performants en vue d'arriver à la construction des modèles de connaissances sur les manières dont l'énergie influence le travail de conception.

Pour interroger ces activités de conception nous avons choisi de mobiliser les concepts du modèle *architecturologique*^{2 3}. Ce modèle se structure autour d'un langage qui s'attache à décrire les opérations de conception utilisées par les architectes. Nous l'utilisons comme grille d'analyse, scientifiquement rigoureuse, de la production d'architectes sur leurs projets (discours, textes, documents graphiques). Cette grille permet de repérer des traces de l'usage de classes d'opérations de conception⁴ en nous éloignant de la subjectivité des discours rhétoriques qui sont souvent employés par les architectes. Par conséquent, l'*architecturologie* est utilisé comme un moyen permettant le développement de niveaux de compréhension à travers une distance critique.

¹ DEBIZET, Gilles, GODIER, Patrice. Architecture et urbanisme durables : modèles et savoirs, Cahiers Ramau 7, 2015

² BOUDON, Philippe, DESHAYES, Philippe, POUSIN, Frédéric, et al. Enseigner la conception architecturale Cours d'architecturologie, 2001

³ LECOURTOIS, Caroline. Un modèle de connaissance de la conception urbaine durable. Le cas des écoquartiers. in Architecture et urbanisme durables: modèles et savoirs, Éditions de la Villette, Paris, 2015, p. 100–115.

⁴ BOUDON, Philippe. Sur l'espace architectural. 2003.

Nos cas d'études ont été choisis pour leur compatibilité avec le sujet. Ils sont extraits du projet d'éco-quartier de Clichy Batignolles situé dans le 17^e arrondissement de la ville de Paris. Porteur des objectifs environnementaux – notamment énergétiques - très ambitieux, cette opération se proclame comme une référence dans le développement urbain durable à Paris.⁵ Le choix de plusieurs bâtiments de cet éco-quartier nous permet d'appréhender la diversité d'approches architecturales de la question de l'énergie sur un espace caractérisé par les mêmes exigences environnementales.

La méthode d'analyse consiste à appliquer la grille architecturologique sur un corpus constitué de trois bâtiments. Leur récit architectural est décomposé en identifiant les opérations prenant part à leur conception. A partir de ces analyses, des modèles théoriques de la conception architecturale de ces bâtiments sont produits. Les résultats sont ensuite exprimés dans une réflexion synthétique.

Mots- clés : architecture durable, architecturologie, conception architecturale, éco-quartier, énergie

⁵ ROUGE, Nicolas. Clichy-Batignolles: Where urban planning meets the climate. OECD Obs., 2015, no. 304, p. 53–54.

Résumé en anglais

This exploratory research is interested in the ways in which architects take into account energy issues. More specifically, it observes the implication of energy considerations in the architectural design work.

Architectural design is now subject to programs that include environmental requirements in terms of energy consumption. We assume that this demanding regulatory framework changes the hierarchy of issues in the activities of city stakeholders and leads to (re)form the knowledge, methods, practices and models of architecture. The main questions on which the research is based are: In what ways are energy issues involved in architectural design? How do they influence a project's design process?

The objective of the research, to answer this question, is oriented towards questioning and analysing the activities involved in the design of energy efficient spaces in order to arrive at the construction of knowledge models on the ways in which energy influences design work.

To interrogate these design activities, we have chosen to mobilize the concepts of the architecturological model. This model is structured around a language that attempts to describe the design operations used by architects. We use it as an analytical grid, scientifically rigorous, of the production of architects on their projects (discourses, texts, graphic documents). This grid makes it possible to identify traces of the use of classes of design operations by taking distance from the subjectivity of the rhetorical discourses that are often used by architects. Consequently, architecturology is used as a means for the development of levels of understanding across a critical distance.

Our case studies were chosen for their compatibility with the subject. They are extracts of the Clichy Batignolles eco-district project located in the 17th arrondissement of the city of Paris. Supporting very ambitious environmental - particularly energy - objectives, this operation proclaims itself as a benchmark in sustainable urban development in Paris . The choice of several buildings in this eco-district allows us to understand the diversity of architectural approaches to the issue of energy in a space characterized by the same environmental requirements.

The method of analysis consists of applying the architecturological grid to a corpus constituted of three buildings. Their architectural story is decomposed by identifying the operations

involved in their design. From these examinations, theoretical models of the architectural design of these buildings are produced. The results are then expressed in a synthetic reflection.

Keywords: sustainable architecture, architecturology, architectural design, ecodistrict, energy

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Introduction générale

En préambule à la thèse, j'ai choisi de citer quelques phrases extraites de discours d'architectes sur l'architecture verte et durable.

Ce que l'on appelle maintenant « l'architecture verte » est une caricature opportuniste d'une considération beaucoup plus approfondie des questions liées à la durabilité avec lesquelles l'architecture s'est engagée depuis de nombreuses années. (...) (Koolhaas, Rem, in Fraioli, 2012)

Il y a un problème de définition : « vert » et « durable », les termes utilisés pour nommer la réponse au problème le plus urgent de notre temps, sont devenus dangereusement à flot dans l'ambiguïté et l'indétermination. L'architecture durable est partout et nulle part. (...) « Vert » et « durable » sont devenus codifiés, marchandisés et certifiés. Les listes de contrôle prescrites se font passer pour une philosophie de conception. En tant que jeunes architectes, notre génération doit adopter de nouvelles idées sur la durabilité, remettre en question la doctrine héritée et forger de nouvelles trajectoires. (JDS Architects, in Mostafavi, 2016, p. 118)

Avec une bonne conception, la durabilité n'est rien d'autre que l'utilisation rigoureuse du bon sens. Les résultats sont souvent des solutions simples aux défis complexes. (Aravena, Alejandro in Alejandro Aravena remporte le prix du développement durable 2017 à Göteborg, n.d.)

Le vert et la durabilité n'ont rien à voir avec l'architecture. (Eisenman, Peter, in Belogolovsky, n.d.)

Le changement climatique et la durabilité sont des défis clés pour notre génération. Nous sommes convaincus que l'architecture peut apporter des solutions. La durabilité doit primer dans toutes les phases du projet : conception, appel d'offres, construction et mise en service. Zaha Hadid Architects (Zaha Hadid Architects, in Magriet, 2020)

S'il faut être vulgaire pour refuser l'escroquerie à la morale environnementale, alors soyons tous vulgaires. S'il faut être asocial pour refuser l'infantilisation d'un débat de société aussi impérieux, alors soyons asociaux. (...) Le sigle HQE⁶ est frappé d'un « registered mark ».(...)

⁷.Rudy Ricciotti

Suffit-il aux architectes, paysagistes et urbanistes d'imaginer simplement l'avenir de leurs différentes disciplines en termes d'ingénierie et de construction d'un environnement plus économe en énergie ? Aussi importante que soit la question de l'énergie aujourd'hui, l'accent mis sur la quantité – sur la réduction de l'énergie – occulte sa relation avec la valeur qualitative des choses. En d'autres termes, il faut considérer la fragilité de la planète et de ses ressources comme une opportunité d'innovations conceptuelles spéculatives plutôt que comme une forme de légitimation technique pour promouvoir des solutions conventionnelles. (...) Imaginer un urbanisme autre que le statu quo requiert une nouvelle sensibilité, capable d'intégrer et d'accommoder les conditions conflictuelles inhérentes entre l'écologie et l'urbanisme. » (Mostafavi, 2016, p. 17)

There are probably as many definitions of sustainable architecture as there are architects in the world...⁸

Je ne parlerai pas d'ailleurs ici d'architecture durable : tout adjectif ajouté au mot architecture le diminue. Il n'y a pas de sous-famille, pas de genre «environnemental» en architecture : l'architecture est ou n'est pas. (Ferrier, 2008, p. 8)

C'est aux questions que m'ont posées les citations ci-dessus que réside le motif du démarrage de ma thèse. Elles indiquent la multiplicité des positionnements des architectes face à un temps où les impératifs du « durable », inscrits dans un contexte du réchauffement climatique et d'épuisement des ressources, questionnent la conception et la pratique architecturale. Visiblement, la pluralité des visions des architectes ne s'appuie pas uniquement sur une

⁶ Certificat Haute qualité environnementale

⁷ <http://www.lespressesdureel.com/ouvrage.php?id=6373&menu>

Réédition augmentée d'un texte polémique de l'architecte contre la charte HQE, un certificat attestant de la haute qualité environnementale des projets de construction. Rudy Ricciotti développe un argumentaire vindicatif visant à démontrer que ce sigle est une arme servant les intérêts de l'économie libérale.

⁸ https://medium.com/thebeammagazine/frank-heinlein-10a308300975_16nov18

Dr. Frank Heinlein is the director of business communications of the Werner Sobek Group, an engineering and design consultancy founded in 1992.

hétérogénéité des perceptions et des approches. Ces citations révèlent aussi des contradictions de points de vue qui interrogent plus profondément les sens des termes employés, leur interprétation et leur appropriation par les architectes.

Une première lecture fait appel aux considérations des architectes à l'égard des normes, labels, prescriptions et directions de pensées liés à ce contexte et qui encadrent aujourd'hui leur conception.

On perçoit dans leurs discours rhétoriques la mobilisation des architectes face à ces prescriptions. Des positionnements fervents exprimant le soutien ou la désapprobation à l'imprégnation de l'expressions « durable » en architecture en font partie.

Il est vrai que les considérations liées aux questions de l'environnement, du climat et des ressources ne sont pas nouvelles. L'histoire montre qu'elles étaient prises en compte dès l'antiquité, à la renaissance et plus récemment dans les années 60. Si elles resurgissent dans l'actualité c'est parce qu'elles sont aujourd'hui inscrites aux discours politiques et questionnées dans des mouvements sociaux et par des communautés scientifiques.

Architecture durable, écologique, verte, bas carbone, énergétiquement performante, énergétiquement efficace, à basse énergie, sans déchets, frugale, aux matériaux pérennes, aux matériaux réutilisés, vertueuse, post-carbone, low-tech ou encore biomimétique, sont des notions qui s'ajoutent à celles d'architecture passive, solaire ou bioclimatique qui préexistaient.

Au-delà des polémiques entre les architectes eux-mêmes et avec les politiques publiques et même si certains cherchent minimiser dans leurs discours l'impact de ces notions sur leur activité, ils sont aujourd'hui confrontés à des transitions nécessaires. Les enjeux induits par les transitions écologique et énergétique devenues obligatoires, remettent en question les savoirs, pratiques et modèles des architectes.

La recherche menée ici se base sur l'hypothèse que les contextes internationaux et nationaux imprégnés de la prise en compte des enjeux environnementaux et des pratiques incitant à réduire les consommations énergétiques, ont un impact sur le processus de conception architecturale.

L'étude présente cherche à comprendre les manières dont la question de l'énergie et ses contextes interviennent dans la conception d'un projet architectural. De quelles manières la performance énergétique prend place dans la conception architecturale ? Comment ces questions énergétiques influencent le processus de conception d'un architecte ?

Pour comprendre ce phénomène, la position épistémologique de la recherche menée s'oriente vers le constructivisme car la réalité construite est subjective et dépendante du système observant. L'approche est inductive et le positionnement est expérimental.

Pour interroger les manières dont les architectes intègrent les considérations énergétiques dans leur processus de conception, l'étude s'oriente vers les recherches sur la conception architecturale, convoquant ainsi le champ disciplinaire plus large des sciences de conception.

Pour répondre à la question, l'*architecturologie* et ses concepts sont mobilisés. L'application de cette méthodologie à notre lecture du discours rhétorique architectural nous permet de prendre la distance nécessaire nous permettant d'appréhender les manières avec lesquelles les architectes ont donné de formes et mesures à l'espace. Constitué d'un langage systémique théorique, l'*architecturologie* vise à rendre intelligibles les opérations cognitives de conception mobilisée par les architectes.

La raison pour laquelle l'*architecturologie* est choisie parmi les théories de la conception est en relation avec ses caractéristiques. Elle prend en compte la spécificité de l'architecture ; elle a établi un vocabulaire formellement construit et un langage scientifique ; et elle présente une capacité de modélisation. En plus, elle démontre un potentiel de généralisation.

En même temps, cette théorie n'a pas été appliquée à l'étude des considérations énergétiques dans la conception architecturale durable, constituant un point de vue original sur le sujet.

En concordance avec recherches antérieures interrogeant la conception architecturale (Boudon, Deshayes, Pousin, & Schatz, 2001) et l'éco-conception (Lecourtois, 2015), l'objectif de la présente étude est de comprendre les manières dont l'énergie impacte et intervient dans la conception d'un projet architectural.

Ce travail de recherche met en œuvre les méthodes de l'*architecturologie* appliquée visant à élaborer les manières dont les considérations énergétiques influencent les processus de conception de l'espace architectural pour produire des connaissances sur les opérations cognitives de la conception architecturale dite énergétiquement performante.

Trois projets (E1 , E2, E5) de la zone est l'éco-quartier de Clichy-Batignolles à Paris constituent des cas d'étude. Ils ont été choisis pour assembler la plupart des paramètres liés une la conception architecturale orientée vers les questions énergétiques. Les édifices choisis comme cas d'étude sont pertinents à étudier car ils suggèrent des approches innovantes particulièrement diverses dans un contexte « durable » très restreint, répondant à une ambition énergétique aussi bien que sociale. A travers le projet de Clichy-Batignolles, la municipalité de Paris a projeté ses ambitions politiques au sein du durable. Ce projet d'aménagement urbain a reçu en 2016 le label ministériel de l'Ecoquartier. Il a été aussi lauréat du prix "Ville durable"⁹ du concours international "Green Building & City Solutions Awards". Les objectifs énergétiques du quartier concernaient en général une réduction du chauffage à 15 kwh/m2/an ; une consommation d'énergie primaire des bâtiments inférieure à 50 Kwh/m2/an et une production d'électricité photovoltaïque autour de 4 500 MWh/an .

Le verbatim, la documentation recueillie¹⁰ ainsi que les entretiens des architectes impliqués effectués par l'auteur– faits par l'auteur lorsque possible-, serviront à reconstituer les récits architecturaux et énergétiques de ces bâtiments.

La démarche expérimentale à suivre propose une lecture des cas par la distance scientifique apportée par la théorie mobilisée. La modélisation de leur processus de conception permettra dans un deuxième temps de comparer les cas ainsi que de fournir des conclusions plus générales sur le sujet.

L'approche suivie ne cherche pas à effectuer une analyse architecturologique exhaustive de la conception architecturale du bâtiment. A partir du vocabulaire de la méthodologie utilisée, une lecture de la conception architecturale sera effectuée en se concentrant sur l'implication des enjeux énergétiques dans son processus. L'utilisation des postulats de l'architecturologie ainsi que les *échelles* qui la composent seront appliqués lors de cette lecture.

L'architecture ne sera pas donc utilisée comme une fin en soi mais principalement comme un outil fournissant une base scientifique. L'utilisation de ses concepts évoqueront d'autres et ouvriront largement la discussion.

⁹ Prix du concours international "Green Building & City Solutions Awards" à l'occasion de la COP22 de Marrakech, le réseau Construction21

¹⁰ Les sources analysées et interprétées sont des textes fournis par l'architecte ayant réalisé le projet, des interviews de ceux-ci, donnés dans des contextes divers, des textes écrits par des journalistes / architectes.

La thèse est divisée en trois parties.

La Première Partie introduit la recherche dans son contexte et illustre l'objectif de la thèse. Elle pose la problématique, la méthodologie qui sera suivie et le corpus de l'étude. Elle présente aussi un état de l'art du sujet et de la méthodologie à partir de la bibliographie.

La Deuxième Partie mène l'analyse du corpus, se structurant autour du langage de la méthodologie choisie.

La Troisième Partie exemplifie les résultats de l'analyse ainsi que les réponses aux questionnements posés au début. Elle produit des connaissances en se basant sur les résultats et apporte des conclusions. En parallèle elle prend du recul et tente des réflexions plus larges.

Première Partie - Introduction

Questions et hypothèses

La transition énergétique devenant nécessaire, l'étude interroge comment conçoivent les architectes aujourd'hui dans ce contexte. L'hypothèse de la recherche est que la conception architecturale est influencée par la considération des prescriptions énergétiques et écologiques, et que le processus de conception se transforme dans cet égard.

L'interrogation est menée sous le prisme des sciences de conception et du vocabulaire systématique de l'Architecturologie. L'objectif de la thèse est de produire de connaissances concernant l'implication des considérations énergétiques sur l'activité cognitive de la conception architecturale.

Contexte de l'état de l'art

Les questions socio-écologiques et énergétiques n'apparaissent pas seulement aujourd'hui parmi les préoccupations de l'architecture. Certes, elles sont désormais standardisées et inscrites dans des normes, mais elles étaient déjà présentes dans d'autres contextes, interprétées et exprimées sous des angles et des formes différentes.

Le climat a toujours été évoqué dans la théorie architecturale comme un paramètre essentiel. Aristote et Hippocrate avaient souligné l'influence des éléments climatiques sur les humains ; les Grecs et les Romains connaissaient depuis longtemps l'importance d'une bonne orientation pour l'utilisation d'un bâtiment¹¹.

¹¹ Par exemple, dans la ville antique d'Olynthos, dans le nord de la Grèce, les parcelles urbaines ont été conçues de manière que chaque maison puisse avoir la meilleure orientation et ainsi bénéficier de la position du soleil. Tous les espaces principaux étaient exposés au soleil en hiver et protégés de celui-ci en été.

Vitruve avait expliqué l'influence du soleil sur les différentes fonctions urbaines et exprimé des préoccupations écologiques dans le choix des matériaux.¹² (Mandoul, 2012) La ville, selon lui, devait être protégée du vent. Les considérations climatiques étaient également abordées dans la ville idéale de Fra Giocondo en 1511, ou celle de Cesariano en 1521. Alberti les avait également examinées dans son ouvrage *De re aedificatoria*.

De Vitruve, Palladio et Alberti à Le Corbusier, Louis Kahn, Renzo Piano, Richard Rogers et Robert Venturi, la relation aux aspects environnementaux en architecture varie dans le temps.

Quelques exemples de telles préoccupations¹³ concernent par exemple une série de maisons solaires basées sur une technologie active développée par un groupe de recherche du MIT en 1947 et un concours pour la conception d'une maison solaire organisé en 1959.

Les cartes énergétiques de Buckminster Fuller dans les années 1940 reconsidéraient la relation entre l'énergie, la technologie et les systèmes sociaux en interrogeant les formations sociales internes, les ressources énergétiques et les possibilités technologiques émergentes d'une situation énergétique donnée.

Dans les années 1970, les projets et les expérimentations architecturales ont servi de terrain de débat important sur les principes du changement environnemental. Ils ont donné l'impulsion à des transformations sociales et à de nouvelles façons de vivre dans des maisons faites de terre, des systèmes et des communautés autonomes, ainsi qu'à la conception participative.

L'année 1973 a marqué l'un des tournants les plus importants de l'histoire du XXe siècle, qui a également eu un impact sur le domaine de l'architecture. La crise pétrolière a déclenché la recherche et le développement de sources d'énergie renouvelables et de technologies améliorées, et a donné lieu à des expériences sociales, des constructions éphémères, des communautés autonomes et des utopies de contre-culture.

Différentes approches architecturales ont fait du climat et de l'énergie des éléments centraux. En parallèle, une réflexion globale sur l'environnement tant dans la pratique que dans l'enseignement et la recherche de l'architecture est menée.

¹² Regarder (Mandoul, 2012)

¹³ Pour plus d'information regarder (Banham, 1969; Braham, 2013; Galiano, 2001; Ionescu et al., 2015; Ragheb, El-Shimy, & Ragheb, 2016) et (Gonzalo & Habermann, 2008)

La dernière décennie, les recherches scientifiques menées au sein des laboratoires des écoles d'architecture ainsi qu'aux corps académiques ont traité entre autres les questions liées à la transition énergétique.

L'énergie en architecture est un objet d'étude situé au carrefour de diverses recherches et approches. Selon le point de vue, le sujet peut être traité dans le cadre de disciplines appartenant à l'ingénierie ou aux sciences sociales.

Pour la conception architecturale, l'énergie est devenue un sujet primordial non seulement dans la période de pénurie de carburant des années 1970, ou les prix élevés de la fin des années 2000, mais aussi pendant les périodes de croissance énergétique.

Si les années 1960 ont été les années de l'architecture solaire et bioclimatique, les années 2000 ont été celles de la multiplication des normes et labels en faveur de la performance énergétique. Normes, labels et incitations politiques, de la loi Barnier en 1995 aux labels HQE (1990-1996) et Passivhaus (1996), ont fait de l'énergie un enjeu central de la construction¹⁴.

La prise en compte de la performance énergétique et les exigences qu'elle induit ont un impact sur le processus de conception de l'architecture qui est par conséquent en pleine mutation.

Même si l'interprétation de la performance énergétique architecturale est un processus culturel complexe, les domaines de la conception sont un lieu important pour discuter des futurs énergétiques¹⁵, en particulier dans un contexte d'évolutions et de transitions.

¹⁴ Regarder (Mosconi, 2016)

¹⁵ À titre d'exemple, à l'été 2009, le service de recherche de l'OMA (Office of Metropolitan Architecture) a soumis à la Fondation européenne pour le Climat un rapport intitulé Energopa, qui se veut un guide pour une Europe prospère et sans carbone.

Méthodologie et études de cas

Des disciplines telles que les sciences de conception, l'informatique, la psychologie et l'ergonomie, la philosophie et l'histoire des techniques ainsi que les neurosciences peuvent être mobilisées lorsqu'il s'agit d'étudier la conception¹⁶. Les activités de conception de l'architecture contemporaine peuvent être interrogées à travers de nouveaux paradigmes et outils, tels que la conception collaborative, la conception paramétrique, la conception numérique, la conception générative, les neurosciences ou le biomimétisme¹⁷.

Les sciences de conception sont abordées à travers différents modèles théoriques qui illustrent les activités de conception, comme l'architecturologie (P. Boudon), la théorie C-K (A. Hatchuel) ou l'ontologie FBS (Function-Behaviour-Structure) (J. Gero). Par exemple, l'*architecturologie* ou la théorie C-K éclairent les processus de conception : elles décrivent et expliquent le processus cognitif du projet architectural ou du projet d'ingénierie. Pour interpréter et clarifier les activités de conception, ces sciences établissent des modèles théoriques. Ces modèles peuvent être utilisés comme grilles de lecture des activités de conception afin de comprendre leurs mécanismes cognitifs.

Les trois projets de l'éco-quartier Clichy Batignolles constituent les cas d'étude sur l'implication des préoccupations énergétiques dans le processus de conception et le champ d'application d'une étude architecturologique. Ils ont été choisis pour assembler la plupart des paramètres liés à la conception de l'énergie durable.

La raison pour laquelle l'architecturologie est choisie parmi les théories de conception est en relation avec ses caractéristiques ; elle prend en compte la spécificité de l'architecture ; elle a établi un vocabulaire formellement construit et un langage scientifique ; et elle présente une capacité de modélisation. De plus, elle démontre un potentiel de généralisation.

Au même temps, cette théorie n'a pas été appliquée pour l'instant à l'étude des considérations énergétiques dans la conception architecturale, constituant un point de vue original sur le sujet.

¹⁶ http://www.paris-lavillette.archi.fr/uploads/images/dsa-dpea/OUVRAGE%20DPEA_2017_WEB.pdf

¹⁷ Ces activités de conception émergentes sont étudiées par le laboratoire MAP-MAACC en France, en utilisant deux ancrages scientifiques : les sciences de la conception et les sciences du numérique.

Les édifices choisis comme cas d'étude sont pertinents à étudier car ils suggèrent des approches innovantes particulièrement diverses dans un contexte « durable » très restreint, répondant à une ambition d'un programme à la fois énergétique et sociale. Leurs concepteurs sont représentatifs de trois différentes générations d'architectes.

La démarche expérimentale à suivre propose une lecture des cas en prenant la distance scientifique nécessaire apportée par la théorie. Ceci permet dans un deuxième temps d'appréhender les processus mentaux présents sur la conception des projets avec une orientation vers des préoccupations énergétiques. La modélisation de ce processus permettra de comparer les cas et de fournir des conclusions plus générales sur le sujet.

L'apport scientifique en termes d'originalité

A cette étude, la durabilité en architecture et plus particulièrement la performance énergétique est étudiée sous un angle qui n'a pas été traité précédemment dans ce contexte. La présente étude s'inspire de la voie initiée par Caroline Lecourtois, (Lecourtois, 2012, 2014a, 2015) qui a examiné l'éco-conception urbaine. En même temps l'étude se différencie car elle se positionne à une autre échelle (celle des bâtiments), et est orientée vers la transformation des exigences quantitatives de l'énergie en un ensemble qualitatif de mesures et de dimensions pour former un espace. Les outils méthodologiques et les concepts utilisés pour effectuer l'analyse, c'est-à-dire le langage de l'architecturologie, sont appliqués dans un contexte qui n'a jamais étudié sous l'angle de l'énergie.

Le but de la modélisation de la conception

Tout d'abord, l'intention n'est pas de proposer un modèle théorique de la conception architecturale énergétiquement efficace, mais plutôt de démontrer l'existence d'une pluralité de modèles. Autrement dit, l'architecturologie en tant que méthode permet de mettre en évidence l'absence de réponse univoque. L'existence d'un modèle spécifique est donc remise en question.

La modélisation de la conception permet dans notre cas d'avoir une base commune afin de poursuivre la lecture des trois bâtiments étudiés, en dehors de leurs spécificités ; pouvoir comparer et trouver des similitudes dans les approches de conception. Plusieurs façons de traiter des questions analogues et des problèmes similaires pourraient être révélées. Or, la modélisation n'est pas le but, une finalité en soi, mais un moyen procédant à l'analyse, qui aidera à formuler de nouvelles questions, à substituer des éléments ou à tirer des conclusions en se situant à la fois en dehors des éléments spécifiques qui concernent chacun des bâtiments.

La modélisation vient après l'analyse et l'interprétation architecturologique.

La modélisation de la conception n'est pas l'objectif de la recherche ; la modélisation permet plutôt la mise en œuvre d'un moyen permettant d'interpréter la conception et de produire de connaissances qui conduirait à tirer des conclusions et à former de nouveaux questionnements.

Positionnement épistémologique

Dans l'étude actuelle, la position épistémologique, c'est-à-dire le mode d'accès à l'objet de recherche, est orientée vers le constructivisme : la réalité construite est subjective et dépendante du système d'observation.

L'approche est inductive : partant d'un élément particulier, on tend à aborder un élément général. Le positionnement est empirique, expérimental. Il s'agit d'une recherche exploratoire qui permet d'identifier et de définir un problème ou une question.

La recherche est ancrée dans le cas où le phénomène observé donne une valeur à la théorie¹⁸ - et non l'inverse, lorsque la théorie fournit une explication du phénomène observé. Dans notre cas, la modélisation réduit¹⁹ l'architecture à la mesure. Via la modélisation, nous n'entendons pas lire la réalité. La connaissance produite ne sera pas le résultat d'une description mathématique mais un produit construit, inscrit dans un certain contexte, avec des filtres et des biais : c'est le point de vue qui crée l'objet.

¹⁸ La théorie étant ici l'architecturologie et le phénomène observé la place de la transition énergétique dans l'éco conception architecturale

¹⁹ Les limites de la modélisation et la réduction qu'elle induit : *L'abstraction, la conception, la modélisation réduisent le réel à quelques dimensions et appauvrissent la perception au lieu de l'enrichir* (Bergson, 1911)

De la dualité de l'état de l'art à une multiplicité de conclusions

Une particularité dans la constitution de l'état de l'art est le fait qu'il est composé de deux parties ; l'une résidant dans le sujet général -c'est-à-dire l'énergie durable en architecture- et l'autre concernant la méthodologie, l'outil de recherche utilisé.

La question de la *durabilité* et par conséquent la question de l'énergie en architecture est un sujet débattu, controversé, interdisciplinaire.

Trois points semblent ici épistémologiquement intéressants :

- 1) Il semble utile à cet égard de rappeler que l'architecture, n'ayant pas pleinement acquis son statut de discipline²⁰, a un caractère hétérogène qui ne peut pas se réduire à un seul aspect.
- 2) Un autre élément épistémologiquement essentiel est la nature de l'architecture qui positionnée au cours du temps au carrefour de la science et de l'art.
- 3) Concernant les *sciences de conception*, le domaine se caractérise aussi par une multiplicité de points de vue (par exemple les points de vue des internalistes et des externalistes²¹).
- 4) Même la question de la *durabilité* et de l'efficacité énergétique se situe à la croisée des disciplines et est traitée au sein de différentes approches, méthodes et outils.

La place de l'architecturologie

Les intentions pour lesquels l'architecturologie est utilisé seront esquissées.

L'architecturologie est choisie car elle constitue l'un des seuls langages construits pouvant décrire la conception en produisant des connaissances sur l'activité cognitive de la conception architecturale. Il s'agit d'un outil scientifique qui permet de prendre une distance pertinente sur les descriptions et de dissocier le discours architectural doctrinal.

Il faut cependant préciser que la présente étude étant empirique, elle reste provisoire et avec une certaine incertitude.

A partir des notions que nous offre le vocabulaire de la méthodologie utilisée, l'objectif est d'effectuer une lecture de la conception. L'accent étant mis sur l'implication des enjeux

²⁰Malgré sa présence évidente dans l'univers académique, l'architecture est encore en train de construire son statut gnoséologique (Mantziaras, 2014)

²¹ Regarder (Raynaud, 2001)

énergétiques et des impératifs de performance environnementale dans le processus de conception, le point de vue sera placé sous ce prisme.

L'architecturologie sera utilisée ais principalement comme un outil fournissant une base scientifique où l'utilisation de ses concepts peut en évoquer d'autres et élargir le champ de discussion.

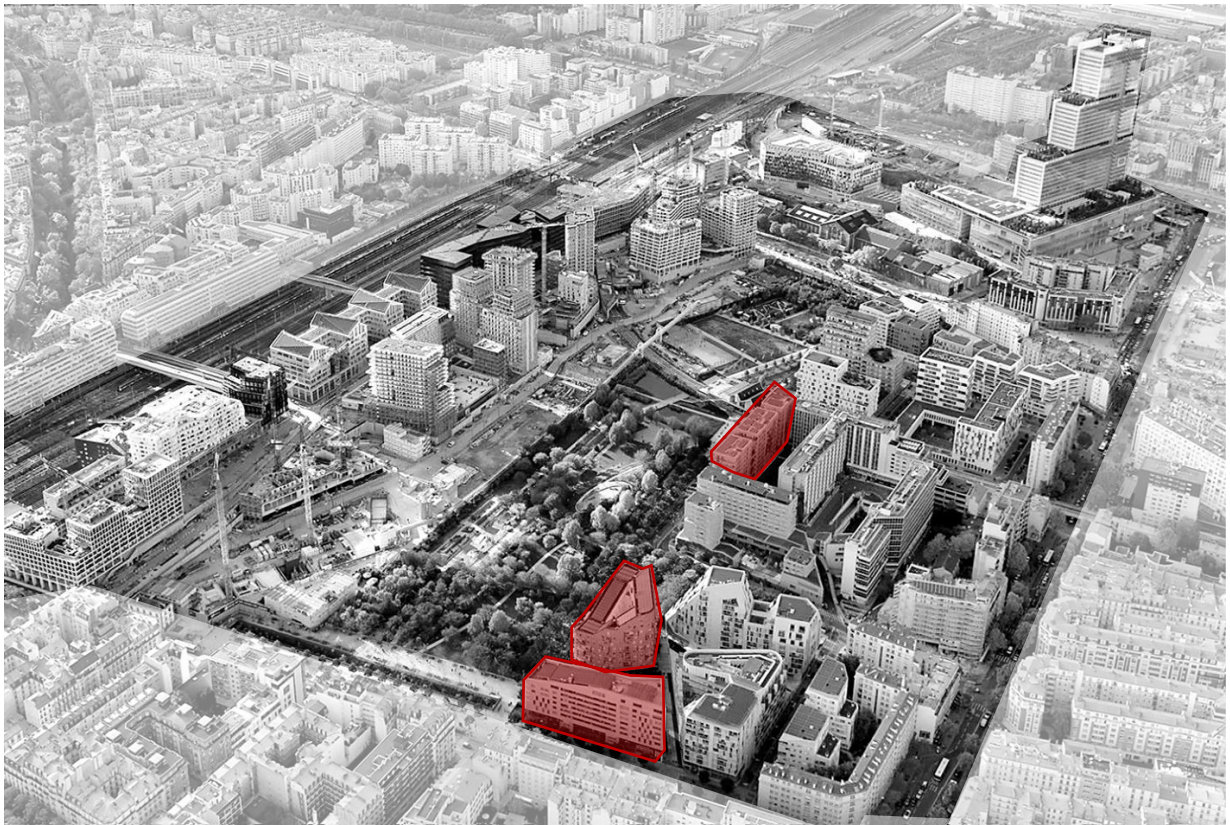


Figure 1 Bâtiments E1, E2 et E5 situés dans la section est de l'écoquartier de Clichy Batignolles au 17^{ième} arrondissement de Paris

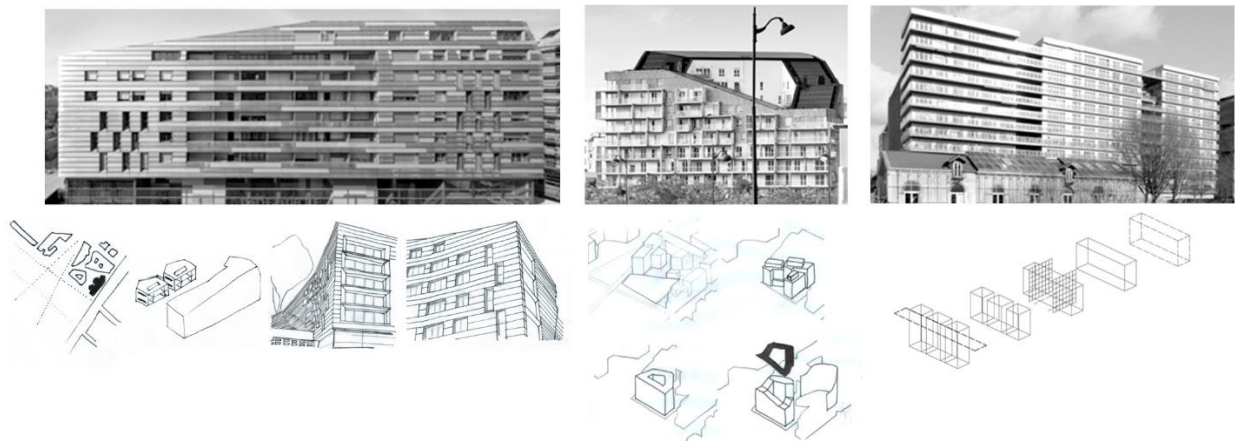


Figure 2 Bâtiments E1, E2, E5

Deuxième Partie - Analyse

Le bâtiment, E1 Cardinet Chalabre.

La première étude de cas (E1) est située au 173, rue Cardinet, dans le 17^e arrondissement de la ville de Paris. Il a été conçu par Franklin Azzi Architecture et les collaborateurs Pablo Boisier B2 Architects. Il regroupe trois programmes, qui ont nécessité la mise en place de trois réglementations²² : il regroupe 61 logements HQE (Haute Qualité Environnementale), une crèche et des commerces. Il s'agit d'un bâtiment basse consommation conforme au Plan Climat de la Ville de Paris.

Des espaces de références potentiels

Le processus de conception, comme décrit par Franklin Azzi, comprend entre autres l'inspiration à partir des images, la méthode de « l'hybridation » et une récurrente contextualisation dans son discours rhétorique, comme « leitmotiv ».

Les *espaces de références* pouvant participer au processus de sa conception semblent convoquer un mélange de visions technico-historiques passées, contemporaines et futures de l'architecture.

Cette interprétation pourrait être liée à une *échelle* de modèle renvoyant à des ordres sociaux, culturels, esthétiques, ou techniques.

Une *échelle* socioculturelle et autre fonctionnelle sont vraisemblablement dans le haut de la hiérarchie des *opérations* de référenciation participant au processus de conception de Franklin Azzi. Une méthode de travail contextuel prenant en considération une *échelle* fonctionnelle : *l'architecture doit refléter les usages*. (Azzi, F. in Abrieu, 2018, p. 73)

Même si Franklin Azzi avoue appartenir à son époque contemporaine et concevoir dans ce contexte, le temps agit en même temps comme une référence pour lui, dans sa globalité : divers

²²<http://www.franklinazzi.fr/projets/cardinnet-chalabre-cc658f90-0f54-4d6e-acd6-461198afc11e#7>

champs de réflexion semblent nourrir ses *espaces de références*, convoquant diverses disciplines.

Une part essentielle de cette mixité hybride entre les époques et les disciplines est probablement liée entre autres à l'immense univers d'images présent sur le web. *Je me nourris d'images et d'images fixes. Je suis boulimique ou collectionneur. Google Images est, pour moi, un véritable outil de travail à l'origine de tout processus créatif. Lambda, banal, sans dimension ni volonté artistique : mon iconographie est constituée d'objets à finalité informative.* (Azzi, F. in "Franklin Azzi, l'insatiable," n.d.) L'image, signe de notre temps et médium omniprésent, sert comme un instrument, un outil qui participe au processus de conception de Franklin Azzi. *La page blanche est une illusion. Nous sommes tellement nourris d'images. Je ne veux être ni influencé ni découragé.*

Globalement, les ordres sociaux, politiques, économiques et géographiques qui participent à la création d'un environnement « contextualisé » dans le processus de conception pourront être liés comme mentionné précédemment à une *échelle* socioculturelle, économique et géographique. L'utilisation des stratifications historiques et temporelles ainsi que la notion de « réinterprétation » peuvent être identifiées dans l'utilisation potentielle d'une *échelle* de modèle. Comme évoqué par l'architecte, cet espace de références semble sous l'égide de « l'hybridation », c'est-à-dire de la combinaison d'espèces et d'éléments divers.

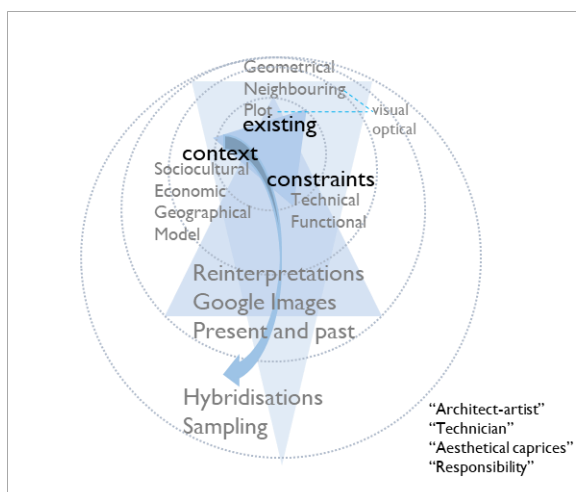


Figure 3 Possibles espaces de références chez le travail de conception de l'architecte

Notion	Inspiration	Action
Hybridation	Memphis Group	
	Nimayer, Aalto	each decorative detail presides over a technical function
Modernism	Claude Parent, Jean Prouvé, Marcel Gascoïn	
	Paul Virilio	the three-step design and three projects
	Finn Gelpel, Frédéric Borel	
Images		The compilation of images
Interdisciplinarity		Crossroad of disciplines
	Rudy Ricciotti	on creativity and constraints in the work of an architect
The industrial atmosphere		

Afin de rendre le bâtiment thermiquement efficace, son concepteur avoue avoir travaillé comme technicien plutôt qu'en artiste (Azzi, F. in Bouchouchi, 2013)

En établissant une corrélation entre art et architecture, il ne considère pas l'architecte comme un artiste, néanmoins il admet un talent artistique dans ce que fait un architecte. *Le temps de l'architecte « artiste » et des œuvres « capricieuses » est révolu (...)* (Azzi, F. in Bouchouchi, 2013)

Une *échelle* technique semble dérouler dans ce cas dans un *espace de référence* socioculturel et un de modèle.

Dans son bâtiment, E1, de l'éco-quartier de Clichy Batignolles, dont une partie de ses caractéristiques techniques est visible, la transition énergétique et la qualité environnementale devaient être considérées *de facto* et donc participer à ses espaces de référence.

Plus précisément dans le processus de conception du bâtiment en question, on peut trouver enracinés les dipôles art-architecture, art-technique, technicité-technique ainsi que la matière de décoration et d'esthétique, tous opérant en référence à la performance et l'aspect quantitatif de l'efficacité énergétique.

Ceci nous amène à reconsidérer la relation entre les aspects de haute performance environnementale invoqués dans le discours d'une part et le processus de conception du bâtiment d'autre part.

Afin de manifester la transition²³ survenue, la place que prend la performance dans le discours architectural rhétorique semble ici s'étendre au-delà de la quantité. Elle vise à se développer en une figure transparente -donc visible- qui élargit les contraintes numériques à un élément éducatif et porteur de message démontrant « l'identité » du bâtiment. En intégrant une *échelle* optique²⁴ les architectes déclarent révéler un changement qui s'opère dans la conception architecturale à ce moment précis (2013) concernant les contraintes d'efficacité énergétique. Les ouvertures de façade, la construction technique de l'enveloppe et les matériaux deviennent les aspects qui veulent porter l'objectif d'un changement de paradigme. La déclaration de contraste avec le modèle des immeubles haussmanniens environnants pourrait être interprétée comme une volonté de créer un bâtiment-symbole représentant sa fonction d'efficacité énergétique.

²³concerning the conception of energy efficient buildings in connection with the environmental requirements and constraints.

²⁴ donner des mesures dans une partie de l'espace architectural selon les points de vue qui s'y fixent

La compacité

Les architectes déclarent utiliser ici une morphologie « extrêmement compacte » comme réponse aux besoins énergétiques du bâtiment. Une forme compacte est principalement associée à une surface réduite en contact avec l'extérieur. En termes architecturologiques, on pourrait situer la compacité à *l'échelle* économique. C'est le Panthéon de l'architecte J. L. N. Durand (Boudon et al., 2001, p. 160) -un plan circulaire en forme de croix- la conception duquel est déterminée des considérations économiques (compacité liée à une perte d'espace minimum). De même, une *pertinence* économique pourrait conduire un architecte à réduire la linéarité d'une façade pour des raisons d'économie d'énergie (Boudon et al., 2001, p. 160).

La morphologie compacte est l'élément majeur qui semble être choisie en lien avec la faible consommation énergétique (avec le choix des matériaux) ; le second est l'orientation sud en combinaison avec les dimensions des ouvertures. Une forme cubique très compacte, qui minimise les surfaces extérieures -les principales zones de déperdition de chaleur-, et une double isolation extérieure en laine minérale de haute performance contribuent vraisemblablement à la performance énergétique du bâtiment²⁵.

Dans ce cas, on pourrait supposer que l'architecte a utilisé un modèle morphologique, exprimé par la forme (similaire à celle d'un *blockhouse* ou d'un *bunker*) qui renvoie à la compacité du bâtiment. En parallèle, un modèle abstrait, le *thermos*, exprimé en mots. Le thermos étant un objet isolé qui maintient la température, nous pourrions le corréler avec le bâtiment conçu qui est performant et économe en énergie.

L'enveloppe

Afin de répondre aux exigences et au cahier des charges environnementales, F. Azzi a conçu une enveloppe protectrice qui veut jouer le rôle d'un « manteau isolant », révélant ses différentes couches comme une illustration anatomique scientifique²⁶.

²⁵L'eco-quartier Clichy-Batignolles, Une référence de développement urbain durable à Paris, Lauréat 2016, page 9

http://www.clichy-batignolles.fr/sites/default/files/exe_web_cb_dossierpresse-fr_1.pdf

²⁶Entretien, Franklin Azzi, publié le 10 décembre 2015 à www.nouvelobs.com, sous le titre « Un bâtiment doit-il être moche pour être écolo ? », consulté le 05.12.2017

La forme de l'enveloppe dépend vraisemblablement d'une *échelle* technique (haute performance, isolant thermique, élément de protection) qui trouve sa *référence* dans une *échelle* économique (d'énergie). L'*échelle* technique est surdéterminée avec une *échelle* optique (intention qu'il soit vu d'un autre endroit, de révéler, de montrer). L'*échelle* optique pourrait relever ici la *pertinence* de la transparence. Les matériaux ont joué un rôle essentiel dans l'obtention de la transparence précitée.

Conclusions architecturologiques

Les éléments qui contribuent vraisemblablement à la performance énergétique du bâtiment pourraient donc être liés à sa morphologie (compacité, coupé dans la masse pour accueillir les technologies (*opération* de découpage et d'intégration), une toiture en pente légère pour mieux orienter les panneaux photovoltaïques (*opération* d'intégration)) ; la différenciation des ouvertures des façades nord et sud (*opération* de dimensionnement); la double orientation (*opération* d'implantation et opération de découpage) et les matériaux de l'enveloppe.

Opération	Dimension	Pertinence	Référence
Intégration dimensionnement	Toiture incliné		Éch. Technique PV
orientation	Toiture incliné progressivement	Éch. géométrique	Orientation soleil (éch. géograph.) Apports solaires Éch. Économie d'énergie
Dimensionnement	Fenêtres, typologie plein et vide	Éch. Économie d'énergie	Le bâtiment haussmannien Échelle de modèle degré zero
orientation	enveloppe	Transparence technique	"element pédagogique" éch. De visibilité
Dimensionnement	enveloppe	Couches de matériaux Économ. énergie	« écorché scientifique » sémantique
dimensionnement	Fenêtres et portes		To assure a high daytime factor in the rooms (éch. économ. énergie)
découpage	Forme du bâtiment	« coupé dans la masse » « compacte » (éch. symbol. Form; géométr)	Intégration des technologies éch. technique (éch. économ. énergie)

Figure 4 Identification des opérations cognitives de la conception architecturale du bâtiment E1 du point de vue de l'énergie

En premier lieu, un espace de référence économique de l'énergie semble avoir été opératoire par la mise en œuvre d'une opération cognitive de dimensionnement de l'enveloppe (pour le rendre énergétiquement performant). L'opération de dimensionnement a probablement conduit

à dimensionner les fenêtres et les portes de telle sorte qu'elles assurent un facteur élevé d'ensoleillement aux chambres.

L'ensoleillement semble être également pris en considération dans l'implantation (orientation, positionnement) de l'édifice. (Protection au nord et ouverture au sud). La prise en compte de l'exposition solaire a conduit également à l'inclinaison progressive de la toiture, afin de maximiser les apports solaires.

L'espace de référence économique d'énergie semble être impliqué en combinaison avec un espace de référence technique par l'intermédiaire des opérations de découpage et d'intégration. L'opération cognitive de découpage se manifeste par la « coupure dans la masse » du bâtiment pour installer des espaces liées à sa performance énergétique ainsi qu'à rendre sa forme plus compacte afin qu'il y ait moins de déperditions thermiques.

L'opération d'intégration vise à intégrer des systèmes techniques de ventilation ainsi que de système énergétique active (PV) procédant de la prise en compte de la production énergétique visée.

Ici l'espace de référence économique de l'énergie semble être à l'origine d'une opération cognitive de reprise. Les proportions de la façade des édifices haussmanniens qui entourent le bâtiment ne sont pas maintenues. Les proportions de fenêtres ainsi que les typologies de plein et vide sont donc écartés du modèle haussmannien. Le nouveau modèle est repensé sous le couvert de matériaux dits soutenable : le recours à une « modernité » et de l'usage des matériaux à faible impact écologique. Cette reprise a conduit à dimensionner les ouvertures sur les façades sud et nord.

Une *échelle* économique (d'énergie) en relation avec les échelles architecturologiques parcellaire et de voisinage ont très probablement été impliquées dans la mesure et la forme de ce bâtiment.

Ainsi, les questions énergétiques tendent à être liées via une *échelle* économique de l'énergie aux *échelles* géométrique, géographique, technique, de modèle, ainsi que sémantique, relayées par une échelle parcellaire et de voisinage. Une *échelle* optique est probablement, comme dit précédemment, surdéterminée dans le cas de l'enveloppe, avec une référence à la performance énergétique.

L'architecturologie permet de décrire ce cas de conception comme une mise en œuvre de l'opération de découpage procédant d'une *échelle* symbolique formelle (se réfèrent à la réception des technologies) et d'une *échelle* technique (qui fait référence à la performance énergétique du bâtiment)

Une opération *d'intégration* est mise en œuvre, à partir d'une *échelle* économique (d'énergie). La morphologie du bâtiment est mobilisée dans le but de relever une pertinence des enjeux symboliques formels (compacité), évoquant des références d'ordres économiques (d'énergie) (réduction de la consommation énergétique)

L'orientation du bâtiment (ordres géographiques nord/sud) dimensionne la taille et la quantité des ouvertures. Parallèlement, la façade se réfère sur une période historique, antérieure au temps des architectes, et énonçant ainsi des modèles sociotechniques. Plus précisément, une *échelle* de modèle (degré zéro²⁷) fonctionne en référence au modèle haussmannien des alentours (et à la typologie des ouvertures).

²⁷ Nous avons affaire à un cas de *degré zéro* de l'*échelle* quand le concepteur prend le contre-pied des informations dont une *échelle* est porteuse

Le bâtiment, E2 Cardinet Chalabre

Le premier édifice de la ZAC Cardinet-Chalabre²⁸, situé dans le lot E2, a été livré en 2012. Il se compose de 96 appartements et de 20 logements sociaux. La volumétrie compacte du bâtiment, resserrée dans les limites de la parcelle trapézoïdale, « résulte d'une équation entre ce qui est déjà là, le parc, les exigences de la toiture photovoltaïque, ainsi que les études sur l'habitat réalisées par l'agence depuis 1997 » (in Léglise & Sautot, 2013, p. 107) Concernant la méthode de travail suivie, l'architecte a déclaré qu'il procédait en s'appuyant sur le contexte « d'un îlot urbain partiellement construit et d'un parc porteur déjà d'une valeur d'usage ». (Trottin, D. in Léglise & Sautot, 2013, p. 107)

Les prescriptions formant un *espace de références* concernant l'énergie

Pour Périphériques Architectes, les prescriptions du cahier des charges du concours avaient placé les objectifs de la haute qualité environnementale comme un des moteurs majeurs du processus de leur conception : « Il fallait en effet intégrer (n. dans la conception) le Plan Climat mais aussi 'avoir une production d'énergie significative » (“Périphériques Architectes,” 2013) Ainsi, leur conception a été primordialement orientée vers une réponse aux objectifs du cahier des prescriptions. « Nous avons répondu aux prescriptions en créant un immeuble le plus compact possible tout en ayant des appartements traversants en créant ce bâtiment en forme d'anneau qui a donc laissé place à une grande cour qui permettra à la fois d'accéder aux différents bâtiments et d'apporter de la lumière au cœur de l'édifice » (“Périphériques Architectes,” 2013)

Afin de répondre aux exigences programmatiques en termes de performances énergétiques et d'économies d'énergie, - qui pourraient être liées mais non limitées à une *échelle* technico-économique - les architectes ont très probablement conçu leur projet en référence à une *échelle* géométrique juxtaposée avec une géographique, et secondairement dépendant d'une fonctionnelle. « nous avons imaginé un bâtiment innovant dans la forme, l'usage et le

²⁸ Fiche Technique : Maître d'ouvrage : Nexity Seeri, Aménageur : Semavip, Architecte : Périphériques – M. David Trottin, Entreprise générale : Campenon Bernard Constructions, Système d'intégration : Adiwatt, Sous-traitants : Charpentiers de Paris (charpente), Enerpur (couverture), Sénergies (électricité), Exploitant de la centrale : Solarvip

fonctionnement » (Trottin, Marin-Trottin, & Jumeau, n.d.) De plus, une *échelle* formelle symbolique (« un bâtiment compact, écologique et économique » (Trottin et al., n.d.)) trouve probablement sa référence dans l'ensemble d'une *échelle* économique (d'énergie), technique et fonctionnelle qui concerne la performance énergétique et le confort thermique.

L'orientation des logements semble avoir une pertinence qui concerne leur transversalité. Elle réfère probablement aussi à une *échelle* économique (d'énergie).

L'épaisseur des façades (peau extérieure et intérieure) semble prendre ses mesures en référence à une *échelle* économique (d'énergie) (afin de limiter les ponts thermiques), et une technique (la grande épaisseur d'isolation est intégrée dans le but d'un encombrement minimum) convoquant une *opération* d'intégration. La peau extérieure, c'est-à-dire la protection extérieure mécanique de l'édifice, est traitée comme un revêtement métallique texturé, vraisemblablement animé également par les échelles architecturologiques précitées.

La conception de la cour intérieure (ses dimensions -« grandes »- et ses matériaux), semble être mise en œuvre en portant référence à une *échelle* fonctionnelle (liée à une *échelle* technique), ainsi qu'à une *échelle* socioculturelle. Elle compose de tôles perforées d'aluminium plié qui « fonctionnent comme des haut-parleurs absorbants pour faire de la cour commune un espace agréable à vivre et à partager » (Trottin et al., n.d.)

Morphologie

Le toit comme référence à une échelle de modèle relayée par une échelle optique

Au cours de l'entretien, l'architecte a initialisé la narration du processus de conception du bâtiment E2 en introduisant certains *espaces de référence*, ou clusters d'informations récurrents, comme les archétypes architecturaux et les préconceptions. Il a notamment affirmé avoir utilisé comme références les « archétypes » de la « cour intérieure haussmannienne » et celui du « toit ».

La morphologie du bâtiment, et plus précisément la forme inclinée de sa toiture, semble trouver sa pertinence à une *échelle* géométrique (inclinaison), relayée par une *échelle* géographique (orientation au soleil pour une performance optimale de la couverture photovoltaïque). De plus, la *pertinence* à laquelle repose cette forme se trouverait dans l'application d'une *échelle* de modèle, portée par une combinaison d'une *échelle* optique qui agit sur une *échelle* symbolique

de la forme. *L'échelle* de modèle semble ici réinterpréter une vieille structure d'organisation spatiale, induisant un symbole d'un nouveau rapport à l'énergie. C'est-à-dire, le modèle typologique d'un toit parisien est interrogé. La forme de la toiture semble porter une connotation symbolique. Elle pourrait être lue comme un contraste avec la « traditionnelle » forme de toitures dans les immeubles parisiens aux alentours ainsi que comme une démonstration de performance énergétique.

« L'autre élément totalement déclencheur du résultat du projet a été la demande du promoteur (...) de fournir une installation photovoltaïque dans les toits des bâtiments. Alors on s'est dit : on va passer de la toiture « en zinc » parisienne à une toiture photovoltaïque ; le bâtiment doit donc illustrer et être démonstratif de cela.

Dans ce cas, il convient de rappeler la demande du cahier des prescriptions du projet qui faisait référence à une installation de panneaux photovoltaïques pour produire de l'électricité, sans toutefois imposer des indications restrictives concernant leur emplacement.

Conclusions architecturologiques

Dans un premier lieu un espace économique d'énergie semble avoir été opératoire par une opération cognitive d'implantation. Cette opération d'implantation vise à assister la performance énergétique du bâtiment. L'orientation de la toiture est pensée de telle manière (*échelle* géométrique) qu'en étant incliné vers le sud elle pourrait profiter idéalement de l'exposition du soleil via une *échelle* géographique. L'orientation et le positionnement des appartements conduit à une transversalité entre la cour et le parc. Le positionnement de fenêtres vise à avoir une double orientation et par conséquent avoir recours à une ventilation transversale et à la circulation de la lumière naturelle à l'intérieur des appartements. (*échelle* géographique) Le positionnement des balcons a été probablement pensé par rapport au confort thermique et à la protection solaire l'été (*échelle* géographique)

Deuxièmement, l'espace de référence économique d'énergie semble d'être à l'origine d'une opération cognitive de dimensionnement : les dimensions données au largeur/longueur du plan du bâtiment, à la largeur de la toiture, à l'épaisseur du bâtiment et au volume de la cour prend en considération des questionnements liées à l'énergie. La toiture est probablement dimensionnée (largeur) par rapport à l'intégration des PV (suivant une échelle technique).

La faible épaisseur du bâtiment (9.50m) qui s'implique aux considérations énergétiques porte référence à un bâtiment déjà réalisé à Nantes en 2008 conçu par le même architecte (*échelle de modèle*)

Au même temps, le volume de la cour a été pensé pour que l'air puisse chauffer et entrer dans les appartements, créant une sorte de microclimat.

Troisièmement, le même *espace de référence* a vraisemblablement conduit à découper l'espace architectural.

La toiture est découpée en sept parties afin de supporter l'inclinaison idéal pour intégrer les PV et suivre l'ensoleillement afin de maximiser les apports solaires.

La masse du bâti vient d'être découpé en créant une cour intérieure consistant à un espace de microclimat thermal (*échelle économique d'énergie*) qui conduit aussi à la transversalité des appartements et par conséquent la circulation de la lumière et ventilation naturelle (*échelle géographique*). La cour crée aussi un espace de circulation des habitants (*échelle fonctionnelle, échelle socioculturelle*)

L'*espace de référence* économique d'énergie a été probablement opératoire aussi dans le cadre de la référenciation de la matérialité de l'enveloppe : l'enveloppe est conçue en polystyrène et grille métallique afin de protéger la peau isolante (*échelle technique*).

La façade intérieure quant à elle est semi-transparente et réfléchissante pour des raisons d'intimité entre les habitants des appartements (*échelles de visibilité et optique*) (masquer les vues, intimité et interaction) ainsi que par rapport aux apports de lumière et de chauffage (*échelles géographique – économie d'énergie*) au sens de l'intérieur de la cour.

Pour conclure, en répondant aux limites quantitatives fixées par le cadre sur les consommations énergétiques, les *espaces de référence* économique (de l'énergie) et technique ont été très probablement mis en œuvre dans l'attribution des formes et mesures à l'édifice. Le raccordement à une boucle d'eau chaude, ayant pour objectif d'utiliser principalement des énergies renouvelables en est un exemple.

En ce qui concerne la production d'énergie par les panneaux photovoltaïques mis en toiture du bâtiment Quintessence, les *opérations* de positionnement, d'orientation et d'intégration ont très probablement été interrogées. Ceci se fait à partir d'une superposition des *échelles* géométrique (ensemble de pentes de toiture), technique (permettant la pose des panneaux) et géographique (selon un ensoleillement favorable)

La performance énergétique de la façade a été introduite probablement par une juxtaposition des *échelles* technique, fonctionnelle et économique, étant mise en œuvre dans un espace de référence économique (d'énergie). Les dimensions et la forme de l'enveloppe étaient vraisemblablement motivées par une volonté de limiter les pertes thermiques du bâtiment. Pour ce faire, l'épaisseur de la peau intérieure et extérieure du bâtiment semble avoir été étudiée, afin de limiter les ponts thermiques et permettre l'intégration de l'isolant en combinaison avec un encombrement minimum.

La morphologie en forme d'anneau triangulaire pourrait trouver sa *pertinence* dans une *échelle* géométrique et une symbolique formelle, avec une référence à une *échelle* fonctionnelle, technique et économique. La forme de la toiture plus précisément, semble étant d'abord orienté par une *échelle* géographique et technique (exposition solaire optimale), mais aussi de voisinage (minimiser les ombres sur les édifices arrières), de visibilité (organiser et offrir les vues vers le parc) ainsi qu'optique (offrant une façade linéaire vue du parc)

L'organisation autour d'une cour offre vraisemblablement également des vues traversantes, de la luminosité et une ventilation naturelles (*échelles* de visibilité et géographique)

Opération	Dimension	Pertinence	Référence
Orientation	Toiture	Inclinaison sud Éch. géométrique	Profitabilité de soleil Éch. Géographique Éch. Économie d'énergie
découpage	toiture	en 7 morceaux de divers inclinaisons	Orientation soleil (éch. géograph.) Intégration des PV (éch. techn) « manifeste » Symbolique formelle, de visibilité
Dimensionnement	largeur toiture		Intégration des pv
découpage	bâtiment en forme couronne	cour intérieure	Transversalité Lumière et ventilation naturelle (éch géograph) Microclimat thermal (éch économ. énergie) circulation (éch.fonction.) éch sociocult. de modèle
orientation/positionnement	appartements	Transversalité	Vue à la cour et à l'extérieur coté parc éch. Optique éch. géographique
dimensionnement	longueur façade	grand linéaire	compacité performance (éch. économ. énergie)
dimensionnement	hauteur bâtiment	éch. géograph.	Absence d'effet de masque pour le bâti derrière éch. voisinage
dimensionnement	empreinte au sol/plan	lignes convergentes vers la profondeur de la parcelle	La vue vers Le Park des bâtiments à coté. éch. de visibilité et optique qui dépend d'une échelle de voisinage

Opération	Dimension	Pertinence	Référence
positionnement	fenêtres	Double exposition	Ventilation transversale, lumière naturelle
decoupage	dimensions de l'appartement	Passage en maçonnerie	relier les 2 appartements en 1 (éch. extension)
	matérialité des la façade intérieure	semi-transparence	Relation de vue aux autres appartements Intimité et interaction Échelle de visibilité et optique
dimensionnement	épaisseur 9.50		bâtiment déjà fait à Nantes (éch. Modèle)
	Matérialité de la façade intérieure	réfléchissante	Plus de lumière Chauffer Masquer la vue (éch. Géograph., économ., optique)
dimensionnement	volume de la cour		que l'air puisse se chauffer pour être utilisé aux appartements
Referenciation	La matérialité de l'enveloppe	"solide" (polystyrene) Et grille métallique	"protéger" la peau isolante (technique) "jeu des ombres" (renvoi aux façades parisiennes) (de visibilité)
positionnement	balcons		confort thermique protection solaire l'été (econom. éner., géograph.)

Figure 5 Identification des opérations cognitives de la conception architecturale du bâtiment E2 du point de vue de l'énergie

Le bâtiment, E5

En mai 2016, le bâtiment de 11 étages de la parcelle E.5 a été inauguré. Il est situé dans le secteur est, entre le parc et l'hôtel Ibis. Le projet consiste en un bâtiment linéaire, avec sa continuité fragmentée en trois volumes qui restent cependant unis dans un tout. Il regroupe 98 logements privés et 871 m² dédiés aux bureaux au troisième étage, utilisés par l'hôtel Ibis.

Les deux premiers niveaux de l'édifice sont des duplex qui se posent au rez-de-chaussée. Initialement, ils étaient destinés à être des ateliers d'artistes ; finalement, ils ont été conçus pour un usage résidentiel.

Espaces de références potentiels

L'architecte Francis Soler présente souvent ses racines méditerranéennes comme une source d'inspiration ; un paysage nourrissant son regard sur ce qu'est l'architecture passive. Les ordres géographiques synthétisant une telle territorialité, sont les caractéristiques physiques du contexte spécifique impliqué : le soleil, le vent, la transversalité, la vue.

En matière d'expression architecturale, F. Soler affirme être opposé à la reproduction des mêmes caractéristiques ordinaires le long de ses projets ; il déclare préférer *isoler les mots et les réassembler différemment*, de manière que chacun conserve son existence propre. Pour décrire sa manière de procéder, donner un aperçu de ses ambitions méthodologiques, il établit un parallèle avec le triptyque du Jardin des délices de Jérôme Bosch : *Unis, ils créent une œuvre parfaitement cohérente qui reste invisible. Ainsi, de la même manière chacun de mes projets, bien qu'il soit isolé, fait partie d'un univers d'une même veine*. Il déclare ainsi s'abstenir de répéter des séries d'objets architecturaux similaires mais admet plutôt utiliser des éléments auto-référentiels de différentes manières et dans des ordres différents.

Il décrit le processus de conception qu'il suit comme une collection de divers paramètres et éléments donnés sans pour autant être parti d'une image donnée dans sa tête. Un mélange d'entre eux, une observation de la proposition, suivi d'une ré-observation, en ajustant, changeant ou ajoutant des éléments.

Francis Soler a présenté les manières dont son agence élabore un projet. La phase initiale concerne l'analyse du programme ainsi que les discussions avec le client. Après cela, la phase de conception est développée, fusionnant la diversité des paramètres définis.

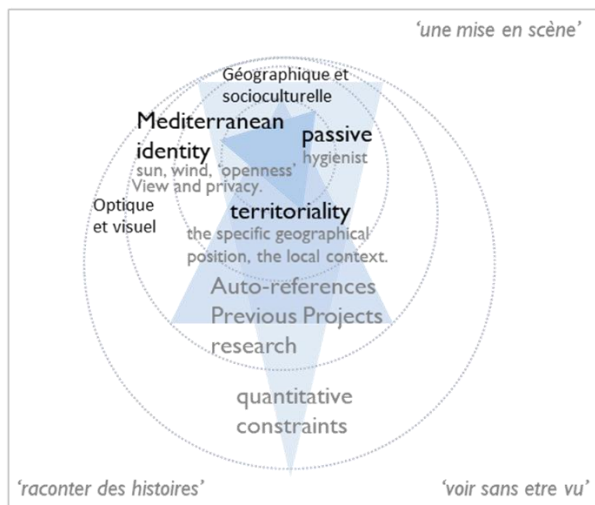


Figure 6 Espaces de références dans le travail de conception de l'architecte Francis Soler

Soler a publiquement exprimé ses positions vis-à-vis des questions environnementales en architecture, après avoir critiqué avec Ricciotti « l'utilisation servile » de celle-ci par de nombreux architectes. En se référant à ce dernier, il sous-entend la promotion d'équipements et de procédés qui sont souvent, selon lui, les gagnants des politiques en cours. Il soutient que les préoccupations environnementales et énergétiques sont considérées comme une base, un point de départ menant à des changements sociaux, plutôt que la poursuite d'un label ou d'une récompense. On pourrait supposer qu'il se situe contre l'abus de l'environnement « sans avoir rien d'autre à dire ».

La durabilité n'est pas seulement le climat. C'est la souplesse du projet pour ne pas les démolir pour les reconstruire, c'est le confort, c'est l'acoustique, toutes ces choses sont déjà prises en compte²⁹

La parcelle dictant la géométrie et la performance énergétique

Une échelle économique de l'énergie semble avoir passé par les dimensions de la parcelle. Or, c'est l'architecte qui en dimensionnant son bâtiment suivant les dimensions de la parcelle (en ayant comme pertinence les mesures de la parcelle (*éch.* parcellaire) et comme référence les

²⁹ Source : l'entretien qu'il a donné à l'auteur

programmes (*éch.* fonctionnelle) qui lui ont été demandés) qui amène à identifier des éléments d'efficacité énergétique le caractérisant.

Dimensionner l'épaisseur du bâtiment à 12,5m n'est pas une opération initialisant à la conception pour des raisons d'économie d'énergie, mais c'est parce qu'il y a cette dimension (de la parcelle) que le bâtiment devient énergétiquement performant.

La faible épaisseur qui résulte de la parcelle est celle qui amène à la bonne inertie thermique et la transversalité des appartements, en réponse aux multiples certifications environnementales requises.

Conclusions architecturologiques

Une *échelle* parcellaire pourrait être caractérisée comme initialisant le processus de conception de ce projet : elle agit fortement sur les mesures et la géométrie du bâtiment. « La dimension de la parcelle est la dimension du bâtiment » « J'avais une largeur, une longueur et une hauteur qui étaient définies. (Soler, F. in "Francis Soler : « Chacun de mes bâtiments est une œuvre »,» 2014)

Les dimensions de largeur et de longueur sont vraisemblablement ainsi intrinsèquement liées à celles de la parcelle, et la hauteur semble en dériver en combinaison avec les contraintes de hauteurs limites imposées par la Ville de Paris. En ce qui concerne *l'échelle* géométrique, active dans l'interruption d'une linéarité massive par la création des soi-disant « failles », il s'agit apparemment d'un choix postérieur, reposant sur une communication collaborative les acteurs municipaux. La hauteur du bâtiment semble donc dépendante non seulement d'une *échelle* parcellaire et d'une contrainte mais aussi d'une *échelle* fonctionnelle. Ce dernier concerne l'espace dédié à chaque programme (logement et tertiaire) qui résulte de la réduction de l'espace privé par étage et de la création d'un espace semi-public.

Une *échelle* optique a opéré dans le processus de conception du bâtiment Park 17, agissant probablement sur le traitement de la façade. Celui-ci est apparemment lié à une *échelle* de voisinage, puisque le placement de la parcelle à côté du parc d'un côté et d'un hôtel de l'autre a influencé les décisions architecturales sur les vues. La position du bâtiment semble de facto le conditionner à être vu. Ce statut a vraisemblablement été pris en compte par l'architecte lors de la conception des façades du bâtiment : prise en compte de la vue des personnes depuis le parc. En allant plus loin, *l'échelle* optique est devenue peut-être intrinsèquement liée à une *échelle* de visibilité, fonctionnant ainsi en synergie pour permettre de voir à l'extérieur sans être vu. En

effet, le dimensionnement et les formes différents qui composent les façades sud et nord sont dus non seulement à une *échelle* géographique, mais à une de voisinage aussi qui dépend d'un « jeu » entre celles d'optique-visibilité.

Il semble que dans ce cas l'implication des contraintes énergétiques sur le processus de conception architecturale n'ait pas mobilisé d'opérations cognitives spécifiques. La faible épaisseur de la parcelle et l'obligation d'une isolation par l'extérieur semblent s'être insérées dans *l'espace de références* de l'architecte, activé à une *échelle* de modèle. Ainsi, son expérience et ses connaissances antérieures, ainsi que ses propres références concernant le concept de passif et de climat dans la conception architecturale ont apparemment joué un rôle important dans l'approche et l'intégration des prescriptions environnementales spécifiques. Son positionnement vis-à-vis des normes françaises sur l'isolation thermique des bâtiments ainsi que sur l'utilisation de matériaux promus pour une conception architecturale performante énergétiquement est à mentionner. Même si les panneaux photovoltaïques semblent avoir été ajoutés a posteriori après la phase de base de l'approche conceptuelle du projet, une synergie permanente entre le bureau d'études techniques était incontestable. Les essais quantitatifs concernant la performance énergétique du bâtiment ont également été travaillés sur une base d'échange entre eux.

Troisième Partie – Résultats et Conclusions

Modélisations architecturologiques de la conception architecturale

Cas E1

Un *espace de références* économique d'énergie a été vraisemblablement impliqué³⁰ à la conception architecturale du bâtiment E1 conduisant aux opérations liées à sa performance énergétique.

Un *espace de références géographique* semble être à l'origine des considérations morphologiques. L'implantation, le dimensionnement, le découpage et la référenciation du bâtiment découlent de ces études morphologiques.

La forme du bâtiment semble étant conçu à partir d'une *échelle symbolique formelle* lorsque l'architecte donne au bâtiment une forme linéaire et continue d'une certaine épaisseur ; on pourrait associer ce signe à une certaine recherche de « compacité ». Il s'agit de considérer les données climatiques et l'orientation des points cardinaux : ceci renvoie à l'implication d'une *échelle* économique et d'une *échelle* géométrique.

Une *échelle économique* d'énergie pourrait être active quant au dimensionnement des ouvertures et au positionnement des appartements en double orientation (exposition) visant à une performance énergétique.

Le dimensionnement des ouvertures (*espace de références visuel*) a été mise en œuvre procédant des *échelles* économiques et de modèle (degré zéro) surdéterminés par rapport aux ouvertures des bâtiments du style haussmannien.

L'*échelle géométrique* a été impliqué quant à elle à la création d'une toiture en pente légère pour l'intégration des PV.

Un *espace de références* technique semble être source des opérations de dimensionnement, découpage, référenciation et intégration suscitant un traitement de la façade en considérant sa performance énergétique. Procédant d'une *échelle* fonctionnelle qui interprète l'adaptation de

³⁰ en combinaison avec un espace de référence technique/géographique/visuel/de modèles architecturaux

l'enveloppe comme un manteau climatique. (pertinence :intégration de technologies, référence : économie en énergie)

Ensuite par la mise en œuvre d'une *échelle optique* faisant référence à « une écorché en médecine » l'architecte pense à la manière dont l'enveloppe sera vue. Cette action désigne également une *échelle sémantique*³¹ car l'enveloppe devient aussi une référence pédagogique. Mettre l'isolation de façon qu'elle soit vue semble relever d'une *échelle* technique relayé d'une *échelle* optique se manifestant par le choix du matériau et ses caractéristiques de transparence. Ainsi les couches de matériaux se sont données de telle forme qu'ils soient vus, démontrant la considération de la dimension environnementale.

Un *espace de références* de voisinage est mis en œuvre procédant d'une *échelle* de visibilité et d'une *échelle* parcellaire.

Cas E2

Un *espace de références* économique en énergie semble avoir été opératoire par la mise en œuvre d'une *opération* cognitive de découpage et d'orientation.

Toiture

L'architecte a vraisemblablement recouru à des considérations géométriques pour découper des parties de l'espace architectural relevant d'une *pertinence* géographique et une *référence* technique³². Une *échelle* géographique semble procéder d'une échelle géométrique.

Ensuite, dérive une *échelle* fonctionnelle de *référence* économique : la toiture est adaptée en correspondance à l'usage comme un lieu de production d'électricité. Ceci amène probablement à l'implication d'une *échelle* optique se relevant d'une symbolique formelle : donner la forme à une partie de l'espace architectural intervenant aux modalités suivant lesquelles il est vu symbolise la prise en compte de la performance énergétique.

La toiture en pente qui en résulte, un degré zéro de *l'échelle* de modèle relève d'une *référence* de voisinage : l'architecte cherche à différencier son bâtiment des toitures des bâtiments haussmanniens aux alentours) en démontrant sa contemporanéité.

Les considérations morphologiques du bâtiment ne sont pas indissociées de la forme de la toiture.

³¹ Effectuer des opérations de référenciation permis/suggérés par des mots ou expressions verbales
Afin d'attribuer à un objet des propriétés caractéristiques le référençant

³² intégrer des pv et les orienter idéalement

D'abord, une *échelle* fonctionnelle prenant en compte les programmes qui devront être suivis semble organiser l'espace en le découpant. Puis, l'implication d'une *échelle* économique relève d'une *référence* de performance énergétique amenant à une *échelle* symbolique formelle qui se réfère à son tour à la « compacité ». Ensuite, l'implication d'une *échelle* géométrique a la pertinence d'une forme en anneau.

Ceci semble passer par la procédure suivante :

Un découpage de l'espace de conception en sous-espaces est initié par une *échelle* de niveau de conception. Une *échelle* de modèle (effet locale) se référant à la densité de la typologie haussmannienne urbaine, agit sur une *échelle* économique. L'échelle économique a une *pertinence* géographique (création microclimat). Elle amène à la création d'une cour intérieure (*pertinence* transversalité) passant par une *échelle* géographique qui se réfère à la circulation de la lumière et du vent.

La cour intérieure se réfère à une typologie haussmannienne et par conséquent à une *échelle* visuelle et optique (« voyeurisme »). Elle implique ensuite une dimension de fonction (usage : cuisine) qui, se relevant d'une *échelle* socioculturelle, permet à la fois l'existence des ouvertures pour l'aération de l'espace et facilite des échanges potentiels entre les occupants.

Au même temps, une *échelle* géographique (considérations des apports des ombres et du soleil) se réfère à une *échelle* de voisinage (effet de masque des bâtiments adjacents)

Dans cette forme en anneau semble puis s'impliquer une *échelle* de modèle : le bâtiment à Nantes déjà conçu par l'architecte. Il existe en outre une symbolique dimensionnelle qui se réfère aux considérations énergétiques (lié au faible épaisseur)

Cas E3

Un *espace de références* parcellaire semble opérer comme initialisant à la conception. Une *opération* cognitive de dimensionnement est mise en œuvre procédant d'une *échelle* parcellaire (le bâtiment a les dimensions de la parcelle et la hauteur prend la capacité maximale comme une extrusion) de *pertinence* géométrique (linéaire, parallélépipède) et d'une *référence* fonctionnelle (inclure les programmes demandes)

Cette opération agit sur la géométrie du bâtiment ainsi que sur son orientation, introduisant un *espace de références* économique en énergie puisque la faible épaisseur agit à la performance énergétique.

Dans un premier lieu, une *échelle* géométrique opère aux longueur, épaisseur et hauteur du bâtiment (85x11.5x27m d'abord). Elle est relayée d'une *échelle* sémantique (« un décor pour le parc ») d'une *pertinence* optique (être vu) et d'une *référence* de voisinage.

Puis, une demande de la part de la Ville concernant la continuité du bâti impose une rupture à l'espace de conception. Une *opération* de découpage semble avoir été mis en œuvre. Une *échelle* géométrique est par conséquent, de nouveau, opératoire, afin de créer de failles et rompre la continuité de la forme « complète ». Ensuite, ceci agit sur la hauteur du bâtiment - par rapport à une *échelle* fonctionnelle (ajustement pour accueillir tous les m² des programmes demandés) - qui augmente de 9 à 11 étages suivant une *opération* de dimensionnement.

Ceci amène vraisemblablement à l'emploi d'une *échelle* fonctionnelle d'une *référence* socioculturelle agissant sur les nouveaux espaces créés, qui sont pensés pour accueillir les balcons, terrasses et espaces communs des habitants.

Synthèses

On estime qu'une *échelle* économique (de l'énergie) est principale dans la conception des bâtiments E1 et E2. Elle est supposée être co-déterminée avec les *échelles* technique et fonctionnelle.

Une *échelle* géographique pourrait être posée comme structurante à la conception du E2, tandis que dans la conception du E1 ce rôle pourrait être implémenté par une *échelle* de voisinage avec une parcellaire.

En ce qui concerne les questions énergétiques il y a dans les deux cas un travail profond mené sur la conception de l'enveloppe. Dans le bâtiment E1 pourtant, la conception de l'enveloppe apparaît temporellement plus tôt qu'au bâtiment E2; elle a une propriété initialisante.

On dira qu'une *échelle* de visibilité tient dans les deux cas le rôle d'une méta-échelle. Hiérarchiquement, elle apparaît juste après l'*échelle* principale d'économie, afin de démontrer, manifester que le bâtiment soit « écologique ».

Elle semble surdéterminée avec une *échelle* technique (rendre la technique visible) dans le cas du bâtiment E1, relayée d'une *échelle* sémantique (« écorché scientifique », « pédagogie ») et implémentée par la matérialité de la transparence de la succession des couches des matériaux.

Sur le bâtiment E2, l'*échelle* de visibilité est probablement surdéterminée avec une *échelle* symbolique formelle ayant comme *référence* le modèle (degré zéro) des toits haussmanniens et donc implémentée plutôt par une morphologie accentuée et inclinée. Plus particulièrement, l'orientation du toit devient la forme du bâtiment qui veut que ça soit vu.

L'orientation du toit semble apparaître temporellement plus tôt au bâtiment E2 qu'au bâtiment E1.

Dans les deux projets E1 et E2 la référenciation des typologies historiques (ici l' « archétype » du bâtiment haussmannien) est mise en relation avec *l'échelle* de modèle. Elle est dite d'être employé dans la succession de plein et de vide et la réduction des ouvertures à la façade du bâtiment E1. Elle semble avoir été utilisé à la conception de la cour intérieure comme espace thermal de microclimat ainsi que comme espace de vues au cas du E2.

La notion de « compacité » est essentiellement présente dans les deux discours.

Par ailleurs, *l'échelle* de modèle qui existe dans les deux cas ne consiste pas à reprendre un modèle antérieur mais à exprimer la visée de produire de nouveaux modèles architecturaux ou de fonctionnement (degré zéro), en exception du bâtiment E2 où la cour est mise en relation avec les cours intérieurs de denses ilots haussmanniens.

Une *échelle* technique - qui se présente comme le siège d'inventions diverses visant à répondre aux objectifs d'optimisation des consommations/production en matière d'énergie - invite ici à penser de nouveaux procédés qui, in fine, entraînent des conséquences sur les choix des formes et mesures de l'espace architectural procédant inévitablement d'une *échelle* économique.

Le dimensionnement de l'épaisseur des bâtiments E2 et E5 joue un rôle important à leur performance énergétique. Cette *opération* semble étant lié à une échelle de modèle pour le E2 et une parcellaire pour le E5.

Globalement, au cas E1 les traitements liés à l'énergie semblent se condenser aux choix de matériaux de l'enveloppe et à la conception de la façade (échelle technique superposé avec une référence optique et sémantique) ; au cas E2 à la conception de la morphologie du bâtiment (5échelles géométrique, géographique et technique avec une référence optique) et au cas E5 à l'épaisseur du bâtiment, sa transversalité et orientation. (échelle parcellaire avec références à une *échelle* de modèle)

Résultats

Façons d'impliquer des considérations énergétiques au processus de la conception architecturale

On suppose qu'un *espace de références* lié à l'énergie vient d'être placé en relation avec l'*espace de références* de chaque architecte.

Quant à la réalisation d'un projet architectural, les questions énergétiques apparaissent très souvent étant traitées comme un « résultat », exprimé en « boîtes à cocher ». En termes de conception, pourtant, **comme on a vu à la seconde partie**, les objectifs énergétiques ne semblent pas pouvoir être réduits qu'à une liste à atteindre. En termes de commercialisation du bâtiment, de 'validation' de sa performance par des labels s'inscrivant aux choix politiques, la conception architecturale se présente souvent restreinte, dépouillée de sa complexité.

Comme l'analyse a permis de montrer, les objectifs de performance énergétique ne peuvent pas être prisent en compte exclusivement comme telles, car il y a parfois des autres ordres, hors énergie, qui amènent à un choix ayant ensuite un impact sur le plan énergétique.

Donner des formes ou des mesures en adoptant certains éléments qui sont prescrits, voire imposés à être intégrés de manière incontestée à la conception, comme l'utilisation du bois ou des biosourcés comme matériaux de construction, ne participe pas de manière active au processus cognitif de l'architecte. Pourtant, même s'ils se sont obligatoirement respectés dans ce cadre, ces éléments ne viennent pas toujours comme étant extérieurs aux opérations cognitives de conception, mais sont parfois adoptés en s'intégrant, en s'ajustant à l'espace de références propre à l'architecte. Pour les architectes du projet E2, l'obligation de production d'énergie a probablement servi de base à une expérimentation conceptuelle. La toiture photovoltaïque semble avoir devenue l'image d'un bâtiment à une forme volontairement déstructurée.

Une contrainte d'ordre énergétique pourrait mobiliser des manières de concevoir une autre proposition que celle prévu initialement.

Comme on a vu au cas du bâtiment E5, le fait d'être obligé d'utiliser l'isolation extérieure pour des raisons thermiques était dit comme étant une force motrice pour l'architecte afin de penser une manière d'expérimenter. Il semble que, malgré cette déclaration entrant plutôt dans la sphère de la rhétorique, cette contrainte ait activé une façon de faire autrement, pas sur ce qui est imposé mais sur ce que cette imposition provoque : concevoir une sorte de vêtement pour l'isolation extérieure. Ceci a un double fonctionnement : celui du matériau isolant ainsi qu'une démonstration étant inscrit quand même aux références propres de l'architecte (et un *espace de références* de modèle).

Dans les trois cas, dépendant des opportunités ou non du contexte qui le limite, l'architecte semble avoir fait référence à ses propres concepts, pensé à un projet, qui ensuite aurait été ajusté aux techniques possibles.

On a vu comment l'énergie est employée comme une contrainte qui restreint l'univers des possibles dans le travail de la conception architecturale mais aussi comment elle peut être assimilée et comprise d'une manière plus indirecte et associées aux opérations de dimensionnement, orientation, découpage de l'espace architecturale. Elle peut être employé en se référant aux œuvres précédentes de l'architecte ou en inventant in-situ.

Une *opération* de référenciation ou l'implication d'une *échelle* de modèle qui agit sur la thermique peut être mis en œuvre indépendamment d'un ordre énergétique.

On a vu dans le cas E5 que la propre expérience de l'architecte en thermique et l'accumulation des savoirs peuvent l'amener à ne pas prendre en compte la question englobant les énergies comme primaire ; elle sera cependant assimilée en même temps ou ultérieurement, quand les autres paramètres auront déjà activé des opérations. L'architecte est donc amené à concevoir dans le contexte existant avec des contraintes multiples qui sont en jeu. Pourtant, sa conception ne s'arrête pas à ce seuil de critères mais elle s'élargit et elle s'adapte aux propres références de l'architecte.

De plus, le résultat de l'application d'une dimension ou forme peut être non lié à l'idée originale de son usage. Les architectes du E2 ont conçu le jardin intérieur étant ouverte, après des considérations sur les incendies. Cette conception a été dans un deuxième temps ré-évalué à un niveau énergétique car permettant la création d'un microclimat.

Un choix donc fait pour d'autres raisons, peut s'inscrire dans un autre espace de référence que l'énergie, impactant toutefois la performance énergétique du bâtiment.

On a vu comment un architecte peut avoir une « idée centrale » (s'inscrivant dans un espace de références) et ensuite la décliner en transformant ses caractéristiques plus spécifiques afin de respecter les règles de l'ordre énergétique. Quant au cas E2, l'idée d'une cour intérieure était posée comme référence dès le début du processus de la conception, ses mesures et sa forme étant pourtant retravaillés pendant la diachronie de la conception.

L'obligation d'une isolation extérieure a ouvert l'opportunité à l'architecte (E5) de choisir comment la recouvrir et l'utiliser comme canevas pour construire ensuite son dispositif de façade. L'architecte de E1 semble avoir conçu in-situ en utilisant le contexte donné.

L'ordre et la priorité avec lequel chaque architecte prend en compte une question énergétique les conduisent vraisemblablement à découper leur espace de conception d'une manière différente.

Les architectes du bâtiment E2 semblent intégrer dès le début de la phase de conception les prérequis concernant la consommation énergétique. L'architecte du E5 semble ne pas les considérer de manière spécifique à sa conception mais les englobe plutôt pendant la diachronie (et avec l'assistance des équipes techniques) ou vers la fin de la conception du projet. Les opérations de conception liées à l'énergie sont souvent difficiles à être distinguées indépendamment des autres paramètres (technique, programmes, voisinage...) car chaque changement amène à considérer le devenir des autres.

Certains architectes semblent commencer leur processus de conception en mettant l'accent sur les normes énergétiques et les paramètres qu'elles englobent, et en cherchant tout de suite à y répondre. Ils utilisent donc ces contraintes comme des données initialisant la conception. (E2) D'autres, semblent commencer en les intégrant en parallèle avec les autres types de contraintes dans leurs espaces de références. (E1) Certains semblent commencer avec leurs propres préconceptions, comme ils feraient avec à un autre projet moins contraint par des exigences énergétique spécifique. Ils tiennent compte des contraintes énergétiques ultérieurement en adaptant leur conception. (E3)

La conception architecturale, orientée vers de considérations énergétiques, apparait ne pas se limiter à un vocabulaire normatif ou à un seuil de calculs à respecter. Les études de la Seconde Partie ont permis d'envisager comment les considérations d'ordre énergétique sont utilisées, transformées, ajustées dans leur propre complexité ainsi que celle de la conception architecturale, sans que la résolution d'un problème soit unidimensionnelle. Il semble qu'il n'y ait pas qu'une unique raison pour donner de forme ou de mesures à l'espace architecturale ; il y a *des* raisons, de divers natures, traités au même temps, comme la surdétermination des échelles architecturologiques a permis de montrer.

Le rôle de l'architecte étant de croiser les contraintes, il semble comprendre la partie purement quantitative comme telle en étant en synergie avec le bureau d'études techniques mais exerce probablement des opérations cognitives sans avoir comme seul but le respect des normes imposés. La considération de la thermique s'intègre à la conception comme une opération de référenciation, en englobant une pertinence socioculturelle et géographique dérivant le contexte et non des calculs, dans le sens de la 'logique', du bon usage de la ventilation, de la bonne

exposition qui font partie d'une bonne inertie. Sans être prescrites comme norme, la flexibilité et la mutabilité des opérations de conception, comme la codétermination des échelles architecturologiques a pu le monter, peut ramener l'ensemble des contraintes sur une production qui prend en compte la totalité des paramètres. Il est possible de les régler d'une manière globale et ensuite de revenir, en cas de besoin, sans que les contraintes énergétiques prennent trop le pas sur les autres.

Chaque architecte semble considérer les enjeux énergétiques par rapport à son système d'espace de références, cela impliquant des modèles et concepts socioculturelles. Ces concepts peuvent renvoyer à des objets architecturaux déjà réalisés, à une expérience professionnelle et des affiliations théoriques. La manière dont un architecte interprète la dimension énergétique/climatique/environnementale et ses expressions formelles ou dimensionnelles ne traite pas de l'énergie que comme une contrainte. Il semble qu'elle est plutôt approchée comme un concept plus général aussi. **Ce sont les relations des échelles architecturologiques qui mettent en évidence cette complexité et interdépendance simultanée, traduit par le concept de la surdétermination.**

Cependant, l'application des éléments quantitatifs de performance énergétique à la conception implique des niveaux d'interaction avec les autres acteurs de la conception (le bureau d'études technique, le conseiller environnementale, ou même les acteurs de l'état) ainsi que l'utilisation d'outils numériques et de modélisation énergétique (logiciels de calculs, d'évaluation environnementale, de simulation des systèmes thermiques, de simulation énergétique...).

Rendre visible la performance énergétique

Comme observé dans deux des cas étudiés (E1 et E2), les architectes ont affirmé vouloir concevoir la performance énergétique de leur bâtiment comme visuellement perçue. Ceci impliquait probablement la mise en œuvre d'une *échelle* optique, sa pertinence étant différenciée dans chaque cas. Dans le bâtiment E1, une semi-transparence à travers le choix des matériaux a appelé à une métaphore de finalité « pédagogique » accompagnant la conception de la façade. Dans le bâtiment E2, la performance énergétique serait perçue visuellement sous la forme, avec des opérations de découpage et d'orientation sur sa toiture faite de manière à accueillir les panneaux photovoltaïques. Cela semble assez inactif dans le

processus de conception architecturale du bâtiment E5 où la mise en œuvre d'une échelle optique semble s'éloigner d'une démonstration des considérations énergétiques

Dans un cas l'utilisation de l'isolation par l'extérieur semble conduire à une application d'une *échelle* de modèle afin de faire face aux contraintes imposées par cette obligation.

L'« identité » visuelle énergétique pourrait dans un des cas étudiés dériver d'une métaphore *in absentia*³³ car elle repose sur la compréhension et la distinction du bâtiment par rapport à son contexte adjacent. On pourrait supposer que la prise en compte des enjeux énergétiques dans ce processus de conception est déjà présente, de manière inhérente, de la même manière que dans les précédents projets de Francis Soler. Cette considération n'initialise pas ici le processus de conception, car il s'inscrit déjà dans un espace de références relayé par l'*échelle* de modèle : le vocabulaire de la « passivité » est déjà utilisé dans ses œuvres précédentes, sans que les normes le prescrivent.

Mettre en œuvre les considérations énergétiques au sein du contexte sociopolitique

Comme précédemment observé, réduire un processus de conception architecturale à une série de « listes » à vérifier semble une considération qui pourrait *in fine* limiter le spectre des méthodes et approches potentielles à suivre. Alors qu'un consentement en termes de résultats d'efficacité énergétique peut sembler ancré dans des périmètres plutôt techniques ou économiques, il peut aussi s'appuyer sur une ambition politique forte que les acteurs politiques de la ville promeuvent vers la « durabilité ». Par exemple, la reproduction de pratiques reflétant une conception respectueuse de l'environnement, telle qu'adoptée dans l'opinion publique, serait encouragée. Dans ces conditions, une superposition des *échelles* optique et technique pencherait vers une approche iconologique de l'énergie en architecture.

Ce que nous avons pu ainsi observer, c'est une intention de démontrer les éléments d'un ordre technique - liés à la production d'énergie - comme moyen d'illustration de la prise en compte de l'énergie.

³³ Pour information :

<https://www.unige.ch/lettres/framo/enseignements/methodes/frhetorique/fr021000.html>

De plus, on pourrait supposer que certains des systèmes techniques utilisés pour la production ou la gestion de l'énergie (refroidissement, ventilation, chauffage des locaux) (dans notre cas principalement les panneaux solaires) ont été traités comme des « images » de référence, impliquant des connotations énergétiques. Autrement dit, leur installation était dans un premier temps liée non à leurs propriétés fonctionnelles mais à une signification métaphorique qu'elles portaient vers un espace énergétique de référence.

Par exemple, dans la deuxième étude de cas, les panneaux photovoltaïques ont influencé la conception architecturale -par leur orientation- et non par leurs taux de production, trop faibles par rapport à ceux initialement prévues.

Autrement dit, de la même manière que la végétation pourrait faire visuellement référence à des considérations écologiques, les appareils techniques liés à l'identité énergétique du bâtiment semblent être promus par les pouvoirs publics et dans un second temps, adoptés de manières différentes par certains architectes.

L'énergie dans ce cas semble être considérée comme un élément extérieur au processus de conception propre d'un architecte, non généré directement de son propre *espace de références*. Elle appartient *a priori* à un système de prescriptions préconstruit. Elle semble donc résider dans le contexte socio-politique plus général, agissant comme une contrainte, une **cible** à atteindre.

Malgré la présence d'une contrainte, la voie de son implication pourrait être multiple - bien que limitée en raison des normes techniques requises : si l'utilisation d'une isolation par l'extérieur ou la pose de panneaux photovoltaïques est prescrite, leur intégration pourra suivre des voies diverses ; leur présence est cependant sans équivoque. Ils peuvent être vus ou non ; leur positionnement peut être accentué ou pas du tout. Une *échelle* géographique semble interagir avec une *échelle* optique, permettant une implication de l'architecte, même trop réduite.

L'intérêt ne résidant plus dans leur référence première à l'utilisation et à la fonction de production d'énergie, de circulation et de pertinence thermique, le risque est que les appareils techniques énergétiques deviennent un élément plutôt décoratif qui ne sert ni un but pleinement fonctionnel, ni un architectural.

L'impératif d'inclure les énergies renouvelables

Dans chacune des études de cas analysées, l'intégration d'une série de panneaux photovoltaïques a suivi un ordre chronologique différent.

La technologie a émergé en trois temporalités : celle de la définition de la prescription, celle du processus de conception et celle de la construction/finalisation du projet. Il existe un décalage temporel entre le moment de la construction et le moment où les spécifications ont été formulées, la technologie de certains appareils est devenue obsolète³⁴. Cela semble avoir conduit à la mise en œuvre des panneaux photovoltaïques comme un élément accessoire sans relation directe avec le cœur du processus de conception. On pourrait supposer qu'ils étaient mis plutôt comme une évidence, comme une preuve de l'adaptation de l'architecte à un impératif politique et sociétal.

Lorsque la démonstration des PV devient prioritaire sur leur fonction, on suppose que la fonction se transforme en image et donc c'est l'échelle optique qui devient structurante³⁵.

Chaque architecte semble considérer les questions énergétiques au regard de son propre système *d'espace de références*, inscrit cependant dans un plus grand, ce dernier requis par la réglementation et ordonné par les ambitions de ses clients³⁶. Les modèles et concepts qui en découlent semblent multidimensionnels. Ils peuvent se référer, entre autres, aux objets architecturaux déjà accomplis, aux projets d'autres architectes, aux intuitions acquises par sa propre expérience professionnelle, à sa formation théorique, à ses affiliations politiques et socio-écologiques, aux manières dont il reconnaît et interprète la durabilité en architecture, aux façons d'utiliser les outils numériques, à l'interaction avec les autres acteurs et membres de l'équipe pendant le processus de conception.

La deuxième Partie analytique a aussi permis un aperçu du rôle de l'architecte à l'époque des impératifs de durabilité prescrits. Il semble qu'un architecte, bien qu'exerçant une influence limitée sur le caractère quantitatif d'un bâtiment énergétiquement performant, peut prendre une distance critique sur le débat politique et technique entourant les considérations énergétiques dans la conception architecturale. Ses choix de conception influencent ainsi le caractère qualitatif global du projet qui peut à un second niveau être interprété dans un résultat numérique.

³⁴ Pour ce sujet regarder aussi (Halloy, Nova, & Monnin, 2020)

³⁵ *Structurante* : une telle échelle ordonne le système des pertinences à l'œuvre dans un cas donné de conception. Elle peut être le produit d'une multiplicité d'échelles.

³⁶ Since the three case studies were inscribed in the Clichy-Batignolles project whose *Maîtrise d'ouvrage* was Paris Habitat OPH and *Aménageurs* : Paris Batignolles Aménagement, related thus to public authorities

Conclusions

- Un *espace de références* globale (lié à la transition énergétique) amène à découper la conception

Pendant la diachronie de la conception l'énergie redécoupe le processus

Les architectes doivent considérer les questions liées à la transition énergétique telles qu'elles sont définies dans leurs cahiers des charges. Ceci a un impact sur le processus de conception de chacun.

- L'insertion d'un nouvel *espace de références* (changement dû à des contraintes programmatiques ou techniques) suppose une re-conception de la place de l'énergie dans le projet.

D'autres contraintes amènent l'architecte à modifier la manière dont il a intégré/pensé l'énergie.

- Les variétés des réponses architecturales au concours d'architecture témoignent de la diversité avec laquelle les architectes organisent les opérations de mesure dans leur processus de conception ainsi que les contraintes quantitatives liées à l'énergie n'ont pas entraîné de solution automatique.

Ce ne sont pas seulement les projets architecturaux qui sont divers mais ce sont les processus de conception adoptés qui ont été différents. Les architectes ont analysé différemment les contraintes, en respectant les cahiers des charges et les listes à cocher mais avec des libertés qu'ils se permettent d'introduire.

- Une étude de la conception des objets énergétiquement performants semble s'éloigner de la réduction à une solution ou une réponse à une question quantitative. Elle incite à prendre en compte d'une complexité difficile à décortiquer à son ensemble

- La question énergétique semble résider dans la pluralité des réponses et non à un modèle

L'architecturologie comme méthode d'analyse de l'activité de conception permet de mettre en évidence l'absence d'une méthode de conception univoque.

A travers ces cas étudiés on a vu comment la forme peut suivre la fonction, l'énergie ou la fiction. Ceci nous amène à défendre qu'une approche qui s'éloigne de la traditionnelle dichotomie entre art et science, contrainte et liberté, technique et poésie pourrait être mieux applicable quant à l'étude de la conception de l'architecture énergétiquement performante

d'aujourd'hui. Un *espace de références* purement technique entrant dans la sphère de la conception semble ne pas réduire la complexité des relations entre les opérations cognitives de la conception architecturale. Les considérations liées à la thermique d'un bâtiment apparaissent être traitées en synergie avec les autres paramètres considérés, ou, le cas échéant, en relation avec eux. Ces considérations n'amènent pas toujours qu'à une seule opération, et vice versa. Autrement dit, une opération de conception n'est pas appliquée toujours que pour répondre à un critère énergétique.

Concernant la comparaison entre les études de cas analysés, on a vu comment les architectes semblent prendre en compte des éléments se référant aux mêmes questionnements ou contraintes, mais avec une hiérarchie différente dans la diachronie de leur processus de conception. En plus, les demandes pareilles apparaissent comme étant gérées avec un choix et une manière d'expression diverse.

Par conséquent, les échelles architecturologiques géographique, parcellaire, économique, fonctionnelle, de modèle, technique, de voisinage (comme l'étude de C. Lecourtois sur l'éco-conception urbain l'a montré) semblent être présentes et liées entre elles mais pas comme une combinaison automatique produite par un ordinateur ou un programme. Ceci nous amène à déduire que même si la question initiale sur la consommation d'énergie et le comportement énergétique est posée de manière quantitative, la conception architecturale demeure complexe, malgré l'utilisation de logiciels ou d'appareils techniques. Il ne faut pas oublier que les bâtiments examinés étaient positionnés dans un tissu urbain, et des périmètres fixés par l'éco-quartier. Ainsi, le niveau de liberté et les restrictions imposées à certains paramètres (ex. éléments existants, bâtiments adjacents, etc.) ont été manipulés de manières propres au projet Clichy Batignolles.

Conclusions épistémologiques

Dans la présente étude, la théorie (architecturologie) a été utilisée comme mécanisme de production de connaissances. L'étude s'interrogeait dans son essence sur l'instrumentalisation de la théorie. Le discours architectural contemporain tend souvent à justifier l'intégration de la dimension énergétique dans la conception architecturale et le vocabulaire utilisé par les architectes n'est pas le leur. Il est profondément influencé par les cadres politiques, économiques et environnementaux de la société dans le temps donné. L'étude a cherché à

comprendre dans quelle mesure ce langage est lié aux opérations cognitives de conception architecturale de l'objet produit et non à l'objet lui-même. En créant ce point de vue, une distance critique a été acquise, mobilisant la théorie afin d'identifier les articulations et les effets générés. C'est-à-dire que l'analyse d'une production architecturale tend ici à être mise en relation avec la théorie évoquée.

De manière générale, en architecture, la pratique est souvent susceptible d'être justifiée par la théorie, alors qu'en même temps la théorie est construite à partir de la pratique.

Au lieu de mettre la théorie au service de la pratique, l'étude visait à démontrer une interaction entre la théorie et la pratique. L'architecturologie est le catalyseur et les échelles architecturologiques les analyseurs qui permettent de démontrer la relation précitée.

On a identifié que les échelles architecturologiques ont été mobilisées à la conception mais aussi à la rhétorique.

Quant au questionnement architecturologique de la thèse, il portait sur l'existence d'une possible échelle écologique. Est-ce qu'elle peut devenir un espace de référence actif dans la conception ? Est-ce qu'un tel passage est possible ?

Correlations

Penser l'architecture, dans les termes que la transition énergétique induit, ne semble pas la restreindre uniquement à une résolution d'un problème posé. A partir des explorations de la présente étude, la complexité que la conception architecturale entraîne, même dans un cadre contraignant et quantitatif, semble ne pas se réduire à une solution automatique fournie par une machine ou un robot.

Nous supposons que la modification de la composition architecturale du bâtiment E2 pourrait être parallélisé à une *vicariance*, ou à la grenouille dans l'Espace de Poincaré³⁷. Alors que la performance énergétique a été initialement abordée à travers la conception d'une cour fermée, elle a finalement été atteinte au travers d'un autre élément -bien qu'intrinsèquement lié à son précédent. Cela constitue une substitution. Cette substitution a vraisemblablement induit un nouvel *espace de références*. Néanmoins, elle a conduit à une approche similaire en ce qui concerne la question énergétique (création d'un microclimat thermique intérieur).

³⁷ *Quand une grenouille est décapitée, et qu'une goutte d'acide est déposée en un point de la peau, elle cherche à essuyer l'acide avec la patte la plus rapprochée, et si cette patte est amputée, elle l'enlève avec la patte du côté opposé.*

*Voilà bien cette double parade dont je parlais tout à l'heure, permettant de combattre un mal par un second remède, si le premier fait défaut. Et c'est cette multiplicité des parades, et la coordination qui en résulte, qui est l'espace.*³⁷ (Poincaré, 1906, p. 8)

Pour aller plus loin, à l'heure où l'architecture « durable » et économe en énergie s'impose comme un impératif, pourrait-on supposer un architecte-hybride entre les postures de Jones ? Sur la base des résultats et des conclusions de la présente étude (chapitres 7 et 8) pourrait-on supposer que l'architecte dans ce cas serait un mélange de ces figures ? En tentant de les superposer, on tend à aborder la complexité de la conception architecturale. Dans chaque architecte, la combinaison de la figure synthétique fonctionnerait différemment : une figure serait plus présente que l'autre, une autre moins active etc.

Est-il possible de faire un parallélisme avec le Mouvement Moderne, ses termes et son langage conceptuel, pour fonder une perspective d'un continuum sémantique dans le discours et la pratique architecturale ?

Une possible analogie avec le XXe siècle pourrait naître à travers les symboles de cette époque ; industrialisation, machinisme, standard, série, progrès technologique. L'architecture prétendait ressembler à des avions ou des voitures. L'histoire se répète-t-elle ? Le XXIe siècle est-il enfin à un point analogue, avec l'écologie et la connotation qu'elle porte, jouant ce rôle ? Y a-t-il quelque part la possibilité de passer d'une écologie du greenwashing à une réalité opératoire ?

De l'Existenzminimum associé au deuxième CIAM à une possible ConsommationMinimum des normes énergétiques d'aujourd'hui ; du Modulor à une possible système de mesure en analogie énergétique ; d'une 'machine à habiter' à une possible 'machine à consommer', est-ce que le contexte et les normes d'ordre collectif partagent des liens communs sous un questionnement plus large ?

De *Je suis un monument* de Venturi à *Je suis un bâtiment écologique*, comment traduire la conception de l'image d'un espace d'une recherche du m² à celle du kwh/m² ?

Perspectives

L'étude a démontré comment et dans quel degré la conception architecturale ne semble pas se réduire qu'à une solution à une question énergétique quantitative. Cela incite à prendre en considération une complexité difficile à décortiquer dans sa globalité. Autrement dit, l'étude tente à montrer comment la conception architecturale ne conduit pas à une réponse univoque – au sens de catégorique, ici-, ou à une solution produite de manière automatisée. Malgré le cadre normatif imposé, on suppose que l'architecture ne devient pas qu'une technique car sa nature intègre, épistémologiquement aussi, de divers ordres et natures.

Au-delà de cette recherche, c'est le rôle de l'architecte-concepteur qui est remis en cause aussi, à une époque où les impératifs de la durabilité s'imposent comme paradigme dominant et s'inscrivent dans l'agenda des politiques publiques.

Cela invite à examiner la nature de l'architecture elle-même, épistémologiquement complexe³⁸. La circulation de modèles et de concepts qui partent d'autres champs disciplinaires vers l'architecture, une métaphorisation qui renvoie à la transposition et à la circulation de concepts, soulèvent des questions sur l'autonomie de l'architecte.

L'objectif de cette étude concernait une exploration empirique de la conception architecturale aux temps de la transition énergétique, visant en parallèle à constituer une nouvelle perspective par rapport aux recherches existantes sur ce sujet. Le point de vue posé peut être considéré comme une continuation aux connaissances produits par les études scientifiques menées par Caroline Lecourtois sur l'écoconception, ainsi que sur les études épistémologiques et architecturologiques du laboratoire MAP-MAACC en France. D'autres laboratoires de recherche liés à des explorations similaires et des recherches en architecture (comme par exemple à l'Université de Liège, de Bruxelles ou l'Université Catholique de Louvain) pourraient éventuellement être intéressés par les résultats et à l'approche adoptée ici.

En outre, sur la base de l'analyse et des conclusions de la présente étude, des possibilités provisoires vers de nouvelles études peuvent émerger.

³⁸Malgré sa présence évidente dans l'univers académique, l'architecture est encore en train de construire son statut gnoséologique (Mantziaras, 2014)

D'une part, dans un premier temps, un examen architecturologique complémentaire du quartier de Clichy Batignolles lu sous une *échelle* globale dans le secteur ouest et une *échelle* de niveaux de conception dans le secteur est pourrait apporter des connaissances. Une étude épistémologique voire architecturologique des influences de la conception collaborative du secteur ouest pourrait s'ajouter aux études sur la conception collaborative menées jusqu'à présent.

La modélisation théorique du processus de conception architecturale d'autres bâtiments de basse consommation énergétique pourrait nourrir les connaissances sur le domaine et contribuer à diverses comparaisons, substitutions hypothétiques entre les cas, et interprétations. Une autre piste possible pourrait concerner l'investigation plus approfondie de l'utilisation des échelles architecturologiques, de leurs relations et propriétés dans des projets similaires, sous le prisme de l'efficacité énergétique. Le triptyque des *échelles* économique-technique-fonctionnelle avec leurs interactions ; le rôle d'une *échelle* de modèle dans la conception architecturale d'un bâtiment économe en énergie ; l'*échelle* optique comme moyen de démonstration de la performance et d'« excellence » environnementale, le passage d'une *échelle* économique à une *échelle* économique d'énergie, constituent des pistes possibles à approfondir.

Il serait aussi enrichissant d'évoquer le concept d' « hybridation » comme utilisé par Dominique Raynaud dans ses recherches et d'étudier une éventuelle corrélation avec les résultats de la présente étude.

A un deuxième niveau, l'investigation des métaphores, des références sur des concepts, des interprétations d'archétypes souvent utilisés dans le discours rhétorique architectural, pourrait conduire à de nouvelles expérimentations vues sous le prisme de la transition énergétique.

Une lecture de la performance visiblement connotée pourrait mériter un approfondissement.

D'autre part, pour les architectes il reste difficile d'identifier et de décrire les opérations et les mécanismes cognitifs actifs dans leur propre processus de conception. Comme toute théorie, l'architecturologie a ses limites. Il serait intéressant d'appliquer d'autres théories et méthodologies et d'acquérir divers points de vue sur la question.

Enfin, d'autres études pourraient éventuellement interroger les manières avec lesquelles les outils numériques, la participation des habitants, ou la conception collaborative, influencent la conception architecturale économe en énergie, aspects qui sortaient du périmètre de la présente étude.

*Lorsque nous parlons du problème de l'énergie (...)
c'est en fait tout le fonctionnement politique et social qui est impliqué,
et tout le mode de vie contemporain.
La crise de l'énergie n'a de sens comme crise, et n'est crise, que par rapport au modèle
présent de société.
(...)la crise de l'énergie est,
en un sens, crise de cette société*

Cornelius Castoriadis³⁹

³⁹ Castoriadis, C. et D. Cohn-Bendit et le public de Louvain-la-Neuve, 1981, *De l'écologie à l'autonomie*, Paris, Seuil, 126 p. [réédition : Castoriadis, C., D. Cohn-Bendit, 2014, *De l'écologie à l'autonomie*, Le Bord de l'eau, 106 p.] p. 34

Plan de la thèse

Première Partie

Introduction

A l'introduction, nous avons situé notre recherche dans son contexte général. Nous avons commencé en faisant référence aux prescriptions et lois faisant de l'efficacité énergétique une obligation à prendre en compte quant à la conception architecturale, en Europe et en France. Ainsi, l'implication de l'énergie est devenue très présente dans les agendas politiques de la société actuelle. Nous avons supposé que les problèmes énergétiques modifient le(s) processus de conception architecturale ainsi que la pratique de l'architecture. On a posé l'objectif de la thèse et la méthodologie qui sera suivie.

Définition de la problématique de la recherche. Comment les architectes prennent en compte les questions énergétiques ?

Chapitre 1 Etat de l'art

Dans ce chapitre, nous présentons les recherches déjà effectuées sur ce sujet ou des sujets proches.

L'énergie dans l'architecture (performance énergétique d'un bâtiment et contexte de la transition énergétique s'impliquant à la conception architecturale) est un objet d'étude qui se situe au carrefour de diverses recherches et approches. Selon le point de vue, le sujet peut être traité dans des disciplines appartenant à l'ingénierie ou aux sciences sociales.

Chapitre 2 Méthodologie

Le troisième chapitre s'est concentré sur la manière dont la question de recherche posée précédemment sera abordée. Il a défini la procédure par laquelle la méthode d'analyse des études de cas sera utilisée. En même temps, il a identifié les connaissances existantes sur le sujet.

Plus spécifiquement, en premier lieu, le chapitre a clarifié la méthodologie par laquelle la question sera examinée ainsi que l'ancrage scientifique.

Deuxièmement, il a construit une bibliographie concernant l'application de la méthodologie choisie dans d'autres études et domaines scientifiques.

Troisièmement, il a cité trois études de cas et a expliqué leur pertinence pour la présente étude. Enfin, il a décrit la méthode d'analyse par laquelle le corpus sera examiné. Cette partie a défini les étapes qui seront suivies dans l'analyse et la comparaison des trois études de cas, ainsi que le protocole scientifique qui servira de base à la deuxième partie. (chapitres 3,4,5,6).

Seconde Partie : Analyse

Chapitre 3 Clichy Batignolles écoquartier

Ce chapitre se concentre sur l'écoquartier Clichy Batignolles. Il présente les principaux éléments ayant orienté la conception de l'écoquartier. Il définit les aspects énergétiques spécifiques caractérisant le projet à son échelle urbaine. En même temps, il identifie les différents processus de conception qui ont été suivis dans son secteur ouest et est.

Plus précisément, tout d'abord, il situe le contexte historique de l'intervention avec les idées centrales dans lesquelles elle s'est structurée.

En second lieu, il cite les prescriptions de la ZAC Clichy Batignolles, urbaines et environnementales, dictant les réglementations spécifiques à prendre en compte lors du processus de conception.

Troisièmement, il met l'accent sur les questions de durabilité ainsi que les préoccupations énergétiques ayant été impliquées dans la conception et explique leur pertinence pour la présente étude.

Enfin, il tente une lecture architecturologique de l'écoquartier, à son échelle urbaine.

Cette partie peut être lue comme introductif de la partie analytique qui suit (chapitres 5, 6, 7), définissant le contexte général dans lequel les études de cas ont été développées et démontrant la pertinence des études de cas choisies.

Chapitre 4 Etude de cas Bâtiment E1

Chapitre 5 Etude de cas Bâtiment E2

Chapitre 6 Etude de cas Bâtiment E5

Ces chapitres explorent les trois cas d'étude.

Les chapitres sont initiés par une brève présentation du bureau d'architecture chargé de la conception du projet.

Tout d'abord, les chapitres décrivent les bâtiments selon les intentions de l'équipe d'architectes qui a effectuée l'étude. Deuxièmement, ils interprètent la conception de l'édifice, mettant en œuvre, comme point de vue, les outils et les concepts fournis par la méthode d'analyse choisie (le vocabulaire de l'architecturologie et sa pertinence sont appliqués).

Les sources analysées et interprétées sont des textes fournis par l'architecte ayant réalisé le projet, des interviews de ceux-ci, donnés dans des contextes divers, des textes écrits par des journalistes / architectes concernant le projet, ainsi que, si c'était possible, d'un entretien réalisé avec l'architecte.

Enfin, les chapitres se concentrent sur les façons dont les préoccupations énergétiques sont intervenues dans le processus de conception.

Troisième Partie : Résultats et Discussion

Chapitre 7 Modélisations théoriques de la conception. Interprétations de cas

Présentation des trois modèles architecturologiques de la conception architecturale, un pour chaque cas analysé.

Chapitre 8 Comment les architectes prennent en compte l'énergie dans leur travail de conception ?

Ce chapitre explore la manière dont les architectes considèrent les questions énergétiques dans leurs activités de conception.

Il produit des connaissances en s'appuyant sur le travail analytique systématique généré sur la deuxième partie. En d'autres termes, il répond aux questions posées initialement et présente les résultats de cette étude de recherche en relation avec l'analyse méthodologique précédemment menée.

Il présente un aperçu - que l'utilisation de l'architecturologie a permis d'identifier - sur les manières avec lesquelles les architectes impliquent des éléments liés à l'énergie à leur conception.

Chapitre 9 Méta-conclusion

Dans ce chapitre, nous prendrons une distance pertinente par rapport à notre travail et nous le réinterrogeons à un autre niveau.

Afin d'élargir les directions de la recherche, nous souhaitons poser quelques réflexions plus générales concernant le domaine que nous avons analysé.

Nous voudrions montrer aussi comment la conception architecturale est une réponse au contexte sociopolitique spécifique du temps : peut-on supposer une analogie avec les concepts développés en architecture historiquement et ceux d'aujourd'hui, en supposant un continuum dans l'architecture, son discours rhétorique et le discours politique ?

Glossaire de concepts architecturologiques

Espace de conception

Il est distinct de l'espace architectural. Il désigne le projet vu à travers l'activité de conception. Il sera appelé 'espace architecturologique' dès lors qu'il sera construit par un ensemble de concepts architecturologiques et non plus seulement identifié par l'intuition ou l'expérience. (Boudon et al., 2001, p. 80)

Espace de référence

Il permet de comprendre le sens des modalités de référenciation qui ont lieu dans la conception. Nous appelons espace de référence de telles classes, quelles qu'elles soient, auxquelles appartiennent des références. Autrement dit, il s'agit de classes de représentation de la réalité. Si, chez l'architecte, les classes de représentation lui permettent d'identifier des références susceptibles d'intervenir activement dans son travail de conception, c'est la référenciation qui va jouer un rôle actif dans son travail. (Boudon et al., 2001, p. 111)

Pertinence

Lorsque l'architecte décide d'une mesure pour un espace, qu'il choisit un ordre de grandeur, une intensité, qu'il introduit du quantifiable ou du qualifiable, il prend sa décision relativement à un point de vue qui renvoie à un ou plusieurs espaces de référence. Dans la conception, convoquer un espace de référence par rapport auquel une ou plusieurs opérations de mesure prennent du sens consiste, entre autres, à définir la pertinence de ces opérations de mesure. Décider d'une mesure nécessite d'en penser la pertinence, c'est-à-dire d'en apprécier la valeur, relativement à un espace de référence. (Boudon et al., 2001, p. 119)

Opération

Le processus de conception est un processus qui implique une transformation progressive de ce qui est en projet et, partant, des modèles répétés. Les opérations sont ce qui règle le passage d'un état à un autre dans un tel processus. (Boudon et al., 2001, p. 135)

Caroline Lecourtois a identifié appart les opérations de dimensionnement, de découpage et de référenciation, les opérations de positionnement et d'orientation.

Surdétermination

Dans une occurrence d'association de plusieurs échelles pour une seule mesure, c'est-à-dire correspondant à une même dimension architecturologique, nous parlons de surdétermination comme mode de relation des échelles entre elles. (Boudon et al., 2001, p. 198)

Degré zéro

On parlera du degré zéro d'une échelle lorsque les opérations de référenciation, de dimensionnement ou de découpage mises en œuvre par le concepteur trouvent leur pertinence *a contrario* -et à dessein- dans cette échelle. En d'autres termes, chaque fois que le concepteur nie intentionnellement les informations dont une échelle est porteuse ou qu'il en prend le contre-pied, nous avons affaire à un cas de *degré zéro* de l'échelle. (Boudon et al., 2001, p. 164)

Dans le texte, le mot échelle en italique *échelle* se référerait à une échelle architecturologique.

Echelle architecturologique

Philippe Boudon appelle une échelle architecturologique une classe réunissant des opérations variées renvoyant à une pertinence homogène. (Boudon et al., 2001, p. 166)

Echelle technique : Utiliser des considérations d'ordre technique pour induire une modalité d'attribution de mesures à une partie ou un tout de l'espace architectural.

Echelle fonctionnelle : donner la mesure d'une partie ou d'une totalité de l'espace architectural en correspondance à quelque élément extérieur qui en règle la destination, l'utilisation, ou l'adapte à un usage.

Echelle symbolique dimensionnelle : La grandeur étant en architecture porteuse de sens, associer le choix d'une grandeur à un contenu spirituel clairement identifiable.

Echelle symbolique formelle : Concevoir l'espace architectural en conformité avec une forme symbolique, forme à travers laquelle un contenu spirituel particulier est associé à un signe sensible concret.

Echelle de voisinage : Attribuer des mesures par contiguïté, relativement à des éléments appartenant au voisinage et induisant une continuité spatiale.

Echelle parcellaire : Mettre en œuvre des mesures en utilisant les possibles permis par la taille, la forme et les limites du terrain donné à l'architecte.

Echelle géographique : informer, de quelque manière, les mesures d'une partie ou d'un tout de l'espace architecturale à partir de considérations sur l'orientation des points cardinaux, la situation et le modelé du terrain, les données climatiques etc.

Echelle de visibilité : Situer un objet ou une partie d'objet de telle manière qu'il soit vu d'un lieu, ou qu'il ait vue sur un lieu ou un ensemble de lieux, ou plus généralement constituer un point de vue dans l'espace réel.

Echelle optique : Tenir compte d'un point de vue -au sens propre-pour donner à une partie ou à un tout de l'espace architectural une mesure qui fasse intervenir les modalités suivant lesquelles il est vu.

Echelle socioculturelle : prendre en considération des conventions, des formes traditionnelles ou autres héritages socioculturels, pour donner forme et mesure à une partie ou un tout de l'espace architectural.

Echelle de modèle : reprendre un modèle antérieur, tout en effectuant éventuellement des modifications de divers degrés et de divers natures.

Echelle sémantique : effectuer des opérations de dimensionnement, de découpage ou de référenciation permis ou suggérés par des mots ou des expressions verbales.

Echelle d'extension : effectuer toute opération de conception d'une partie ou d'un tout de l'espace architectural qui intègre un devenir futur.

Echelle économique : concevoir une partie ou un tout de l'espace architectural en relation avec leur cout, ou en se livrant à des jeux possibles d'échanges de couts entre diverses parties de cet espace architectural.

Echelle géométrique : recourir à des considérations géométriques pour découper ou référer des parties ou des totalités de l'espace architectural ou encore pour transcrire d'autres modalités de mesure.

Echelle des niveaux de conception : découper, référencer, dimensionner la réalité à concevoir, du micro au macro, suivant le niveau de représentation dû à une échelle cartographique ou, plus généralement, découper l'espace de conception en sous-espaces de conception.

Echelle globale : faire jouer de façon dominante, principale ou structurante une pertinence qui peut être le fait de l'une des différentes échelles.

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Explorations in architectural design at the time of energy transition

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Annexe 2 Provisory architecturological model of the architectural design - building E2

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If I had to write a book to communicate what I have already thought, I'd never have the courage to begin it. I write precisely because I do not know yet what to think about a subject that attracts my interest. In doing so, the book transforms me, changes what I think. As a consequence, each new work profoundly changes the terms of thinking which I had reached with the previous work. In this sense I consider myself more an experimenter than a theorist; I do not develop deductive systems to apply uniformly in different fields of research. When I write, I do it above all to change myself and not to think that same thing as before. (Michel Foucault in Foucault & Trombadori, 1991, p. 27)

General Introduction

Prologue

The Introduction situates the research in its general context, demonstrating at a second level the relevance of the subject and its objectives.

It sets the question of the research, presenting how it will be approached.

Finally, it briefly layouts the thesis plan.

Preface

As a preamble to the thesis, I have chosen to quote a few citations from architects' discourses on sustainable architecture.

What is now called 'green architecture' is an opportunistic caricature of a much deeper consideration of the issues related to sustainability that architecture has been engaged with for many years. It was one of the first professions that was deeply concerned with these issues and that had an intellectual response to them.

The "Spaceship Earth" concept that emerged in the 1960s had a visionary awareness of the interdependency of things, and also of the need to be systematically frugal. I have more affinity with this tradition than with the current "greenness." At the same time, there is now strong pressure on buildings to function better, and there are finally clients willing to pay for it and the engineering needed to realize it. The exciting thing is not green buildings, it is that buildings are built better (Koolhaas, Rem, in Fraioli, 2012)

There is a definition problem: "Green" and "sustainable", the terms used to name the answer to the most pressing problem of our time, have become dangerously afloat in ambiguity and indeterminacy. Sustainable architecture is everywhere and nowhere. (...) "Green" and "sustainable" have become codified, commodified, and certified. Prescribed checklists masquerade as design philosophy. As young architects, our generation must embrace new ideas about sustainability, questioning inherited doctrine and forging new trajectories (JDS Architects, in Mostafavi, 2016, p. 118)

Sustainability is nothing but the rigorous use of common sense (Aravena, Alejandro in Alejandro Aravena remporte le prix du développement durable 2017 à Göteborg, n.d.)

Green and sustainability have nothing to do with architecture. (Eisenman, Peter, in Belogolovsky, n.d.)

Sustainability is a defining challenge of our generation (...) Architects and others must act as politicians scramble to clinch a climate change deal at the COP21 summit in Paris (...) Processes can be established that embed sustainability into the design, procurement, construction and operation of a project, (...) By simplifying the sustainability agenda with understandable action plans, it becomes accessible to every member of the team, (...) This collaborative relationship between the client, operator, design team and contractor, together with the development of an overall understanding of the sustainability agenda across the whole project team, is critical to delivering the sustainable construction and management of a building throughout its lifetime.(Zaha Hadid in Architect's Journal, 2015)

If we have to be vulgar to refuse the environmental moral scam, then let's all be vulgar. If we have to be asocial to refuse the infantilization of such a compelling social debate, then let's be anti-social. (...) The acronym HQE⁴⁰ is stamped with a "registered trademark" (...) (Ricciotti, 2013)

Is it enough for architects, landscape architects, and urbanists to simply conceive of the future of their various disciplines in terms of engineering and constructing a more energy-efficient environment? As important as the question of energy is today, the emphasis on quantity –on energy reduction- obscures its relationship with the qualitative value of things. In other words, we need to view the fragility of the planet and its resources as an opportunity for speculative design innovations rather than as a form of technical legitimaticon for promoting conventional solutions. (...) Imagining an urbanism that is other than the status quo requires a new sensibility-one that has the capacity to incorporate and accommodate the inherent conflictual conditions between ecology and urbanism. » (Mostafavi, 2016, p. 17)

⁴⁰ The HQE (Haute Qualité Environnementale) charter, a certificate attesting the high environmental quality of construction projects.

*There are probably as many definitions of sustainable architecture as there are architects in the world... (Frank Heinlein in *The future of buildings lies in sustainable architecture with Frank Heinlein*, 2016)*

'I will not talk here on sustainable architecture: every adjective added in the word architecture decreases it. There is no sub-family, no "environmental" gender in architecture: architecture is or is not.' (Ferrier, 2008, p. 8)

"I don't think sustainability is a design aesthetic, any more than having electricity in your building, or telephones, or anything else," says Stern. "It's an ethic, a basic consideration that we have to have as architects designing buildings." (...) "in 10 years we're not going to talk about sustainability anymore, because it's going to be built into the core processes of architecture." (...) Advertising sustainability, will be like an architect getting up in front of a room to "proudly proclaim how his buildings didn't fall down." (Robert Stern, Architecture Dean of the Yale School of Architecture, in Conniff, 2010)

'Can we continue to think that the current passing beyond the thousand-year-old positions of the relationship of man to nature, manifested by sustainable development, will be resolved only by regulatory and technical provisions, without initiating profound upheavals of the foundations and forms of human facilities? Faced with climate, environmental, energy and societal upheavals, our areas of intervention, are experiencing major upheavals, and are called upon to experience even greater ones. Building and planning professionals cannot shirk their responsibility. (...). Collective and individual commitment is imposed.' (Philippe Madec in *Conférence Secrets de Fabriques : Philippe Madec - "L'architecture frugale,"* 2018)

Les protagonistes de " Ré-enchanter le monde " affirment, eux, qu'un architecte n'est contemporain que s'il affronte ces réalités, met en cause les programmes, les modes de production ou de décision hérités de l'ordre industriel moderne. (Contal, 2014)

(...) L'ensemble de ces transitions pose la question d'un nécessaire renouvellement des ressources de l'architecture, dessine les contours d'un changement complet de paradigme. (Revedin, 2018)

In architecture, the massive accumulation of energy in all its forms and formations in a building is routinely cited as an ecological problem, perhaps the ecological problem, with a litany of statistics about the consumption of material and energy. Unfortunately, this techno-theological litany is then habitually coupled with a Calvinist notion of frugality: the excess of architecture must be minimized, or, the aim of the good is to do less bad. Efficiency is the beginning and the end of the consideration of energy in the system. This cripples the latent power of this massive accumulation of matter and energy. (Moe, 2014, p. 247)

These citations are only an indication of the multiplicity of architects' positions in a time when the imperatives of "sustainable", inscribed in a context of global warming and resource depletion, interrogate, among other, the architectural design and practice.

The plurality of visions of architects is not based only on a heterogeneity of perceptions and approaches. It also reveals contradictions of points of view which question more profoundly the meanings of these terms and, still, their interpretation and appropriation by architects.

It is on the questions posed by these quotes that lie the motive of the thesis.

An initial interpretation appeals the considerations of architects with regard to standards, labels, prescriptions and directions of thought related to this context framing their design. How do architects respond to these requirements? In what ways do they express their own concerns in this context? Further on, what are the impacts of the changes on their ways of thinking and doing? Does the binding framework limit an architect's "freedom" of creation?

The mobilizations of architects regarding challenges are widespread and accentuated by their rhetorical discourse. For instance, fervent positions supporting or disapproving the permeation of sustainable expressions in architecture are one of them.

However, considerations related to environmental, climate and energy issues do not appear only today in architectural research and practice. History and architectural theory have dealt with such concerns in the past, from the ancient Greeks and Romans to the Renaissance and the 1960s for example. If they remain relevant today, it is because they have become part of the ongoing political discourse as well as re-questioned within social movements and scientific communities.

Sustainable, ecological, green, low carbon, energy efficient, energy performant, low energy, zero energy, zero waste, virtuous, post-carbon, low-tech or biomimetic; are only some of the adjectives describing concepts that have been added to those of a passive, solar or bioclimatic architecture.

What stimulates the starting point of the research and is essential to underline is the inexistence of a unique definition describing what a sustainable city is.

"The concept of the sustainable city poses in fact a whole series of problems both semantic and practical" (Füzesséry, Stéphane Roseau, 2012) and "sustainable design has no precise definition" (Lecourtois, 2012)

Undoubtedly a relevant subject, in the last decade it has arisen a controversy among architects themselves as well as with public policies, which is also manifested by the above-mentioned citations.

Introduction

Why the architects

Energy still remains an abstract concept; a largely metaphorical term in everyday use, representing and concerning a wide range of fields, from sociocultural to economic, political, technical, aesthetical choices. Energy has become the philosopher's stone that would make it possible to reconcile technology and nature, economics and ecology. (Galiano, 2001)

Architecture confronted with energy and ecological questions produce constantly interpretations under various prisms. Over the last decades, the fields related to architecture and urban planning have thus been developed into an essential discussion ground for comprehending, considering, debating and challenging environmental issues and particularly energy questions.

With over one-third of all final energy and half of global electricity consumed there, buildings are responsible for approximately one-third of global carbon emissions. With an expected population increase of 2.5 billion people by 2050, and given improvements in economic development and living standards, energy use in the buildings sector is set to rise sharply. (IEA, 2013, p. 7)

Buildings are responsible for the emission of nearly 40% of greenhouse gases, mainly due to the release of CO₂ into the atmosphere during the combustion of fossil fuels for heating. The materials used along with the entire life cycle of a building (conception, design, construction,

maintenance, end) question the resources available, energy consumption and emissions as well. Architecture is thus, obviously, on the front line when it comes to energy considerations.

Contemporary architects face among other, the dilemma of their participation in the critical combat for habitat's adaptation to climate change, energy savings and the treatment of matter and energy, in confrontation with social and societal needs. The thinking and practice of architecture is subjected to re-mobilisations that include experimentation, interdisciplinary dialogue, knowledge acquired in-situ.

Architects have been frequently asked to present visions of future conditions in a context of environmental, climate or energy change while merging with fields of diverse disciplines from biology, agronomy, physics, and natural sciences to environmental sciences, sociology, political sciences and economy.

Since the 2000s, architects witness the transformations in the architectural and urban thinking and practice following the mobilisations on global warming. On the same time, prescriptions and laws making energy efficiency an obligation in architectural design, in Europe and in France, have emerged.

Confronted with an ecology and energy transition having become compulsory, architects are led to question their knowledge and ways of practice.

Architecture is therefore present in the societal dialogue, participating in collectives, groups, manifestos, exhibitions, debates.⁴¹

The last decades, organisations along with architects have released manifestos concerning this subject in general.

In 2015, as part of the international climate negotiations, COP 21, the Council of Architects of Europe published a *Manifesto for Responsible Architecture*⁴² on the role of the architect in the

⁴¹ Some of the latest expositions in France (2021) on *Histoire Naturelle de l'Architecture - Comment le climat, les épidémies et l'énergie ont façonné la ville* in Pavillon de l'Arsenal in Paris <https://www.pavillon-arsenal.com/fr/expositions/11867-histoire-naturelle-de-larchitecture.html> and *Energies Désespoirs* in Centquatre in Paris <https://www.amc-archi.com/photos/collection-d-energies-positives-exposition-au-centquatre.75718/centquatre-paris-exposition.1>

⁴² For more information see https://www.ace-cae.eu/services/news/?tx_ttnews%5Bpointer%5D=24&tx_ttnews%5BbackPid%5D=108&tx_ttnews%5Btt_news%5D=1302&cHash=f7f2bcc64c69e6e57a686f66606b2c55

energy efficiency of buildings, summarizing the commitments of architects in the fight against climate change. Among the propositions we can find

Favour the use of local resources and solutions for construction

Study the life cycle and demolition of buildings

The environmental performance of a building should be closely linked to architectural solutions from the preliminary design stage. The building orientation and its compactness are just as important as the thermal performance of materials and systems.

In the same year, Architects Council of Europe (ACE), Union Internationale des Architectes (UIA) and AIA (American Institute of Architects) Presidents have signed the Declaration of Tallinn, where the role of the architectural profession is highlighted as a key when it comes to tackling local and global challenges of our times (*Architects' Council of Europe, 2015 Annual Report & 2016 Outlook*, 2015, p. 8); one of the responsibilities of architects is coping with the challenges emerged by climate change, at building and city levels, by implementing a low carbon, resource efficient and resilient design.

In the end of 2015, the International Meeting on *Architecture, the Climate of the future*⁴³ in Paris focused on the essential role of architects in the energy transition. They conclude that *architecture cannot save the world, as Alvar Aalto said, it can set a good example*. In addition, in a video message that inaugurated the conference *Architecture, the climate of the future*, Dominique Ristori, Director General of DG ENER at the EU Commission stated that *Architecture is a central actor in the energy transition* (Ristori, 2015)

In 2018, the Manifesto for a joyous and Creative Frugality⁴⁴ by the French architect Philippe Madec declares the objective of *frugality* in energy, in matter, in technicity, for the territory.

The *Architecture Guide to the 17 UN SDGs*⁴⁵ was released in 2018 (followed by a second edition in 2020), aiming to translate the Sustainable Development Goals into practical methods. It aimed to show that architects can provide ideas and proposals for regulations so to enable a future development of sustainable cities and territories.

In 2019, the French architects joined the *Architects Declare* movement⁴⁶, declaring the requirement for a change of model.

⁴³ Rencontre internationale *Architecture, le climat de l'avenir* organisée par l'Ordre des Architectes, le CIAF, le CAE et l'UIA dans le cadre de la COP 21 à la Cité de l'Architecture et du Patrimoine, 30 novembre 2015, Paris, France. <https://www.architectes.org/sites/default/files/atoms/files/17-programmeclimat-a4-fr.pdf>

⁴⁴ Manifeste pour une frugalité heureuse et créative, see more in <https://www.frugalite.org/fr/le-manifeste.html>

⁴⁵ The guide was created, in collaboration, by the Institute of Architecture and Technology at the Royal Danish Academy of Fine Arts (KADK – Schools of Architecture, Design and Conservation), the Danish Association of Architects and the UIA Commission on the UN Sustainable Development Goals.

⁴⁶ For more information see <https://www.architectsdeclare.com/>

In 14 October 2020, the European Commission has revealed its plan for a *New European Bauhaus*⁴⁷, manifesting its visions for an ‘interdisciplinary approach on building, materials, and mobility’.

As far as architectural competitions are concerned, to name some of them, the *Global Award for Sustainable Architecture*⁴⁸ created by Jana Revedin rewards each year five architects who build in an innovative approach, responding into societal needs. The *Concours d’architecture Bas Carbone EDF* is a competition of ideas committed to energy transition launched in 2008 by the company of Electricity of France. *Green Solution Awards*⁴⁹ launched by Construction21⁵⁰ network rewards sustainable buildings, districts, or infrastructures.

Some groups of architects are as seen above mobilised within the current sociopolitical context. The aforementioned actions are some examples of the participation of architects in the environmental and energy discourses the last decade.

Energy transition’s vocabulary deals with a set of parameters encompassing various scales within multidisciplinary systems⁵¹. Even if energy efficient and low-carbon technologies are intended to play an important role in the transition, the energy performance of a building is also linked to its architectural design.

Presentation of the research study

The research conducted here is based on the hypothesis that international and national contexts impregnated with the consideration of environmental issues and practices encouraging the reduction of energy consumption have an impact on the architectural design process.

The present study seeks to understand the ways in which the issue of energy and its contexts intervene in the design of an architectural project. In what ways does energy performance take place in architectural design? How do these energy issues influence an architect's design process?

⁴⁷ For more information see https://europa.eu/new-european-bauhaus/index_en

⁴⁸ For more information see <https://www.citedelarchitecture.fr/fr/article/global-award-sustainable-architecture>

⁴⁹ For more information see <https://www.greensolutionsawards.org/>

⁵⁰ For more information see <https://www.construction21.org/>

⁵¹ From biodiversity to physics, the issues of social, technique, mobility, inclusion or density seem relevant from different angles.

To understand this phenomenon, the epistemological position of the research is oriented towards constructivism as the constructed reality is subjective and dependent on the observing system. The approach is inductive, and the positioning is experimental.

To interrogate the ways in which architects integrate energy considerations into their design process, the study interrogates the research on architectural design, thus summoning the broader disciplinary field of design sciences (sciences de conception). Multiple points of view have led to debates in relation to design (conception), either placing the works that explore the act of design on a cognitive level (internalism) or considering it as a place of social interactions between the actors of the project (externalism). (Raynaud, 2001) This study is placed in an internalist posture.

To answer the question, *architecturology* and its concepts is mobilized. The application of this methodology allows us to take distance from the architectural rhetorical discourse in order to apprehend the ways in which architects have given forms and measures to space. Consisting of a theoretical systemic language, architecturology aims to make intelligible the cognitive operations of design mobilized by architects.

The reason why architecturology is chosen among the theories of design is related to its characteristics. It takes into account the specificity of architecture; it has established a formally constructed vocabulary and a scientific language; and it has a modelling capacity. In addition, it demonstrates a potential for generalization.

At the same time, this theory has not been applied to the study of energy considerations in sustainable architectural design, constituting an original point of view on the subject.

In line with previous research questioning architectural design (Boudon et al., 2001) and sustainable design (l'éco-conception) (Lecourtois, 2015), the objective of this study is to understand the ways in which energy impacts and intervenes in the design of an architectural project.

To do so, the study implements the methods of applied architecturology aiming at elaborating the ways in which energy considerations influence the design processes of architectural space so as to **produce knowledge** on the cognitive operations of the so-called energy efficient architectural design.

The corpus consists of case studies.

Three projects in the east sector of the Clichy-Batignolles eco-district in Paris (E1, E2, E5) have been chosen to assemble most of the parameters related to an architectural design oriented towards energy issues. The buildings are relevant to be studied because they suggest diverse approaches in a very restricted "sustainable" context, responding to an energy as well as social ambition. Through Clichy-Batignolles project, the municipality of Paris has projected its political ambitions towards sustainability. This urban development project received the ministerial label of Ecoquartier in 2016. It was also the winner of the "Sustainable City" prize in the international Green Building & City Solutions Awards competition⁵². In general, the district's energy objectives concerned a reduction in heating to 15 kWh/m²/year; a primary energy consumption of buildings below 50 kWh/m²/year and a photovoltaic electricity production around 4,500 MWh/year .

The verbatim, the documentation collected⁵³ along with the interviews of the architects involved -made by the author when possible⁵⁴-, will be used to reconstruct the architectural and energy stories of these buildings under architecturology's scientific grid.

The approach followed is far from an exhaustive architecturological analysis of the architectural design of the building. Using the vocabulary of the methodology, a reading of the architectural design will be carried out by focusing on the implication of energy issues in its process. The use of architecturology's postulates as well as its concept of *scales* will be applied during this reading.

Architecturology will not be used as an end in itself but mainly as a tool providing a scientific basis. The use of its concepts will evoke others and open up a wider discussion.

The experimental approach to be followed proposes thus a reading of the cases by the scientific distance brought by the mobilized theory. The modelling of their design process will allow in a second time to compare the cases as well as to provide more general conclusions on the subject.

⁵² Award of the international competition "Green Building & City Solutions Awards" by the Construction21 network on the occasion of the COP22 in Marrakech, Maroc

⁵³ The sources analyzed and interpreted are texts provided by the architect who realized the project, interviews of them given in various contexts, texts written by journalists or architects regarding the projects.

⁵⁴ The author has conducted interviews with the architects of E2 and E5 building.

The thesis is divided into three Parts. The First Part introduces the research in its context and illustrates its objective. It presents the questions, the methodology that will be followed and the corpus of the study. It also presents a state of the art of the subject along with a state of the art of the methodology based on the bibliography.

The Second Part leads the analysis of the corpus, structuring itself around the language of the chosen methodology.

The third part exemplifies the results of the analysis as well as the answers to the questions posed at the beginning. It produces knowledge based on the results and bear conclusions. At the same time, it takes distance and attempts to pose considerations within a broader level.

Epilogue

The imperatives of reducing the carbon footprint and energy consumption have called for an architectural and urban design based on an integration of various dimensions within interdisciplinary visions. This leads to a rearrangement of priorities as well as their elaboration is concerned.

At an international and national context impregnated by the considerations of environmental and energy issues and the application of energy objectives and directives, the practice of architecture evolves and creates links with other disciplines. The notion of energy efficiency at all scales, in different temporalities and contexts, rise questions of an urban and architectural point of view.⁵⁵ At the same time, energy issues have an impact on the process of architectural design.

Architectural design, as part of the construction sector as well as production of a society and its culture, is not only related to the energy behaviour of a building, but participates in the ongoing social, political and economic discourse on energy and climate concerns as well.

Energy transition, situated in a general sustainability context, is re-questioning and forming the knowledge and practices, leading to experimentations, innovations as well as controversies among architects.

Even if a 'green' and a 'sustainable' approach of architecture has become a sign of our times, the definitions these notions englobe are still various.

Our hypothesis is that the energy issues are changing the ways, methods and conditions of conceiving architecture –in other words, the architectural design process.

As the energy transition has become mandatory for architects, the study questions the ways in which their design activity is influenced. This research seeks to understand the ways in which the notion of energy and its context intervene in the conception of an architectural project. In other words, it interrogates the ways in which energy issues are implicated in the architectural design process.

The interrogation will be conducted under the prism of design sciences and the systematic vocabulary of Architectology, applied so as to take distance from the rhetoric architectural discourse.

⁵⁵ For an insight see Cuniberti Barbara, JRC report on green buildings and architecture, Ispra, Italy (ongoing)

Architecturology (architecture + *logos*) is a scientific field of research in architecture initiated by Philippe Boudon and developed in France since 1970. Constituted with a systemic theoretical language, it aims to make intelligible the cognitive operations undertaken by designers.

Three buildings of Clichy Batignolles eco-district in Paris are explored as study cases through the analysis grid of architecturology, with the aim of identifying the influences of energy awareness issues in their architectural design process.

While some buildings clearly demonstrate with their forms and materials that energy issues were taken into consideration, others do not: however, this diversity meets the same energy performance results.

In addition to the diversity in architectural responses that the Clichy Batignolles neighborhood offers, this corpus was chosen in relation to its ambitions on the use of renewable energy and the optimization of the buildings' energy performance, set by prescriptions.

By situating energy transition and the terms it englobes in the vocabulary of the architecturological concepts, the method consists of a collection of qualitative data (issued from documents provided by the architects and interviews conducted by the author) on which the correlations of cognitive operations of design will be examined.

The Introduction situated the research in its general context, demonstrating at a second level the relevance of the subject and its objectives.

It set the question of the research, presenting how it will be approached.

Finally, it briefly layout the thesis plan.

La génération des bâtiments BBC basée sur l'optimisation de l'énergie d'usage ayant montré ses limites, la réflexion porte désormais sur la maîtrise de l'énergie grise, nécessaire pour extraire, fabriquer et mettre en œuvre les matériaux de construction. Nous redécouvrons ainsi la terre crue, la pierre et les matières biosourcées que la modernité avait délaissées. Un pas plus loin, c'est notre modèle de développement occidental né avec la révolution industrielle qui fait l'objet de vives critiques de plus en plus partagées. Le moment ne serait-il pas venu d'imaginer des scénarios post-carbones changeant radicalement notre rapport au vivant et à ses territoires ? (Berthier, 2019)

The energy transition is part of a cycle of transitions traversing the 21st century; the crises of 1974 and 2008 have demonstrated a historical caesura of the instruments and tools of the last century based on Progress, which calls for a dismantling of the established functionalist order. By questioning more deeply the modes of space conception and production, the ecological - conflictual- debate calls for a transformation of architecture's thinking and making. (Revedin, 2017)

First Part

Introduction

1. Context and State of the art

You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete. Buckminster Fuller

I live on Earth at present, and I don't know what I am. I know that I am not a category. I am not a thing- a noun. I seem to be a verb, an evolutionary process- an integral function of the universe. Buckminster Fuller

Architecture cannot be invented, but interpreted and reconstructed. Alejandro Aravena

Prologue

This chapter presents a brief state of the art describing the current knowledge about the studied matter through related published work. At a first level, it attempts a succinct historical indication of such considerations in architecture throughout time. It then reminds the basic definitions and concepts of the buildings' energy performance and outlines the regulations prescribing architectural design. By stating research related to the subject it constructs the basis of the study that will follow.

1.1. Research question and hypothesis

As the energy transition becomes necessary, the study questions how architects design today in this context. The hypothesis of the research is that architectural design is influenced by the consideration of energy and ecological prescriptions, and that the design process is transformed in this regard.

The interrogation is conducted under the prism of the design sciences and the systematic vocabulary of Architecturology. The objective of the thesis is to generate knowledge about the implication of energy considerations on the cognitive activity of architectural design.

1.2. State of the art

«The dual position of the planner, both technical and political, is inevitable. To advance, he must accept and value the contradictions of this dual competence » (Cremaschi, 2019, p. 45)

As seen before, the context of plural transitions (financialization, environment's protection, digital revolutions; energy) redefine the perimeters and roles of the architect. It is the "paradigm" framing the profession that changes in order to integrate different methods, associate regulatory constraints and demiurge, create links with other actors and disciplines.

1.2.1. Expressions throughout the history of architecture, a brief state of the art

The socio-ecological and energy questions do not appear only today among the preoccupations of architecture. Certainly, they are now standardized and inscribed in norms; however, they were already present within other contexts, interpreted and expressed through different angles and ways.

Climate has been always evoked in architectural theory as an essential parameter. Aristotle and Hippocrates had pointed out the influence of climatic elements on people.; Greeks and Romans had long known the importance of good orientation for the use of a building.⁵⁶

Vitruvius had explained the influence of the sun on the different urban functions and expressed ecological concerns in the choice of materials. (Mandoul, 2012) The city, according to him, should be protected from the wind. Climate considerations were also addressed in the ideal city of Fra Giocondo in 1511, or that of Cesariano in 1521. Alberti had also examined them in his work *De re ædificatoria*.

From Vitruvius, Palladio and Alberti to Le Corbusier, Louis Kahn, Renzo Piano, Richard Rogers and Robert Venturi, the relation towards environmental aspects in architecture vary.

The history of the discussion of energy in architecture dates to a long time⁵⁷. Buckminster Fuller, Norman Foster and Richard Rogers are only some of the representatives to be cited here⁵⁸.

Some examples of such preoccupations concern for instance a series of solar houses based on active technology developed by a research group at MIT by 1947 and a competition to design a solar house held in 1959.

The energy maps of Buckminster Fuller in the 1940s were reconsidering the relationship between energy, technology and social systems by interrogating inner social formations, energy resources and emergent technological possibilities of a given energy conditions.

In the 1970s, architectural projects and experimentations served as an important ground for debating principles of environmental change. They provided impetus for social transformations and new ways of living in houses made of earth, autonomous systems and communities along with participatory design.

1973 marked one of the most important turning points in the history of the twentieth century impacting the field of architecture as well. The oil crisis triggered research and development of renewable energy sources, improved technologies and sparked social experiments, ephemeral constructions, self-autonomous communities and counterculture utopias⁵⁹.

⁵⁶ For example, in the ancient city of Olynthos, in northern Greece, the city blocks were designed so that each house could have the best orientation and thus benefit from the position of the sun. All the main spaces were exposed to the sun in winter and protected from it in summer.

⁵⁷ For an insight see (Banham, 1969; Braham, 2013; Galiano, 2001; Ionescu et al., 2015; Ragheb et al., 2016)

⁵⁸ For an insight see (Gonzalo & Habermann, 2008)

⁵⁹ see (Borasi & Zardini, 2007)

In his *Theories and Manifestoes of Contemporary Architecture*, Jencks includes 14 manifestoes in the section concerning “Post Modern Ecology”⁶⁰. (Ch. Jencks & Kropf, 2006)

Jencks demonstrated how ecology considerations, or ‘versions of green architecture’, are not present only in all architectural movements of the twentieth century.

Another surprise is that a polemical movement may not be the preserve of just one tradition. One would have thought the ecological imperative might have been monopolized by the Activist tradition, but it has been taken up by all of them in different ways. (...) (...). In any case, the point is that green architectures, in the plural, are coming from everywhere while we might have thought the ecological issue would be taken over by just one or two movements. (C. Jencks, 2000)

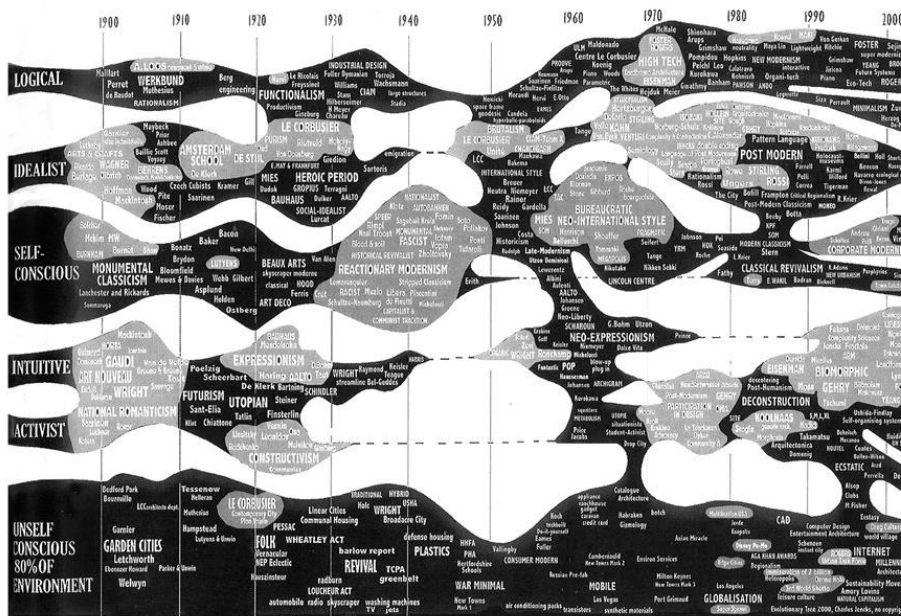


Figure 7 Charles Jencks, "The Century is Over, Evolutionary Tree of Twentieth-Century Architecture" source: (scanned from *Architectural Review*, July 2000, p. 77

Energy and environmental effectiveness does not demand a stylistic response in architecture, but a more fundamental change in design approach. (Loftness, 2013, p. 92)

Designing energy efficient buildings cannot be separated from the cultural, socioeconomical and technological context in which those objects operate.

⁶⁰ 1969 Ian Mcharg, *Design with Nature*, 1979 Sim Van Der Ryn and Stuart Cowan, *Integral Design*, 1984 Anne Whiston Spirn, *The Granite Garden*, 1984 Nancy Jack Todd and John Todd, *Bioshelters, Ocean Arks and City Farming: Ecology as the Basis of Design*, 1986 Hassan Fathy, *Natural Energy and Vernacular Architecture*, 1987 Kenneth Yeang, *Tropical Urban Regionalism*, 1990 Christopher Day, *Places of the Soul*, 1990 James Wines, *Architect's Statement*, 1991 Team Zoo/Atelier Zo, *Principles of Design*, 1991 Brenda and Robert Vale, *Green Architecture*, 1992 William McDonough, *The Hannover Principles*, 1993 Peter Calthorpe, *The Next American Metropolis*, 1994 Kenneth Yeang, *Bioclimatic Skyscrapers*, 1996 Sim van der Ryn and Stuart Cowan, *Ecological Design*

“There is growing comprehension that sustainability issues cannot be discussed in isolation. They must always be examined within their broader context. Every system is a component of another system and is, itself, made up of systems” (Kay, 2001)

Even if these preoccupations have already existed, there are nowadays codified and prescribed through regulations and standards.

1.2.2. Regulations and standards

On a global, European⁶¹ or national scale, the energy issue in the building sector is framed through policies and regulations that aim to reduce energy consumption.

The Energy Performance of Buildings Directive (2010) and the Energy Efficiency Directive (2012) are the European Union's main legislation covering the reduction of the energy consumption of buildings⁶².

On 30 November 2016 the Commission proposed an update to the Energy Efficiency Directive, including a new 30% energy efficiency target for 2030.⁶³

In France, standards and regulations related to energy management and energy efficiency have created an evolving a regulatory context, by releasing frameworks, directives or thermal regulations⁶⁴.

Some of the labels of energy performance destined to new constructions in France are the HQE Haute Qualité Environnementale, BEPOS effinergie 2017, BBC Batiment Basse Consommation, EcoQuartier⁶⁵, EcoCité.

⁶¹ European regulations: The first directive concerning the energy efficiency of buildings appeared in 2002.

In 2005 the European Commission published the Green Paper on Energy Efficiency, in 2007 it set the 3x20 objective for 2020, in 2010 it adopted a directive on the energy performance of buildings

⁶² For more information see https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en#directive-amendments

⁶³ For more information see <https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive>

⁶⁴ Stratégie nationale de développement durable (2003), Plan Climat (2004), loi de programme du 13 juillet 2005 qui fixe les principales orientations de la politique énergétique (2005), directive Européenne sur la performance énergétique des bâtiments (DPEB), Grenelle de l'environnement (2007), Grenelle I (2009), Grenelle II (2010). Les réglementations thermiques : RT 1974, RT 1982, RT 1988, RT 2000, RT 2005, RT 2012. A new thermal regulation will be released in 2021

⁶⁵ Until now, in 2021, in the municipality area of the city of Paris 5 sites have been labelled EcoQuartier. Clichy Batignolles (4th level), ZAC Claude Bernard (3rd level), Boucicaut (3rd level), ZAC Pajol (1st level), and Fréquel-Fontarabie (3rd level)

For more information see <http://www.ecoquartiers.logement.gouv.fr/le-label/etapes/>

It is interesting to recall here that in 2005 the Order of Architects in France left the HQE association of the High Environmental Quality label⁶⁶, saying that ‘the HQE approach, in its current conception, proves to be reductive, minimalist, technician and castrating’ Rudy Ricciotti have also criticised the concept of High Environmental Quality in architecture, denouncing the ‘hijacking of democratic legitimacy by technocracy’.

Such directives using a specific set of terms concerning energy performance or efficiency, it seems relevant to briefly remind the concepts they englobe.

1.2.2.1. Building’s energy performance

Buildings’ energy performance will be briefly outlined under the prism of sustainability.

First of all, to remind the origins of the term, Sustainable development was defined by the United Nations World Commission on Environment and Development in the Brundtland Report on 1987 as *those paths of social, economic and political progress that meet the needs of the present without compromising the ability of future generation to meet their own needs*. A year after the Earth Summit in Rio de Janeiro, in June 1993, the World Congress of Architects stated that *sustainability means meeting our needs today without compromising the ability of future generations to meet their own needs*.

Why is building sector related to energy? As seen previously, buildings are the largest energy-consuming sector in the EU and offer the largest cost-effective opportunity for savings. (*Building Energy Efficiency in European Cities Urbact II*, 2013, p. 4) According to European Commission, buildings are responsible for 40% of energy consumption and 36% of CO₂ emissions in the EU. Currently, about 35% of the EU's buildings are over 50 years old. By improving the energy efficiency of buildings, total EU energy consumption could be reduced by 5-6% and lower CO₂ emissions by about 5%.⁶⁷ Since buildings are sharing those percentages of use of total EU energy consumption and of greenhouse gases in Europe, reducing its CO₂ emissions by at least 80% and its energy consumption by as much as 50%,

⁶⁶ For more information see <https://www.architectes.org/l%E2%80%99ordre-des-architectes-quitte-l%E2%80%99association-hqe-quelques-explications-avril-2005-0> consulted in 29.10.2018

⁶⁷ For more information see <https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings>

the construction sector is today on a critical path to help decarbonise the European economy by 2050.

Energy efficiency in buildings is crucial for sustainable development, climate and resource protection and a low-risk worldwide energy system. (Thomas, 2015, p. 7)

The energy efficiency of a building is mainly related to two components: passive properties-given by thermal insulation, captured solar radiation, natural ventilation, shading; and active properties given by equipment of capture, conversion and use of renewable energy. (Ionescu, Baracu, Vlad, Necula, & Badea, 2015)

As a building's need of energy for heating, cooling and ventilation is primary affected by its envelope design, which comprises roofs, walls, windows, foundations. (IEA, 2013, p. 117), the form and materials of a building influence its energy consumption. In other words, the architectural design of a building has an essential impact on its performance.

A better control of the indoor environments from the design phase would reduce the building's energy consumption without neglecting the occupants' needs and attitude patterns, or the climatic and socio-cultural specificities.

Passive technologies that reduce heating and cooling loads by improving the building envelope could be for instance implemented using reflective roofs and walls, integrated facade systems that optimise the lighting performance, energy efficiency options such as shading attachments, insulation, triple glazing etc.

Some of the strategies that are implemented in the so-called low-energy architectural projects include among others a 'low-tech' use of renewable resources via natural cross ventilation, evaporative cooling, use of high thermal mass. Photovoltaics, heating pumps, geothermal energy or thermal building mass activation are considered elements of a 'high-tech' technology approach⁶⁸.

Overall, carbon-neutral operations in architectural design can be related to integration of design strategies such as daylighting, passive heating and cooling or energy generation.

⁶⁸ Low-tech and high-tech terms are sometimes presented within a controversial framework. For some approaches on the subject see (Bernigaud, 2018), (Bihouix, 2014) . For a research insight see (Halloy et al., 2020),

In a more holistic approach, issues such as community enhancement, land use and effect on site ecology, water use, impact on health, approach of materials and construction, adaptation, or long-life considerations can also be considered.

The bioclimatic and the passive design approaches, englobe strategies regarding this subject.

In general terms, the bioclimatic design of a house considers the orientation of the sun, wind and noise levels of the site; the protection from heat and light during the summer and the heat capture during the winter; this can be amongst others related to the shape of the building, its positioning in relation to the neighbours; the size of the openings and their protection.

The passive building is based on a concept of construction that involves a very low energy consumption, based on the use of the passive heat input of the sun, on a strong insulation in the walls and windows as well as on the control of ventilation. A passive house does not need more than 15 kWh per m² and per year (or 1.5 litre per m² and per year of oil equivalent) in heating. Technically, it can be reinforced with external wall insulation, ventilation with heat recovery, airtightness, suppression of thermal bridges, optimization of free solar inputs, as well as with the use of devices that consume less energy.

The *Passivhaus* standard was developed in Germany in the early 1990s by Professors Bo Adamson and Wolfgang Feist, and the first *Passivhaus* standard dwellings were built in Darmstadt in 1991.

The last decade, in France, an increasing part of urban and architectural projects tend to be “reduced” to “exercises of form and aesthetics, or responding to normative labels”⁶⁹, that could be generalised in, on the one hand technical approaches integrating technologies but not fully responding to the nature of the challenges risen, “participative” initiatives and procedures of different methods, mobilising diverse actors -politically supported- on the other one.⁷⁰

It remains to be seen whether the new frames and spectres inside which architecture and urbanism are being mobilised could provoke not only transformations in the processes of the ways of thinking and practicing them, but could also contribute to an emergence of new **relations** between private and public actors and actions in regard to societal matters.

The ongoing mutations undergone by the architectural practice are intrinsically linked to the fact that architecture is also involved in the “technical progress”: it **does** participate in the context of achieving ecological and energy transition(s). On the same time, it seems considering social justice and mixity, public use etc. and reformulates constantly -without adopting uncritically- not only the knowledge but the know-how as well.

Among practitioners architects, Philippe Rahm has talked about an Anthropocene style and architecture as a climatic construction (Rahm, 2019). Antoine Picon have driven a passage from a technological challenge to disciplinary refoundation.⁷¹ (Picon, 2019) Like the thematic dossier of *D’Architectures* in this subject, the *Architecture d’Aujourd’hui*⁷² have published an issue focusing on how current climatic issues are redefining architecture. In France, architects such as Philippe Madec, Encore Heureux Architectes⁷³, PCA Chiambaretta, Pascal Gontier, Franck Boutté, Jacques Ferrier, XTU or Anthony Bechu, to name but a few, have questioned these issues within their architectural design. Vincent Callebaut, Tadao Ando, Kengo Kuma, Alejandro Arajeva, Mario Cucinella, Arup, Renzo Piano, Thomas Hezrong, Foster and partners, Francis Kéré or Stefano Boeri are examples of architects having worked on energy performance within a variety of approaches and contexts.

⁶⁹ Vers un urbanisme postindustriel ?, Vincent Bourjaillat, in *La Revue Urbanisme*, n. 415, p.38 – 39 HERE 38

⁷⁰ Give examples Appels à Projet , « Réinventer Paris », « Inventons la Métropole du Grand Paris », « Reinventing cities » of C40, Manifestations d’intérêt...

⁷¹ For more information refer to *D’Architectures* n°277

⁷² For more information refer to *Architecture d’Aujourd’hui* n°411

⁷³ See here one of their projects on material reuse and circular economy <http://encoreheureux.org/projets/pavillon-circulaire/>

In 'Les professionnels du bâtiment face aux défis énergétiques et environnementaux - Compétences et pratiques en transition' (Molina, Musy, & Lefranc, 2018) a transversal analysis of the actual problems encountered in building sector explores the characteristics of pioneers in energy efficient construction.

On the same time, architectural research on the subject is being carried out by a variety of viewpoints.

1.2.3. Research in architecture and energy

The last decade the scientific research conducted within the laboratories of the schools of architecture as well as its academic and student dynamic, concerned among others the questions related to energy transition. To cite some of them, on November 27 and 28, 2015, the symposium 'Que fait l'énergie à l'architecture?'⁷⁴ within the Interdisciplinary Research Program 'Ignis mutat res'⁷⁵, Thinking Architecture, City and Landscapes through the prism of energy', aimed to explore the correlations between architecture and energy in light of the current crisis. One of the questions was to what extent the prospect of the depletion of fossil fuels creates as a conceptual and material framework for architecture.

The Network "ENSAECO"⁷⁶, founded in November 2016⁷⁷ and driven by the Ministry of Culture and Communication, aims to initiate and pursue a reflection around the teaching of the ecological transition in the French university departments of architecture.

Energy in architecture is an object of study situated in the crossroads of diverse research and approaches. Depending on the viewpoint, the subject can be treated under disciplines belonging to the engineering or the social sciences.

We will hereby cite some of the doctoral dissertations having dealt with the question of energy and architectural design in the French bibliography.

⁷⁴ À l'ENSA Paris-Belleville, Programme interdisciplinaire de recherche Ignis Mutat Res

⁷⁵ <https://www.culture.gouv.fr/en/Sites-thematiques/Architecture/Formations-recherche-et-metiers/La-recherche-architecturale-urbaine-et-paysagere-en-France/L-organisation-de-la-recherche/La-politique-de-recherche-incitative/Ignis-Mutat-Res-2011-13-2012-14-et-2013-15>

⁷⁶ Réseau de l'enseignement de la transition écologique

⁷⁷ <https://ensaeco.archi.fr/>

From a point of view of comparative and case studies approach we can mention the following research works.

In “Evolution of architectural design process confronted by the requisiteness of sustainable construct : towards a theory on design process in ecosophic times” (Perysinaki, 2014) Aliko-Myrto Perysinaki analysed influences of sustainable development on the architectural design process. Examining the mutations of the process along with the dimensions tackled and the complexity arisen, the study calls for a construction of a new identity for the architects in such a context.

In “Conditions for the implementation of the energy transition in urban development projects : a case study analysis. Paris Rive Gauche, Paris Nord Est and Clichy-Batignolles (Paris, France)” (Tardieu, 2015), Charlotte Tardieu compared three urban projects undertaken by the City of Paris. Through their analysis she examined the design parameters used for energy quality as well as the considerations of energy issues. The study interrogated the appropriate scale and actors when it comes to the implementation of energy strategies in urban development projects.

In his doctoral thesis on Energy, Material, Architecture (Ménard, 2018), Raphael Menard attempted an exploration of the relationship between architecture, energy and material, in an aim to bridge two approaches, the one resulting from a technical culture and the other from the culture of a design project. He linked thus a quantitative and a qualitative approach towards environmental issues. In this study he drew references throughout the history of architecture in a chronological order. More technical chapters followed as well as personal experiences and projects reinterrogated under a retrospective prism.

In his doctoral research on “Housing projects in Europe in the light of sustainable development : adaptations, transformations, innovations and obstacles in the architectural conception (2005-2015)” (Toubanos, 2018) Dimitri Toubanos analysed contemporary housing operations characterised by sustainable design approaches. The study identified mutations of architectural design as well as obstacles regarding the challenges of sustainable development.

As far as the design process is concerned the following works are pertinent.

In “Integration of energy issues in the design of the architectural project : a methodological approach” (Moreno Sierra, 2012) Andres Moreno Sierra analysed the complexity of integrating energy issues in the design process, from a methodological point of view. The research study proposed a design strategy for optimising the energy performance based on the building’s morphology and the use of digital tools.

In “Energy design process of sustainable buildings” (Romo, 2015), Ernesto Velázquez Romo developed a decision-support methodology for the energy design of sustainable buildings. Assessed through case studies at each stage of the design process it is aimed to assist architects and engineers within a French context.

From the point of view of the domain of history of architecture, Fanny Lopez, in *Déterritorialisation énergétique 1970-1980 : de la maison autonome à la cité auto-énergétique, le rêve d'une déconnexion* (Lopez, 2010) proposed a historical perspective of the energy autonomy movement and disconnection ideal, within the complex ideological and symbolic configuration they bear.

Léa Mosconi in « Émergence du récit écologiste dans le milieu de l'architecture.1989-2015 : de la réglementation à la thèse de l'anthropocène » (Mosconi, 2018) have questioned the implication of ecology considerations, after their institutionalisation in 1988, to the French architectural production. The research expands from the regulatory and energy issues of the 1990s to the end of the 2000s.

Bruno Peuportier has worked on eco-conception (Peuportier, 2008, 2013a, 2013b). His research treats methodological bases concerning eco-conception and life cycle analysis addressing public transport, building materials and energy management. His team has also developed and applied tools to a case study⁷⁸. In a recent study he presented a state of the art in the field of eco-conception, describing the methodology illustrated on a case study and discussing the limits of current knowledge. (Peuportier, 2019)

Caroline Lecourtois has also conducted research on éco-conception having as an objective to enlighten the ways in which architectural urban spaces are conceived so that they are sustainable. As an analysis grid of the design activities she used the architecturological⁷⁹ model according to which operations are identified as references whereby the architect attributes measurements to his project. This research on sustainable urban design was pursued by an investigation on 4 cases of eco-districts and a construction of a theoretical model on the cognitive design operations mobilized by an architect when conceiving a sustainable space. In this initiated route we will add knowledge by situating our study, focusing on the energy issues in architectural design process, as it has never been studied under this scientific angle.

⁷⁸ chaire Eco-conception des ensembles bâtis et des infrastructures, créée par ParisTech en partenariat avec VINCI

⁷⁹ Architecturology will be explained in the following chapter

Epilogue

For architectural design, energy has become a topic not only in the 1970's period of fuel scarcity, or the high prices in the late 2000s, but also during periods of energy growth.

If the 1960s were the years of solar and bioclimatic architecture, the 2000s were those of the multiplication of standards and labels in favour of energy performance.

Standards, labels and political incentives, from the Barnier law in 1995 to the HQE (1990-1996) and Passivhaus (1996) labels, made energy a central issue in construction (Mosconi, 2016)

The consideration of energy performance and the requirements it adduces have an impact on the design process of architecture that is by consequence undergoing changes.

Even if the interpretation of the signs of architectural energy performance is a complex cultural process the design fields are an important site for discussing energy futures⁸⁰, especially in a context of evolutions and transitions.

Different architectural approaches have made climate and energy central elements. In parallel, a global reflection on the environment both in practice and in teaching and research of architecture are conducted.

⁸⁰ As an example, in the summer of 2009 the research branch of the OMA (Office of Metropolitan Architecture) submitted a report to the European Climate Foundation called Energopa as a guide to a prosperous, carbon-free Europe.

2. Methodology

Prologue

This chapter focuses on the ways in which the research question set previously will be approached. It defines the procedure by which to interrogate the method of analysis of the case studies. At the same time, it identifies the existing knowledge on the subject.

More specifically, firstly, it clarifies the methodology by which to examine the question as well as its scientific anchoring and positioning.

Secondly, it constructs a bibliography concerning the application of the above methodology, in other studies and scientific domains.

Thirdly, it cites three case studies and explains their relevance to the present study.

Finally, it outlines the method of analysis by which to scrutinize the corpus. This part sets the steps that will be followed in the analysis and the comparison of the three case studies, as the scientific protocol that will serve as the basis of the Second Part. (chapters 3 ,4,5,6).

C'est Gaston Bachelard qui a mis en évidence l'activité de construction propre à la démarche scientifique. La science, dit-il, « réalise ses objets sans jamais les trouver tout à fait, elle ne correspond pas à un monde à décrire, mais à un monde à construire » (Bachelard, 1934)

Ceci a été repris par Georges Canguilhem. « La nature n'est pas elle-même découpée et répartie en objets et phénomènes scientifiques. C'est la science qui constitue son objet » (Canguilhem, 1968)

« Those who have handled the sciences have been either Empiricists or Rationalists. Empiricists, like ants, merely collect things and use them. The Rationalists, like spiders, spin webs out of themselves. The middle way is that of the bee which gathers its material from the flowers of the field, but then transforms and digests it by a power of its own » (Bacon, Urbach, & Gibson, 1994, p. 105)

« (...) toute théorie, y compris scientifique, ne peut épuiser le réel, et enfermer son objet dans ses paradigmes. » Edgar Morin, in *Le paradigme perdu* 1973

2.1. Methodology

2.1.1. Method and methodology – definitions

The method refers to the tool implemented to answer the research question, that is describes the ways that will be used to collect the data. They may vary among others- from surveys and experiments to interviews.

As far as methodology is concerned, it is the rationale adopted for the research approach; in other words, it consists of the prism through which the analysis takes place: it describes the « general research strategy that outlines the way in which research is to be undertaken »⁸¹ . With one methodology, therefore, several methods could be carried out.

2.1.2. Introduction

To interrogate the ways in which architects integrate energy considerations in their design process of spaces, the study is orienting towards the research on architectural design, thus convene the larger disciplinary field of design sciences.

According to Jeremy Till (Till, 2007) architectural research must develop synergies across traditionally independent intellectual fields; these kinds of interactions refer to three areas of research: architectural processes, products, and performance⁸². As stated by Sequeira (Sequeira, 2011, p. 140), this first stage that Till called “process”, consists of the research on the processes implicated in the design and construction, hence, consisting of theories on processes of design (Schon, Alexander, Jones, Lebahar)⁸³, modelling of the environment,

⁸¹ An Introduction to the Philosophy of Methodology, Howell 2013

⁸² Definitions that have been developed by Professor Bryan Lawson et the University of Sheffield as a means of research analysis.

⁸³ Jones, John Christopher ([1970] 1992) *Design Methods: seeds of human futures*. New York and Chichester: John Wiley & Sons.

Alexander, C. (1979) *The Timeless Way of Building*. New York : Oxford University Press.

Alexander, C. et al. ([1968] 1977) *A Pattern Language: Towns, Buildings, Construction*. New York : Oxford University Press.

Alexander, C. (1964) *Notes on the Synthesis of form*. Cambridge: Harvard University Press.

Schön, Donald ([1963a] 1983) *The reflective practitioner: How professionals think in action*. New York: Basic Books.

Schön, Donald (1963b) *Displacement of Concepts*. London: Tavostock Publications.

cognitive operations of conception (Boudon)⁸⁴, relationships between the various actors of the project (Conan, Prost)⁸⁵ etc.

2.1.3. Design Sciences

Significant progress in the field of design research was made during the 1970s (Cross, 1984) (Cross, Dorst, & Roozenburg, 1992). The methods used to study the designers' way of thinking are (but not limited to) interviews with designers, observations and case studies, protocol studies; this empirical research has been supplemented by thinking and theorizing analyses (Simon (Simon, 1969) being an important example) as well as simulation essays to study the designer's thinking (Cross, 2002, pp. 36–37).

2.1.3.1. Design process

Design process has been approached from different angles throughout history, some of them being the theory of problem solving (Simon) or the C-K theory. On the same time the definition of *design (conception)* is evolving. Multiple models theorizing design process as well as the process of architectural design have been emerged. For instance, models in engineering being prescriptive while in architecture descriptive. (Chupin, 2010)

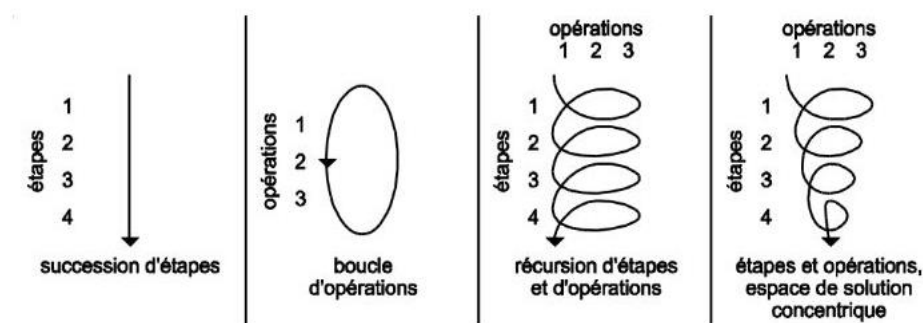


Figure 8 Typologies of design models after Blessing (1995) source: (Stals, 2019, p. 37)

2.1.3.1.1. Cognitive design process

⁸⁴ Boudon, 1992, 1994, 1997

⁸⁵ Conan, 1981, 1990, Prost, 1992, 1994

The design process can be studied either in a cognitive⁸⁶ or in a collective level⁸⁷. (Halin, 2004, p. 16) The first ones consider the designer facing the design while the second one considers design as a collective work among diverse actors and professions that needs to be organised and coordinated⁸⁸.

Design has been studied under a cognitive prism in the form of process by several works, (ex. JC Jones and C. Alexander) that present an interest in terms of the description of mechanisms they propose to implement in a design process. In his research studies on modelling the design process, JC Jones have suggested the representations of the designer-magician and the designer-computer, assimilating the mind to a black box on the one side and a glass box on the other.

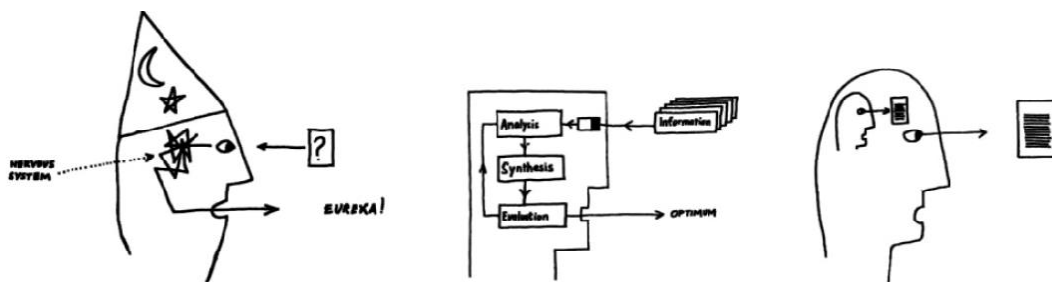


Figure 9 The three postures of Jones. The designer-magician, the designer-computer and the auto-organised designer

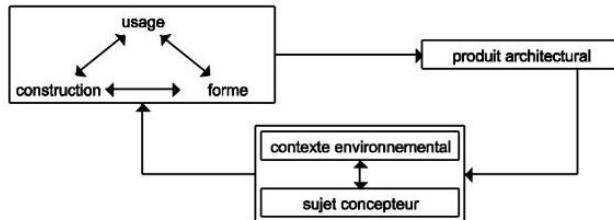


Figure 10 Design process model from Farel source: (1991, taken from Claeys, 2013) (Stals, 2019, p. 41)

In the systemic approach of design⁸⁹, Simon and Newell have described the design process as a process of a problem resolution. Boudon has demonstrated why this thesis is not relevant in architecture (Boudon & Raynaud, 1997)⁹⁰

⁸⁶ il s'agit de définir les activités et les mécanismes mis en œuvre par un concepteur en phase de conception

⁸⁷ , c'est la définition d'une organisation autour d'un projet, à l'intérieur d'une communauté industrielle ou scientifique, pour l'obtention d'un nouvel objet.

⁸⁸ See Midler, 1993 and 1996

⁸⁹ L'étude d'un système complexe consiste à proposer un modèle qui, par simulation, produira les mêmes effets ou se comportera de la même manière que le système considéré. Par opposition à l'approche analytique, qui aborde un système par décomposition et par l'étude de la nature des interactions internes, l'approche systémique étudie les actions réalisées par le système et les effets de ces actions sur le système lui-même (rétroaction) [De Rosnay 1975]. Taken from (Halin, 2004, p. 16)

⁹⁰ <https://drive.google.com/file/d/0B4EBXDa3NIKfZDA2NzJIYmYtY2FhNS00YmExLWExYzktY2FjNTg4MTU2ODNI/view>

2.1.3.1.1.1. Features specified in architecture

Cross have distinguished the phases that structure design process (Nigel Cross, 1984). Although design process is recurrent in domains such as informatics, engineering, industry⁹¹ or mechanics, the cognitive process of design mobilised in architecture is distinguished from the general design process. This is mainly because of the notions related to architecture.

Safin has studied conception from a cognitive viewpoint and has listed the major particularities of architectural design (Safin, 2011, pp. 65–68) as the ones that follow. The complex and situated character of the design, particularly in the field of architecture is far from a mechanical problem-solving process. The diversity of constraints, the central role of the drawing, the situated character of the design, the lack of prescribed methods, the diversity of representations, the specificities of the volumic approach and the central role of the analogies

Those elements of the architectural design have led some researchers to propose theoretical models adapted to architecture; and became more present since the emergence of the use of digital tools in architectural design.

Another characteristic present in architectural design is the consideration of constraints simultaneously to a “creative” activity, by formulating responses to multiple and various constraints. By traversing a complex process of creation, characterised by a collection of data along with an elaboration of “guiding ideas”, the architect represents an edifice to be built.

Mais qu’entendre au juste par “idée” ? Ne doit-on pas déjà distinguer l’idée au singulier, qui sous-tend un édifice, une œuvre, des idées de l’architecte ? Les idées de l’architecte sont à comprendre comme des convictions générales, des croyances, des engagements de l’architecte ou, plus simplement, des opinions. Il s’agit aussi d’influences diverses, souvent culturelles, que recherche l’architecte lorsqu’il est en situation d’éveil, de réceptivité. L’architecte et plus largement tout concepteur se trouvent souvent en situation de recherche d’inspiration. L’idée est à comprendre différemment. Elle permet de mettre en rapport intellect et production matérielle : l’idée, quelque part, opère dans le travail de l’architecte. (Boudon, Deshayes, Philippe Pousin, & Schatz, 1994)

Dans cet écrit il y a un article de Philippe Boudon (pp. 84-99) qui explique pourquoi la notion de "résolution de problème" ne convient pas pour parler de la conception. (les conclusions de ce texte ont été reprises dans son livre *Conception*).

⁹¹ Dominique Raynaud has identified three elements distinguishing an object that is to be built, from objects designed in industry. (Raynaud, 2000)

An architectural project requires the communication among the different actors taking part in the design process, making it inevitable for the architect to use tools to express his work (Stals, 2019, p. 70). The tools in use in architectural design can be analog (physical model, freehand drawing, speech), computer aided design (CAD) tools (CAO) (ex.: AutoCAD, ArchiCAD, AllPlan etc) / BIM, or parametric modelling ones. Claeys names as the architects' main modalities of exteriorisation of his internal representations to be the discourse, the dessin and the maquette. (Claeys, 2013, pp. 167–168)

Auteur ou Source	Etape 1	Etape 2	Etape 3
Simon (années 1980)	Structurer et analyser	Résoudre le problème	
Schön (années 1980)	Nommer/cadrer	Evoluer	Evaluer
Modèles classiques	Construction de la représentation du problème	Génération de la solution	Evaluation de la solution
Jones (1984) VDI Guideline 2221 (1987)	Analyser Analyse du problème et définition	Synthétiser Synthèse du système	Evaluer Analyse du syst., évaluation et prise de décision
Hamel (1989 ; 1995)	Analyser	Synthétiser	« Mouler »
De Groot (?)	Perception et observation	Essayer	Evaluer
Goel (1995)	Conception préliminaire	Affinement	Mise en détail
Cross (2000) ; Baxter (1995)	Concevoir	Concrétiser	Détailler
Ulrich et al. (2003)	Concevoir	Définir les niveaux du système	Détailler
Press et al. (2003)	Concevoir	Développer le prototype	Conception Finale
Pipes (2007)	Générer les concepts	Développer la conception	Spécifier

Figure 11 "The cognitive artefacts of designing" (Visser, 2006, p.34) completed by (Self, Dalke & Evans, 2009) source: (Stals, 2019, p. 38)

2.1.4. The study of architectural design

The architectural design studies have been and continue being a research object demonstrated by diverse publications since 1980 (Lebahar, Boudon, Conan, Prost)⁹².

⁹² A brief panorama of the studies on architectural design have been outlined by D. Raynaud in his articles (Raynaud, 1999, 2001)

The reflexions on architectural design is linked to the studies of Herbert A. Simon⁹³ (1963) who formulated indications on design processes specific to architects, engineers, and designers in general. Christopher Alexander (1964) continued the path based on Simon's considerations.⁹⁴ The study of architectural design initiated by Simon was oriented towards heuristic research of a non-optimal solution (*satisficing*), when Alexander pursued to comprehend the architectural design process as a scientific one, by an inductive viewpoint.⁹⁵ Their studies, oriented towards a rational exploration of the design process, remain apparent in contemporary studies.

The different scientific approaches of the study of architectural design process as well as its modelling is a research topic that remains relevant. H.A. Simon's studies were synthesised by Michel Conan (Conan, 1990) the research of whom was summarised by P. Fernandez (Fernandez, 2002)

Inaugurated thus by Anglo-Saxons studies (H. Simon and C. Alexander) in the 1970's, the domain reached a numerous number of publications in the years 1980 and 1990 as well as an important representation of sociological angle. The viewpoints having treated architectural design studies having been multidisciplinary, have led D. Raynaud to distinguish two frames of references (Raynaud, 2001), the positions aroused by the "internalists" (Boudon, Conan, Prost, Raynaud) and "externalists" (Toussaint and Younès, Champy, Tapis), borrowing those terms from the epistemology of the history of sciences⁹⁶.

The epistemological consequences of the idea of conception⁹⁷ are not all drawn; it often remains a notion used empirically (Boudon, 2002b, p. 50). Architectural design has long been perceived as empirical and intuitive. Given the complex nature of the designer's thinking, the proposal of an understanding of this process aims to make the design communicable by providing an entry into the "black box" of architectural design, deemed impenetrable. (Boudon et al., 2001) Can

⁹³ la conception architecturale est un domaine à solutions sous-optimales ou satisficing et un domaine d'heuristiques

⁹⁴ Sa contribution principale concerne la décomposition de problèmes en problèmes semi-indépendants.

⁹⁵ Afterwards abandoned

⁹⁶ 'Ces termes qualifient, relativement à la conception, les travaux qui explorent les actes de conception sur un plan cognitif (internalisme), et ceux qui envisagent la conception comme un lieu d'interactions sociales entre acteurs du projet (externalisme). L'intérêt du débat tient à ce que ces positions apportent souvent des éclairages complémentaires sur les tâches de conception, l'une mettant en évidence la façon dont les données et contraintes initiales du projet se construisent, l'autre, par quelles opérations mentales les concepteurs se servent de ces données et contraintes pour parvenir à une proposition architecturale acceptable'. (see (Raynaud, 2001))

⁹⁷ La conception selon Jean-Louis Le Moigne, est « du point de vue de la connaissance, une idée neuve », cité par (Boudon, 2002b, p. 50)

we make "analysable" a major skill of the architect, the design, and therefore after "modellable"?

The study of architectural design (in French *conception architecturale*) can be positioned at the crossroads of three approaches focusing on design sciences, cognitive psychology and *architecturology*. (Raynaud, 1999, p. 35). Boudon and Deshayes (in Boudon & Raynaud, 1997) evoke the main areas of research on architectural design that consist of the interest in virtual objects (the building in project rather than what is realized); the exploration of processes and the transition from each state to another; the consideration of processes under the material but also cognitive prism as well as the process approach from the poetic angle⁹⁸ (Raynaud, 1999, p. 39)

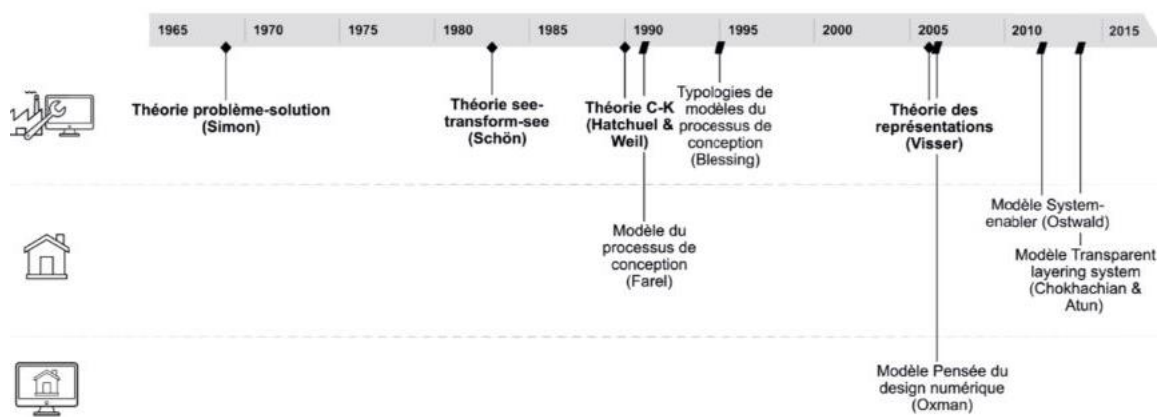


Figure 12 Timeline demonstrating the theories and models developed to elucidate design process. From top to down: all domains, architecture, digital architecture source (Stals, 2019, p. 52)

2.1.5. Architecturology

The scientific field of architecturology have significantly cultivated the development studies in architectural design. The mayor proposal of this theory (sharing the general framework of constructivist epistemologies described by le Moigne) (Raynaud, 1999) is to constitute a knowledge on architecture that is distinct from aesthetic doctrines and normative discourses.

⁹⁸ Poietic activity is defined by Aristotle as the act of making or creating⁹⁸. According to him, the three domains of human activity are observation (theôria), action (praxis), and production (poiesis). He has therefore chosen to situate Poetics in the conceptual place of production and not in that of action⁹⁸. Paul Valéry uses the word "poietic" and not simply the term "poetic" in order to emphasize on the greek root of poiesis as know-how⁹⁸. In his view, the aesthetic experience must integrate two perspectives, an aesthesic and a poetic one, inseparable from each other.

How does the architect give measurements to space? I call here "theoretical", quite simply the work involved in the project to answer this question. "Simply" is naturally a euphemism here because it follows the program of the architecturological work, which starts from a real "question". Again, it is not a question of producing a "theory of architecture" (the term rather meaning doctrine in general use); nor even a theory of design. It is a question of indicating the nature of the theoretical work which is essential for the understanding of an object, as everywhere else. And it is the fact of opening up this question - a question whose purpose is to provide an entry into the "black box" of architectural design. (Boudon, 2003, p. 10)

Architecturology is a scientific field of research that was initiated in France by Philippe Boudon in the 1970s. It belongs to design sciences and reduces architecture to measure. As epistemology designates the discourse (*logos*) on "true" knowledge (*episteme*), *architecturology* (architecture + *logos*) talks about architecture; it refers to the discourse on architecture. It « makes intelligible the cognitive activity of design in terms of design operations aimed at the attribution of architectural forms and measures ». (Lecourtois, 2014b, p. 20) Architecturology intends to outline the order of changes that are developed during the design process. (Raynaud, 2002b) This scientific field introduces the passage from the practice of architecture to questions related to its knowledge, that is to say, it distinguishes architecture as an *object* and architecture as an *object of knowledge*. In other words, by questioning the nature of knowledge related to architecture, a transition towards an epistemology of architecture is effectuated, where architecture becomes the object of knowledge⁹⁹. While among the sciences, *space* is referred to as a concept, object or terrain, for this scientific discipline architecture as the thought of space becomes the object of knowledge. (Lecourtois, 2004a, p. 84) Architecturology proposes the «constitution of a knowledge on architecture by referring to it as the thought of space -architectural or urban-, thus the space becoming a material for the designer. Seeking to explain the design of space, architecturology questions the cognitive work of architects to illuminate their space of design. » (*espace de conception*) (Lecourtois, 2004a, p. 79)

⁹⁹ « Parler d'architecturologie c'est de quelque manière s'interroger sur le *logos* de l'architecture. » (Boudon, 2003, p. 6)

The roots of Boudon's work on an epistemology of architectural design can be found in Bachelard's idea relying on the rupture between science and experience, or scientific and phenomenological knowledge, so that he disconnects the creativity problem from the design one. (Sequeira, 2011, p. 146)

Boudon himself reminds us that his working hypothesis was inspired by Gaston Bachelard's « espace sous l'espace »¹⁰⁰ His hypothesis was based on defining architecture as the thinking of space, considering architectural space dependent of the way in which it was thought and the architectural thought dependent of the space that acts as its reference.

He recognises a relationship problem between a thought **of** architecture and a thought **on** architecture. (Boudon, 2003, p. 47) More precisely, Boudon's aim was to found the basis of a knowledge of architecture, that is, of « an architecture as an object of science which is to be built, that is, a scientific theoretical construction of architecture » (Boudon, 2003, p. 37)

It is of an utmost importance to highlight the fact that Boudon considers design as a multimodal activity, rather than a problem-solving one -the latter being an approach advocated as mentioned before by Herbert A. Simon In other words, architecturology considers the designer as someone who must respond to multiple goals and thus describes his design work by a multiplicity of purposes. In that way, the architect takes into account the various intentions he seeks to fulfil and adapts the project so that a hypothesis does not consist a definite «solution». Where the designer is implicated to, could be described as a situation of « problems with multiple goals and sub-optimal solutions » (Raynaud, 2002b)

To conclude, by architecturology, « it is the passage between the mental space of the architect and the true space of the edifice which must be envisaged (...) as Panofsky examines that of the space of a figure to be represented, to the space of the represented figure » (Boudon, 2003, p. 98). Design is not considered as a problem-solving activity:

The contribution of architecturology relies on providing a language to talk about design (*conception*). This established language enables the discourse on conception by not limiting it solely to the description or evaluation of an architectural object already accomplished. Studying hence the cognitive aspects of architectural design elucidate the activity of the architect and his

¹⁰⁰ He distinguishes space as it is daily lived and space built to understand it, the second being, one could say using an expression of Henri Poincaré, a "representative space" of the first, concrete space -in relation to the Kantian idea of space understood as "a priori form of representation".

thinking behind the completed object. The study of the cognitive aspects clarifies the thinking behind the accomplished work of the architect.

Sequeira, in his article entitled *Architecture and Research: a possible structure*, refers to the development of Architecturology, claiming that the «complexity of its arguments, (...) the redefinition of some of its terms already assimilated in common architectural language» have possibly contributed to its low expansion worldwide. He observes though, that opposed to design research having been generalized to design disciplines, architecturology is « the only current that is claimed to be on architectural research ».(Sequeira, 2011, p. 146)

(...) we can say that, more generally, architecturology is inscribed, fundamentally, between two major fields: on the one hand the sciences of design as advocated by Herbert Simon, or in France, Jean Louis Le Moigne, and on the other hand, poetics, the notion and term of which, introduced by Paul Valéry, tend to constitute a field of knowledge in which architecturology participates. (Boudon, 2003, p. 31)

2.1.5.1. Fundamental and applied architecturology

A general logic is called afterwards applied when it aims at the rules of the use of the understanding under the subjective and empirical conditions that psychology teaches us. It has thus empirical principles; although it is general as long as it refers to the understanding (comprehension) without object distinctions. (Kant, 1869, p. 113)¹⁰¹

Some of the most important publications on fundamental architecturology, comprise among others the studies of Ph. Boudon, Ph. Deshayes, F. Pousin, F. Shatz, and C. Lecourtois, as well as writings presented in the works of (Boudon, 1971), (Boudon, 1975), (Boudon, 1978), (Deshayes, 1986), (Boudon, 1992), (Boudon et al., 1994), (Boudon et al., 2001), (Boudon, 2002a).

In the 2000s, the path of *applied architecturology* has been established, initiated by Caroline Lecourtois (Lecourtois, 2004b). It aims at « confronting the theoretical model of knowledge with empirical reality ».(Lecourtois, 2011, p. 19) Based on fundamental architecturology and

¹⁰¹ « La logique *générale* est *appliquée*, lorsqu'elle a pour objet les règles de l'usage de l'entendement sous les conditions subjectives et empiriques que nous enseigne la psychologie. Elle a donc aussi des principes empiriques, bien qu'elle soit générale à ce titre qu'elle considère l'usage de l'entendement sans distinction d'objets. » derived from https://fr.wikisource.org/wiki/Critique_de_la_raison_pure/Partie_2

by using its concepts as analysis instruments, Lecourtois evolved new empirical methods in order to examine architectural design. In order to describe and explain the conception of an object by identifying cognitive operations of conception, the corpus of empirical cases consist of theoretical/historic/technical texts, verbal descriptions, sketches, physical or virtual models. In her paper *From Architecturology to Architecturological research* (Lecourtois, 2011) Lecourtois presents the research studies conducted under the concept of applied architecturology and outlines six methods in which it has been developed. As presented, some of the research studies in which applied architecturology has been involved are on conception ((Lecourtois, 2004a)), perception ((Lecourtois, 2007)), architectural style (Delaveau, Guéna, & Lecourtois, 2009), collaborative operations of design ((Ben Rajeb, 2013), (Ben Rajeb, 2012), (Ben Rajeb, Lecourtois, & Guéna, 2010), (Lecourtois et al., 2010)) , aided modelling operations of design ((de Boissieu, Lecourtois, & Guéna, 2010), (de Boissieu, 2013)) ; a software developed to support architectural design ((Lecourtois & Guéna, 2009), (Guéna & Lecourtois, 2009))

Far from aiming at a production of architectural artefacts, the applied architecturology remains connected to a scientific questioning. It consists of using the fundamental concepts of the theory to carry out case studies, aiming at the reconstruction of the design process and the examination of initial hypothesis in the field. (Vitalis & Guéna, 2020) Consequently, there is a *a posteriori* work that is effectuated in research, along with the *a priori* one of the fundamental architecturology. Various research projects such as the ANR CoCréa¹⁰² (pratiques collaboratives en créativité architecturale) have implemented them.

To conclude, as shown in the aforementioned part, architecturology has been mainly used as a tool in pedagogy, to teach architecture and design (conception), as well as in research. Some of the domains in which it has been implicated concern collaboration and collaborative design, parametric design, perception, architectural style.

¹⁰² For information see <https://anr.fr/Projet-ANR-08-CREA-0030#>

2.1.5.2. Epistemological conditions of architecturology

The major epistemological consideration of architecture concerns the requirement that architecture, in order to exist, must first have been conceived (Boudon, 2007, p. 73) The transition from architectural practice to questions relating to his knowledge changes the very nature of work (Boudon, 2003, p. 8) and suffices to require the distinction between the term architecturology and architecture¹⁰³. In *Sur l'Espace Architectural*, (Boudon, 2003, p. 9) Boudon points out three main distinctions - between *object / terrain*¹⁰⁴ and *empirical object / scientific object*¹⁰⁵ by adding the one between *doctrine* and *theory*, that is to say between the doctrinal discourse of the architect, aiming at a practice¹⁰⁶ and theoretical discourse aiming at a knowledge.

The mayor epistemological conditions of Boudon's work could be genetically reduced to the forenamed distinctions.

Another distinction underlined by Boudon concern the "architectural scale" and the "architecturological scale"¹⁰⁷.(Boudon, 2003, p. 11) The notion of *scale (échelle)* was posited as the place of an epistemological distinction between two thoughts of space, architecture and geometry. (Boudon, 2002a)¹⁰⁸.

It is such an example of confusion that we find in Henri Raymond who confuses the aesthetic question of scale with the epistemological question it raises as a locus (place) of the difference between geometric space and architectural space. As soon as the concept proceeds from an a priori modelling, as Philippe Deshayes has shown, and no longer an a posteriori, the scale is no longer a subject and becomes a problem, that of the construction of an intelligibility of the complexity of measurement in architectural design. (Boudon, 2003, p. 11)

¹⁰³ La distinction est, cette fois, à faire entre architecture comme *objet* et architecture comme *objet-de-connaissance*.

¹⁰⁴ La différence faite entre architecture comme *terrain d'étude* et architecture comme *objet* est une première distinction fondamentale à poser d'un point de vue épistémologique. (Boudon, 2003, p. 7)

¹⁰⁵ « Cet objet (d'une science de l'architecture) n'es pas l'architecture dont on suppose l'existence préalable, mais une architecture comme objet de science qui est à construire, autrement dit une construction théorique scientifique de l'architecture » (Boudon, 1971, p. 4)

¹⁰⁶ see (Boudon, 2003, p. 9)

¹⁰⁷ The concept of architecturological scale will be analysed in the following part

¹⁰⁸ Débordant le domaine de l'architecture, il considère les questions de mesure soulevées de points de vue aussi divers que ceux de la poïétique, de la sémiotique (C.S. Peirce), de la phénoménologie (M. Merleau-Ponty, L. Wittgenstein) ou de l'épistémologie (G. Granger, K. Popper)

2.1.5.3. Epistemological obstacles

Visiting a building cannot tell us much about its *design (conception)* and one might think that the analysis of buildings can create a real epistemological obstacle to the knowledge of *architectural design* (Boudon, 2002b, p. 52). To the difficulty of knowing what one perceives by "analysis" is added the postulate of the architecturology which requires that at the time of its analysis, one distances himself from the design of an existing building¹⁰⁹. The question that therefore emerges, is how one can analyse something that does not exist yet. By thus examining the *result* (the existing building) we do not understand the *process*, which makes Boudon conclude that there is not a *process* but rather *operations* that must be looked for at that point. The epistemological position of architecturology as design research considers that empirical analysis is not sufficient, coming in opposition to the fact that there is nothing to analyse.

2.1.5.4. Concepts (the language of the methodology used)

The postulate of architecturology is that the project takes place in a design space (*espace de conception*) that is to be conceptually distinguished both from the geometrical space and from the architectural space (where the accomplished, finished object is situated). This design space, the space in which the architects thinks and works on, situated between the two forementioned spaces, is thus a theoretical space in which the operations assign measurements to objects.

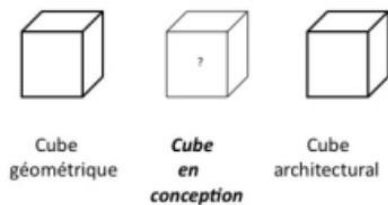


Figure 13 The design space, situated between the geometrical and the architectural one. (source Philippe Boudon)

The scientific object on which architecturology is founded is the design space from the point of view of measurement. This scientific object is commanded by a question: how does the architect give measurements to space? (Boudon, 2014)

¹⁰⁹ On ne peut comprendre l'espace architectural en tant qu'il a été conçu en se contentant d'analyser cet espace architectural, qu'un déplacement est nécessaire vers ce que, en architecturologie, nous appelons l'espace de conception. « Ceci nous amène à considérer cette fois trois espaces conceptuellement distincts : à côté de l'espace géométrique, dans lequel se situe le cube du géomètre, et avant l'espace architectural, dans lequel se situe l'objet ou l'édifice une fois réalisé, l'espace de la conception est postulé comme espace dans lequel travaille l'architecte pour donner des mesures aux objets en conception. Un espace théorique – fictif comme tout espace théorique - dans lequel se déroulent les opérations que met en œuvre l'architecte. »

In the following section we will briefly present the key concepts that characterize architecturology.

2.1.5.5. Architecturological scales

Considering the polysemy of the term *scale* according to the various contexts of meaning, Boudon shows that the scale in itself does not exist (Boudon, 2014, p. 9). The reason is that there are multiple *scales*; It is always necessary to refer to a context and specify the space of reference¹¹⁰ for the scale to have a meaning.

To situate his concept, *scale*, Boudon is situated as mentioned previously between the geometric space on the one hand and the architectural on the other.

Architectural scales make it possible to consider the multiplicity of points of view that can be addressed to the architectural space, both in the order of design and in that of perception. The change in space of architectural problems then consists in becoming aware of this multiplicity: the architectural object is a "multi-object" - a notion I borrowed from Yves Barel - whose knowledge presupposes a reference. to a diversity of reference spaces which form a (potentially infinite) series of points of view from which it can be considered. The change of point of view amounts to placing this space in another reference space and to reassess the relevance of these measures according to new scales. (Boudon, 2003, p. 118)

An architecturological scale is defined as the relevance of the measure. (Boudon, 2014, p. 10). The concept of scale as described by Boudon could be used to define the ways in which a form is elaborated from a pattern, then adapted and set to the scale, by means of an operator. (Wippler, 2018, p. 204) At this concept, D. Raynaud opposes the idea of the scheme as the operator of the design, leaning towards a systemic exploration of patterns of the language. (Raynaud, 1999)

The architecturological scales are, in other words, a systemic concept of the architecturological language; its vocabulary for the description of the design from the point of view of the measurement. In this context, an architectural object is a multi-object that can be seen through scales that represent classes of cognitive operations of the design. These classes of operations

¹¹⁰ Look at the next page for further analysis on the space of reference

relate the *reference*, the *relevance* and the *dimension*, pluralistic concepts allowing to describe the act of attribution of measurements (Lecourtois, 2014b, p. 20).

As the concept of architecturological scale designates classes of cognitive operations of conception that link three other plural architecturological concepts (that is space of reference, relevance and dimension) (Lecourtois, 2011, p. 13), before naming the architecturological scales, the following sub-chapter will briefly situate the context in which they operate.

2.1.5.6. The space of reference (*espace de référence*)

By using references architects construct a part of their project in an environment that bears to them a significance. They can be stemming from various considerations related to culture, societal, parcel, geographical matters and operate actively in his work. The presence of architectural elements in a project could be even linked to a reference belonging to the imaginary world.

During the design process, an input deriving from an immense universe of data¹¹¹ can potentially serve as an element eligible to become a reference for the architect. On the same time, such a reference can stem from another branch of knowledge, constituting its taking cognizance of impossible.

The distinction of this « potentially unlimited » reference to its deliberate investigation is being demonstrated by Boudon (Boudon et al., 2001, pp. 109–112) when identifying the *space of reference*, or « categories of representation¹¹² of the reality that have an active role in the design» and on the other hand, the *référenciation*, that concerns the action of referring to an acknowledged element linked to the personal or professional experience of the conceiver (architect in this case) when designing a form. The latter is attached either in an object or in a class. Thus, the object of the reference belongs to the real world, while the category (class) to which belongs the reference to a representation of it, specific to the architect.

By using a terminology operating on the distinction made by Roman Jakobson, Boudon sets a differentiation between a metonymic reference and a metaphoric one. By the first he introduces the syntagmatic axe, inducing a relation of continuity between the proposed architectural object

¹¹¹ This data can be related to a programmatic, functional, plot, neighbouring etc. relevance but also to an incidentally crossed image, piece of film, work of art, or drawn from the history and theory of architecture.

¹¹² *Classes de représentation*

and the referents; whereas by the second one he intends a paradigmatic association subjected to a non-spatial continuity.

2.1.5.6.1. Archetype, type and model

2.1.5.6.1.1. The preconceptions¹¹³

By questioning an architectural project and considering various influencing data, a designer establishes a primer potential domain of solutions deriving from hypothesis having been set. While the final product of the project is not yet defined and still unknown by the designer, preconceptions, “primary generators”¹¹⁴ at the start of the process can use certain reference spaces or recurrent information structures such as the architectural (arche)types. (Claeys, 2013, p. 265)

Demonstrating that a designer never starts a design process from a blank page, the preconceptions are present in the work of Simon (Simon, 1969) and Darke (Darke, 1979). Initially chosen rationally, those related information are in a second point assimilated empirically by the designer so as to function the project’s examination process. (Claeys, 2013, p. 266)

2.1.5.6.1.2. Archetype

« All architectures, across all ages, can be considered as deriving from a limited number of archetypes. Knowing how to characterize them makes it possible to summon them as instruments of comprehension, analysis, and design. (...) » (Bonzani, Durand, & Teyssou, 2017)

Archetypes could in a broader sense be characterised as primordial images or data which nourish the ones deriving from personal contexts with a common archaic background and proceed in the production of others. They can be characterised as « an ideal model, a supreme type or prototype »¹¹⁵. Archetypes can become instruments of comprehension, of analysis and conception, enabling the description of parts of architectural objects. Moreover, they could be

¹¹³ The word pre-conception comes from the Greek *prolepsis* ("anticipation") which is the art of associating a type with a word. With each act of thought, the related information present in the (auto) repository and the network of intentions make that a conceptual *déjà-là* already exists. Even scientifically false or inoperative when facing the project’s situation data, the latter serves as a starting point for the designer. See (Claeys, 2013)

¹¹⁴ See the work of Darke, J.

¹¹⁵ See more in <https://www.universalis.fr/encyclopedie/archetype/>

constructed socially, historically, technically, referring to different periods of time and their ideologies.

In his *Archetypes and the Collective Unconscious*, Carl Jung developed the concepts of « *archetype* » and « *collective unconscious* ». (Jung, 1954) According to him, the archetypes are referring to a collective non-verbal unconscious. The archetypes are innate complexes, forms *a priori* or pre-formed structures influencing the individual experience. (Claeys, 2013, p. 11)

« Archetype is an innate complex, an a priori form of preformed structures of the psyche that influence the materials of individual experience. The word comes from *arkhe* (ancient, primitive) and *typon* (imprint). In architecture, the archetype is a model of spatial organisation from which multiple variations can be declined” (cited in Claeys, 2013, p. 402)

Architectural archetype, as a conceptual reference of the relevant typology of buildings, bear design principles which have the potential to be used as guidelines of spatial definition. (Piecbara, 2019). In this case, the typological analysis of the archetypes’ interpretations are traced back to a common prototype, a concept, an idea of an object. In his discussion on *Form and Design*, Louis Kahn claimed that buildings of the same type have an archetypal essence (or “form”) in common, that is transcendent. (Fleming & Reynolds, 2006, p. 34). According to his theory, architects translate these *forms* into buildings through the process of *design*.

« (...) Form encompasses a harmony of systems, a sense of Order and that which characterizes one existence from another. Form has no shape or dimension. For example, in the differentiation of a spoon from spoon, spoon characterizes a form having two inseparable parts, the handle and the bowl. A spoon implies a specific design made of silver or wood, big or little, shallow or deep. Form is “what”. Design is “how”. Form is impersonal. Design belongs to the designer. Design is a circumstantial act, how much money there is available, the site, the client, the extent of knowledge. » (Kahn, L. (1961), cited in Roth, 2020) ¹¹⁶”

2.1.5.6.1.3. Type

The *type* has been an essential concept when it comes in the architectural discourse, broadly operated in the architectural theory and literature by several critics. It has had several

¹¹⁶ “The discussion “Form and Design”, prepared by Kahn for the Voice of America *Forum Lectures* in 1960 , first appeared in *Architectural Design* (31 April 1961, pages 145-54), is reprinted in modified form in *The Notebooks and Drawings of Louis I. Kahn* (edited by R.S. Wurman and E. Feldman (Cambridge, Massachusetts, 1973)), and was published in V. Scully, *Louis I. Kahn* (New York, 1962), which version is given here”

definitions (Moneo, 1978)¹¹⁷. *Type* can be defined as a group of objects characterized by the same formal structure. (Groat & Després, 2013)

« The type is therefore a reference that can be mobilised by the designer, that contains already in itself an operation of referenciation. The type is the association of a scheme similar to an archetype (*représenation d'un réfèrant*) and a signification (*acte de réfèrenciation*) » (Claeys, 2013, p. 265)

2.1.5.6.1.4. Model

For Philippe Boudon, in architecturology, the *model scale* consists of re-taking a previous model by changing it eventually in varying degrees and natures. (Boudon et al., 2001, p. 177). He demonstrated the duality of the architecturological concept *model scale* (Boudon, n.d.) that deals with the reconstruction of the empirical model in architectural design by a theoretical complexity. (Lecourtois, 2010, p. 5,6)

In the case of a building appearing as a distorted return of an archetype present in the surrounding or distant buildings - thus the relation between models can be established by a comparison in the real space- the neighbouring architecturological scale enters in the foreground in relation to the model one: recalling a frame, a form, or proportions of a building to another one.

The copy model contains the empirical notions of form/shape model, concrete model, iconic model, painter's model; the architectural model is operand of the operations embodied under the term of copy. (Claeys, 2006)

2.1.5.7. Reference, relevance, dimension

The space of reference involves various abstract or concrete knowledge domains and abilities implicated in the design.

¹¹⁷ ' For Quatremère de Quincy the type is a general form of building that retakes the intrinsic nature of a family of objects. The type should not be used as a model, otherwise it is applied to buildings whose uses do not correspond with those of the type. Aldo Rossi also distinguishes *type* and "*model*": the "model" is to be copied, while "type" is an object that can lead to a design of different edifices.' (Claeys, 2013)

« Attributing multiple references to a cube consists in selecting data and instruments and, beyond the idea they contribute to enrich, to use them concretely in the design of forms or architectural objects. » (Boudon et al., 2001, p. 109)

The concept of *reference*¹¹⁸ in architecturology refers to the fields of knowledge convoked to serve as a reference at the time of attribution of measures. In other words, the reference relies on using in a precise way chosen input and tools when designing architectural forms or objects. Boudon differentiates this reference (potentially infinite) from the deliberated research of a designer during a project:

For an architect, everything is likely to become a reference. A project's design process is fed by all kinds of potential data. This data is drawn by the architect from the program that is proposed to him, the site, the neighbouring objects, but also the history of architecture, an image seen in a film or a random encounter. (...) The referenciation work is the work of referring, for the design of a form, to a reality recognized by the designer through his experience as an individual or a professional of the domain of architecture. (Boudon et al., 2001, p. 109)

The concept of *relevance* regards the ways in which a reference is implied in the design. Through the concept of relevance, the architect situates his project or part of it in a universe that bears meaning for him. (Boudon et al., 2001, p. 111) In other words, relevance describes operations of design of choices or ways by which a space of reference is involved in design.

The declared measurement therefore has no value in absolute terms, it must be reduced to a point of view. Whatever the mode of measurement and its degree of precision, a measurement has value only if a point of view is associated with it, that is if the relevance is given. In the design, convoking a space of reference in relation to which one or more measurement operations are meaningful, consists inter alia, of defining the relevance of these measurement operations. The relevance constitutes the theoretical unity of the term scale. To sum up, deciding on a measurement requires to consider its relevance, in other words to appreciate its value, relative to a space of reference. (Boudon et al., 2001, p. 119)

¹¹⁸ A reference can be related to geometry, technique, culture, neighbouring elements, symbols, function, economy etc

Finally, the concept of *dimension* (a shape, a length, a diagonal, a boundary ...) refers to the elementary units of the project to which measurement is attributed.

2.1.5.8. The architecturological scales

The architecturological scales constituting until now the formal language of architecture are the following: economic scale; functional; semantic; optical; geometrical; of visibility; form symbolic; neighbouring; technical; plot; model; socio-cultural; geographical; of extension; human; representation; cartographical; global; symbolic; dimensional; of design level; of integration.

Geographical scale refers to a design operation class that consists of informing the measurements of part or all of the architectural space based on considerations of the orientation of the cardinal points, situation and terrain modelling, climate data, etc (Boudon et al., 2001, p. 173) . This concept represents the set of cognitive operations by which forms and measures are attributed to the project by its relation to the data of the geography of the site (Lecourtois, 2014b, p. 22).

The plot scale designates a class of design operations that the architect is susceptible to implement relatively to the size, shape and boundaries of the plot given to him. As a parcel is characterised by its form, surface, orientation and topology; each of these elements may become involved in the design of a project: the architect can use them to refer, form, position, cut, orient, or dimension his project. (Lecourtois, 2010, pp. 5–6)

The economic scale refers to the set of cognitive design operations consisting of designing part or all of the architectural space in relation to its cost or engaging in possible exchanges of costs between various parts of it Architectural space (Boudon et al., 2001, p. 180).

The technical scale refers to cognitive design operations which involve the use of technical considerations to induce a method of attribution of measurements to a part or all of the architectural space (Boudon et al., 2001, p. 167).

The *scales* are not to be confounded with the *spaces of references*: « for every architectural space there is the possibility of referring it to a technique, a cost, a land plot, or to functions. But this does not signify that this space of reference was used as mode of conception. However, it is only in the latter case that one should mention a *scale* of architectural conception »

(Boudon, 1978). That is to say, for a space of reference to be used as a scale of conception, it needs to be active during the design process and present in an architectural choice on form and measurement. Boudon gives the example of economic concerns that exceed the limits of a simple and passive reference, when the architect reduces the *linéaire de façade* (through which the heat losses occur), in order to save on heating demands of the building: in that case, the economic space of reference is treated as an economic *scale*.

2.1.5.9. Models a priori and models a posteriori

Modelling is a contemporary scientific practice that works on the intelligibility of a phenomenon by constructing representations located at an intermediate level between theory and reality

In reality, the epistemological question posed at the point of analysis (Boudon, 2002b, p. 53) could be reduced to the nature of the analysis which is to be *a posteriori*; that is, we always analyse something that is firstly given to us. The authors of *design research* (the anglosaxons G. Broadbent, B. Archer, O. Akin, B. Lawson or the french M. Conan and R. Prost) denounce – regardless of the diversity of the design process models each of them propose- an *a posteriori* model of an already given element. The *architecturological* model differs in its character *a priori*: "we do not place the process as a given data that would have to be modelled (...) but we propose *a priori* a design operation model supposed to be locally implemented."¹¹⁹ (Boudon, 2002b, p. 56) Philippe Deshayes made a distinction between *a priori* and *a posteriori* models (Deshayes, 1986, p. 94) He demonstrated the character de facto *a priori* of the architecturological modelling (Deshayes, 1986) by deploying the passage from a posture *a posteriori* to a posture *a priori* in the work of Christopher Alexander.

A model is *a posteriori* because of its capability to represent a reality, while an *a priori* model is not constructed from reality but implies a heuristic capacity, making it possible to question reality.(Vitalis & Guéna, 2020) It is « not conceived or chosen from reality (...), but alongside it, therefore independently of it » (Deshayes, 1986, p. 94). The architecturological scale is considered as an *a priori* model.

¹¹⁹ « on ne pose pas le processus au départ comme un donné qu'il s'agirait de modéliser (...) mais on propose a priori un modèle d'opération de conception supposées être localement à l'œuvre. »

To conclude, architecturology suggests that, the objects of design being objects that do not exist yet - therefore, not being able to be analysed - require the consideration of an epistemological posture *a priori*¹²⁰ dissociating itself from *a posteriori* analytical approach followed most often by design studies.

« Dans son travail, l'architecte réunit ce que chacun des points de vue sépare. Ainsi faut-il plutôt envisager la conception comme un système complexe, pouvant être rendue intelligible par un travail de modélisation *a priori*, plutôt que comme l'addition de différents points de vue réducteurs dans une sorte de conjonction alchimique...la démarche architecturologique tente de rendre compte de la diversité des modalités de décision dans une cohérence globale (un modèle) » (Boudon et al., 2001)

2.1.5.10. Constraints

We are slaves of the law so that we may be able to be free. Marcus Tullius Cicero

« The constraint does not, in general, abolish decision and choice » (Neuberg, 1990, p. 518)

D. Raynaud (Raynaud, 2004) have tried to clarify the concepts of *freedom* and *constraint* studying architectural design as an activity that is said to be « a constraining space while achieving to design original solutions » More specifically, by aiming at a factual as well as a theoretic approach and relying on philosophical and sociological legacy, he studies the ways in which architects manage to unfold a space of freedom within a constraining situation. At first Raynaud distinguishes the form of the constraint and its content, by using the term *injunction* to refer to the « objective content » of it, and the *constraint* as « the effect that an individual has on another individual via this injunction ». The injunction is subdivided in order, permission, prohibition. He considers a classification of constraints to redefine the articulation between freedom and constraint; the simple constraints include the negative injunction (interdiction), the injunction simply restricted, the injunction doubly restricted and the positive injunction. When an architect designs a project he is being exposed to elements that can be combined; simple constraints, composed constraints, of principle and disposition, and lateral ones.

¹²⁰ ce modèle théorique engage que toute opération de conception transforme un état donné dans un autre *via* une opération (Boudon, 2002, p. 56) (Boudon, 2002b, p. 56)

The status of the architect is often being dichotomised between a pure artist and a technician. However, his autonomy is never unlimited or unconditional: an architect is neither totally free to choose, nor totally constrained by the technical and juridical framework. « La confrontation aux contraintes externes transforme la nature du travail de concepteur. (L'architecte) n'apparaît plus comme un artiste libre de donner les pleins pouvoirs à sa fantaisie ou à son imagination créatrice » (Farel, 1995, p. 53)

Architecturology considers constraint as a concept by de facto differentiating it from that of *scale*- as the former by definition does not proceed from the freedom of action. Supposing that the architectural design reposed only on the resolution of constraints would reduce it to a determinism, where the design process would be a fixed, defined process. The conceptual position of architecturology is that even if an architect responds inevitably and undoubtedly to multiple constraints, the design is not restricted solely in their satisfaction but entails even a minimum freedom of the conceiver.¹²¹

« La modalité d'exercice de la *contrainte* en tant que nécessité incontournable est étrangère à l'espace de conception, par définition, puisqu'elle exclut la liberté de choix. (...) Mais le *traitement de la contrainte* se situe à un autre niveau que la contrainte elle-même. La prise en considération d'une contrainte n'exclut pas, elle, des alternatives, donc des choix. » (Boudon et al., 1994, p. 157)

According to the classification of Raynaud (Raynaud, 2004) the simple constraints include the negative injunction (interdiction), the injunction simply restricted¹²² (limited), the injunction doubly restricted and the positive injunction¹²³.

Following a simply limited injunction, an architect has a limited interval of freedom, as he has a regulatory dimension to respect, of a lower or upper limit.

In a positive injunction, the architect is not subject to an interpretation of the design act but is bound to pursue a preconceived design activity. 'What is restrictive for the designer is to

¹²¹ Le Dictionnaire de l'Architecturologie

¹²² « *l'injonction simplement bornée* enjoint le concepteur de respecter, dans les dispositions de l'ouvrage, une borne soit inférieure, soit supérieure, limitant un intervalle donné de liberté. (par exemple article du Code de l'urbanisme une distance au moins 4m peut être exigée entre deux bâtiments non contigus) (Raynaud, 2004, p. 348)

¹²³ Exemple (code de la construction : un éclairage de sécurité doit être prévu dans tous les cas) » (Raynaud, 2004, p. 349)

translate the content of the injunction into space, and to adjust this content to the shapes and dimensions of the building' (Raynaud, 2004, p. 349)

As Raynaud demonstrates, there is an order among the forementioned injunctions regarding the degree of constraint: it increases from the negative injunction to the positive one. That is because a negative injunction does not intervene in the design activity in a way that it annuls only one of the possible hypothesis or choices of the architect; contrarily, these latter are rather intruded with a positive injunction.

The theory of Simon¹²⁴ on *satisficing*, advocates that the suboptimal solutions composed by a designer are not constituting a delimited array. 'The solutions being imagined by the architect, the transmission of the constraint is broken, except if the architect's interlocutor himself sets out the terms of a compulsory choice between several positive injunctions. In all other cases, the architect is free to imagine the solution that suits him, as long as it does not contravene the regulations.' (Raynaud, 2004, p. 352) It must be noted here that the satisficing solutions of Simon cannot be applied in every case of architectural design, as in a case of 'the most reasonable solution' for instance, only the architect is able to define what it seems to him to be one.

2.1.5.11. Architect's discourse

Naturally, an architectural discourse combines diverse levels and elements. Regulatory constraints, data, scales, measurements given are evoked in relation to spaces of reference. Often in this kind of discourses architectural space and space of design are interwoven.

The scales concern not only the objects measured by the architect (architecturological dimensions) but also the instruments he uses (relevance) as well as the spaces to which he refers. (points of view) (Boudon et al., 2001, p. 276)

In this part we are going to focus on some discourse that mainly refers to the general ideology of the architect, in an attempt to take a distance from the doctrinal discourse of the building itself – sometimes linked to a rhetorical discourse or marketing purposes- in order to take an insight in elements that influence his design process.

The doctrinal discourse on architecture has the aim of promoting the architectural object by representing it, as well as guiding the architect itself in the creative process he pursues. In other words, it describes the project. The words that formulate that kind of discourses have more

¹²⁴ Simon H. A., 1969. Sciences des systèmes, sciences de l'artificiel, Paris, Epi. P.84

often a descriptive value or serve as a legitimating tool towards others. In addition, the discourse can contribute to drawing correlations that concern the production of an architectural project situated in its contemporary socioeconomic and cultural environment.

In the specific point of view of architecturology it would be beneficial to have an insight into the discourse that accompany the architectural design process, that is thinking on the discourse, words, texts that participate actively in the design process. When questioning architecture, we do not deal solely with a built object, a built space: we rather interrogate the work that pre-exists its construction. The questions related to the «verbal material» of architecture constitute the inaugural work of architecturology as the discourses on the design become the medium through which a knowledge of the architectural design can be initiated (Boudon et al., 2001, p. 51).

2.1.5.12. Architect's drawings

Among the different approaches in architectural design by authors of architectural and urban research, architecturology has promoted the use of graphic sketches for the reconstruction of the design process of a building. The reconstitution of a design process carried out from a semiotics of sketches and a possible clarification of the cognitive mechanisms involved, -its acceptance however being far from reaching a consensus- can lead to a development of distinct scientific models. (Lecourtois, 2006)

2.1.5.13. State of the art of research in architectural design process since 2000

Dominique Raynaud carries out an essential research on architectural conception. (Raynaud, 1999, 2000, 2001, 2002b, 2004, 2017)

Gilles Halin, in his mémoire HDR¹²⁵ « *Modèles et outils pour l'assistance à la conception. Application à la conception architecturale* »¹²⁶ (Halin, 2004) refers to different approaches in applications and experiments in architectural design assistance, implementing information technologies.

The Doctoral thesis of Damien Claeys, « *Architecture & complexité. Un modèle systémique du processus de (co)conception qui vise l'architecture* » (Claeys, 2013) intends to elaborate an

¹²⁵ Habilitation à Diriger des Recherches en Informatique

¹²⁶ Models and tools for design assistance. Application to architectural design

analytico-systemical model of the design process that aims at architecture. He presents a critical history of the theories on architectural design and models of (architectural) design process.

Thomas Zédin have conducted a research in design mechatronics, focusing on the concepts production for construction robotics. In his Doctoral thesis (Zedin, 2020) he led a series of experiments on case studies, the scientific foundations of their analysis and observation being architecturology and C-K theory.

Among the recent francophone studies in relation to architectural design process we can cite the following ones:

Jean-Luc Wippler, in his doctoral thesis entitled « *Une approche paradigmatique de la conception architecturale des systèmes artificiels complexes* » (Wippler, 2018) proposes a paradigm of the architectural design of the complex artificial systems in a holistic and systemic way.

Damien Claeys, in his article « *Discontinuités des processus de conception architecturale : crises de la représentation ?* » (Claeys, 2018) investigates the design and representation process of an architectural project in relation to the use of representation tools and contemporary digital tools.

Adeline Stals, with her Doctoral thesis entitled “*Pratiques numériques émergentes en conception architecturale dans les bureaux de petite taille. Perceptions et usages de la modélisation paramétrique*” (Stals, 2019) aims at identifying the cognitive strategies and adaptations deployed from the use of parametric modelling tools within the architectural design processes observed.

Louis Vitalis, in his Doctoral thesis “*Modéliser le processus de conception architecturale à l’aune d’une « conception de la réception ». Étude épistémologique*” elaborates the concept of « conception of the reception” aiming to elucidate this thinking process. In his study, the theory of architecturology is analysed. The cases projects of Bernard Tschuli and Rem Koolhaas for La Villette park competition in 1982 are being studied under this prism. The modelling of their design process aims at evaluating the capacity of the chosen theory to describe the “conception of the reception” (Vitalis, 2019)

Franck Li is currently working on the case study of the Humble Administrator's Garden in Suzhou, China, interrogating its landscape design by the viewpoint of architecturology and mesology¹²⁷. (Li, 2019)

¹²⁷ For an insight in Mésologie see recent research conducted by Augustin Berque

2.1.5.14. State of the art of research respecting architecturology since 2010

Samia Ben Rajeb has interrogated more specifically the cognitive operations of remote collaborative architectural design (Ben Rajeb, 2012, 2013; Ben Rajeb et al., 2010; Lecourtois et al., 2010)

Auréli de Boisseau in her Doctoral thesis « *Modélisation paramétrique en conception architecturale: Caractérisation des opérations cognitives de conception pour une pédagogie* » (de Boissieu, 2013) identified cognitive operations involved in the uses of parametric modelling in architectural design. The results are proposed as a support towards a pedagogy to assist architects to parametric design. Architecturology is used as a scientific support of the research.

Fathia Bouchareb Bellagha's article « *Pratiques et représentations dans la conception des intérieurs chez Matali Crasset et Zaha Hadid* ¹²⁸» (Bouchareb Bellagha, 2014) is based on architecturology and semiotics; to understand the cognitive mechanisms of the design from the designed space on the one side; and to interpret the meaning of the architectural productions considering the context of their generation on the other.

Joana Mourato Vaz in her Master thesis « *Analysis of the Architectural Design based on architecturology on Modern Buildings. A route between São Pedro de Moel and Manuel Tainha's Architecture* » (Mourato Vaz, 2014) applied architecturology in the analysis of architectural works in Sao Pedro de Moel in Portugal-

Amira Bejaoui carries out architecturological studies referring to the collective architectural design process, suggesting a characterisation of a “collective style” of the architecture agencies analysed. (Bejaoui, 2017; Bejaoui, Allani Bouhoula, Guéna, & Lecourtois, 2018)

Natasha Chayaamor-Heil and Louis Vitalis have initiated in 2019 the research in biology systems, biomimicry and architectural design from the viewpoint of the scientific field of architecturology.¹²⁹ (Vitalis, 2020)

Architecturology as methodology in architectural research is, as seen above, mainly observed in France with the mayor representatives of the last decade being C. Lecourtois (applied in sustainable urban design) and L. Vitalis (reception design – conception de la réception).

¹²⁸ Practices and representations in the design of interiors at Matali Crasset and Zaha Hadid

¹²⁹ See also « Biology and Architecture : scientific knowledge meeting design practice » in <https://calenda.org/804617>

Research paths with architecturology being applied in analysis in Schools of Architecture can be as well observed in Belgium (UC Louvain and U Liège) and Portugal (Lisboa Tecnico).

It has been used in architecture education, pedagogy and research, explaining architecture in university courses¹³⁰.

However, architecturology has not been used only by architects but by authors of other disciplines as well. For instance, Dominique Raynaud (Raynaud, 2002a) questioned architecturology relatively to anthropology¹³¹.

Based on the scientific projects with regard to architecturology, the evolution of practices that model the architectural design can be related to diverse dimensions of architecturology¹³²: conceptual (reception design, architecturology on biomimetics), epistemological (comparative epistemology of design, meta-modelling of design), methodological (architecturology-action, architecturology-mesology), concerning the extensive empirical amplitude of architecturology (landscape, collaboration), as well as the intensive one (conception of the reception).

As far as the fields of study are concerned, architecturology has been implicated in the contexts of parametric design, biomimicry, computer aided modelling design, collaborative design, remote collaborative design and sustainable urban design. It is to the latter context that we tend to anchor.

As seen in the aforementioned framework, an interrogation of the energy efficient architectural design (process) has not been effectuated under the prism of design sciences as well as the theory of architecturology.

2.1.5.14.1. The studies of Caroline Lecourtois on sustainable urban design

A scientific work on sustainable urban design from an architecturological point of view is developed by Caroline Lecourtois. The purpose of her research is to understand « *the specific mechanisms involved in the consideration of sustainability within the processes of designing urban spaces called eco-neighborhoods* » (Lecourtois, 2013) using the methods of applied architecturology. An ecological scale is not present in the architecturological scales that have been empirically produced until now. By developing three studies, her work seeks to

¹³⁰ For example note F. Schatz, Ph. Deshayes, S. Fiszer

¹³¹ For information see http://www.intelligence-complexite.org/fr/cahier-des-lectures/recherche-dune-note-de-lecture.html?tx_mcxapc_pi1%5Baction%5D=noteDetail&tx_mcxapc_pi1%5BidNote%5D=385&cHash=2e2d5d09c2cd3122a3f1c0b63912bfde

¹³² For information see http://fujiyama.crai.archi.fr/wp-crai/?page_id=2884

understand how sustainable considerations influence the design of urban space. She aims at identifying, through architecturology, classes of design operations that are implemented in an eco-design.

The first case is constituted by the writings of three urban planners (Cerdà, Sitte en Unwin) which are read under the prism of architecturology, in order to demonstrate the ways in which, according to them, ecology is involved in urbanism. This part therefore questions the ways in which Cerdà, Sitte and Unwin take account of or evoke ecological considerations in order to describe the mechanisms of urban planning (Lecourtois, 2014b, p. 22). The results of this study concerning the reflexions of these three urban planners on urban ecology are that they are *architecturologically interpretable in terms of the combination of geographical, plot and economic scales.* (Lecourtois, 2014b, p. 25).

The results are then compared with the principles developed by the Ministry of Ecology, Sustainable Development, Transport and Housing concerning the design of eco-neighborhoods. Based on the French Ministry's label of *éco quartier*, this section aims to specify what an urban eco-design would be like. This phase of work led to the modelling of eco-design in the form of a system (Lecourtois, 2012, p. 3)

The second case of this work concerns the analysis of the cognitive operations of design in four eco-neighborhoods *chosen for their exemplarity* (Lecourtois, 2012, p. 4) in order to produce a model in the form of an architecturological map that could describe eco-design. The descriptions and presentations of these *éco quartiers* were studied architecturologically and produced as result a modelling of the design in the form of an architecturological identity card. The third case also aimed at identifying the mechanisms of eco-design: This time, the corpus consisted of the new town of Sénart in France, and the data collected comprised the textual, graphic and discursive productions of the actors involved (Lecourtois, 2015, p. 103) .

This scientific work involving the three aforementioned studies have provided an initial phase of the results: The geographical, plot and economic architecturological scales describe in this first point what sustainable design (*éco-conception*) could be (Lecourtois, 2014b, p. 22).

The modelling of sustainable design from the perspective of architecturological scales was conceived and structured in a form of a system in which the geographical, plot, economic, functional, model, technical and neighbourhood scales would be interlinked (Lecourtois, 2012, p. 3).

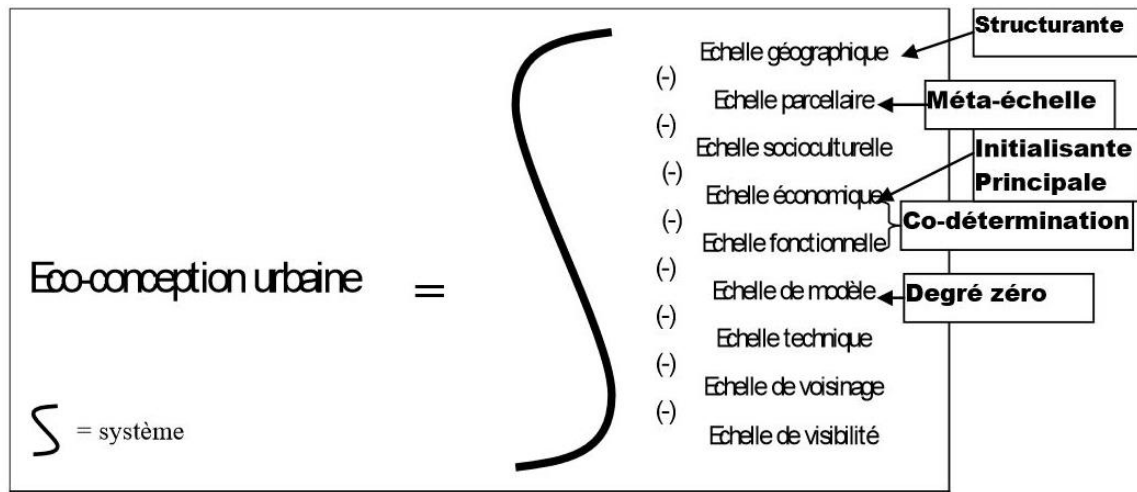


Figure 14 An architecturological modelling of the urban sustainable design and properties of the architecturological scales, C. Lecourtois source (Lecourtois, 2012)

Eco-designing (designing sustainably), would in such a way mean to use considerations related to the geography of the site and the territory, the economy of the project, the future functions of the project, models of spaces or previous processes, the technique of manufacturing, the construction of the spaces and the characteristics of the surrounding neighbourhood of the project (Lecourtois, 2012, p. 3). The scales related to geography, plot, economy, function, model, technicity and neighbourhood would be interwoven.

2.2. Case studies

The corpus of this study will consist of case studies.

Three buildings of the project of the eco - district Clichy Batignolles in Paris will be examined under this prism.

Carrying highly ambitious environmental objectives, this operation proclaims itself as a reference for sustainable urban development in Paris, paving the way for contemporary urban planning that addresses energy and climate concerns (Rougé, 2015)

2.2.1. The choice of the study cases

The eco-districts have been the subject of several analysis as laboratories of experimenting new ways of conceiving architecture and urbanism (Da Cunha, 2011). At the same time, the word eco-district refers to different realities: it does not only question the challenges of ecology or

energy performance but includes issues related to urban sprawl, climate change, local democracy and the management of social and spatial segregation (Jund & Blanc, 2011).

The Clichy Batignolles eco-district project caught our attention because of its size, its high environmental performance requirements and as well as its strong political ambition as implemented by the city of Paris.

The choice of the project allows us to comprehend the diversity of architectural approaches as far as the energy issue is concerned, in a perimeter characterized by the same environmental and energy regulations as well as with the same climate conditions. Located in the 17th district of Paris, Clichy-Batignolles is an eco-neighborhood project currently under construction, while some of its parts are already in use. Characterized as a bearer of ambition by the City of Paris that supports its transformation into a large demonstrative eco-district, it was launched in 2002 and is to be completed by 2020. In the 5th February 2020 it received the *stage 4 EcoQuartier* certification of the Ministère de la Cohésion des territoires et des Relations avec les collectivités territoriales; in particular, the nomination was based on an evaluation of the uses and practices of the ecodistrict, carried out with the Sciences-Po urban planning course on the foundations of the CoRDEES project¹³³.

The architectural writings of the district are dictated by specifications that require a design of buildings capable of producing their own energy as well as spending the least possible energy. Considering the aforementioned elements, three edifices of this eco-district have been chosen to get their design process analysed.

Observing the buildings designed in the eco-district, one can remark their diversity in terms of forms and measures, even though they all achieve the required levels of energy consumption. In other words, they all meet the quantitative standards but with qualitative expressions in different ways.

On the one hand, a building in the form of a bunker, on the other a complex morphology which could call on the digital tools used during the design -in a search for optimization and better use of the solar contributions. In addition, a building with a façade that explores new construction methods and materials, instrumentalised in a way that “demonstrates” its function

¹³³ It will be briefly in chapter 3

CoRDEES : Co-Responsibility in District Energy Efficiency & Sustainability. Pilot project focusing on the energy performance of the west sector, led by the City of Paris in partnership with Paris & Métropole Aménagement, the companies EMBIX and Une Autre Ville, and the engineering school MINES ParisTech through its research centre for energy efficiency of systems.
For information see <https://www.paris-et-metropole-amenagement.fr/en/clichy-batignolles-paris-17th>

and the environmental concerns it arises. Buildings purposely illustrating the consideration of energy issues and buildings adopting *a posteriori* addition of the so-called equipment in their design.

In particular, three buildings with diverse morphology, architectural writing and energy approach have been chosen. They are designed by three architects that are representatives of three different generations.

Situated in the east sector of the Clichy Batignolles eco-district and, more specifically, in the ZAC¹³⁴ Cardinet Chalabre, the buildings have been designed and constructed prior to the current study. The edifices of the lots E.1, E.2 and E.5 will be examined in the following chapters.

Franklin Azzi (born in 1975), David Trottin (born in 1965), Francis Soler (born in 1949) are to be questioned on the ways in which they have appropriated and interpreted the energy issues implicated in the design of their project. The east sector was chosen as a potential terrain for the analysis to be carried out, since the west sector's design has been more present in the bibliography, until this moment. The intention was thus, to shed light on a design process less demonstrated in the public and architectural discourses.

2.2.2. The constitution of the corpus

This eco-district is intended to be a benchmark for sustainable development, by implementing the objectives of the Climate and Biodiversity Plans of the City of Paris. Declared to be a « model of sustainable urban development » its design is said to follow the frameworks of environmental strategies and allow « functional and social diversity, energy efficiency, reduction of greenhouse gases, biodiversity and water management. »

¹³⁴ ZAC : zone d'aménagement concerté

Les ZAC sont définies à l'art L. 311-1 du code de l'urbanisme de la manière suivante : « Les zones d'aménagement concerté sont les zones à l'intérieur desquelles une collectivité publique ou un établissement public y ayant vocation décide d'intervenir pour réaliser ou faire réaliser l'aménagement et l'équipement des terrains, notamment de ceux que cette collectivité ou cet établissement a acquis ou acquerra en vue de les céder ou de les concéder ultérieurement à des utilisateurs publics ou privés ».

Il s'agit donc, au sein d'un périmètre identifié, de concentrer des moyens d'action techniques et financiers au service d'un programme d'aménagement.

2.2.3. Energy criteria

The energy aspects¹³⁵ implemented in the design of the eco-district concern the energy-efficient buildings along with the renewable energy production. The first one refers to the *insulation and bioclimatic design of the buildings lower heating needs to 15 kWh/sqm/year (equivalent to the German Passivhaus standard for passive houses) and air conditioning in commercial buildings*, while the second part concerns the use of *geothermal energy: the heating network (heating and hot water) gets 85% of its power from renewable geothermal energy; and photovoltaic electricity: 35000 sqm of photovoltaic panels on roofs provide 40% of the eco-district's electricity consumption*.

However, it of an utmost importance to underline the fact that the aforementioned quantitative elements were theoretical prerequisites at the moment of the design, do not, thus, ensure the completed project's quantitative results.

In the current study, the energy criteria of the buildings chosen to interrogate were based on four descriptive documents as found in the bibliography: the CDD¹³⁶ of the Zac Cardinet Chalabre, the CPE¹³⁷ ZAC Cardinet Chalabre Lot 2.1.1, the CPAP¹³⁸ ZAC Cardinet Chalabre and the CCC¹³⁹ ZAC Cardinet Chalabre Lot 2.1.1. B.

2.2.4. Positioning the limits

Among the different types (institutional, associative, residents) of operators (municipality, developer, operator, urbanist, associated research offices, territorial actors, inhabitants, special operators and offices of energy and environmental studies, assistant to the project manager, project manager (architectural agencies)) being involved in the project of the eco-district, the study aims at the architects-conceivers taking part in the design of the edifices in question.

Under this prism, the considerations of the points of view of the inhabitants along with the degrees of their proper participation in the design of the buildings are not part of the perimeters of this research.

¹³⁵ <https://www.paris-metropole-amenagement.fr/en/clichy-batignolles-paris-17th>

¹³⁶ Chartre de qualité environnementale, Zac Cardinet Chalabre

¹³⁷ cahier des Prescriptions Environnementales

¹³⁸ Cahier des Prescriptions Architecturales et Paysagères

¹³⁹ Cahier des charges du concours d'architecte

On the same way, among the diverse sustainable and ecological components of the design (biodiversity, rainwater, waste, recycling, energy, grey energy, materials, climate, mobility, social diversity, logistic, carbon footprint etc), a particular focus on the energy considerations will be effectuated.

2.2.5. State of the art of the case study

Clichy Batignolles eco-district has been a terrain for research in the Doctoral thesis of Charlotte Tardieu entitled « *Transition énergétique dans les projets urbains : conditions de mise en œuvre. Analyse des cas Paris Rive Gauche, Clichy-Batignolles et Paris Nord Est* » presented in 2015 (Tardieu, 2015) and studied under the energy prism (Tardieu, 2017)

In 2011, it was studied under a sociological viewpoint, in a Master thesis entitled « L'écoquartier de Clichy Batignolles: Le développement durable à l'épreuve des conflits d'acteurs »¹⁴⁰

The book « *L'Atelier des Batignolles, une nouvelle fabrique de la ville* » (de Gravelaine, 2014) describes the collective work of the atelier having co-produced a part of this project.

In the French architecture review *Architecture d'Aujourd'hui* the project has been the tribute of a hors-série issue published in February 2019. Previously, the issues AA395, AA 416 and AA 423 have referred to thematic elements of Clichy Batignolles ecodistrict.

2.3. Method of analysis

2.3.1. Input materials

The collected data is composed of documentation on the case studies, texts presented in public events and transmitted 'officially' by the actors involved in the projects' construction, written texts on the buildings provided by the architects themselves, texts written in regard to the buildings examined in books and architectural magazines, the transcript of recorded oral discourses of the architects, as well as effectuated interviews of the architects, when this was possible.

¹⁴⁰ It can be found here https://declic1718.org/sites/default/files/docs/ZAC%20Clichy-Batignolles_Le_developpement_durable_a_l_epreuve_des_conflits_d_acteurs.pdf

At the same time, texts- ‘manifestos’ from architects making a stand on the questions of energy and sustainability regarding architectural design¹⁴¹ will be examined.

2.3.1.1. Architects’ texts

The information presented on the official internet sites of the architectural agencies, the leaflets on the buildings provided by the Municipality, the architectural magazines that referred on the projects¹⁴²

2.3.1.2. The official documents

The main sources of officially published data used as input material for the analysis comprise the following elements: the documents produced by the French Ministry of Energy Transition¹⁴³; the documentation of the municipality of the 17th district as well as the one provided by the City of Paris¹⁴⁴ in form of communication booklets about the project; information collected after in-situ visits in the *Maison du Projet* situated in Cardinet Street in Paris- a space dedicated to the communication on the project towards the general public - (collection of photographs, informative panels and posters on the design and the chronology of the project, the history of the location, the energy and environmental objectives,) ; the participation into architecture walks commenting the design of the new ecodistrict,. the website of the City of Paris¹⁴⁵ on the specific project as well as an archived one¹⁴⁶ dedicated to the

¹⁴¹ Rudy Riccieti, Patrick Bouchain, Philippe Madec, Philippe Rahm, Encore Heureux to name some.

¹⁴² Especially Architecture d’Aujourd’hui, D’Architectures and AMC in our case.

¹⁴³ See more in <http://www.ecoquartiers.logement.gouv.fr/operation/1785/>

¹⁴⁴ See more in <https://www.paris.fr/pages/labellisation-ecoquartier-confirme-pour-clichy-batignolles-7531>
<https://www.paris.fr/pages/ecoquartier-clichy-batignolles-la-ville-de-paris-laureate-d-un-appel-a-projets-urbains-innovants-de-l-union-europeenne-4159>

¹⁴⁵ see more in <https://www.paris-metropole-amenagement.fr/fr/clichy-batignolles-paris-17e>

¹⁴⁶ See more in <https://archive-clichy-batignolles.paris-metropole-amenagement.fr/>

project, its documentation and publications¹⁴⁷, communiqués de presse¹⁴⁸, dossiers de presse¹⁴⁹, interviews¹⁵⁰; the blogs of associations¹⁵¹ and officials or residents¹⁵².

2.3.1.3. The interviews

The approach towards the architects interrogated were oriented and adjusted in relation to the specific elements and contexts of their work. However, a more general interview grid was addressed to them, while discussing, with a common corpus of open-ended questions. The frame on which the discussion was based, was applied in the specificities that every project presented.

Aiming at a comprehension of the references implicated in his design process, the recurrency of architectural models connected with his project, the identification of cognitive operations possibly appearing in the design. Re-construct the narrative of the architect with the relevant scientific distance provided by our methodological tool -architectureology- and modelling the conception to diagnose the implication of energy requirements in the design. To illustrate if so the existence of decisive moments in the design process and primordial concepts in the architect's mind without reducing the complexity it folds to

Even if the architects tend to describe the accomplished object the purpose is to shed some light in the mental process proceeding its finalisation and form hypothesis on a possible unfolding of the narrative, the conception.

The structure of the questions posed is the following:

How have you conceived the building (i) ? Could you provide a description/narrative of the architectural conception of this building?

How have you taken into consideration energy in the conception of the building? How have you thought in regard to energy?

¹⁴⁷ See more in <https://archive-clichy-batignolles.parisetmetropole-amenagement.fr/documents.html>

¹⁴⁸ See more in <https://archive-clichy-batignolles.parisetmetropole-amenagement.fr/communiques-de-presse%20.html>

¹⁴⁹ Such as https://archive-clichy-batignolles.parisetmetropole-amenagement.fr/sites/default/files/exe_cb_dossierpresse-fr_220217.pdf

And https://archive-clichy-batignolles.parisetmetropole-amenagement.fr/sites/default/files/exe_web_cb_dossierpresse-en_2.pdf

¹⁵⁰ See more in <https://archive-clichy-batignolles.parisetmetropole-amenagement.fr/interviews.html>

¹⁵¹ See more in <https://parc17.fr/>

¹⁵² See more in <http://didierfavre.com/>

In which ways energy questionings have intervened during the design process? When? Was there a moment when they provoked a change in the hierarchisation of choices, or the organisation of the approach you had initiated with?

Were there moments when it was necessary to reinterrogate and re-study recurrently on the dimensions and forms because of the energy prescriptions? How?

Concretely, in which forms and dimensions of the architectural space energy considerations have been implicated? In which ways?

In which ways energy as a constraint influenced the different phases of the conception?

How have you positioned / oriented / cut the building?

How have you thought the forms and dimensions of the building as far as energy is concerned?

How have you managed the rigorous frame of the energy and environmental context required regards to the 'creativity' and 'freedom'?

Have you incorporated techniques or approaches already treated in other projects of yours even in a different way?

Did any image/notion/project/theory/historical element 'inspired' your thinking during the design? In what way, where can we find it referring to the project?

Have you changed the ways you design and think a project, because of the specific context it imposed?

Have you relied on the utilization of digital design tools aimed at the energy efficient design/ how did this influenced the design process and the decisions?

Could you give us access to the esquisses de travail, the models...?

2.3.2. Scientific protocol of analysis

The general lines of the structural organisation of the analytical part of the current study (chapters 4,5,6) have a common table of contents that reside on the division into three sub-parts.

The first one, briefer, presents the architect concerned, his works and architectural approaches, based on his words. The second one describes the edifice according to the intentions of the architectural team who designed it. Thirdly, an interpretation of the design will follow, implementing as a viewpoint the tools and concepts provided by the methodology chosen.

2.3.2.1. Analysis grid

Approaching an initial detection of the references mobilised, as implied in the architects' discourses, a table will be produced comprising the following elements: the notion, a term or a general concept in from which the reference is generated; the inspiration, based on the previous word, belonging to a more specific universe that activates the design process of the architect; and the action, that is the materialisation of the inspiration in spacious context.

Notion	Inspiration	Action
Notion1	Inspiration1	Action1
Notion2	Inspiration2	Action2

Table 1 Concepts and references mobilised on the design process by the architect N(i)

After the input data being collected, an analysis of them will categorise the aspects possibly related to energy preoccupations. The text will be deconstructed under the prism of the following three concepts, in order to describe the spaces of reference and the operations of design they imply.

The ideal would have been to be able to collect texts produced by the architects at the time of designing the project. The temporality of the study with respect to the one of the designs of the edifices could not permit such an action. The content analysis of the aforementioned documents allowed to establish an initial list of spaces of reference and cognitive operations composing the actions of their design while considering the energy question.

Operation	Dimension	Relevance	Reference
Operation1	Dimension1	Relevance1	Reference1
Operation2	Dimension2	Relevance2	Reference2

Table 2 Identification of cognitive operations of design from the energy viewpoint in the building B(i)

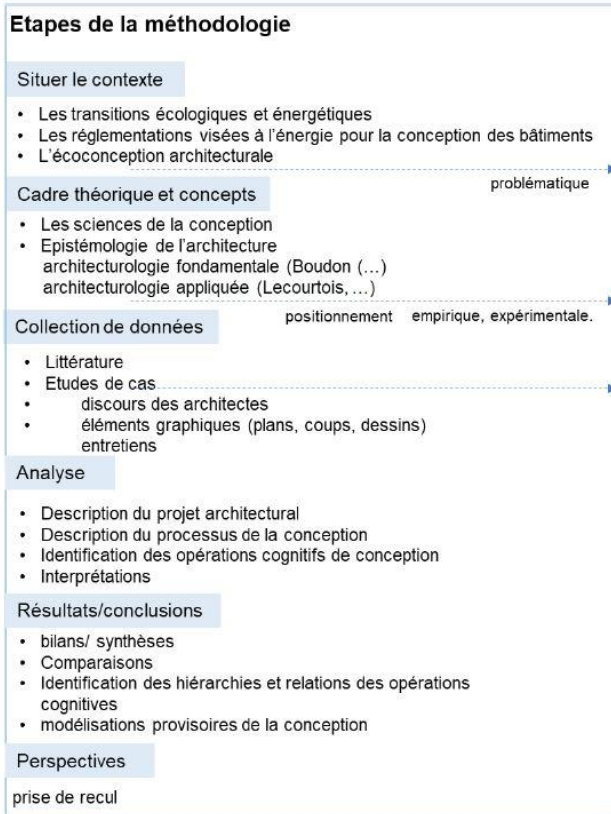


Figure 15 By observing and analysing the study cases, investigations will be carried out to obtain answers to the raised research questions

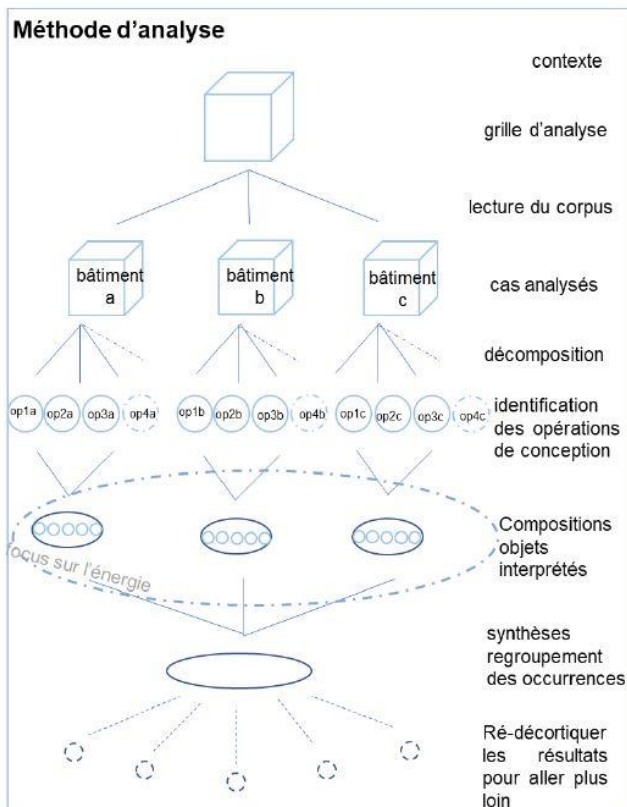


Figure 16 The analysis method consists in applying the chosen analysis grid on the study corpus – the three buildings. Their architectural narrative is decomposed by identifying the possible operations taking part in their design. Provisional models of the design will be produced, followed by a synthetic reflexion.

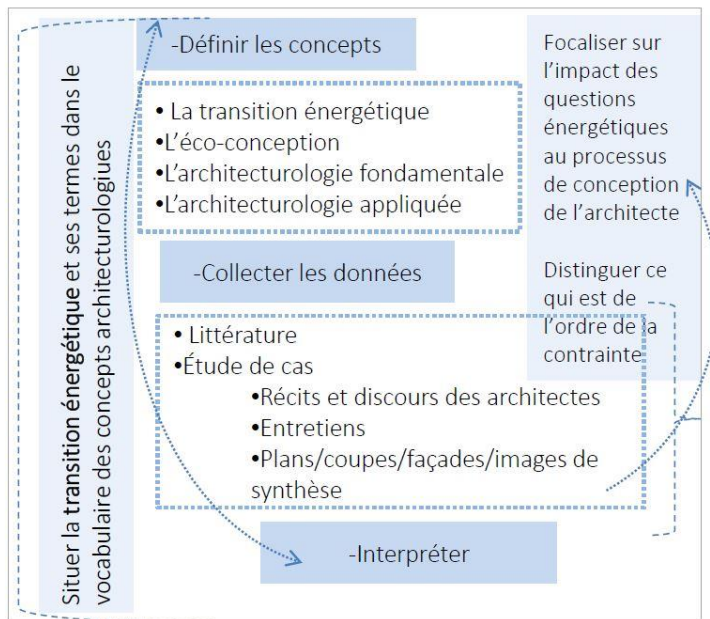


Figure 17 The adopted approach to interpretate the corpus of study

2.3.3. Interpretations under the method's prism

The work that is hereby effectuated consists of an empirical identification of phenomena that refer to the space of conception. As demonstrated in the beginning of this chapter, the architecturological scale is a modality corresponding to a reference space used in the design of the project. (Boudon, Ph., Ville de Richelieu, in Claeys, 2006, p. 16)

The observation of the building and the examination of the discourses formulated in its regard by the architects, make it possible to detect or recognise characteristics of the architectural object that could refer to architecturological scales. What will follow is hence a reconstructed story; « an artificial staging intended to make intelligible facts » (Boudon et al., 2001, p. 265) One of the initial postulates of architecturology is the consideration of the architectural design as a combination of multiples scales producing architectural objects -or « multi-objects»¹⁵³ The aesthetical orders do not belong to the terrain of an architecturological study, dealing rather with an eventual architectural interpretation.

In the architecturological interpretation of an edifice the space of architectural conception is « cut » according to decisions and choices whose relevance and reference are enunciated,

¹⁵³ See more in La notion de multi-objet est reprise par Philippe Boudon de Yves Barel, Le paradoxe et le système, Essai sur le fantastique social, PUG, Grenoble, 1979.

followed by assumptions on the nature of problems underlying the architectural « solutions » that constitute the building (Boudon et al., 2001, p. 88). In order to formulate rigorously those questionings¹⁵⁴, the use of concepts is necessary; they can allow a more precise fragmentation of the architectural conception.

As already mentioned before, the observation of the building, the review of discourses formulated towards it –have allowed an identification of elements that could be related to architecturological scales. However, this does not suggest a deduction that would derive from a simplistic determinism; it rather consists an assumption (hypothesis) of a choice among others possible.

2.4. Conclusions

2.4.1. Re-set the question and the procedure

The question will be approached from the angle of the design sciences.

Based on case studies, we will identify the influences of energy issues awareness on the design process by examining the mutations, interdependencies, and interpenetrations of cognitive operations specific to the architectural design of these projects. The verbatim, the collected documentation along with the interviews of the architects involved -when possible-, will serve to reconstruct the architectural and energetic narratives of the buildings of this urban project.

2.4.1.1. The objectives of the research

In line with previous research questioning architectural design (Boudon et al., 2001) and eco-design (Lecourtois, 2015), the objective of the current research study is to understand the ways in which energy impacts, takes place and intervenes in the design of an architectural project.

This research work implements the methods of applied *architecturology* in order to understand the specific mechanisms proceeding from the consideration of energy within the design processes of architectural spaces named energetically efficient or performant. The research

¹⁵⁴ The point of view of architecturology examines the object by bringing it back to the questionings the architect worked on during the conception.

aims to elaborate the ways in which energy considerations influence the design processes of the architectural space to build knowledge of the cognitive operations of the so-called energetically performant design.

In other words, it focuses on the impact of energy issues in the design process by situating the concepts of energy transition in the vocabulary of the *architecturological* concepts.

2.4.1.2. The scientific objective

The scientific objective of the study lies in demonstrating to what extent and how sustainable energy design cannot be reduced to a solution or an answer to a quantitative energy question. Does it incite to take into consideration a complexity that is difficult to dissect at its whole? The scientific objective aims in demonstrating how the design does not lead to an unequivocal – in the sense of categorical, here- answer, or a solution produced in an automated way, and, despite the imposed normative framework, architecture does not become a pure act of technique.

Understand how energy questions lie in the plurality of responses and not in one (theoretical) model (of design), when the varieties of architectural responses to the architectural competition demonstrate a diversity with which architects organize measurement operations in their design process. Thus neither the program and the plot given, nor the quantitative constraints linked to energy had led to an automatic solution. Energy questions various design spaces. Partial elements can be elaborated through use of digital programs and software applications, without however being reduced or limited to them.

Beyond that, it is the role of the architect-designer that is questioned, in an era where the imperatives of sustainability impose themselves as a dominant paradigm and are urgently inscribed and promoted on the public policy agenda.

This invite to further consider/examine the epistemologically complex nature of architecture itself. The circulation of models and concepts that depart from other disciplinary fields towards architecture, a metaphorization, which refers to the transposition and circulation of concepts, raise questions on the autonomy of the architect: what are the effects of the energy transition on architectural production? What are the limits of this transposition of concepts, notions, models, along with the effects it produces?

2.4.1.3. The scientific contribution in terms of originality

The field of sustainability in architecture and more specifically that of energy performance is set under a point of view that has not been treated previously in this context. The current study is situated in the path Caroline Lecourtois have initiated (Lecourtois, 2012, 2014a, 2015) - having examined the urban eco-design - , positioned however in another scale (that of buildings), and oriented towards the transformation of quantitative energy requirements into a qualitatively set of measures and dimensions to form a space. In addition, the methodological tools and concepts used in order to proceed the analysis, that is the language of architecturology, in a broader context part of the design sciences, has not been used in the same way to confront this subject, as the previous studies mentioned.

2.4.1.4. The aim of the theoretical design modelling

First of all, the intention is not to propose a theoretical model of energy-efficient architectural design, but rather to demonstrate the existence of a plurality of models. In other words, architecturology as a method makes it possible to highlight the absence of a univocal answer. The aim of a specific model is questioned.

The modelling of the design allows in our case to have a common base in order to pursue the reading of the three case study buildings, far from their specific details; to be able to compare and find similarities in the design approaches. Various ways of dealing with analogous questions and similar issues could be revealed. Yet, modelling is not the goal, a finality in itself, but a means proceeding the analysis, which will assist in formulating new questions, substituting elements or drawing conclusions by being on the same time situated outside the specific elements which concern each one of the buildings.

The modelling comes after the analysis and the architecturological interpretation.

The modelling of the conception is not the objective of the research; it is rather being implemented a means for constitute its reading and enabling a production of knowledge that would lead to drawing conclusions and forming new questionings.

2.4.1.5. Epistemological positioning/stance

In the current research, the epistemological position, in other words, the mode of access to the object of research, is oriented towards constructivism: the constructed reality is subjective and dependent on the observing system.

The approach is inductive: departing from a particular element we tend to approach a general one. The positioning is empirical, experimental. Research methods: exploratory research which helps identify and define a problem or a question

The research is anchored in the case where the observed phenomenon gives a value to the theory¹⁵⁵. (*accommodation*) - and not vice versa, when the theory provides an explanation of the phenomenon observed. In our case, modelling reduces¹⁵⁶ architecture to measure. Via modelling we do not intend to read reality. The knowledge produced will not be the result of a mathematical description but a constructed product, inscribed in a certain context, with filters and biases: It is the point of view that creates the object.

2.4.1.6. From the duality of the state of the art to a multiplicity of conclusions

A particularity in constituting the state of the art is the fact that it is composed of two parts; the one residing in the general subject -that is the sustainable energy in architecture- while the other concerning the methodology, the research tool used.

The question of *sustainability* and consequently the question of energy in architecture is a debated, controversial, interdisciplinary subject. At the same time, the tools with which an architect is currently interacting are abundant and continue to develop.

Three points seem epistemologically interesting here:

- 1) It seems useful in this regard to recall that architecture, not having fully acquired its status as a discipline¹⁵⁷, has a heterogeneous character which cannot be reduced to a single aspect.
- 2) Another epistemologically essential element is the nature of architecture positioned at the crossroads of science and art during time.
- 3) Regarding the *design sciences*, the field is characterised too by a multiplicity of points of view (for instance the internalists' and the externalists' viewpoints).

¹⁵⁵ La théorie étant ici l'architecturologie et le phénomène observé la place de la transition énergétique dans l'éco conception architecturale

¹⁵⁶ Les limites de la modélisation et la réduction qu'elle induit : *L'abstraction, la conception, la modélisation réduisent le réel à quelques dimensions et appauvrissent la perception au lieu de l'enrichir* (Bergson, 1911)

¹⁵⁷ Malgré sa présence évidente dans l'univers académique, l'architecture est encore en train de construire son statut gnoséologique (Mantziaras, 2014)

4) Even the question of sustainability and energy is situated at the crossroads of disciplines and treated within different approaches, methods, tools.

However, the two states of the art, the discourse on sustainability as well as the design sciences share a common base: they both use the same language structure and organisation.

2.4.2. Reset the methodology – the place of architecturology

The reason of using architecturology and the intentions will be outlined.

Architecturology is chosen for it consists one of the sole constructed languages that can describe conception by producing knowledge on the cognitive activity of architectural design. It is a scientific tool that provides the relevant distance on the descriptions and dissociation from the doctrinal architectural discourse.

It has to be stated though that as the study is empirical, it remains provisory and with a degree of uncertainty.

The direction to be followed is away from carrying out an exhaustive architecturological analysis of the design of the building but rather of continuing an analysis of the elements present in its design process that will be considered essential. On the basis of the concepts offered to us by the vocabulary of the methodology used, a reading of the design will be carried out. As we focus on the involvement of energy issues and the imperatives of environmental performance in the design process, the point of view will therefore be set under this prism. The use of the postulates of architecturology as well as the scales that compose its vocabulary will be applied when reading the conceptual phase of the project.

Architecturology will not be used as an end in itself but mainly as a tool providing a scientific basis where the use of its concepts can evoke others and open widely the discussion.

2.5. Epilogue

With the energy transition becoming mandatory for the architects, the study interrogates how do architects do today. The interrogation is carried out under the prism of the design sciences and the systematic vocabulary of Architecturology.

Disciplines such as design sciences, computer sciences, psychology and ergonomics, philosophy and history of techniques, neurosciences can be mobilised when it comes to study the design¹⁵⁸. (*conception*). The design sciences (*sciences de la conception*), for instance *architecturology* or the C-K theory enlighten the design processes: they describe and explain the cognitive process of the architectural project. To interpret and clarify the design activities, they establish theoretical models. These models can be used as reading grids of design activities in order to understand their cognitive mechanisms. In other words, design sciences are approached through different theoretical models that illustrate the design activities, such as *architecturology* (P. Boudon), C-K theory (A. Hatchuel) or FBS (Function-Behaviour-Structure) ontology (J. Gero)

The design activities of contemporary architecture can be interrogated through new paradigm and tools, such as collaborative design, parametric design, digital fabrication, generative design, neurosciences, or biomimicry¹⁵⁹.

The three projects in Clichy Batignolles eco-district constitute the study cases on the implication of energy concerns in the design process and the application field of an architecturological study. They have been chosen for assembling most of the parameters related to sustainable energy design.

The reason why architecturology is chosen along the design theories is in relation to its characteristics; it takes the specificity of architecture into account; it has established a formally constructed vocabulary and a scientific language; and it presents a modelling capacity. In addition, it demonstrates a potential of generalisation.

¹⁵⁸ See more in http://www.paris-lavillette.archi.fr/uploads/images/dsa-dpea/OUVRAGE%20DPEA_2017_WEB.pdf

¹⁵⁹ Those emerging design activities are studied by the MAP-MAACC laboratory in France, by using two scientific anchorages: design sciences and digital sciences.

On the same time, this theory has not been applicated as for now in the study of the energy considerations in sustainable design, constituting an original viewpoint on the subject.

The edifices chosen as study cases are relevant to study as they suggest particularly diverse innovative approaches in a very restricted “sustainable” context, meeting an ambition energy program as well as a social one.

The experimental approach to be followed proposes a reading of the cases by the scientific distance provided by the theory, allowing at a second phase to comprehend the mental processes present on the design of the projects with an orientation towards energy concerns.

The modelling of this process will allow to compare the cases and to provide more general conclusions on the subject.

Second Part

Analysis



*'It seems that the fact that the world is round and that it rolls is not up for debate anymore.
What is up for debate, instead, is how to live on it.'*
(Superstudio, "Design d'invenzione e design d'evasione", Domus, 475, juin 1969 [1967])

Glossary of architecturological concepts

Space of conception or space of design (*Espace de conception*)

It is distinct from architectural space. It refers to the project seen through the design activity (*activité de conception*). It will be called *architecturological space* when it will be constructed by a set of architecturological concepts and no longer identified only by intuition or experience. (Boudon et al., 2001, p. 80)

Space of reference (*Espace de référence*)

It allows to understand the meaning of the referencing modalities that take place in the design. In other words, they are classes of representation of reality.

For an architect, such representation classes allow to identify references likely to intervene actively in his design work. In that case, the referenciation will play an active role in his work. (Boudon et al., 2001, p. 111)

Relevance (*Pertinence*)

When the architect decides on a measure, whether he chooses an order of magnitude or an intensity, whether he introduces the quantifiable or the qualifiable, he decides relatively to a point of view that refers to one or more several reference spaces. In the design, summoning a reference space in relation to which one or more measurement operations take on meaning, consists, among other, in defining the relevance of these measurement operations. Deciding on a measure requires thinking about its relevance, that is, appreciating its value, relatively to a reference space. (Boudon et al., 2001, p. 119)

Operation (*Opération*)

The design process is a process which involves a gradual transformation of what is planned. The operations regulate the transition from one state to another in such a process.

(Boudon et al., 2001, p. 135)

Caroline Lecourtois has identified apart from the operations of dimensioning, cutting and referencing that Ph. Boudon had demonstrated, the positioning and orientation operations as well.

Overdetermination (*Surdétermination*)

In an occurrence of association of several architecturological scales for a single measure, that is corresponding to the same architectural dimension, we refer to overdetermination as a mode of relation between them. (Boudon et al., 2001, p. 198)

Zero degree (*Degré zéro*)

We will refer to *zero degree* of a *scale* when the referencing, dimensioning or cutting operations implemented by the designer find their relevance on the contrary in this *scale*. In other words, when the conceiver intentionally denies or disagrees with the information that a *scale* carries, we are dealing with a *zero degree* case of the *scale*. (Boudon et al., 2001, p. 164)

In the text, the word *scale* in italic (*scale*) would refer to an architecturological scale.

Architecturological scale (*Echelle architecturologique*)

Philippe Boudon calls an architectural scale a class bringing together various operations referring to a homogeneous relevance. (Boudon et al., 2001, p. 166)

-Technical scale (*Echelle technique*): Use technical considerations to induce a modality of attribution of measurements to a part or the ensemble of the architectural space.

-Functional scale (*Echelle fonctionnelle*) : Give the measurement of a part or all the parts of an architectural space in correspondence to some external element which regulates its destination, use, or its adaptation to a use.

-Symbolic dimensional scale (*Echelle symbolique dimensionnelle*) : Associating the choice of a size with a clearly identifiable spiritual content.

-Symbolic formal scale (*Echelle symbolique formelle*) : Conceiving an architectural space in accordance with a symbolic form, a form through which a particular spiritual content is associated with a concrete sensitive sign.

-Neighbouring scale (*Echelle de voisinage*) : Assigning measures by contiguity, relatively to elements belonging to the neighbourhood and inducing spatial continuity.

-Plot scale (*Echelle parcellaire*) : Carrying out measurements using the possibilities permitted by the size, shape and boundaries of the land given to the architect.

- Geographical scale (*Echelle géographique*) : Informing, in some way, the measurements of a part or the ensemble of the architectural space from considerations on the orientation of the cardinal points, the situation and the contours of the land, climatic data etc.
- Scale of visibility (*Echelle de visibilité*): Situating an object or a part of an object in such a way that it is seen from a place, or that it has a view towards a place or a set of places, or more generally constitute a point of view in the real space.
- Optical scale (*Echelle optique*): Taking into account a point of view - literally - to give to a part or a whole of the architectural space a measure which involves the modalities according to which it is seen.
- Sociocultural scale (*Echelle socioculturelle*): Taking into consideration conventions, traditional forms or other socio-cultural heritages, to give shape and measure to a part or the whole of the architectural space.
- Model scale (*Echelle de modèle*): Resuming a previous model, while possibly making eventual modifications of various degrees and of various kinds.
- Semantic scale (*Echelle sémantique*): Performing dimensioning, cutting or referencing operations permitted or suggested by words or verbal expressions.
- Scale of extension (*Echelle d'extension*): Carrying out any design operation of the architectural space that incorporates a future state.
- Economic scale (*Echelle économique*): Designing part(s) of the architectural space in relation to their cost, or by engaging in possible cost exchange games between various parts of this architectural space.
- Geometrical scale (*Echelle géométrique*): Using geometric considerations to cut out or refer to parts of architectural space or to transcribe other measurement methods.
- Scale of design levels (*Echelle des niveaux de conception*) : To cut out, reference, give dimensions to the reality to be designed, from micro to macro, according to the level of representation due to a cartographic scale or, more generally, to cut the design space into design sub-spaces.
- Global scale (*Echelle globale*): Treat a relevance in a dominant, main or structuring way, that can be the result of one of the different *scales*.

3. Clichy-Batignolles eco-district

3.1. Prologue

This chapter focuses on Clichy Batignolles. It presents the main elements having directed the design of the eco-district. It defines the specific energy-related aspects characterising the project in its urban scale. At the same time, it identifies the different design processes that were followed in its west and east sector.

More specifically, firstly, it situates the historical context of the intervention along with the central ideas in which it has been structured.

Secondly, it cites the prescriptions of the ZAC Clichy Batignolles, urban and environmental ones, dictating the specific regulations to consider during the design process.

Thirdly, it outlines the focus on sustainability issues along with the energy concerns having been implicated in the design and explains their relevance to the present study.

Finally, it attempts an architecturological reading of the eco-district, in its urban scale.

This part could be read as an introductory level of the analytical part that follows (chapters 4, 5, 6), setting the general context in which the case studies have been developed as well as demonstrating the pertinence of the case studies chosen.

3.2. Introduction on Clichy-Batignolles eco-district

The operation of Clichy Batignolles, located in the 17th district of Paris, is an eco-district project, currently under finalisation, where urban planning aims to meeting energy and climate concerns. By ambitioning to be a model of energy efficiency and environmental excellence through its sustainable design, the project is said to pave the way for contemporary sustainable urban planning, by its conceivers.

The City of Paris desired to make Clichy-Batignolles a model for sustainable urban development -and an exemplary paradigm of eco-neighborhood in compliance with the French environmental pact objectives - bringing to life through this project its ambitions in terms of mixed functions and social diversity, energy efficiency, reduction in greenhouse gas emissions and biodiversity. Indeed, as far as energy considerations are concerned, the energy consumption of buildings is set to be limited to 50 kWh per sq. m. per year. Heating must not exceed 15 kWh per sq. m. per year, i.e. equivalent to that of Germany's Passiv Haus certification. The buildings in Clichy-Batignolles will be connected to a heating grid supplied with geothermal energy¹⁶⁰.

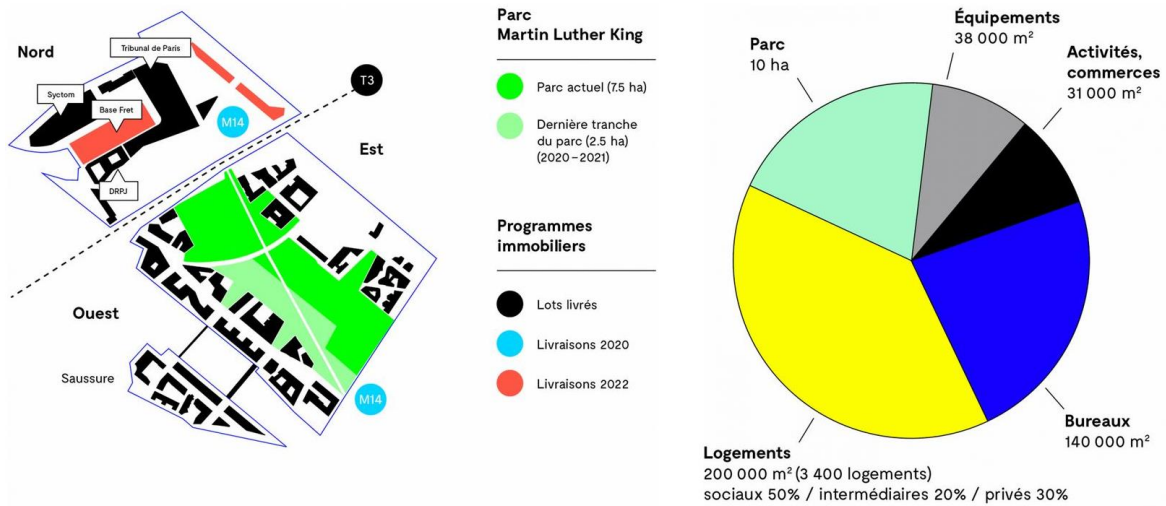
On the same time, the project has been the subject of a significant procedure as far as the site development method is concerned: diverse functional entities, public and private stakeholders gathered under the aegis of workshops to exchange on its implementation.

The site where this urban intervention takes place is an area of 50 hectares built around Martin Luther King park, accommodating around 3500 housing units, the Tribunal de Grande Instance and the Cité Judiciaire.

program	surface
general	54 hectares
parc	10 hectares
Housing units	3 400 -
Office spaces	140 000 m ²
courthouse and regional headquarters of the judicial police	120 000 m ²
shops, culture and recreational facilities	31 000 m ²
public facilities	38 000 m ²

Table 3 The program of Clichy-Batignolles urban intervention. Data retrieved from <https://archive-clichy-batignolles.paris-metropole-amenagement.fr/la-programmation.html>

¹⁶⁰ i.e. energy that uses the natural heat from a warm groundwater table. Geothermal energy enables heat production using at least 85% renewable energy sources.



Equipements remarquables

Parc	10 ha
Pôle judiciaire	Tribunal de Paris Direction Régionale de la Police Judiciaire Maison des Avocats
Cité du Théâtre	Odéon - Théâtre de l'Europe Comédie Française Conservatoire National d'Arts Dramatiques
Pôle loisirs	Cinéma de 7 salles Centre Paris Anim'

Transports

Existants	Méto lignes M13, M2, M3 RER C Transilien ligne L Tramway T3b
A venir	Méto ligne 14 prolongée (2020)

Immobilier

Logements (200,000 m²)	3 400 logements 50% de logements sociaux 30% de logements en accession 20% de logements intermédiaires
Bureaux	140 000 m²
Commerces et services	31 000 m²
Equipements publics	38 000 m² 3 crèches 1 halte-garderie 3 groupes scolaires 1 centre PMI 1 collège 2 gymnases 1 centre d'animation 1 école maternelle

Figure 18 General information on the program of Clichy-Batignolles urban intervention. data retrieved from <https://www.paris-metropole-amenagement.fr/fr/clichy-batignolles-paris-17e>

Lot	operator	architect
east sector		
Phase 1		
e1	Paris Habita	Franklin Azzi Architecte
e2	Nexity Seeri	Périphériques
e4	RIVP	Philéas K Architecte
e5	Vinci	Francis Soler
e6	Vinci + Orpé	BP Architecture, Atelier du Pont
e7	La Sablière	Antonini et Darmon
e8	Sodearif, Cogedim	Gausa+Raveau, Avenier Comejo
e9	RIVP	Babin Renaud
e10A	SNI	MAAST
e10B	Paris Habitat	TOA, AASB

Table 4 Operators and architects taking part in the design of the Clichy-Batignolles east sector project. data retrieved from <https://www.paris-metropole-amenagement.fr/sites/default/files/2018-11/montage-pba-01.pdf>

Lot	operator	architect
west sector		
Phase 1		
o1/o3	Bouwfonds Marignan et MAB Développement	Le Penhuel, Saison Menu et Agence Sud

o2	Emerige	Biecher et Mad
o4a	Paris Habitat	Brisac Gonzalez et Antoine Regnault
o4b	Aires Mateus, Kaufman & Broad	AAVP (Vincent Parreira)
o5	Sefri Cime, AG2R/La Mondiale	Viguiet & Associés et Agence Search
Phase 2		
O6a	I3F, GEC Ingenierie	Querkraft Architekten, Sam architecture et Atelier Roberta
O6b	Egis Concept, OGIC, Demathieu Bard Immobilier	Fresh Architectures, Itar Architectures, Base
O7	Alto Ingenierie, Emerige, BNP Paribas Cardif	Chartier-Dalix, Brenac & Gonzalez, OLM
O8	Frank Boutte, Sodearif, Nexity	TVK, Tolila + Gilliland, Praxys
O9	Enbergelio, Bouygues Immobilier, Caisse des dépôts et consignations	Baumschlager Eberle, Scape, Latz+Partner

Table 5 Operators and architects taking part in the design of the Clichy-Batignolles west sector project. data retrieved on https://archive-clichy-batignolles.paris-metropole-amenagement.fr/sites/default/files/cahier_central_int_24p_web.pdf

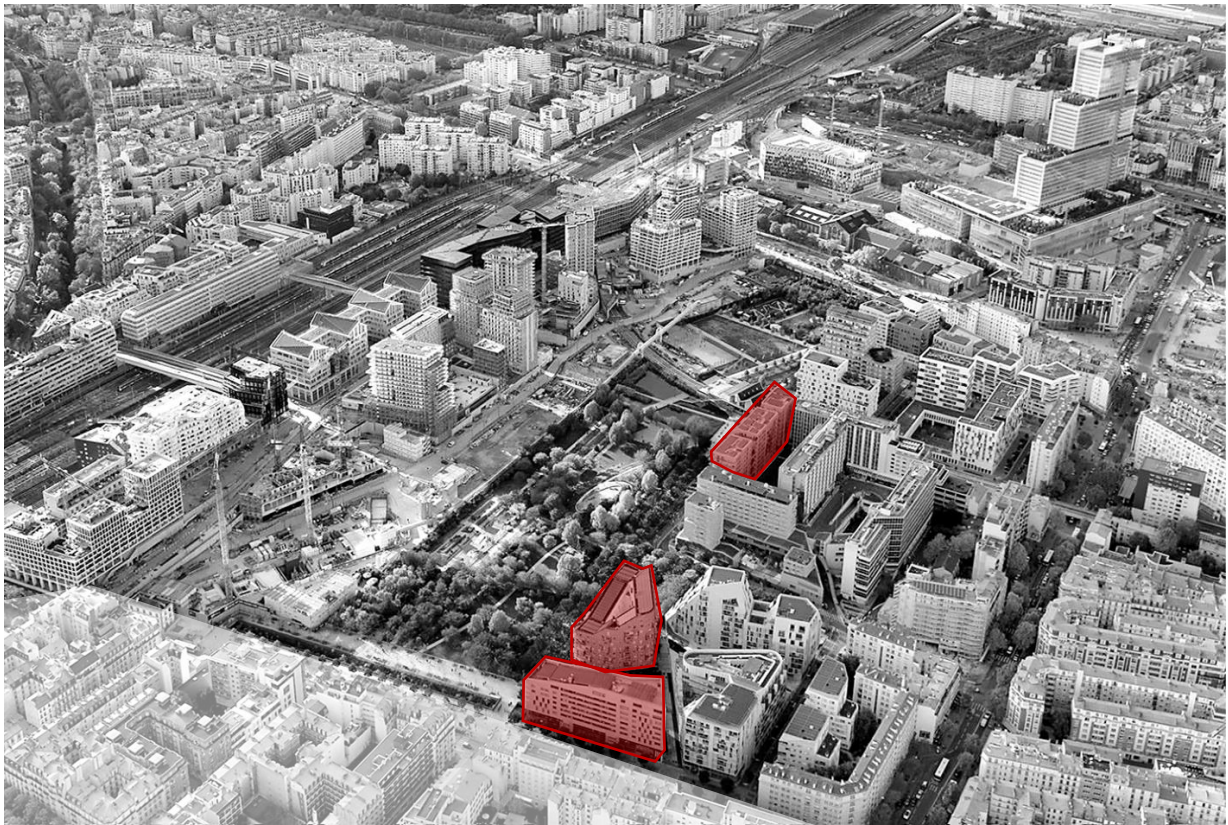


Figure 19 Case studies. Buildings E1, E2 and E5 situated in the east sector of the Clichy-Batignolles eco-district in Paris, 17th arrondissement.

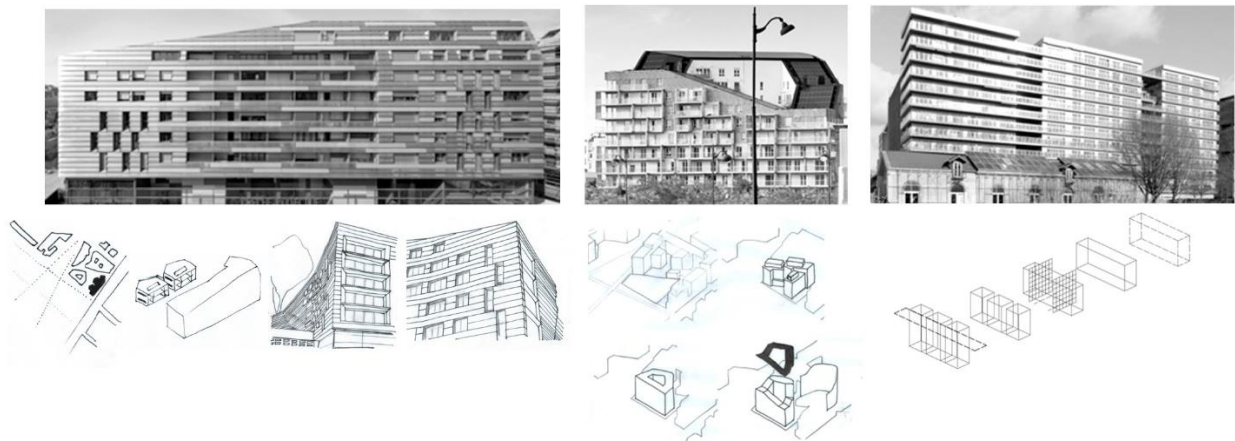


Figure 20 Case studies. Buildings E1, E2, E5

3.2.1. General lines of the project's ambitions

From the 19th century this site has been linked to railway activities and large infrastructures. This area in the 17th arrondissement of Paris, transferred by railway companies in 2004, has been the subject of projected interventions before, accommodating a possible olympic village for the Olympic games of 2012 as well.

The 54-hectare ZAC¹⁶¹ Clichy-Batignolles is claimed not to elude « the leitmotifs that have been the heyday of the French-style Concerted Urban Development Zones. » (Borne, 2019): that is to say, the approach of urban planning -leading mostly in a collection and apposition of architectures- is said to be gradually led to a more “*in-situ*” approach, oriented towards a joint enunciation rather than an assembling of juxtaposed objects. The Clichy Batignolles operation, undertaken by the City of Paris in 2002, is at the present time under the aegis of the *Paris & Métropole Aménagement* public developer¹⁶², that bears the ambition of addressing this change of the paradigm previously defining the methods of proceeding with urban planning. The “fieldwork” planning approach, yet abstaining from a solid definition, could be potentially linked to the *Réinventer Paris*¹⁶³ call for projects launched in november 2014, prompting an urban experimentation.

In Clichy Batignolle's case, the architectures of the buildings in the East, West and North sector may be different as well as the design process between the east and west sector, yet the design of green spaces, voids and circulation arteries prior to housing and tertiary programmes, developed the grounds of an operation ambitioning an assemblage based on articulating elements rather than a mix and match collage/collection of pre-defined objects.¹⁶⁴

The district has transformed a former infrastructure site. Even if the project has been launched in 2002, it is claimed to still « remain a reference for eco-districts today ». (Danon, 2019). From the initial phases of the process, the design of the district had to tackle the questions of energy transition. For instance, the very high energy performance of the buildings, the planted surfaces and the geothermal energy use were from the outset elements to be inserted in the project. However, energy is not the sole aspect that had to be treated; the social aspect included in the

¹⁶¹ (Urban Development Zone). ZAC stands for *zone d'aménagement concerté*. In France it refers to a development operation resulting from a public initiative

¹⁶² Previously being « Paris Batignolles Aménagement »

¹⁶³ <https://www.pavillon-arsenal.com/fr/expositions/10317-reinventerparis.html>

<https://www.paris.fr/pages/reinventer-paris-4632>

¹⁶⁴ for a similar project see Lyon Confluence, Presqu'Île in Grenoble

sustainable design scheme was also materialised in this case, through the social housing programme that aims to a social diversity, and the structures for elderly people that are being accommodated in the district as well.

Another element that claims to be innovative, in the ways and methods applied on working and sharing the project with the diverse partners teams, is, according to Jean-François Danon¹⁶⁵, the design of the Mstislav Rostropovitch street in a multifunctional environment. *“To manage this complexity, we created the Atelier des Batignolles in 2011. It was the first workshop of such a scale, bringing together the City of Paris, the public developer, the project coordinator, the housing operators and their contractors. It unquestionably stimulated the teams, allowed to question the uses, reconcile constraints, and foster a dialogue between the buildings, contributing to an urban quality that presently benefits over 2600 residents and employees.”*

Clichy Batignolles is claimed to serve as an example of urban project, an urban planning ‘laboratory’ that contributes to « inventing new ways of making the city »; along with conceiving methods of participatory work and observe the lessons drawn.

The CoRDEES project aims as well to act as an « energy facilitator » service, ensuring the achievement of the goals of energy consumption.

The surrounding context and its characteristics is claimed to have pre-set the development of the project: « there is a reflection on the nearby surroundings. The development results from a certain way of intervening in a given context: that of the Saint-Lazare network and the wasteland to reconvert. Then there is the broader environment, that of the North-West of Paris. (...) » (Grether, F., in “A park in the heart of the city,” 2019, p. 5) The **objectives** of the operation expressed in sharing places and public spaces was the exemplarity as far as environmental issues are concerned, along with a social and program diversity. Another element promoted by the project managers regarded the use of vegetation as “quality landscape devices” to “organise space” (Centlivre,C. in “A park in the heart of the city,” 2019, p. 5)

As far as the park is concerned, two are the main proposed ideas of the landscape design: the variety of contemplative and active uses and an expression of the seasonal changes, spatially manifested by grouping varieties. “So, when crossing the park, we travel through temporal sequences.” (Osty, J. in “A park in the heart of the city,” 2019, p. 6)

¹⁶⁵ Paris & Métropole Aménagement Managing Director

Also: Jean-François Danon and Catherine Centlivre, respectively managing director and operations manager at Paris & Métropole Aménagement , Jaqueline Osty landscape designer, François Grether, urban planner, discuss the aims behind the reconversion of the former Batignolles railway site and the approach chosen to carry out this transformation.urban development that is redefining the norm as urban ecology issues go.

The Clichy-Batignolles project has changed the skyline of the Parisian landscape in the way that it develops new heights in its urban context.¹⁶⁶ In 2009 the installation of the Tribunal de Grande Instance and of the Police Judiciaire in the north part of the ZAC Clichy Batignolles was announced, modifying the programme and the height of the buildings in the ZAC. As a result of the revision of the local urban plan the maximum authorised height of buildings was raised from 37 to 50 meters. Grether sees in this decision an originality of the project that leads to a less massive urban outline that liberate space. *It also creates more views and perspectives, as the buildings are perpendicular to the street and do not form a united front. Everywhere there are openings, light that break linearity and create a mixed landscape*(Grether, 2015).

This modification led to a study of multiple scenarios concerning implantation and height parameters. On the same time, the impact of Palais de la Justice's height in the energy performance along with the shading in the adjacent spaces had to be examined as well. As underlined by Danon and Centlivre and, the PLU¹⁶⁷ was revised in 2011 in order to make possible the evolution of the project and thus the construction of the Judiciary City¹⁶⁸ by modifying the height regulations. This allowed the construction of the Paris Courthouse with the height raised to 160m and that of housing freed up to 50m, with the intention of « reconciling density and urban quality by taking advantage of the wide-open space created by the park. » (“A park in the heart of the city,” 2019, p. 8)

In these extra meters I see above all a way to ventilate, to create openings between the buildings in order to offer generous views on the city. The gain in height creates vaster breakaways. We wanted to avoid a row of buildings walling in the park. The perpendicular axes were planned to play the role of freeing views for the second and even third row of buildings. The height was not a programme requirement bound to the search for density (Grether, F. in Archit. d’Aujourd’hui Hors Série / Proj. L’éco-quartier Clichy-Batignolles, 2019)

Overall, the basic **principles** of the urban project concern the presence of the parc, the liaisons between existing and future programmes, relations created between buildings and the parc, an architectural diversity under the aegis of a sustainable design.

¹⁶⁶ More info and analysis can be found in (Tardieu, 2015, p. 168)

¹⁶⁷ Plan Local d’Urbanisme

¹⁶⁸ That is the Paris Courthouse and the Direction Régionale de la Police Judiciaire (Criminal Investigation Department)

The parc lies in the middle of the sector limited on the sides by the buildings, from Cardinet street to Berthier boulevard; it is however extended in the surroundings via pathways and access areas.

The site is being traversed by paths – links in the east-west and north-south, with the intention to assemble the territorial fragments and create continuities between the existing and the new.

Even if, from the beginning, the program «mixity» was declared to be an intention, housing and offices are not combined on the same buildings. According to Danon and Centlivre this is due to technical limits of the site's landscape on the one hand, and collaboration with the office developers and the tertiary real estate market on the other. 'The office developers came with their investors, which was an entirely new way of doing things. We worked together on how the different programmes were assembled.' (Danon, J.-F., Centlivre, C. in Catsaros, 2019, p. 9)

The mixed-use program is not thus materialised via scattered offices in the east and west sector. A social mixity is however implemented by a combination of 50% social housing, 20% controlled rents units, and 30% home-ownership status in the housing programme. Another kind of mixity could be found in the coexistence of shared¹⁶⁹ and private spaces in the residential and tertiary lots.

¹⁶⁹ such as terraces, shared gardens, collective equipment such as gyms, concierge areas, or laundry rooms

3.3. Prescriptions

The urban planning of Clichy Batignolles sector is organised in three operations: ZAC Clichy Batignolles (developer SEMAVIP), ZAC Cardinet Chalabre (developer SEMAVIP) and Secteur Saussure (developer SNEF).

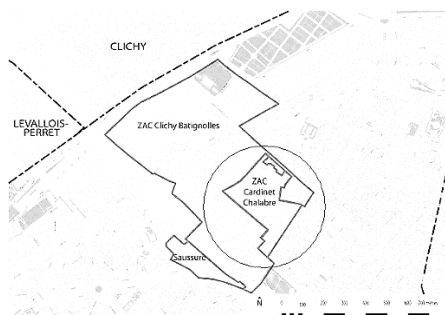


Figure 21 The position of the intervention urban zone, ZAC Cardinet Chalabre in Clichy-Batignolles district

The project's **prescriptions** have set general urban, architectural and landscape directions to be followed in order to assure a cohesion among the different projects. Their aim is « to place the conception of the projects in their broader future context. »

Cahier des Charges du Concours d'Architecte

The aim of this document is to outline the general objectives of the ZAC Cardinet Chalabre as well as to describe the options set by the operator as part of the consultation. In this context are included the documents addressed to operators¹⁷⁰, the certification H and E option 'performance and the BBC label, the Cahier des prescriptions architecturales et paysageres, the prescriptions of the operator along with the prescriptions of the developer.

Charte de qualité environnementale - CDD

The ZAC Cardinet Chalabre environmental quality charter is a reference document determining the environmental commitments made by the developer. It is a voluntary process that engages the partners to implement the objectives set. The actions defined are intended to encourage operators (planner, promoters, owners, companies and individuals) to integrate the environmental issues into the different phases of the project. Environmental issues¹⁷¹ are

¹⁷⁰ Règlement de la consultation d'opérateurs, Charte de qualité environnementale, Cahier des prescriptions environnementales

¹⁷¹ (gestion d'eau pluviale, bruit et nuisance, energy, landscape and biodiversity, gestion de l'eau potable, gestion des déchets, déplacement accessibilité stationnement, matériaux, climatologie et géographie, gestion des eaux usées, chantier verts, formes urbaines utilisation rationnelle de l'espace, qualité des sols et du sous sol, contexte social usage et mixité).

prioritised according to their proper consideration in the project. Energy is places in the higher degree of importance, dealing mainly with a energy consumption control and reduction, an encouragement towards a low-consumption equipment and the use of renewable energies.

Cahier des prescriptions environnementales

The environmental specifications must be pursued by the various *maitres d'oeuvre* (project managers). They include environmental quality elements, energy study results and certification procedures.

Cahier des prescriptions architecturales et paysagères CPAP

These urban, architectural and landscape specifications addressed to *maitres d'ouvrage* and *maitres d'oeuvre* outline the overall project in an intention to set the architectural design of the edifices into their future context. Beyond the regulatory provisions of the Plan Local d'Urbanisme, this document aims to 'ensure the desirable cohesion between the different buildings.' The architectural prescriptions concern the volumetric organisation (building heights, insertion, basements), the private open spaces (treatments of the boundaries between parcels and the parc, plantation types and rules, rainwater), the parking facilities, as well as the facades, materials, roofs and terraces.

Cahier des prescriptions techniques particulières pour les chantiers

The purpose of the technical specifications is to define the rights and obligations of SEMAVIP and the different operators *maitres d'ouvrage* within the framework of the ZAC Cardinet Chalabre operation. It refers to waste, clearance management, noise, air, traffic, sanitation, site conditions, soil pollution, public facilities and equipment, water and energy consumption.

Cahier de prescriptions environnementales et de développement durable (CPEDD)

The developer (SEMAVIP) has established documents ensuring that the environmental and energy objectives would be carried out, composing a *chartre de développement durable* and prescriptions: For each one of the lots commercialised¹⁷², the *cahier des charges de cession de terrain* (CCT) includes the objectives set by the *Plan Climat* translated into Environmental and Sustainable Development Prescriptions (CPEDD)¹⁷³ (see more in Tardieu, 2015, p. 167) These prescriptions include quantified objectives to be achieved along with recommended actions. From the competition phase these requirements had to be verified by thermal simulations¹⁷⁴. To implement the requirements of the CPEDD, the *maitres d'ouvrage* (clients) had to ensure the association of an office specialised in sustainable development and HQE with the *équipe de maîtrise d'œuvre* during the competition phase, the operation and the delivery of the project. Concerning the energy consumption objectives, they were depending on the program Table 6

	Heating	Cooling	Domestic hot water	Specific electricity (collective needs)	Specific electricity (private needs)	Total Conventional energy (RT 2012)	primary
Housing kWh/m ² SHAB/an	<=14	0	<=20	<=40	<=85	Cep≤50kWh/m ² SHONRT/an	Label Effinergie plus
Offices kWh/m ² SUR/an	<=15	<=4,5	<=45	<=45	<=70	Cep≤50 x 1,4	kWh/m ² SHONRT/an
trading facilities/shops kWh/m ² SUR/an	<=15	<=20	<=10	<=10		Cep≤120	kWh/m ² SHONRT/an
School kWh/m ² SUR/an	<=10	0	<=15		<=32	Cep≤50 x 1,4	kWh/m ² SHONRT/an
Cinema kWh/m ² SUR/an	<=20	<=30	<=2	<=85	<=100	Cep≤150	kWh/m ² SHONRT/an

Table 6 Objectives of energy consumption by function for each programme. source CPEDD lot 3.4, lot 08, lot 09 (in Tardieu, 2015, p. 179)

For the housing units, the CPEDD required the following quantitative objectives (Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009, 2009, pp. 37–38) to be met, detailing the ways the calculations would be carried out: Table 7

primary energy consumption	net need for each building	duration of winter sunshine	airtightness	number of hours per year of exceeding the
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¹⁷² During the commercialisation, the developer and the Assistant à la Maîtrise d'Ouvrage have evolved and adapted the CPEDD

¹⁷³ cahiers de prescriptions environnementales et de développement durable (CPEDD). These documents include methods of calculating the construction materials' embodied energy.

¹⁷⁴ 'However, the CPEDDs are also based on indicators that are simpler to designers (indice d'ouverture des façades, facteur solaire des protections, etc.) and verifiable at any stage of the design'. Source: ([Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009, 2009, p. 38](#))

	kWh/m ² SHAB**/year	kWh/m ² SHAB/year	principal space of each dwelling	temperature discomfort of 28 ° C	of
heating	<=14	<=15			
domestic hot water	<=20				
specific electrical uses*	<=45				
			>=2 hours or >= 25 ° of angle in azimuth	<=1 m ³ / m ² .h under a pressure difference of 4 Pascals	<=30 hours

Table 7 Objectives of the CPEDD for the housing programme, source of data: https://archive-clichy-batignolles.paris-metropole-amenagement.fr/sites/default/files/clichybatignolles_23-3-9_0.pdf

* (within a wider scope than RT 2005) excluding the consideration of photovoltaic energy production in the calculation

** Surface habitable d'une construction

The CPEDD specified that the energy production of photovoltaic panels cannot be accounted for achieving the energy consumption objective of a programme. With the aforementioned rates Clichy Batignolles project was placed at a performance level higher than the BBC label, higher than the common standards of new constructions in Paris at that time¹⁷⁵ and close to the German *Passivhaus* label¹⁷⁶ without photovoltaic compensation.

In the *Dossier de Réponse* of mars 2009, the importance of combining the energy approach with a comfort one is being highlighted, as to avoid the buildings being reduced to simple receivers of photovoltaic panels. To reduce thus the part compensated by renewable energy, the document promotes the control of energy demand along with a building and urban form optimization. This latter is translated in the integration of bioclimatic approach in the design¹⁷⁷, that was ambitioning in that time to be more a re-study process producing scenarios, rather than a final result -reminding that this would be expressed by the architectural design competition. *'It is not a question of turning everything upside down in favour of a south (or north) tropism, but to identify in the project an effective climate grid, not necessarily superimposable on the urban grid.'*¹⁷⁸ Concerning the 'optimisation of the built form', a passive approach on energy needs was being promoted as the ideal one, considering the energy management along with the interior spaces' comfort and quality.

Urban forms optimisation	Quality of public and private urban spaces & a future bioclimatic design accès au soleil d'hiver privilégié pour les logements,
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¹⁷⁵ (Climate Plan - 50 kWh / m².year),

¹⁷⁶ (final energy ≤ 50 kWh / m² / year),

¹⁷⁷ privileged winter sun access for the apartments, access to natural light and protection against summer sun for the tertiary sector, natural access to outside air for all types of buildings.

¹⁷⁸ (*Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009*, 2009, p. 35)

	accès à la lumière naturelle et protection contre le soleil d'été pour le tertiaire, accès naturel à l'air extérieur pour tous les types de bâtiments.	
	AMO Développement Durable	analyse qualitative
	AMO énergie	Analyse quantitative (simulation thermique dynamique sur l'ensemble des lots)
Buildings optimisation	Dual objective: energy management and interior environment comfort	summer/winter insulation levels optimisation size and quality of glazed surfaces optimisation (losses/winter solarisation/summer overheat/natural lighting)
	Passive approach on heating/ synthesis between winter comfort and energy savings	
	Passive approach on cooling/ synthesis between summer comfort and energy savings	Solar protections, inertia, transversing apartments, access to the exterior air for tertiary units
	Passive approach on lighting/ synthesis between visual comfort and energy savings	Natural lighting, limited depth on office units
	Passive approach on ventilation/ synthesis between air quality and energy savings	Air renewing, natural ventilation as soon as energy issues allow it in summer

Table 8 Approaches towards urban form and buildings optimisation in CPEDD

The photovoltaic energy production targets were set in each CPEDD by lot according to its situation and orientation.¹⁷⁹

General objective guidelines on energy efficiency		
	CO2 emissions	
	Energy and comfort	
Ways/means for achieving them		
	Energy management – morphology optimisation	
	Energy production	Photovoltaics, geothermal
	Energy compensation	

Table 9 Photovoltaic production targets set out in each CPEDD

Photovoltaic production targets are set out in each CPEDD and set by plot according to its situation and orientation.

¹⁷⁹ For example, 120 MWh / year currently planned for lot 2.1.1.B. (*Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009*, 2009, p. 37)

3.4. Design process

3.5. Introduction on Clichy-Batignolles eco-district

The design process and production method of the two areas in question, the east and the west part of the intervention, followed different methodological as well as temporal paths.

3.5.1. East sector, the heterogeneity of a concerted conception

The east sector of the project, the first one constructed gradually, is situated between the park, Avenue de Clichy and rue Cardinet.

In each of the sides of this terrain of the project, the pre-existing urban morphology directed a different approach: on the side of Avenue de Clichy the edifices are constructed behind buildings dating to the second half of the 20th century while the side facing the park is totally formed by new constructions. As far as the rue Cardinet is concerned, it is said to be characteristic of ‘a concerted way of making a city that implies blending the new and the old’(Archit. d’Aujourd’hui Hors Série / Proj. L’éco-quartier Clichy-Batignolles, 2019, p. 17). The sidewalks of Cardinet street in its connection with the park are gradually widened with plantations, forming a space, in an intention to convey the entrance and act generally as a sign of reference to the park. In the intersection with avenue de Clichy however the road remains preserved, in an objective of a dialogue with an older edifice.

The projects that won the competition on the lots e1 (*Franklin Azzi/Paris Habitat*) and e2 (*Périphériques/Nexity Seeri*) of the east sector were the first to be constructed, as of 2010.

A methodological similitude with two French urban projects / experiments

The development of this sector could recall the one of Confluences 2¹⁸⁰, evolving on the same time in the city of Lyon.

This second phase of the urban project ‘seeks to reduce the impression of assembling heterogeneous objects that characterised Confluence 1.(Archit. d’Aujourd’hui Hors Série / Proj. L’éco-quartier Clichy-Batignolles, 2019, p. 19)

¹⁸⁰ <https://www.lyon-confluence.fr/fr>

Another project coinciding in time with the east sector’s production method is the one of rue Rebiere¹⁸¹, concerning the creation of 180 housing units in the 17th arrondissement of Paris. In the context of the Grand Projet de Renouveau Urbain, this project set up a collective work in the form of a ‘workshop’ that united the architectural teams, along with residents, technicians, elected officials etc. This design process method permitted a common thinking or dialogue on certain aspects -as the relations between facades and in-between spaces-, even if the groups of conceivers were different for each project. “The city would like this principle to be transposed on a greater scale to the Batignolles ZAC”¹⁸² (Biecher, C. in Léglise & Sautot, 2013, p. 106)

3.5.2. West sector, a ‘collaborative’ conception

The west sector of Clichy Batignolles, the second phase of the urban operation, is located between the parc and the railway landscape.

The decision of the developer, Paris Batignolles Aménagement, and the City of Paris, to use this working method is said to rely on the specificity of the West sector: an urban space of 200,000 m², 600 m in length, located between Martin Luther King Park and the Saint-Lazare station with an incline of 10 m. *«We knew that the solution of architectural competitions by lot was not the right one because it would have led to fixed projects that did not necessarily take into account neither each other, nor the particular urban constraints of this sector»*¹⁸³

Phase 1 : Program lots o1-o5	surface	
Housing	58.000 m ²	660 logements familiaux, 235 logements pour étudiants/jeunes actifs et doctorants/post doctorants
Offices	26.600 m ²	
Commerces	11.600 m ²	un pôle de 9300m sur la rue Cardinet et des commerces en pied d'immeuble
Public Equipment		1 crèche, 1 groupe scolaire de 15 classes, 1 gymnase accompagné de 2 salles de sport, 2 sorties de la station Pont Cardinet de la ligne 14, dans les lots o1/o3 et o2, 1 parc de stationnement en entrée de voie vers la rue Cardinet
Total	(environ) 100.000m ²	

Table 10 Programs and surfaces of the western sector, Clichy Batignolles, phase 1, lots o1-o5. Data retrieved from https://archive-clichy-batignolles.paris-et-metropole-amenagement.fr/sites/default/files/cahier_central_int_24p_web.pdf

¹⁸¹ <https://www.pavillon-arsenal.com/fr/expositions/9683-autrement-rue-rebiere.html>
<https://www.pavillon-arsenal.com/fr/arsenal-tv/documentaires/paris-architectures/9096-42-autrement-rue-rebiere.html>

¹⁸² Christian Biecher is architect of a west zone lot, MAD architects’ associate.

¹⁸³ (Bailly, D. in Moutarde, 2013) Didier Bailly est directeur général de Paris Batignolles Aménagement

Phase 2 lots	surface	
O6A		logements sociaux, d'une résidence sociale, d'une école maternelle, d'une crèche et de commerces, sera réalisé par Immobilière 3F
O6B	8 000 m ²	logements en accession (3 760 m ²) logements à loyer maîtrisé (3 760 m ²) commerces (480 m ²) stationnement
O7	24 200 m ²	bureaux (23 050 m ²) commerces (1 150 m ²)
O8	29 240 m ²	logements en accession (7 350 m ²) logements à loyer maîtrisé (5 050 m ²) logements sociaux (11 000 m ²) centre d'animation (1 000 m ²) à réaliser en VEFA pôle culture-loisirs associant commerces et miniplexe 7 salles (4 840 m ²) stationnement
O9	17 000 m ²	bureaux (15 800 m ²) commerces (1 200 m ²)
	78 440 m ²	
Total	(environ) m ²	

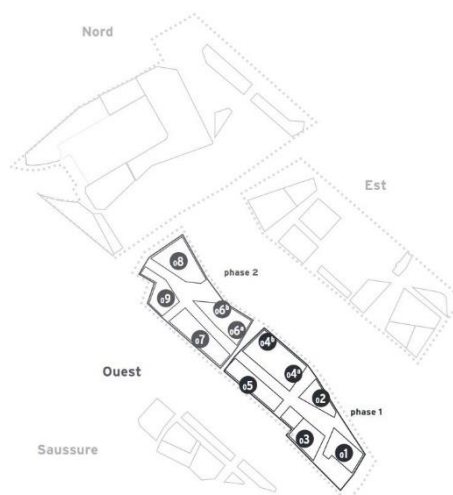
Table 11 Programs and surfaces of the western sector, Clichy Batignolles, phase 2, lots 06-09. Data retrieved from <https://www.cadredeville.com/InfoBusiness/paris-clichy-batignolles-appel-aux-promoteurs-investisseurs-pour-la-deuxieme-phase-de-la-partie-ouest-du-quartier>

Phase 2: Program lots 06-09		
un pôle culture / loisir (un centre d'animation, un cinéma, des commerces)		
une école maternelle et une crèche		
logements	37 220 m ²	17 300 m ² de logements sociaux (dont une résidence sociale pour travailleurs migrants) 11 110 m ² de logements en accession 8 810 m ² de logements à loyers maîtrisés
commerces /services	3000 m ²	
bureaux	38 850 m ²	

Table 12 Programs of the western sector, Clichy Batignolles, phase 2, lots 06-09. Data retrieved from https://archive-clichy-batignolles.paris-metropole-amenagement.fr/sites/default/files/cr_atelier_batignolles_so-phase2_seance1_2013_05_14_0.pdf

Phase 1

The projects of the first phase of Clichy Batignolles western sector are composed of 4 lots (o1-o5), including a double and a public one. The private clients (maîtres d'ouvrage privés) were selected in May 2012, chose their project management team (équipe de maîtrise d'œuvre) in consultation with the developer and the city of Paris through a call for applications. Together with Paris Batignolles Aménagement and the City of Paris, the forementioned teams participated in the bimonthly working sessions moderated by the



amenageur with the assistance of F. Grether and D. Alba¹⁸⁴; experts, City of Paris departments, managers of future public facilities, participated as well in the discussions of this initiated procedure.

Phase 2

The consultation call launched by the operators received up to 200 applications from interdisciplinary teams, among which 20 were called to express their interest in taking part in the collective design method ambitious for the new district. At the end of the audit 10 teams, composed by 2 architectural agencies, a landscape designer and an environmental studies office were selected. ¹⁸⁵ The teams were invited to “*innovate on issues of use, mode of living and working (...) in this 21st century district.*”¹⁸⁶

The program included 80,000m² of offices, private and social housing, equipment (school, nursery, animation centre, cinema) and commerce.

At that moment, the edifices on the bank of the park were authorized by the PLU to reach a height of up to 50 metres.

Design Workshops (“ateliers”)

«The decision to use this working method is due to the specificity of the West sector. The construction of this part will constitute a major urban landscape, given its size and its visibility. (...) It is therefore necessary to have a global approach.»(Hidalgo, A. in Moutarde, 2012)

An ambitious element of the operation as proclaimed was the *Ateliers* of design that took place during the conception process. They assembled the architectural teams and the promoters along with residents that were invited and encouraged to take part. Declared an ‘innovative’ design method, we hereby mention the conditions under which this work was conducted.

The design workshop

In the first operational phase (June-december 2012) of the west sector’s urban planning, maitres d’ouvrage and concepteurs participated in the Design Workshop¹⁸⁷ “(…) *will the unusual site development method: a collaborative workshop uniting urban planners, architects, landscape*

¹⁸⁴ directrice générale de l’Atelier parisien d’urbanisme (APUR).

¹⁸⁵ They were : •Lot O6B - Fresh Architectures, Itar Architectures, Base et Egis Concept (pour OGIC / Demathieu Bard Immobilier) ; •Lot O8 - TVK, Tolila + Gilliland, Praxys et Franck Boutté (pour Sodearif / Nexity) ; •Lot O7 – Chartier-Dalix, Brenac & Gonzalez, OLM et Alto Ingénierie (pour Emerige / BNP Paribas Cardif) ; •Lot O9 - Baumschlager Eberle, Scape, Latz+Partner et Enbergelio (pour Bouygues Immobilier et la Caisse des dépôts et consignations).

Elles seront rejointes par l’équipe Querkraft Architekten, Sam architecture, Atelier Roberta et GEC INGENIERIE précédemment retenue par la société I3F pour le lot O6A.

¹⁸⁶ (“10 agences d’architectes retenues pour finaliser le futur quartier situé entre le parc et le paysage ferroviaire.” 2013)

¹⁸⁷ Atelier de conception

designers, elected officials and developers, the intention of which is to be symbolic of the deep reflection process today at work in the city.”(Léglise & Sautot, 2013, p. 97)

A similar workshop began in June 2013 with the design of the second phase.

The design process of the west sector of the operation is not officially characterised as “participative”¹⁸⁸, but rather includes “collaborative” attributes. The workshops having been organised during the design process on the west side regarded the public space, the streets along with the connections with the park, the views and relations¹⁸⁹ between the different buildings. Apart from the programs, a special interest was drawn in Mstislav-Rostropovitch street traversing the edifices of the west park, as to ‘break’ a rigidness and linearity by recesses, implying connections between buildings as well as a dialogue with the parc:

‘These workshops fostered an intense work on the streets so that they would not merely run along the building façades but be enlivened by small squares, shops, vistas, recesses. (...)

The workshops materialised the main lines of the plan with the openings and views between the park and the rail tracks. These options were discussed and improved during these meetings.’(Danon, J.-F., Centlivre, C. in Catsaros, 2019, p. 9)

Ateliers	
04.05.2009 – 14.03.2011	Saussure
11.06.2009 – 15.07.2009	Ambiance du future quartier
18.06.2009 – 25.06.2009	Parc Martin Luther King
06.07.2009 – 27.01.2010	Enjeux environnementaux
05.11.2009 – 20.01.2010	Espace public et mobilites
21.01.2010 – 05.05.2010	Mixites, densite, identite
28.01.2010 – 25.03.2010	Commerces, services et equipements
01.06.2010 – 11.10.2011	Enjeux environnementaux et architecturaux
09.12.2010	Rue cardinet
12.05.2012 – 05.07.2012	Porte de clichy
14.06.2012 – 05.07.2012	Batignolles (west sector – phase 1)
14.05.2013 – 04.07.2013	Batignolles (west sector – phase 2)

Table 13 Agenda de la concertation: ateliers. info retrieved from <https://archive-clichy-batignolles.paris-metropole-amenagement.fr/version-texte-de-lagenda-de-la-concertation-249.html>

Phase 2 workshops	day	topic
introductory	27.06.2013	operators, methods, challenges, programme propositions, expectations for the equipment, shopping facilities and cinema
1	04.07.2013	Volumes, outlines, landscape. orientations, views, site insertion, visual openings
2	11.07.2013	Relation with the street, the parc. access in parking and ground floors
3	18.07.2013	Architectural proposals on lifestyles. Shared and private spaces, workplaces, cultural places, environmental issues on volumes, sunshine and shadows projected
4	25.07.2013	Pre-sketches
5	05.09.2013	Analysis of pre-sketches
6	19.09.2013	sketches
7	03.10.2013	Steering committee on sketches
8	24.10.2013	Writings, relations between buildings

¹⁸⁸ An example of such an intervention could be the reconversion of the Parisian Saint-Vincent-de-Paul hospital

¹⁸⁹ ‘A frequently cited example is that of the synergies between the o5 office programme, designed by the Jean-Paul Viguier Architecture and Search offices, with a patio extending all the way to the rails the central garden of the o4B building, designed by AAHP and Aires Mateus. The workshop allowed the two projects to dialogue so this common space became a lateral visual opening from the park to the rail.’ (Danon, J.-F., Centlivre, C. in Catsaros, 2019, p. 9)

9	07.11.2013	Landscape
10	21.11.2013	Compositions on facades and materials
11	05.12.2013	Facades
12	19.12.2013	Cohesion between projects, relation with the public space
13	16.01.2014	Presentation of Avant Projets Sommaires
14	30.01.2014	Preparation of the steering committee Avant Projets Sommaires

Table 14 Dates and topics discussed in the design workshops (ateliers de conception) of sketches and preliminary design drafts of the 2nd phase of the west sector (according to the workshops programmes sent by Paris Batignolles Amenagement. Source (in Tardieu, 2015, p. 213)

L' Atelier citoyen "Batignolles"

In parallel with the design process carried out by international architectural teams and promoters for six months, a participatory citizen design approach was encouraged to accompany the procedure. The citizens were invited to participate with the aim of '*establishing an iterative dialogue with the professional design workshop*' ('*L'Atelier Batignolles,*' n.d.). Initiated in may 2012 for the first phase of west sector's design, a second one followed as of 2013.

To clarify the method pursued, the four steps that follow 'condensate' ('*L'Atelier Batignolles,*' n.d.) the procedure undertaken by this workshop involving citizens. First, the participants were informed on the challenges as well as the program of the urban project by F. Grether in the help of the physical model of the operation. Second, the participants imagined and projected uses and ways of life of the new district. After this, the stories were synthetised into sketches and served as tools for discussions. The 'long-term follow-up' concerned the three exchanges of inhabitants and the professional teams at the start, in the sketch-phase and during their own design process.

The chronological order and general topics discussed in the citizens workshops organised are briefly outlined in the following tables.

Citizen Workshops Batignolles – west sector		
Phase 1		
	Séance 1	14.06.2012
	Séance 2	20.06.2012
	Séance 3	26.06.2012
	Séance 4	05.07.2012
Phase 2		
	Séance 1	14.05.2013
	Séance 2	28.05.2013
	Séance 3	18.06.2013
	Séance 4	04.07.2013
	Séance 5	03.10.2013
	Séance 6	28.11.2013
	Séance 7	16.01.2014

Livrets des ecoliers¹⁹⁰

Restitution porche
ilot O6A

Restitution espaces
partages ilot O8

Table 15 dates ateliers info retrieved from <https://archive-clichy-batignolles.paris-metropole-amenagement.fr/latelier-batignolles.html>

3.5.3. Short conclusion of east and west design process

If the east part of the Clichy Batignolles project were to be described within a phrase, it has been said to resemble to a fragmental operation of linking together parts of the urban fabric: ‘*a piecemeal town of structures with little consultation between them, and created a feeling of frustration and the impression of a lack of coordination*’ (F. Grether, in Légglise & Sautot, 2013, p. 106) In the east sector, the design process did not included organised workshops; the edifices were juxtaposed in their diverse fomes and appearances, without however preventing exchanges and synergies between the architectural teams of neighbouring projects on certain issues. Although a fragmentary approach is evident in the conception of the east part (stemming principally from the different design time along with a segmentation of the terrain) resulting to an architectural diversity, Grether does not reduce the design process to a rigid division of the parcels. He supports east sector’s design process by seeing it as characteristic of those times, comparing the formal variations to contemporary lifestyle diversities. Instead thus of a random juxtaposition, he prompts a pertinent design process that adapts to the existing by bridging the old and new elements of the territory (Archit. d’Aujourd’hui Hors Série / Proj. L’éco-quartier Clichy-Batignolles, 2019, p. 19), with the connection and coherence among the edifices stemming from visual interchanges and implications.

The west sector’s workshops were intended to assembly the different groups involved in the operation, from promoters and their architectural teams to residents and conceivers. The main conductor line of such associations concerned a global view on shared spaces via the establishment of relations between the edifices. This approach, open to residents, was intended to create a vision of a collective design method, that could consider the expressions of the latter too. In a critical viewpoint, even if the design method in the west district was not clearly participatory, it did invest in the construction of a connection basis and dialogue with citizens who wished to take part in the process. The ‘collaborative’ aspect was moreover present in the synergies and exchanges between the different architectural teams. Rather than a co-creation

¹⁹⁰ The CAUE75 (Conseil d’Architecture, d’urbanisme et de l’environnement de Paris) worked with the students of 2 primary classes on propositions including among others the shared spaces of lot o8 and the school porch of o6A.

of the district, we could characterise it as an willingness of the stakeholders to relate to the inhabitants, heading towards a bottom-up design -although not being a such-, inscribed in the general context of the district's identity, ambitioned contemporary and original, 'Une expérience novatrice de conception urbaine'¹⁹¹. A remaining question still arise, above all; that of the possibility and conditions of thinking a city collectively.

¹⁹¹ (Hidalgo, A. in *L'Atelier de conception de Clichy-Batignolles Premier bilan d'une expérience novatrice de conception urbaine*, 2013)

3.6. Martin Luther King Parc

This public space aims above all to be a link between the East and West, South and North of Clichy-Batignolles (“Martin Luther King Park, Towards a new centrality”, in Archit. d’Aujourd’hui Hors Série / Proj. L’éco-quartier Clichy-Batignolles, 2019, p. 12)

During the design process, the parc plan was revised, especially when it comes to the extensions it was ambitioned to bear, in the beginning. *It was meant to be the highlight of a green fabric extending beyond the belt, towards Clichy, but this intention was blocked by the operational and administrative limits of the ZAC.(urban development zones)(Grether, F. in Catsaros, 2019, p. 10)*

The physical limits of the parc was a question arising regularly in the exchanges between the different municipal teams implicated, especially when it concerned the night function. It was decided that the space would be enclosed, leading consequently towards a particular interest on the types of plants and facilities chosen. However, *“in the conceptual design, it was accepted that the park would not have a drawn outline, since the building development looked directly over it, nor would it have fencing, separation or intermediary roads.”*(“A pioneering park”, in LÉglise & Sautot, 2013, p. 100)

The parc was intended to be in connection with the surrounding edifices to intensify the relationship with the urban landscape, apart from the visual interactions. The paths traversing it, continuing the urban axes, enhance the willingness of the designers to attach the parc to the city, not only with the uses and social practices it receives. *‘On the plan, the park is organized along a large diagonal which is part of a continuation of the Batignolles square as far as Porte de Clichy, with the future Tribunal de Grande Instance in its axis. Directly touching the existing districts and those to come, its paths are aligned in the continuity of the streets and create a feeling of natural passage from or to the city.’*(“A pioneering park”, in LÉglise & Sautot, 2013, p. 100)

The choice of the type of plants as well as their positioning and density in the parc were thought so as to demonstrate the seasonal cycles and the colour changes they imply. *The first phase alone, more planted, illustrates the landscape choices as well as the demands of the environmental approach applies to the whole of the site*¹⁹². The chromatic cycles are not reduced though solely in a graphic, visual effect, but are intended to merge with the landscape

¹⁹² (“A pioneering park”, in LÉglise & Sautot, 2013, p. 102)

scenery and its peculiarities, spatial or ecological ones, as well. For instance, a perennial ground cover planted in the paths and the bottom of the trees is a practice that aims at reducing maintenance *'by preventing the growth of undesirable plants' and contributing to saving water by keeping the ground cool*¹⁹³

At this moment, a metro station (M13 Brochant), a RER line (RER C Porte de Clichy), a SNCF station (Transilien ligne L Gare de Pont-Cardinet) and a tramway one (T3b Porte de Clichy-Tribunal de Paris)¹⁹⁴ are located in proximity of the park. An ensemble of new transportation lines and connections is programmed to operate in the area with the intention to make the park 'a multimodality hub'. This objective is driven by a resemblance to the performance of public squares: enact, thus, the flows of everyday passages. Moreover, the Courthouse of Paris being in proximity, tends to enhance this functional purpose in practice.

In terms of function, the parc' design is intended to accommodate crossings, movements as well as stances. *The concept of the Martin Luther King park aims to make the two uses compatible: contemplative and slow for those who linger there, dynamic and transitory for those who cross it.*(*"Martin Luther King Park, Towards a new centrality"*, in *Archit. d'Aujourd'hui Hors Série / Proj. L'éco-quartier Clichy-Batignolles*, 2019, p. 14)

The presence of water in the parc is linked not only to environmental aspects but to cultural and technical as well: apart from promoting a plant and animal biodiversity, it favours the presence of young and elder population around a collective space during summer months, and it supplies a storage of 1500m³, used for sprinkling. *This natural space that shall mellow one of the most mineral areas of Paris grants the utmost importance to one element: water. Thus, an ingenious circulation system allows to decant and re-oxygenate collected rainwater, transforming the park pools into authentic aquatic biotopes.*(*"Martin Luther King Park, Towards a new centrality"*, in *Archit. d'Aujourd'hui Hors Série / Proj. L'éco-quartier Clichy-Batignolles*, 2019, p. 14).

¹⁹³ ("A pioneering park", in L'église & Sautot, 2013, p. 102)

¹⁹⁴ Today the station Porte de Clichy is served by the metro, the RER, and recently the tramway Line 3

3.7. Sustainability as a ‘prescribed’ element of the design

3.7.1. Sustainability

According to Grether the environmental status of the operation can be found in the organisation of the buildings on the side of the rail network, along with the conception of the park. On the same time, Danon and Centlivre claim that mixity and density respond in a first place to the general context of environmental ambitions set, followed by rules on buildings’ energy consumption and production. This was achieved through a synergy, exchange and negotiations among the participating parts.

Energy is not the exclusive element treated under the ecological umbrella, as the water treatment along with the park’s identity are innate to the character of the project. To meet the objective of 30% rainwater consumed a soil’s demineralisation was pursued, together with planted roofs¹⁹⁵ (Danon, J.-F., Centlivre, C. in Catsaros, 2019, p. 10)

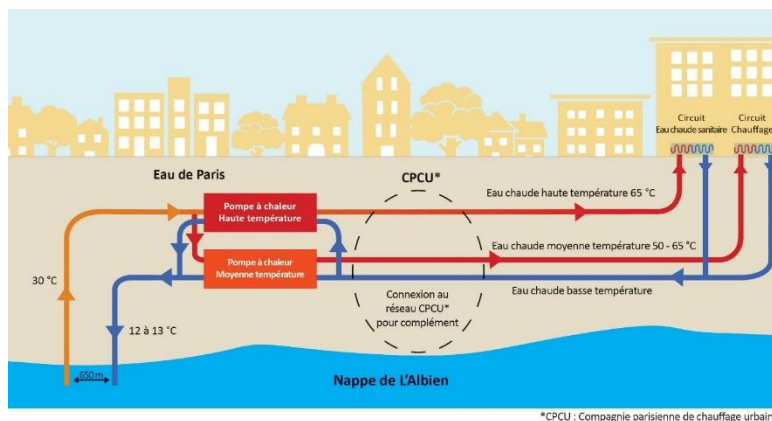


Figure 22 A simplified image of the geothermal system of Clichy- Batignolles. source: <https://www.planete-energies.com/fr/medias/decryptages/clichy-batignolles-un-ecoquartier-paris>

¹⁹⁵ 26.000m²

3.7.2. Energy conception prerequisites

The Paris Climate Action Plan¹⁹⁶, updated in 2018, aimed to reduce by 50% the energy consumption in 2050 compared to 2004 levels, and by 50% the local greenhouse gas emissions as of 2030.

For Clichy Batignolles operation the main axes of the ‘strategy against climate change’ of Plan Climat are the use of renewable energy sources -solar, geothermal or biomass- and the control of energy demand.

Three main aspects are claimed to have driven the consideration of energy matters in Clichy Batignolles eco-district’s design¹⁹⁷: the imperative for low- energy buildings, the use of renewable energy for heating and domestic hot water and the production of electricity.

The energy consumption of buildings had to be limited to 50kWh per sq.m. per year¹⁹⁸ with heating not exceeding 15kWh per sq.m. per year¹⁹⁹

In order to meet those aims, the buildings had to be conceived in a way to limit their primary energy needs²⁰⁰; small volumes (limiting the contact with the outside), dual exposure, solar protection, green roofs and exterior building insulation were some of the commonly promoted elements in the design.

The ‘criteria’ proposed to take active part in the architectural conception in order to meet the energy consumption targets concerned the compactness, the reduction of thermal bridges by an external insulation, a building inertia, a glazing surface varying according to façade’s orientation; solar protections on the facades exposed, double flow ventilation with heat recovery and the impermeability of the building. (Tardieu, 2015, p. 166)

The local production of photovoltaic energy had to offset the energy consumption due to lighting, auxiliary heating, domestic hot water, and services. Photovoltaic panels were aimed to produce the equivalent of approximately 40% of the electricity consumed in the buildings

¹⁹⁶ See more in <https://api-site-cdn.paris.fr/images/101081>

<https://www.paris.fr/planclimat>

¹⁹⁷ (Clichy-Batignolles the eco-district. A reference in sustainable urban development in Paris, 2017, p. 4)

¹⁹⁸ making it lower than required by current energy regulations in Paris (RT 2012: 70 kWh per sq. m. per year for housing).*

* For housing, regulations limit the amount of solar electricity production to 12 kWh per sq. m. per year that can be deducted from consumption; at Clichy-Batignolles, this production is not taken into account so that the housing units consume little and actually produce energy.

¹⁹⁹ equivalent to that of Germany’s Passiv Haus certification

²⁰⁰ (Clichy-Batignolles the eco-district. A reference in sustainable urban development in Paris, 2017, p. 10)

of Clichy-Batignolles, used mainly for lighting.²⁰¹ Rooftops with the best exposures and some facades would be equipped with photovoltaic panels, creating an overall surface of 35,000 sq. m. that should produce nearly 3,500 MWh per year²⁰². The electrical current produced, purchased by EDF, would be fed back into the overall electricity grid.

Moreover, an optimisation of user consumption was enabled through heat regulation and energy recovery solutions.

The cooling of the building had to abstain from a recourse to active technique. To minimize electricity consumption air conditioning systems were to be maintained to a minimum²⁰³. In the tertiary programmes a generalisation of cooling systems was preferred to air-conditioning solutions²⁰⁴.

In addition, a pneumatic waste collection system was installed to the site. Finally, the buildings in Clichy Batignolles would be connected to a grid supplied with geothermal energy enabling heat production.

Concerning the emissions related to transportation, they were not included in the objective of a zero carbon footprint; however, the city of Paris chose to maintain the services and logistics near the railways in the north part of the site. (Tardieu, 2015, p. 167)

The carbon footprint has been used since 2009 as a design tool and resource for technical choices regarding the project.

The method²⁰⁵ involved the translation of aims into environmental demands; targets for energy needs and production of renewable energy sources were set (integrating external factors that would possibly influence the consumption -such as the climate change scenarios published by the IPCC-); followed by a modelling based on these targets and the adaptation of the initial aims towards the acquirement of a zero carbon footprint.

In 2016, the project received the label *EcoQuartier* from the French Ministry of Housing and Sustainable Habitat. In the same year, the project won the European call for innovative urban

²⁰¹ Household electricity consumption (from home appliances, computers, etc.) has not been taken into account due to the great variations between the appliances used in individual households and to the fact it is impossible to obtain strict commitments as regards their levels of consumption

Source (*Clichy-Batignolles the eco-district. A reference in sustainable urban development in Paris*, 2017, p. 14)

²⁰² This production is the equivalent of roughly 40% of the electricity consumed by buildings in Clichy-Batignolles, primarily for lighting. (*Clichy-Batignolles the eco-district. A reference in sustainable urban development in Paris*, 2017, p. 14)

²⁰³ for specific uses such as server rooms or temporary solutions during heat waves (housing for the elderly) (*Clichy-Batignolles the eco-district. A reference in sustainable urban development in Paris*, 2017, p. 10)

²⁰⁴ (Danon, J.-F., Centlivre, C. in Catsaros, 2019, p. 10)

²⁰⁵ (*Clichy-Batignolles the eco-district. A reference in sustainable urban development in Paris*, 2017)

projects for the creation of the first Parisian smart grid. In addition, it won the price ‘Sustainable City’ of the international competition international «Green Building & City Solutions Awards» by the Construction 21 network.

In 2017 the project received the award²⁰⁶ ‘Adaptation to climate change and territories’ awarded by ADEME.

In 2020 the district was acquired the *EcoQuartier - étape 4*, the final level of an ecodistrict labelling by the Ministère de la Cohésion des territoires et des Relations.

3.7.2.1. Integrating the environmental ‘exemplarities’ in architectural design

« The ambition of the project is to combine the architectural quality and the environmental quality of the constructions, in particular housing, like the exemplary eco-districts of Northern Europe. » (*Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009*, 2009, p. 30) In other words, the quantitative energy objectives of this urban operation as initially declared on the *Dossier de Réponse* in mars 2009, are basically driven by the high requirements imposed by the *Plan Climat* of the City of Paris. This means that the edifices had to have an energy consumption alike to a reinforced BBC building, reaching a *PassivHaus* level of performance. (50 kW/2/m²/an) The challenge was lying mainly in the implementation of these standards in a context that generated a complex set of constraints that were increasing as the urban density was high, questioning the sunshine levels, the perspectives, the height and thickness of the built forms. The complexity of the situation called for a response that would not compromise the « architectural quality and the values of use ». An ideal design approach to this complexity, looked for by Semavip, would be combining « creativity and environmental sensitivity necessary to go beyond technicality and develop a real architectural design tool ». The basic requisite in question could be therefore generalised in search of an architectural design integrating the environmental imperatives.

²⁰⁶ Information retrieved on <https://www.paris-metropole-amenagement.fr/fr/clichy-batignolles-paris-17e>

3.7.2.2. The Photovoltaic panels

1 Photovoltaic panels incorporated in the architecture

PLOT E2 Périphériques

The roof of the "Quintessence" apartment building is equipped with an electrical unit of over 600 sq. m. that produces enough energy for approximately 25 households. The slope at the top of the building helps to incorporate the photovoltaic cells into the roof with an exposure that is at once highly efficient and aesthetically pleasing.

Façade panels

PLOT 05 Viguiet and Associés + Agence Search

To reach yearly photovoltaic production of 248,000 kWh, two systems will be used: standard panels to be located on the four roofs of the buildings, as well as 388 monocrystalline silicon high yield (over 18%) photovoltaic shutter systems installed on facades whose southern exposure and approximately 30° slope guarantee maximum electricity production.

Courthouse

The photovoltaic panels blend in with the court building's architecture like a backbone. They cover the elevator shaft from top to bottom of the building, frame the green terraces and the interior courtyards, and are interspersed throughout the façade without blocking any windows or doors. The system will produce 75,000 kWh per year.

Figure 23 Photovoltaic panels in buildings of Clichy Batignolles. Information retrieved from Clichy Batignolles Aménagement

‘Co-responsibility in district energy efficiency and sustainability’

Cordees project is a large-scale energy governance project, relying on the use of smart grids. Real-time energy consumption and production data (on heating, domestic hot water, lighting, ventilation, ambient temperature, and consumption of energy appliances) is collected by residential and tertiary buildings, accessible to the district's energy performance stakeholders via a digital platform. The aim of this project apart from the observation and of the energy performance of the district, seeks -in the words of its administrators- to engage users in participating in a collective knowledge ‘coaching’ of the district's energy operation.²⁰⁷

‘(...) With the CORDEES project we are experimenting with smart grid solutions as well as an effective governance, enabling us to achieve the ambitious objectives set in terms of energy performance. We hope that Clichy-Batignolles eco-district will serve as a model for other cities as well.’²⁰⁸

3.7.3. Short conclusion of the subchapter

Through this project the municipality projected its political will to transform the concerned area not only in terms of energy efficiency but in the promotion of mixed functions, social diversity, reduction in GHG emissions and biodiversity as well.

²⁰⁷ Information on the project can be found in <http://cordees.paris/>

²⁰⁸ Jean-Louis Missika, Député Maire de Paris en charge de l'Urbanisme, de l'Architecture, des projets de la Banlieue parisienne, du Développement et de l'attractivité économique, in <https://www.uia-initiative.eu/fr/uia-cities/paris>

The general energy objectives of the district are listed as below: reduction of heating to 15 kwh / m2 / year; primary energy consumption of buildings less than 50 Kwh / m2 / year and photovoltaic electricity production around 4,500 MWH / year.²⁰⁹

While the requirements on buildings' energy performance were established in 2003, yet their indicators are superior to ones of the RT 2012.

In the urban scale, the district's design promoted an installation of photovoltaic panels and the use of geothermy: '35.000 sq.meters of photovoltaic panels have been installed, covering up 40% of the district energy needs'²¹⁰ and geothermal energy supplies the district heat network. In addition, a pneumatic refuse collection aimed to reduce the use of vehicles needed for the waste management of the site. The "CoRDEES" project was implemented with the intention to contribute to the energy management of the district along with the residents' implication, the first smart-grid in Paris, financed by the European Union.

²⁰⁹ source : <https://www.paris-metropole-amenagement.fr/fr/clichy-batignolles-paris-17e>

²¹⁰ (Danon, J.-F., Centlivre, C. in Catsaros, 2019, p. 10)

3.8. Architecturological Analysis²¹¹

“The project approach aimed to begin with something – the park- that would introduce a positive dynamic” (Grether, F. in Léglise & Sautot, 2013, p. 98)

The 3,5 hectares Martin Luther King park, located on the railway embankment of a site previously occupied by the French Railway Company, acts as an initialisation element in the design process.

It intends to play the role of a joining component between the surrounding spatial objects.

“The fabric of the park merges with the urban fabric. The lanes extend the bordering streets instead of interrupting them. The park is conceived as a link rather than an interruption of the adjacent districts. The large diagonal that structures it, joining the Batignolles Square to the Porte de Clichy, reflects this intention to interconnect the territory. This is also the case for the many footbridges that were built. “ (Osty, J. in “A park in the heart of the city,” 2019, p. 7)

3.8.1. Architecturological Analysis between urban scale and parc

As seen before, Clichy-Batignolles development sector is carrying very ambitious energy objectives: proclaiming itself as a sustainable urban development reference project, it declares a contemporary urban planning activity structured around the 10-hectare Martin Luther-King park. Landscape designer Jacqueline Osty says that « Martin Luther-King Park espouses the city and vice versa. We use the park as we use a street » (Osty, 2013). Thus, it is interesting to reflect upon the relationship that the designers establish between the park and the surrounding buildings within the eco-neighbourhood.

3.8.1.1. The design of Martin-Luther-King parc

The founding act of Clichy Batignolles eco-district is based on the creation of a large urban park dedicated to leisure and relaxation in the middle of the site, around which the buildings are developed. This park is intended to be a gathering and meeting space for the surrounding

²¹¹ For this analysis see also (Vitalis, Li, Apostolou, & Guéna, 2020)

areas (*Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009*, 2009, p. 17) : its boundaries extend to neighbouring buildings and are visually fluid.

This insertion of the park into the islets was designed by the decision-makers of the project François Grether and Jacqueline Osty and associates²¹² taking into account the intention "to open direct and extended views from the depth of the islets" but also « to enlarge the dimensions by views towards the interior spaces of the islets » (*Cahier des Prescriptions Architecturales et Paysagères*, cité in *Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009*, 2009, p. 33) Thus, the paths that cross the park, extending the urban fabric, contribute to the continuity and integration of the surrounding landscape inside the park (see Figure 4).

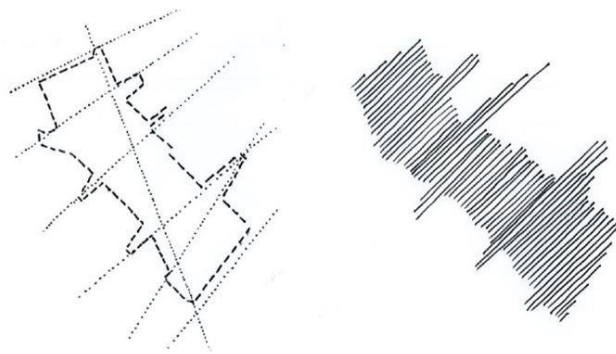


Figure 24 The park crossed by axes (a) and designed as a connecting space where nature is extended to the hearts of islets and on public space (b)

This idea of extending the park towards the city refers « to the image of the contemporary and sustainable city, of the Paris of the 21st century » (*Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009*, 2009, p. 29). Rather than the 19th century Haussmann models which isolate a domesticated nature in the image of the Batignolle's square parallelepiped, the landscaper created «vegetal entrances to make a« seam »with the surrounding districts » (Osty, 2013)

This design choice could be architecturologically described by the implementation of a visibility scale of global relevance which creates a way of seeing the city without interruption from the park. In addition, the park limits are at first blurred visually: multiple points of view are created deeply in the hearts of the islets over the park but also over the common green areas of the buildings. It consists of an optical scale which is also accentuated by a geometric one:

²¹² Le parc Martin Luther King est réalisé et entretenu par la Direction des Espaces Verts et de l'Environnement de la Ville de Paris, avec Atelier Jacqueline Osty et associés (paysagistes), Atelier François Grether (architectes urbanistes), OGI (Bureau d'études) et Concepto (concepteurs lumière)

the general outline of the park does not draw a clearly identifiable shape. The serrated shape of the planted entrances generates park excrescences which are inserted in the built environment. The designers declare having also taken into account the surroundings of the park. Thus, the axes - alleys and paths - cross it by extending the urban fabric. Considering irrigation savings and a development of biodiversity, they created biotope basins. Finally, the railway history of the site is said to be integrated into the park so as to stage its traces: the rail lines carrying the memory are remodelled by being inserted into the emerging landscape, in particular in the « garden of the rail ».

These aspects of the internal design of the park can be architecturologically interpreted. Spatial continuity is induced relatively to elements belonging to the surroundings and vicinity and thus fall under the neighbourhood scale which raises the question of its own limits. The division of the space by the presence of basins can be interpreted by an economic scale which here concerns the recycling and recuperation of water for ecological and environmental purposes. The size of the basin and its central positioning are induced by the relevance of the water economy and its management. The expression "rail garden" (small thematic garden) acts as a semantic scale which cuts out a space in which a symbolic scale becomes dominant: this part is designed with reference to the site's memory. « We decided to integrate this aspect into the landscape. Instead of making it a constraint, we have nurtured the industrial aspect of the site » . (Osty, J., in Seres, 2011) Thus, the size and orientation of the railway lines are preserved as the structure of the alleyways. This scale is relayed by an optical scale which leads to leaving the rails visible and to reusing the paving stones of the old railway site.

3.8.1.2. The architectural design in relation to the parc

This strong global willingness to extend the park into the islets and the surrounding spaces impacts not only the design of the park but also the design of the buildings around it. In this part we will focus on the design of the buildings in relation to the park through the implementation of visual interactions of « seeing and being seen » carried out in several lots (see Figure 2). Via the visibility scale, the areas of vegetation inside the lots are conceived so as to show/to make visible the park's greenery. The establishment of this scale is permitted either by cutting up the built space by the use of vegetation (lot o4b and e2); or by cutting the lot in relation to the visual paths coming from the park and the positioning and orientation of

the built form in a way that pursues them (o8, o6a); or by placing the vegetated boundaries around the lots (o6a) or inside them in different levels (o6b) which could refer to a zero degree plot scale.

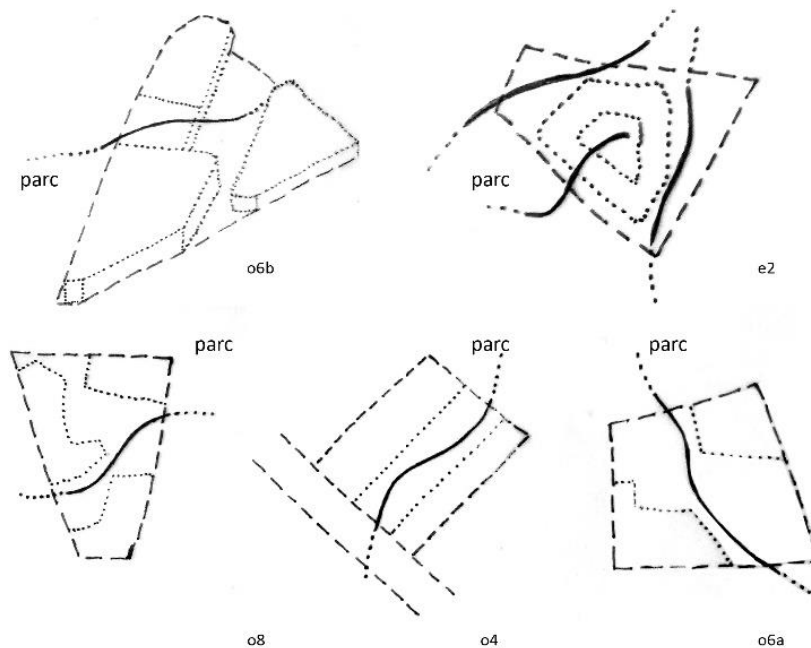


Figure 25 Extension of the park into islets

The park is « connected » by visual extensions into the interior of the lots in diverse ways: a positioning of garden on a roof views the park and the heart of the block; visual connections extend the park inside the block until the street; a garden ‘cuts’ the plot extending the landscape and linking the street and the park; a space division enables the visual interaction of the park landscape from the street; a positioning of a building ‘invites’ the park and an interior courtyard is visually linked to the park by the transparency of the ground floor.

More specifically, in the lot o6b the parc extends in the interior of the lot through an aromatic vegetable garden in the rooftop (R+1) along with a collective garden in the interior of the parcel. In the lot o8 the “dialogue” with the parc concerns the development of visual paths following in the interior of the parcel and leading it to the road. In the lot o4b the link with the parc is established by a space division: a garden traverses and cuts off the parcel, creating a “porosity” between the road and the parc; a prolongation of the landscape. The conceivers of the o6a lot associate visually the parc with the road by cutting off the space to be “placed in the level of the parc so that its landscape can be perceived from the road through a visual fault in double height”. Moreover, plant bench placed along the wall separating the parc from the islet maintains the planted scenery. The extension of the parc in the interior of the lot e2 is

expressed by a positioning operation along with a slicing of the space so that the building receives the parc in his centre and surroundings. The courtyard in the middle of the edifice is visually prolonged towards the parc by the ground floor's transparency.

Staging of the visibility scale towards a landscape city

These examples demonstrate various ways of the implementation of a visibility scale in the design of this space. The urban landscape here is meant to be designed by nature, which, like a « visual breakthrough » infiltrates all axes of the district (trees in the public space, green walls, planted terraces, facades, gardens inside islets) by creating visual extensions linked to the park. These porous relationships between exterior and interior are manifested in a seek for transparency and perspectives that revolve around the « seeing and being seen ». If the staging of the landscape involves in this case visual relations, the district wants to proclaim itself as a landscape city where the fusion of spatial artificial objects is built beyond the use of nature as a decorative element.

The rich vegetation visually multiplies the ten or so hectares over which it will soon extend, giving the impression of a far greater surface. This sensation is increased by the line of constructions rising to the East and the West that make the plan of the park become three-dimensional (...). This volumetric illusion is enhanced by staging the seasons with a polarity based on the seasonal blooming of certain species. (Archit. d'Aujourd'hui Hors Série / Proj. L'éco-quartier Clichy-Batignolles, 2019, p. 14)

3.9. Epilogue

The 3,5 hectares Martin Luther King Park, located on the railway embankment of a site previously occupied by the French Railway Company, seems initiating the project. *This public space aims above all to be a link between the East and West, South and North of Clichy-Batignolles*(Archit. d'Aujourd'hui Hors Série / Proj. L'éco-quartier Clichy-Batignolles, 2019, p. 12)

The design of Clichy-Batignolles district claims that, although being part of the urban fabric - extending its structural grid-, it is created around an open space prolonged in the adjacent built and open spaces as well as in the interior of the plots. A neighbouring architectural scale seems to be activated through a visual scale, relayed by a geometrical one, when it comes to the conceptual limits of the parc and the design of void/solid in the plots so as to connect them. *'The urban composition around a vast unifying green space is the opportunity to reconnect with a model that can be found in Parc Monceau or in the garden cities of the suburbs'*.(Dossier initial Projet Clichy Batignolles. Candidature à l'appel à projet nouveaux quartiers urbains. Aout 2009, 2009, p. 7)

In parallel, a *space of reference* concerning history is probably activated during the design process mobilising the architectural types of the past, compared to a 'contemporary' urban image with the connotations it carries. An architectural scale of model is probably implemented regarding the haussmanian Square de Batignolles and the Parc Monceau, when it comes to the organisation of a collective space in its interior as well as in relation to its surrounding environment.

A *scale of extension* (relayed by a neighbouring one) could have participated in the design choices of the plan of the parc especially in its boundaries with the built frame surrounding it, as well as in the size and location of the paths in the interior. However, this is not linked to a future projected; it is related instead to a 'porosity' and merging intended to gradually unify the project with the city.

The economy of the project in terms of applying the ambitions on ecological and energy performance in the design calls apparently for an economical scale whose relevance interrogates energy reduction. Although this kind of requirements being meticulously prescribed, the design choices seem to consider energy concerns in diverse ways.

Moreover, an economical *scale* is seemingly implicated in the plant density, the type of material chosen, with a reference to the reduction of maintenance along with the water savings. The location of the water basins, the size of the jets and waterfall, are presumably relayed by a juxtaposition of a technical, economical and sociocultural *scale*.

A global *scale* has been apparently applied in the landscape choices, whose relevance could be found in the environmental approach of the parc site in its whole.



Figure 26 view from Cardinet street of Clichy Batignolles eco district, west sector. Source M. Apostolou



Figure 27 view from the parc of Clichy Batignolles eco district, west sector. Source M. Apostolou



Figure 28 view from the parc of Clichy Batignolles eco district, west sector. Source M. Apostolou



Figure 29 view from the parc of Clichy Batignolles eco district, west sector. Source M. Apostolou

4. Study case, Building E1

4.1. Prologue

In the fifth Chapter the first study case will be explored. It consists of the second building that was delivered in the east zone of the Clichy Batignolles eco-district in 2013.

A brief presentation of the architectural team and their work will initiate the chapter.

At first, a description of the building according to the intentions of the designers who pursued the study will be presented.

An interpretation of the architectural design of the edifice will follow, implementing as a viewpoint the tools and concepts that our method of analysis, architecturology, provides.

Finally, a focus on the consideration of energy issues in the design process of this case study will tend to intersect the vocabulary of architecturology and its relevance when applied on the energy performant design.

More specifically, what is intended here is not to proceed in an exhaustive architecturological analysis of the design of the building but rather an analysis of the key points present in its design process that would be linked to energy considerations. Based on concepts that the vocabulary of the methodology used offer us, a reading of the design process will be thus proposed. The use of the postures of architecturology as well as the *scales* it consists of will be applied in this reading. As the research is oriented towards the implication of energy issues and the imperatives of the environmental performance in the architectural design process, the point of view will be therefore set under this prism.

4.2. The architect, Franklin Azzi Architecture

‘I start from the idea that a project is a whole, achieved with different disciplines’ (Azzi, F. in “Franklin Azzi, l’archi-talentueux,” 2018)

Franklin Azzi was born in France in 1975 and is a graduate of Ecole Spéciale d'Architecture de Paris and of Glasgow School of Art. He founded his architectural agency Franklin Azzi Architecture²¹³ in 2006. He has accomplished various projects, from interior and furniture design to boutiques, installations, cultural projects of public procurement and urban scale interventions in France as long as worldwide. In 2017, with the team AOM, he won the competition on the Tour Montparnasse metamorphosis in Paris, France. Other notable completed projects are the Docks in Saint Ouen, the transformation of the old Alstom warehouses in Nantes to the Beaux Arts de Nantes Saint Nazaire, or the design of Beaupassage-Grenelle commercial center. He has won several awards.

The input material used to base the architecturological analysis, that is the interpretation of the architectural design process that follows, is composed of an interview of Franklin Azzi and his collaborator Pablo Boisier (“Clichy Batignolles, Interview Franklin Azzi et Pablo Boisier,” 2010, accessed on 10.12.2017), a descriptive text of the project derived from the agency of Franklin Azzi Achitectes (Azzi, 2014, accessed on 11.11.2017), an article (Bouchouchi, 2013) on the design of the building , a text (*Clichy Batignolles Fiches Programmes Logements. Lots attribués du côté de l’avenue de Clichy*, n.d.) published in the official site of Clichy Batignolles eco-district project as well as an interview (*Lot E.1 Franklin Azzi Architecture*, n.d.) of Franklin Azzi.

4.3. The building, E1 Cardinet Chalabre

The building E1, Figure 38 is situated at 173, rue Cardinet, in the 17th arrondissement of the city of Paris. It was designed by Franklin Azzi Architecture and his collaborators Pablo Boisier B2

²¹³ See more in <http://www.franklinazzi.fr/>

Architects. It is a mixed building grouping three programs, which required the implementation of three regulations: it gathers 61 residential units HQE (of High Environmental Quality), a crèche and shops. Figure 39

It is a low energy consumption building complying with the City of Paris Climate Plan.

The environmental performances that the project has achieved are a BBC label (low energy consumption building)²¹⁴, a Plan Climat Paris label²¹⁵, the french Habitat and Environment certification - Performance option (housing), the french standards and High Environmental Quality certification - tertiary building (crèche) and the High Environmental Quality pilot operation for tertiary building (shops).

4.3.1. Description

4.3.1.1. Geometry

The building's morphology seems apparently as solid and monolithic: it is composed of a base of double height and a body of building in overflow with an overhanging structure, offering two distinct facades. Figure 40 Figure 41 Figure 42 The crèche takes the form of two volumes connected in a winter garden being developed in the heart of the plot (Ardenne, 2014b, p. 120). Figure 43 The architects claim that the intention of the winter garden is to serve as a protective sensory, optical and soundproofing filter of the crèche. They also declare that the volumetry opening into the garden is designed to provide the children with natural protection from outside nuances (Ardenne, 2014b, p. 120) Figure 44 Figure 45

The edifice's compact cubical shape is intended to minimize the surface area in contact with the exterior environment where heat loss takes place, that is said to contribute to the reduction of the energy needs (*L'éco-quartier Clichy-Batignolles, Une référence de développement urbain durable à Paris, Lauréat 2016, 2017, p. 9*). Like it has been pointed out by its architects,

²¹⁴ In France, an official label relative to the "high energy performance" labels was created. BBC stands for *batiment basse consommation*, having as a norm the energy exigence of consumption of 50 kWh of primary energy by m² by year, as defined by the thermic regulation RT 2012.

²¹⁵ Adopted for the first time in 2007, then updated in 2012, the Paris Climate Plan have set goals, as necessary to implement the Paris Agreement, in terms of reducing greenhouse gas emissions (GHG) and details more than 500 measures in several areas of action (building, transport, energy, food, waste, living environment, mobilization, finance etc), The objectives for 2020 were set to reduce by 25% the GHG emissions and energy consumption of Paris and to have 25% of renewable energies in the consumption (compared to 2004). By 2030, an operational action plan will be implemented with the aim of reducing GHG emissions by 50%, consumption by 35% and renewable energies by 45%.

For more information see <https://www.paris.fr/municipalite/action-municipale/paris-pour-le-climat-2148>

‘the elements that contribute to the high environmental quality of the project lie in the basic morphology of the building: in order to consume less energy it is necessary to reduce energy needs, hence the compactness of the building’. (P. Boisier, in “Clichy Batignolles, Interview Franklin Azzi et Pablo Boisier,” 2010)

Every apartment has a double exposure, providing thus a variety of views and sunshine but intending also to meet the low energy use objectives of the standards of the French THPE²¹⁶. The building has a south-east alignment on the Cardinet street: Figure 46 ‘The highly compact building provides a strong south-east alignment along rue Cardinet’ (Ardenne, 2014b, p. 111) It is claimed to be ‘cut in the mass’ so as to be able to accommodate environmental technologies that make it possible to achieve the objectives that were requested at the competition stage, that is to consume 50 KWh per m² per year. The composition of the envelope, the site plan and the size of the balconies are also said to be closely tied to the anticipated energy performances (Ardenne, 2014c, p. 114).

4.3.1.2. Envelop

The envelope of the building is said to have taken a meticulous part in the design process, as far as its contribution to the energy behaviour of the building is concerned. Figure 47 First of all, the dimensioning of openings in the south part Figure 48 are the higher than in the north one. Figure 49 Figure 50 Figure 51 Figure 52 ‘The envelope's structure, layout, compactness and orientation all combine to meet thermal requirements’ (Ardenne, 2014c, p. 114). Because of the use of 60 cm thick multi-layered facades the architect decided that the outer walls should also serve an educational purpose; a way of showing sustainability and revealing what others try to conceal (Ardenne, 2014c, p. 114). As a result, the facades are designed to have a degree of transparency Figure 53 in order to demonstrate the succession of their components (reinforced concrete outer wall, joinery, external insulation, vapour barrier, glazed window frames, polycarbonate external skin), like a ‘scientific cut-away’. Overall, the envelope is ambitious to serve additionally as an element that demonstrates the building’s environmental and energy performance character.

²¹⁶ Très Haute Performance Énergétique –Very High Energy Performance

4.3.1.3. The analogy to a scientific anatomical illustration

‘We wanted to do as when we do a flesh-flaying, for example, of the human body. Well, we see what the human body is made of. And here, the treatment of our facade allows to see all the layers that form these new ecological building’s envelopes. We have a structure that is in concrete, then we have insulation made of two layers of rockwool; we have a breathable cover that protects the insulation from the rain; and then finally we have a so-called mechanical skin that is a kind of polycarbonate tiling but is transparent. This transparency shows all the different layers that are creating this complex of performant envelope.’ (“Clichy Batignolles, Interview Franklin Azzi et Pablo Boisier,” 2010, accessed on 29 November 2017) The envelope remains consistent and unified despite the differentiation of its materials between photovoltaic panels and polycarbonate ones. ‘The high thermal performance wood and aluminium external doors and windows offer a vertical format without lintels Figure 54 They are dimensioned to assure a high daytime light factor in the rooms. The fabric shutters concealed within the façade offer a good level of visual comfort’.(Ardenne, 2014c, p. 166)

The material transparency for a «pedagogy»

‘The idea was to turn the façade into an almost educational element. (...) (...). Here too, the treatment of our façade allows to see all the layers that form this new ecological building’s envelope. (...) finally we have a mechanical skin that is a kind of polycarbonate tiling but transparent. (...) this transparency allows to see all the different layers that compose the complex of this performant envelop (...).’ (P. Boisier, in “Clichy Batignolles, Interview Franklin Azzi et Pablo Boisier,” 2010, accessed on 05.12.2017)

‘(...) We wanted to show from the facades that we were more respectful of the environment.’ (F. Azzi, in Bouchouchi, 2015, accessed on 05.12.2017)

A double insulation on exterior walls using very high-performance mineral wool contributes as well to the reduction of the building’s energy needs to a minimum. Figure 55 Figure 56 Figure 57 (*L’éco-quartier Clichy-Batignolles, Une référence de développement urbain durable à Paris, Lauréat 2016, 2017, p. 9*)

4.3.2. Interpretations

4.3.2.1. Spaces of reference of F. Azzi

The references of Franklin Azzi stemming from his verbatim/discourses could be condensed in a correlation between past and present. 'My generation works with many more constraints than the 1950s (...) Our colleagues could devote most of their budget to plastic. This is no longer the case today.'(Azzi, F. in Bouchouchi, 2013) They can also be related to a 'reinterpretation' of Hausmannian Paris. This could be consequently translated in a more general sociotechnical consideration that acts actively in the design. Historical references as well as contemporary cultural concerns seem participating in his proper design process. 'We are a generation born in responsibility' (Azzi, F. 2018, p. 32)

4.3.2.1.1. The framework of his contemporary generation and the architect-artist

The process that Franklin Azzi follows seems including among others the inspiration from images²¹⁷, the method of 'hybridisation' and the recurring imagery of contextualisation in his discourse/rhetoric, as a 'leitmotiv'. 'Context analysis is essential, be it social, political, economic, geographical. When you do the sum of all, this creates layers of analysis; layers of understanding which, after a while, form a solution. I am not in architecture so-called spontaneous, or sketch becomes reality'.(Azzi, F. in Abrieu, 2018, p. 73) The sociocultural, economic and geographical *scales* seem operating as active references in the work of giving measurements and forms of Franklin Azzi, alongside with the plot, neighbouring and technical ones.

The notion of hybridisation already evokes an intersection, a voluntary mixing between varieties. '(...) I am part of a generation that carries out hybrid universes from all those of our former ones. Like an exquisite corpse. (...) So our style is difficult to be defines as the only way to have new things is the hybridization.'(Azzi, F. in "Franklin Azzi, l'insatiable," n.d.) The *space of references* that could though take place during the design process seem not denoted to be rigidly and solely depending on his contemporary society and the context it

²¹⁷ It will be analysed in the next paragraphs

implies, but rather convoke a mixture of past, present and future technicohistorical visions of architecture. 'If you ask me what my style is, I cannot answer. My generation is the one of sampling, hybridization. Everything has already been done. Today, we are only reinterpreting.' (Azzi, F. in Quinton, 2017) This reinterpretation could be here related to a model *scale* referring to social, cultural, aesthetic, technical orders.

Even if Franklin Azzi admits belonging to his contemporary times and designing for this context, the time seem acting at the same time as a source of inspiration in its entirety: various fields of reflection are nourishing his *spaces of reference*, convoking diverse disciplines.

'(...) the city must rebuild on itself and adapt to changes in society and use. But in order to adapt, we must have understood the history otherwise we will get uprooted projects, out of their context. As a process that goes through an analysis and advanced research.' (Azzi, F. in Abrieu, 2018, p. 73)

The sociocultural and functional *scales* appear to be evidently boosted in the hierarchy of the *operations* of referenciation taking part in the design process of Franklin Azzi. A method of contextual work implies taking in consideration the functional *scale*: 'architecture must reflect the uses'. (Azzi, F. in Abrieu, 2018, p. 73)

An essential part of this hybrid matching between eras and disciplines is linked among others to the immense universe of images that are present on the web. 'I feed on images and still images. I am bulimic or collector. Google Images is, for me, a real working tool at the origin of any creative process. Lambda, banal, without dimension or artistic will: my iconography consists of objects of an informative purpose.' (Azzi, F. in "Franklin Azzi, l'insatiable," n.d.) Images, a sign of our times and a ubiquitous medium, probably serves as an instrument supporting the design process of Franklin Azzi. 'The blank page is an illusion. We are so fed with images. I do not want to be neither influenced nor discouraged'.

In order to make this building thermally efficient, the designer confesses having worked 'as a technician rather than an artist'. (F. Azzi in Bouchouchi, 2015)

It remains interesting the correlation he is drawing between art and architecture: he does not consider the architect as an artist, nevertheless he admits an artistry in what an architect does. 'The time of the architect "artist" and of "capricious" works is over (...)' (F. Azzi in Bouchouchi, 2013)

'For me architecture is a mixture of demonstrative reasoning and manual action. I like the pertinence of philosophy, which is close to the idea of demonstration. And it's precisely this

pertinence that I seek in my projects - a pertinence which, moreover, is a form of poetry' (Azzi, F. in Ayers, 2018, p. 23)

The technical *scale* could be in this case proceeding in a sociocultural *space of reference* along with a *scale* of model.

In his high performant building in the eco-district of Clichy Batignolles, a part of whose technical skeleton is visible, the energy transition and the environmental quality had to be *de facto* considered and thereby get an active part in his *spaces of reference*.

More specifically in his specific rhetoric discourse describing the design process, one can find rooted the dipoles of art-architecture, art-technique²¹⁸, technicity-technique as well as the matter of decoration and aesthetics²¹⁹, all of them operating in *reference* to the performance and the quantitative aspect of energy efficiency.

An assumption is hereby supported; it concerns the relation of environmentally high-performance aspects invoked in the discourse on the one hand and the actual design process of the building on the other.

In order to manifest the energy transition arisen, the place that performance takes in the rhetorical architectural discourse is intended to be expanded beyond quantity. It aims to develop the object conceived into a transparent –thus visible- figure that broadens the numerical constraints to an educational, message-carrying element demonstrative of its 'identity'. By integrating an optical²²⁰ *scale* the architects declare an ambition to reveal at this specific moment of time (2013) a change that is being operated in the architectural design concerning the energy efficiency constraints. The facade openings, the envelope's technical construction and materials become the aspects that bear the aim of a paradigm shift. The declaration of contrasting to the model of the Haussmannian surrounding buildings could be interpreted as a willingness to create a building-symbol representing its function as an energy efficient one: 'It's macro-architecture. The volumes are voluntarily dense, and the openings reduced, contrary to the Haussmannian style. But this is the only way to build energy buildings' (F. Azzi in Bouchouchi, 2013)

The main aspects taking part according to the architect in his design process could be therefore resumed in a hybridisation, a saturation, a contextualisation, a merge between the past and the

²¹⁸ «a job that demands to be «more technician than artist»,

²¹⁹ «to break the capriciousness of aesthetics»

²²⁰ giving measurements in a part of the architectural space according to viewpoints set on it

present as well as the viewpoint towards the future, thus a reinterpretation of the different historical layers of architecture. Figure 31

In the following lines an interpretation of this universe of references will be made, based on the architecturological concepts.

Overall, the social, political, economic and geographic orders that participate in the creation of a ‘contextualised’ environment active in the design process are linked as mentioned before to a sociocultural, economic and geographical *scale*. Figure 30 The use of the history and time stratifications as well as the notion of ‘reinterpretation’ can be identified in a use of a model *scale*. This *space of references* is evoked by the architect under the umbrella of ‘hybridisation’, that is the combination of diverse kinds and elements or the action of changing, adapting, evolving some of their parts.²²¹

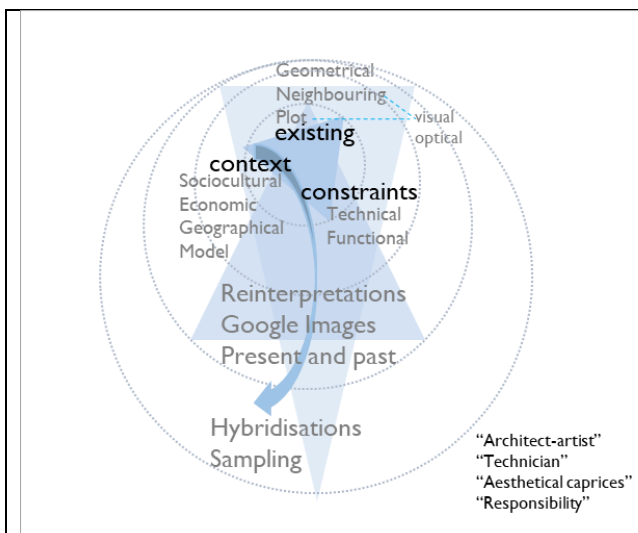
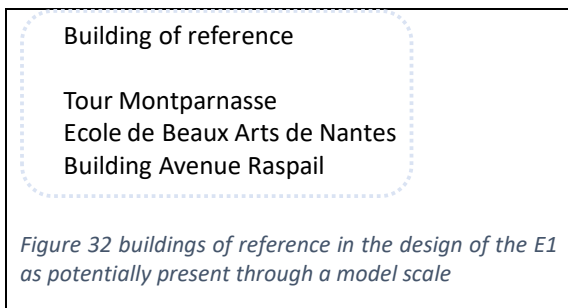


Figure 30 Possible reference spaces in the design work of architect Franklin Azzi

Notion	Inspiration	Action
Hybridation	Memphis Group	
	Nimayer, Aalto	each decorative detail presides over a technical function
Modernism	Claude Parent, Jean Prouvé, Marcel Gascoïn	
	Paul Virilio	the three-step design and three projects
Images	Finn Gelpel, Frédéric Borel	
		The compilation of images
interdisciplinarity		Crossroad of disciplines
	Rudy Ricciotti	on creativity and constraints in the work of an architect
The industrial atmosphere		

Figure 31 Concepts and references mobilized in the design work of architect Franklin Azzi



²²¹ It would be interesting to mention the ‘hybridisation’ concept used by Dominique Raynaud in his research and investigate a possible correlation.

4.3.2.2. The operation of positioning

Positioning their building along Cardinet Street in a way that a dialogue between the surrounding elements (Martin Luther King park, the new buildings as well as the existing ones) is emerged, resorts apparently from a neighbouring *scale*, aiming at preserving an urban landscape continuity. Figure 58 This *operation* is implemented as well proceeding a functional *scale* that refers to the constraints of the three programs.

In addition, the *operation* of positioning the building aligned to Cardinet street holds its references on a plot and a neighbouring *scale* (parallel to Cardinet street and continuing of the urban fabric) The concentration alongside Cardinet street depends also on a functional *scale* that refers to a neighbouring *scale* due to the maintenance of a communication with the environs. Figure 59

The operation of positioning of the building in the parcel holds its *reference* in visibility and neighbouring orders that concern a preservation of the views of the backward urban islands to the parc. Figure 61 Figure 60

4.3.2.3. The operation of dimensioning

The height being R + 8 seems to be an anchoring choice to the existing urban landscape. The progressive declination towards the park seems to be linked to the optimization of the positioning of the photovoltaic panels on the rooftop: it probably depends thus on the neighbouring and geographical *scales*. Figure 58

The *operation* of dimensioning finds its *pertinence* in the form of the progressively slanted roof related to technical, geographical, functional and neighbouring orders. An *operation* of integration and orientation seem overdetermined in the dimensioning and cutting of the roof as for the photovoltaic panels to be positioned and functionable.

The *operation* of dimensioning of the base of the building (double height) possibly resorts from a visibility and an optical *scale* relayed by a semantic *scale* that leads to a visual permeability. The 'dense' volumes and the 'reduced' openings operate probably in a *space of references* related to the economies on energy and the performance of the building: The dimensioning of the windows holds thus a *relevance* on the economic scale (of energy) and a *reference* on the

scale of model zero degree²²² relayed by a symbolic *scale* of form, that of the model-type of voids and plain characterising an hausmanian edifice.

In the case of Franklin Azzi's building a possible questioning of the general volumetry consists in examining the relation of the edifice with the parcel in which it is inscribed (in link with the Paris of Haussmann on the one hand and the park on the other, as well as the orientation facing the north-south axis), but also with the orientation and the views face to the park on the one hand and the urban landscape on the other. The linearity is presented as an architectural choice responding to plot and geographical issues along with neighbourhood ones. It seems related to an economy of energy question too.

4.3.2.4. The operation of orientation

The orientation of the housing units depends probably on a geographic and a neighbouring *scale* evoking references of visibility (diversity of views), geographical (sunshine) and economic (of energy) orders (responding to the criteria of energy performance and low consumption). Their orientation (opening on the park or the interior garden) probably has equally a *relevance* of a transversality order, lying on the *scales* of visibility and neighbouring. The optical *scale* appears in the positioning of a garden in the interior of the parcel- that induce a visual connection with the city and the parc.

In the conception of this winter garden an *operation* of cutting seems having been executed, proceeding from a functional *scale* (access to the housing units) and an optical one (extend the views towards the interior of the plot). They seem having been relayed by a neighbourhood *scale* referring to the interaction between the dwellings and their urban environment. The decision for placing this garden in the depth of the parcel is related thus to the fore-mentioned scales with reference to plot, function and road-related orders, 'veiled' under the mobilisation of a semantic scale ('sensorial, visual et phonic filter')

The morphology of the crèche probably relates its *relevance* a geometrical *scale* (form of "en tiroir" towards the interior of the parcel) with *reference* to a function, this of the protection of children intimacy. The *operation* of cutting and positioning of the crèche finds its *relevance* in

²²² 'in contrast to the Haussmannian style'

a neighbourhood and an overdetermination of visibility and optical *scales* (creating a link between the green spaces of the garden and the parc's landscape). This operation seems relying in a *reference* that concerns the prescriptions' demand on the recreation space keeping more than 8 metres of distance to the dwellings' façade.

4.3.2.5. Interpretation of the envelope

When referring to the north Figure 62 and south Figure 63 facades, an opposition is arisen, that sends to a geographical and neighbourhood points of view. However, this should also be linked with the functional organisation of the plan and the division of the programs as well.

The facades appear therefore to be related to geographical; visual, neighborhood and economy of energy issues.

A model *scale*²²³ appears probably in the size and number of openings on the facade. Here we find an example of zero degree at the south facade of the building, which is at the antithesis of the Haussmannian façades²²⁴, which repeat the same pattern of openings.

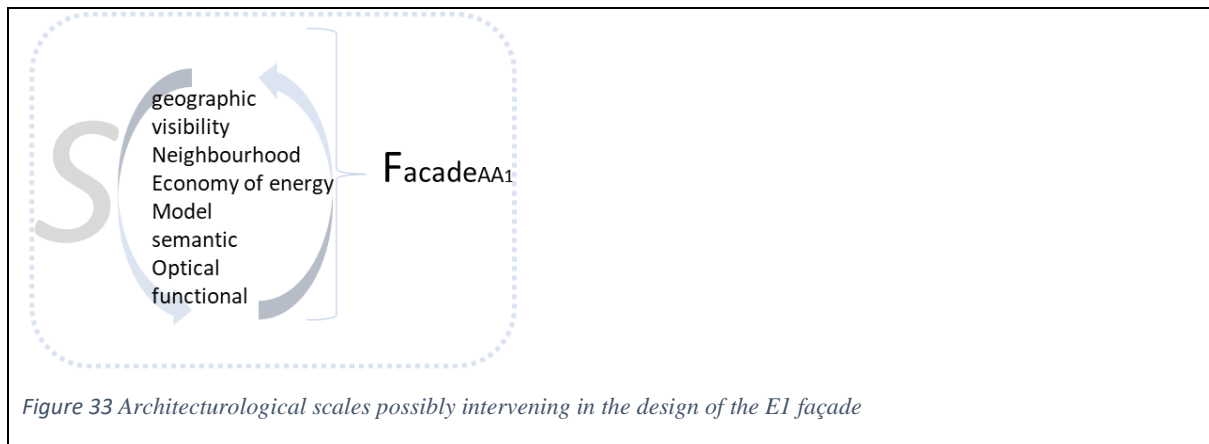
The expression 'écorché scientifique' acts as a semantic *scale* that cuts out a space in which a symbolic *scale* becomes dominant: the façade is designed with reference to an element of pedagogy. The scale is relayed by an optical *scale* that leads to leaving the materials visible and a technical one, by choosing the successive materials to be transparent.

The operation of cutting of the envelope in successive layers of materials lies its *relevance* in the energy-savings of the building; It can be additionally identified in a *scale* of visibility and a functional one²²⁵. Figure 33.

²²³ The architecturological *scale* of *model*, as defined but not restricted by Philippe Boudon, is the *resumption of an earlier model, while possibly making modifications of various degrees and of various natures.*

²²⁴ 'The volumes are voluntarily dense and the openings, reduced, contrary to the Haussmannian style'

²²⁵ 'Protective' envelope, 'a kind of an insulating coat'



The use of translucent polycarbonate in the façade Figure 64Figure 65Figure 66Figure 67 relies probably on the implementation of an optical *scale* with reference to a technical (letting to appear the colours of the waterproofing membrane) overdetermined here with the optical one (diverted into a decorative element).

The optical scale appears in the treatment of the envelope and its materials²²⁶as well as in the materials of the building and the glass base in the ground level

Figure 42

‘We wanted to do like when we do a scientific anatomical illustration, for example of the human body (...)’

The scientific cut-off of the human body’s skin is hereby used as a metaphor of the façade’s transparency.

In the French definition form Larousse, *l’écorché* (literally the act of removing the skin) is defined as:

- Human or animal represented stripped of his skin. (The skinned, especially in the form of a plaster model allows to study the dispositions and form of the muscles, veins, joints. There are flayed figures of animals, in particular of horses. The Ecorché de Houdon (1767) is the most famous human figure.
- Drawing of a machine, an apparatus, a building, the outer parts of which have been partially removed to show the internal organisation or the functional system.

If the architect had used exclusively the word *écorché* in order to describe the design act concerning the façade of this building, it would belong to the reference space of architecture, as a design that reveals its interior operating organisation. However, by adding the adjective ‘scientific’ when referring to the *écorché*, the reference space moves to another universe of

²²⁶ ‘see from the road how an environmental building is composed’

possibles: it rather operates here in the crossroad of art and science. It may refer to a scientific anatomical cut and a drawn skinned figure on the same time: In this case, it is interesting to mention that this term is not used under the description of the produced drawing of the building; it is though inserted linguistically as part of the architectural discourse.

The anatomical studies and flayed drawings on the work of artists existed in the Renaissance era²²⁷, one of the most significant being Leonardo da Vinci. By the late eighteenth century, the representation of the human body in the medical academies was based on anatomical models whose skin had been ripped off the body.

Alberti, in his *On Painting*, refers to anatomy and the meticulous study of the human body; he suggests a process of figural construction that must be pursued by artists. After having dealt with anatomy and proportion he outlines that an artist must then ‘provide that every member can fulfil its function in what it is doing’ (Alberti, n.d., p. 73) implying hence that form precedes function (Powell, 2012, p. 18) : perceiving the body derives from implementing its movement; that is establishing a connection between a condition and a consequence. His exploration expanded thus towards the mechanics of human movement. For Alberti the anatomical study was of an utmost relevance and importance as an appropriate representation of people and animals could be generated only by a comprehension of their interior components. ‘Isolate each bone of the animal, on this add its muscles, then clothe all of it with its flesh (...) So in painting the nude, we place first his bones and muscles which we then cover with flesh so that it is not difficult to understand where each muscle is beneath’

Leonardo da Vinci followed Alberti’s incentives. ‘The painter who has acquired knowledge of the nature of the sinews, muscles, and tendons will know exactly in the movement of any limb how many and which of the sinews are the cause of it, and which muscle by its swelling is the cause of this sinew's contracting; and which sinews, expanded into the thinnest cartilage, surround and support the said muscle²²⁸.’ he wrote, demonstrating the necessity for the painter to know the inner human structure. Like Alberti, he studied the role of individual parts of the body in mechanical activity²²⁹In his times, the study of anatomy was mainly scientific -in the medical communities- rather than artistic. However, he did not consider them as disconnected elements (Isaacson, 2017); on the same way as he regarded art and science in his studies.

²²⁷ Scientists were allowed to dissect human bodies for study (Ginn & Lorusso, 2008)

²²⁸ Quel dipintore, che harà cognitione della natura de nerui, muscoli e lacerti, saprà bene nel mouere uno membro quanti e quali nerui ne sono cagione, e qual muscolo, sgonfiando, è cagione di racortare esso neruo, e quali corde conuertite in sotillissime cartilagini circondano e racolgano detto muscolo. (McMahon, 1956)

²²⁹ see more in <https://www.britannica.com/biography/Leonardo-da-Vinci/Anatomical-studies-and-drawings>

What do we intend here by making this brief reminder on historical aspects of the anatomical drawings? By setting a correlation between the skinned illustrations and the use of this term as part of the discourse on an architectural object we intend to shed light on possible ways of it being interpreted by architecturology.²³⁰

We are going to retain the following terms: inner, structure, function, visible and establish a connection with the energy issues in architecture.

At a first place, the architecturological scales of technique, optical and function seem in this case intrinsically interrelated: the envelope is meant to be characterised not only by its materiality (that implies its performance) but also by an immaterial value; the symbolic message it carries concerning the pedagogy on the energy performance. It could be an over-determination²³¹ that links the above-mentioned scales respective to a cohesion of the form of the envelope anchored in a semantic scale expressed with words. The three *scales* are being juxtaposed by an economic *scale* (of energy). Figure 34

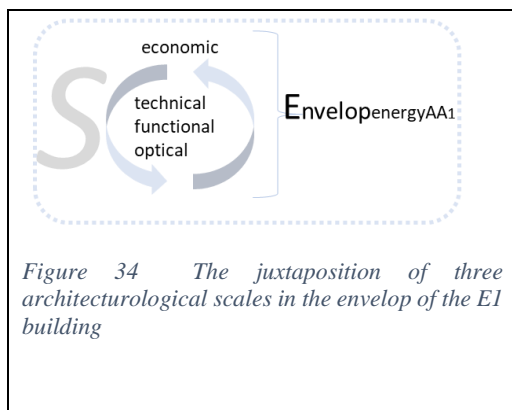


Figure 34 The juxtaposition of three architecturological scales in the envelop of the EI building

In our case, the ‘treatment’ of the façade is related metaphorically to a scientific cut, the interior of the body being analogously the successive layers of concrete, rockwool, a cover, a polycarbonate tiling. The materials become an analogy to the structure (bones, muscles, joint); the function they fulfil are here linked to the energy performance. This analogy is principally

²³⁰ After having considered the discourse on the edifice -since the *écorché* does not refer to a drawing but to the intentions of the architects- it is essential to investigate the presence -or absence- of the *scales* identified above, in the measurements and forms of the architectural object itself. A question arises on whether this term is being activated as a support to the creation of a concept and thus not participating in the design process actively, rather necessitating a mental leap in order to be linked to it.

²³¹ The overdetermination takes place when an object belongs simultaneously to several *scales*.

enrolled in a system of concepts related to the reduction on energy consumption and economy purposes, denying the preservation of a model that demonstrates the previous historical age.

4.3.3. Conclusions – on architecturological scales

To conclude, Table 16 an economy of energy *space of reference* was probably operated by implementing a cognitive dimensioning operation of the envelope (to make it energy efficient). The dimensioning operation apparently led to the dimensioning of the windows and doors so that they ensure a high daytime factor in the rooms.

The sunlight is also taken into consideration in the implantation (orientation, positioning) of the building. (Protection to the north and opening to the south). The consideration of the solar exposure also led apparently to the progressive inclination of the roof Figure 68, in order to maximize the solar contributions.

The economy of energy *space of reference* seems to be involved in combination with a technical *space of reference* through the operations of cutting and integration.

The cognitive operation of cutting is manifested by the 'cut in the mass' of the building to install spaces related to its energy performance as well as to make its form more compact so that there is less thermal loss.

The operation of the integration aims to integrate technical systems of ventilation as well as active energy system (PV) proceeding from the consideration of the targeted energy production.

Here the economy of energy *space of reference* seems to be at the origin of a cognitive operation of recovery. The proportions of the façade of the Haussmannian buildings that surround the edifice are not maintained. The proportions of the windows as well as the typologies of full and empty are thus discarded from the Haussmannian model. The new model is rethought under the guise of so-called sustainable materials: the use of modernity and the use of materials with low ecological impact. This design has probably led to the sizing of the openings on the south Figure 69 and north facades. Figure 52

Table 16 Identification of provisory cognitive operations of the architectural design of the EI building from the point of view of energy

Operation	Dimension <small>what is given measures?</small>	Relevance <small>how?</small>	Reference <small>in relation to what</small>
Integration dimensioning	Sloped roof		technical <i>scale</i> (PV)
dimensioning	Windows Full and empty typology envelope	Economy of energy <i>scale</i>	Hausmannian building model <i>scale</i> (zero degree)
dimensioning	envelope	Layers of materials Economy of energy <i>scale</i>	Semantic <i>scale</i> 'écorché scientifique'
dimensioning	windows and doors		To assure a high daytime factor in the rooms Economy of energy <i>scale</i>
orientating	envelope	Transparency technical <i>scale</i>	optical <i>scale</i> 'élément pédagogique'
orientating	Progressively inclined roof	geometric <i>scale</i>	Sun orientation geographic <i>scale</i> solar gains economy of energy <i>scale</i>
cutting	Form of the building	'compact', 'cut in the mass' Symbolic formal <i>scale</i> Geometric <i>scale</i>	Integration of technologies technical <i>scale</i> economy of energy <i>scale</i>

4.3.3.1. Compacity as an approach towards energy prerequisites

'By a fortunate inversion of systems, this risk of showing what others try to conceal affirms a 'generational' architecture based on a sustainable approach' (Ardenne, 2014a, p. 114)

Here the architect uses the "extremely compact" morphology of the building as a decision linked to the energy requirements. A compact shape of building is primarily related to a reduced surface in contact with the exterior. In architecturological terms we can situate compactness in the economic scale. It is the Panthéon of the architect J. L. N. Durand ²³²-a circular plan in cross shape- a project where the viewpoint stemming from economy considerations -compactness – minimum of space losses- contribute in determining the design. In the same way, an economic relevance could lead an architect in reducing the linearity of a façade due to reasons of energy economy²³³. At this point we could draw a correlation between the argument being based on economy and an architectural composition being based on the *economism*, a theory that reduces to economic terms other factors in society such as culture etc.

²³² See (Boudon et al., 2001, p. 160)

²³³ *ibid*

The compact morphology is the major element that is said to have been chosen in connection to low energy consumption (alongside the choice of materials); the second one is the south orientation in combination with the openings' dimensions.

'(...) there has been a rationalization of the openings of the building. So we are more open to the south, more closed to the north.' (P. Boisier in "Clichy Batignolles, Interview Franklin Azzi et Pablo Boisier," 2010, accessed on 05.12.2017.)

4.3.3.2. Building's performance as the envelope's performance

The architects of this building, in order to meet the environmental requirements and specifications, have designed a protective envelope that plays the role of an 'insulating coat', revealing its different layers as a *scientific anatomical illustration*.(F. Azzi in Bouchouchi, 2015, accessed on 05.12.2017)

The envelope's form Figure 70 seems depending on a technical *scale* (high performance, thermic insulant, a protection element) that finds its reference in an economic *scale* (of energy). The technical *scale* is probably over-determined with an optical one (intention to reveal, to show).

The architects stated that they wanted to incorporate an educational character into their project, so that the public can understand that it consists of a building related to environmental requirements. In order to achieve this, we assume that they used transparency as materiality; that could be driven by the implementation of a technical *scale* and an optical one: the building becomes a symbol itself of the intentions of its designers; a statement. Considering the traditional forms of the existing edifices in this district and trying to differentiate their building from them, the facade is conceived in such a way that it is *seen*, constituting we could say, a model of an energy-efficient object. The optical *scale* (situating an object in such a way to be seen from another place) has here the relevance of transparency. The materials to be chosen have an essential role in the achievement of the aforementioned transparency. (...) *it has a pedagogic character. We wanted to show from the facades that we were more respectful of the environment.* (F. Azzi in Bouchouchi, 2015, accessed on 05.12.2017)

Figure 35

The envelop is an element that wants to be demonstrated, to be revelatory of the ecological character of the building: the architects declare their willingness to communicate the environmental quality of their project, treating the facade as an object of pedagogy; a narrative

that describes and makes visible the series of its components and thus referring to its environmental qualities; the façade becomes thus a skin that consists of different layers of materials. Their desire is to make visible the layers and consequently the performative aspect of the envelope, revealing its technical complexity.

‘There is clearly a decade of architects, of which I am a part, whose purpose has been to make buildings greener and more virtuous. Without really knowing how to start. The first recipe for building environmental buildings is to make buildings a bit massive: in our jargon they are called "Thermos". These are closed envelopes with little glazing. Part of the projects out of the ground was thus conceived, because one had to respect this dogma of the rate of breakthrough: a certain balance between empty and full, essential to reach good energetic performances’. (F. Azzi in Bouchouchi, 2015)

‘(...) We would not do it the same way, yes, it's normal. But I do not deny it. (...) But now, taking into account the environment, it is no longer the exception, it is the standard. We came out of this era when a building was to look like a blockhouse.’

In this case, one could suppose that the architect used a morphological model, expressed by the shape (that of the *blockhouse*, *bunker*) which refers to the compactness of the building; and an abstract model, the *thermos*, expressed in words. The thermos being an insulated object that keeps the temperature, we could make a correlation with the designed building that is performant and energy efficient.

4.3.4. Epilogue

The elements that contribute to the building's energy performance could be therefore its morphology (compactness, cut in the mass to accommodate new technologies (opération de découpage et d'intégration), a lightly sloped roof to better orient the photovoltaic panels (opération d'intégration)); the differentiation of north and south facades' openings (sizing operation) (opération de dimensionnement); the double orientation (implantation operation and cutting operation) and the envelope materials.

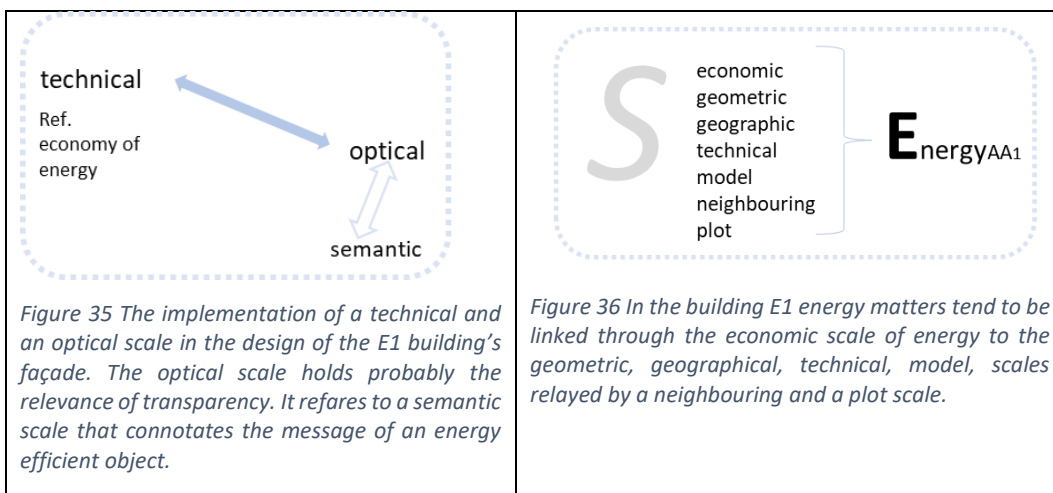
The economic scale (of energy) in relation with the architectural scales of the plot and the neighbouring have been most probably involved in the measure and the form of this building.

Thus, energy matters tend to be linked via the economic scale of energy to the geometric, geographical, technical, model, semantic scales relayed by a neighbouring and a plot scale. An optical scale is overdetermined in the case of the envelop, with a reference in energy performance. Figure 36 Figure 37

Architecturology allows to describe this case of conception as an implementation of the operation of cutting proceeding from a formal symbolic *scale* (with reference to the reception of the technologies) a technical *scale* (with reference to the energy performance of the building) An operation of integration is implemented, proceeding from an economic (of energy) *scale*. The morphology of the building is mobilised with the aim of raising a relevance of formal symbolic issues (compacity), evoking references of economic (of energy) orders (reduction of the energy consumption)

The size and quantity of openings are treated with reference to geographical order, consequently evoking energy performance issues. On the same time a scale of model is operating (zero degree) with reference to the Haussmann-ian style of buildings and the typology of its openings. This holds also a reference on a historical period, former to the architect times, and thus enunciating sociotechnical models.

Another issue to be examined in order to investigate expressions of the model *scale* is relevant to the standards or archetypes of social housing and energy-efficient buildings in comparison with the building of Franklin Azzi.



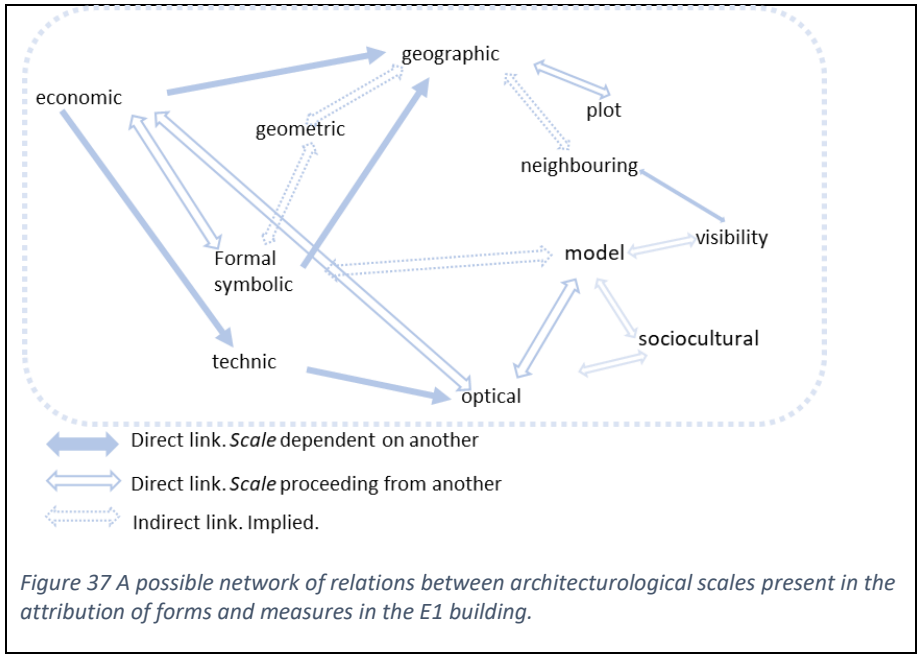


Figure 37 A possible network of relations between architectural scales present in the attribution of forms and measures in the E1 building.



Figure 38 E1 building, south façade, Cardinet street, Paris. Source M. Apostolou



Figure 39 Building E1, View from the park. One can see the creche in red colour. The E1 building is developed mainly along the rue Cardinet, according to a succession of different opaque or glazed elements arranged according to a random rhythm, accentuated by the different colours of the elements characterizing the building's cladding. Source M. Apostolou



Figure 40 The base of the building E1, which houses the shops and the crèche, is closed by a double height glass curtain wall. Source M. Apostolou

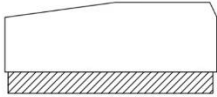


Figure 41 The base of the building E1 Source M. Apostolou



Figure 42 Building E1, view from the parc, façade. Source M. Apostolou

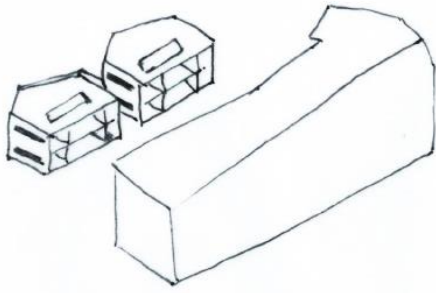


Figure 43 *The volumetry of the E1 building and the crèche units. Source M. Apostolou*

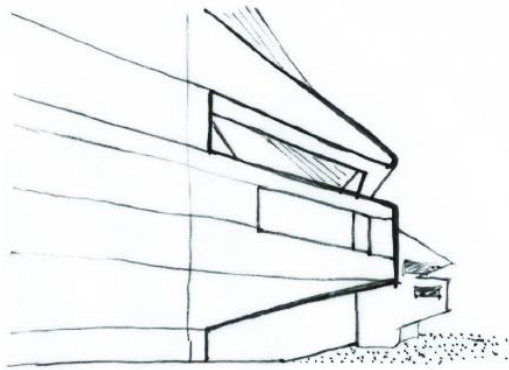


Figure 44 *The form of the crèche in the interior of the E1 plot. Source M. Apostolou*

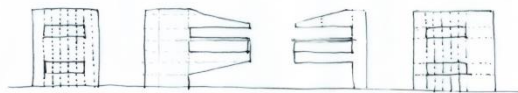


Figure 45 *The form of the crèche, E1 plot. Source M. Apostolou*

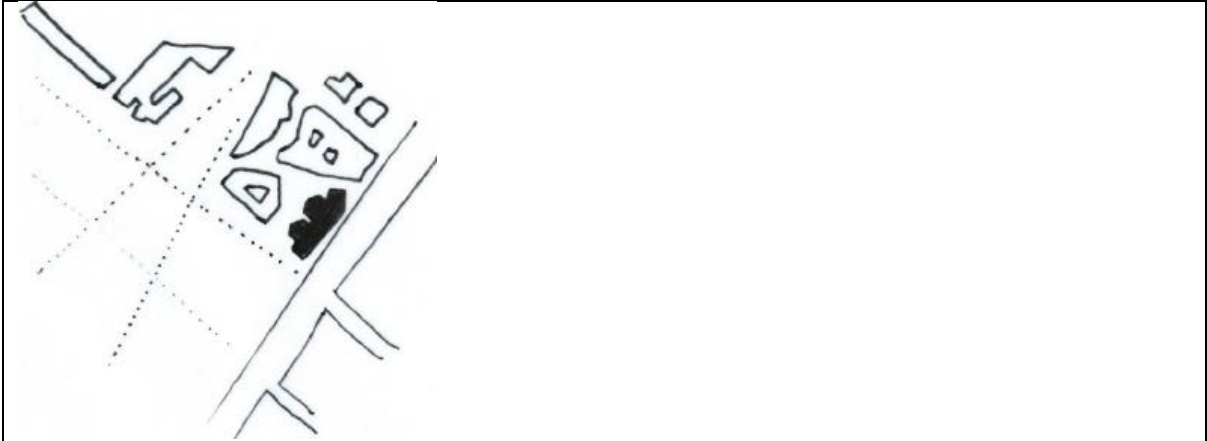


Figure 46 The E1 building situated in ZAC Cardinet Chalabre, along Cardinet street in the 17th arrondissement of Paris. Source M. Apostolou

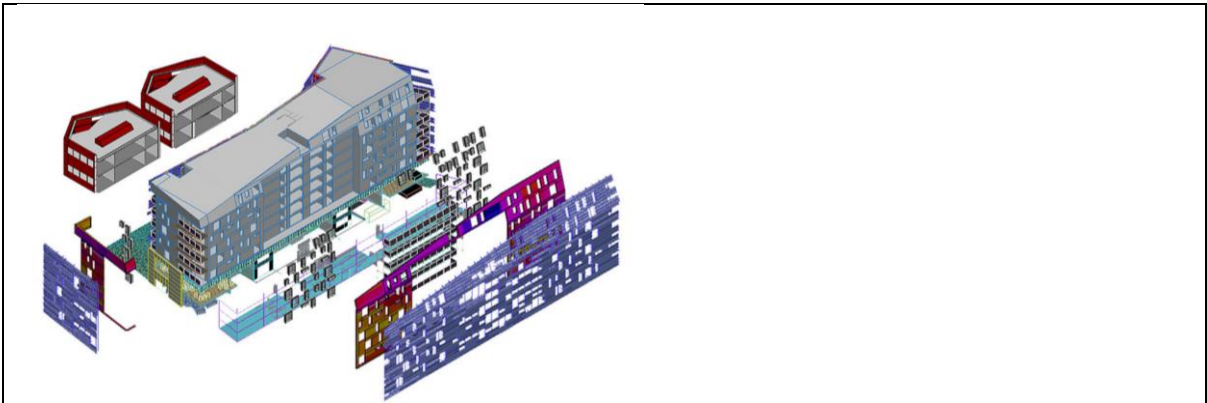


Figure 47 The composition of the envelope of the E1 building. source: Franklin Azzi



Figure 48 The positioning of the openings at the main façade along Cardinet street. Source M. Apostolou

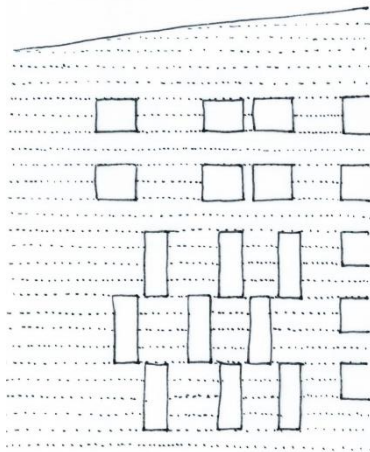


Figure 49 Detail of the southeast façade. Building E1. Source M. Apostolou

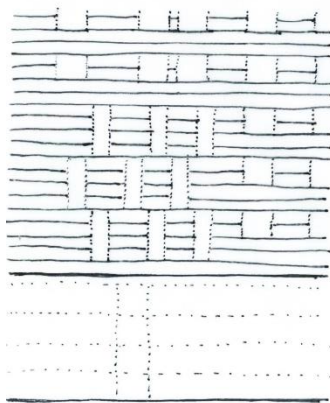


Figure 50 Detail of the southeast façade. Building E1. Source M. Apostolou

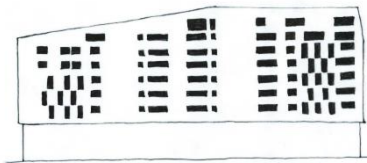


Figure 51 Southeast façade along Cardinet street. Building E1. Source M. Apostolou

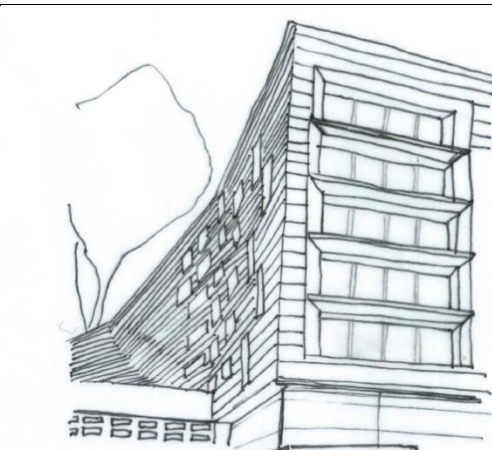


Figure 52 *The building E1 seen from the parc. Source M. Apostolou*



Figure 53 *Façade, detail. Building E1. Source M. Apostolou*

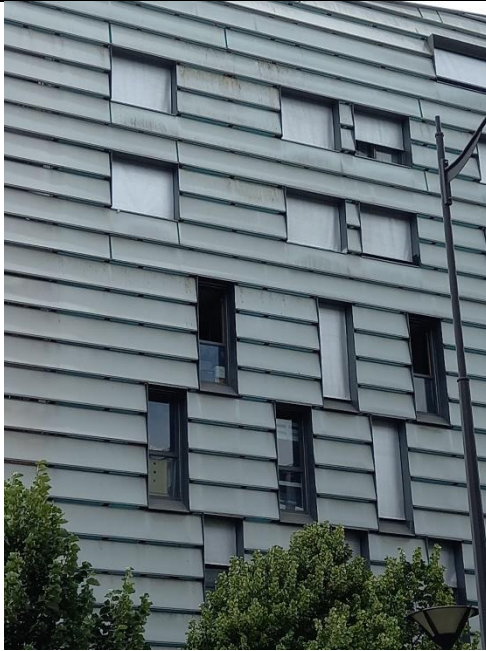


Figure 54 The glazed parts of the building are made up of mixed aluminium-wood joineries in double insulating glass. .
Source M. Apostolou

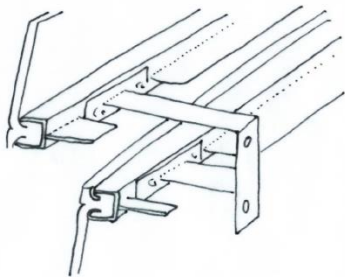


Figure 55 Construction detail, openings.

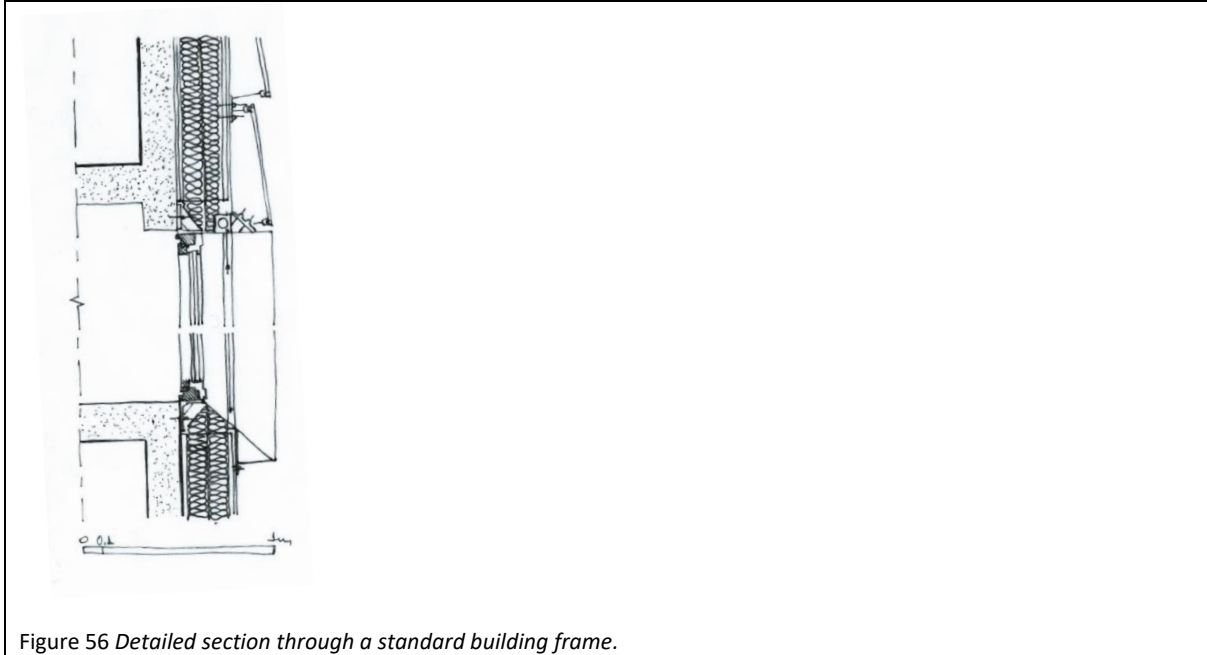


Figure 56 Detailed section through a standard building frame.

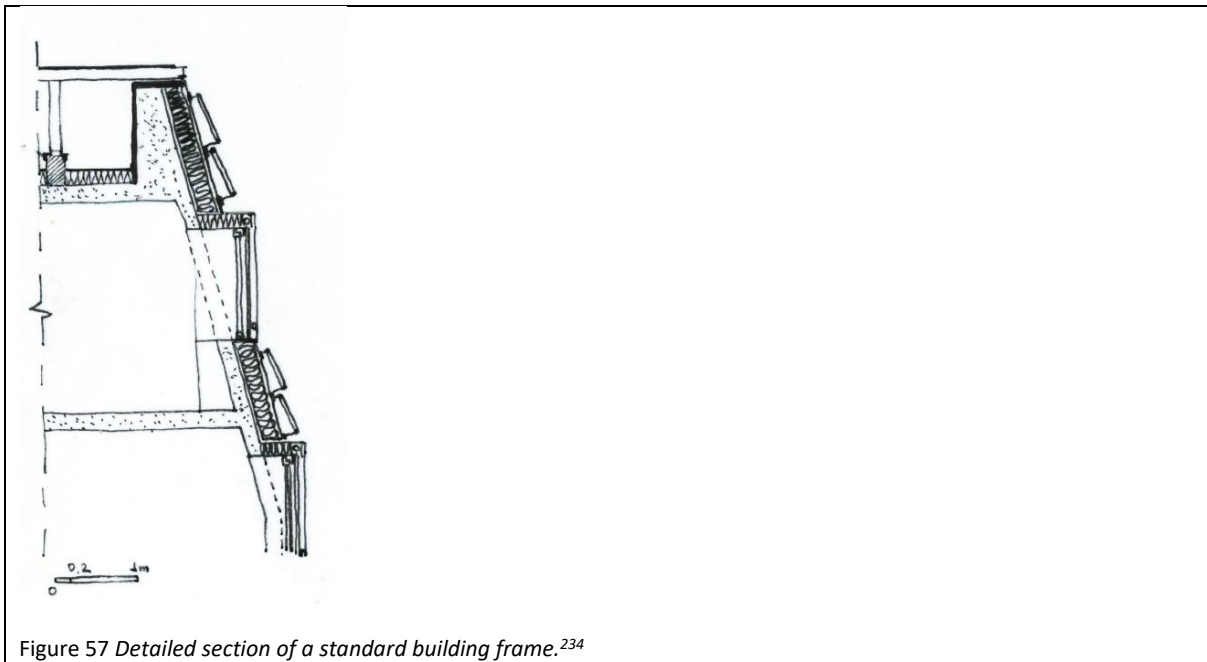


Figure 57 Detailed section of a standard building frame.²³⁴

²³⁴ (lacquered aluminium coping, polycarbonate panel, isolated pads, insulating complex, waterproof and gravel, 16cm thick, breathable membrane, rigid insulation and waterproofing insulated aluminium unit, external fabric blind, external metalwork in aluminium and wood, triple glazing, inward opening casements, balustrade in 4cm diameter lacquered steel, reveal and arch, plaster and paint, wood shelf on breast wall, breast wall with plaster finish, roof level renewable energy production panel 80x160cm, secondary structure below roof)

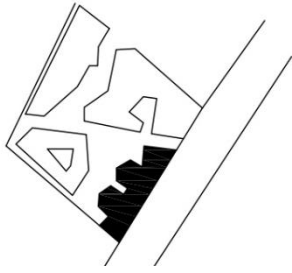


Figure 58 Positioning of the E1 building and the neighboring buildings. Source M. Apostolou



Figure 59 E1 building, schematic section through the small façade of the parc. Source M. Apostolou

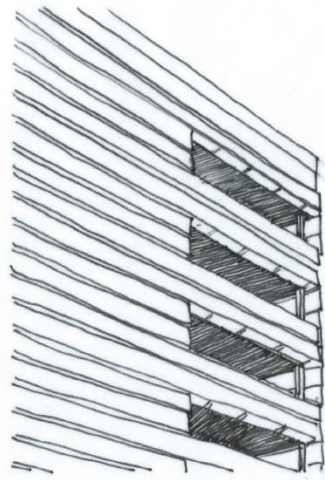


Figure 60 Detail of the openings. Façade building E1. Source M. Apostolou

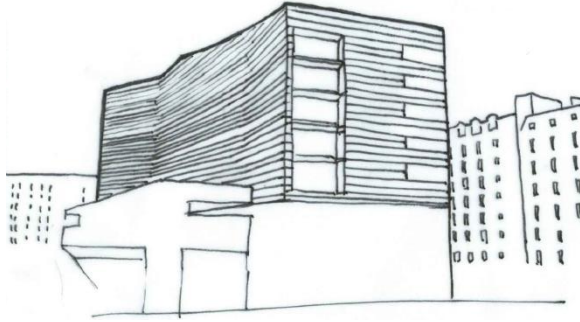


Figure 61 *Openings of the façade view parc and the neighboring haussmannian buildings.* Source M. Apostolou



Figure 62 *Detail of the envelop. Building E1. Source M. Apostolou*



Figure 63 *The main facade of the building is, in fact, a cladding in extruded polycarbonate, made with inclined panels arranged in tiles. Source M. Apostolou*



Figure 64 *Detail of the inclined panels. Source M. Apostolou*



Figure 65 *Detail of the inclined panels and the opening. Source M. Apostolou*



Figure 66 The inclined panels, spaced at approximately 150 mm intervals are attached to a concrete support insulated with several layers of insulation in order to reach the environmental objectives of the objectives of the project (Climate Plan of the City of Paris) and obtain the BBC label. *Source M. Apostolou*



Figure 67 detail of the inclined panels of the façade of the E1 building. *Source M. Apostolou*

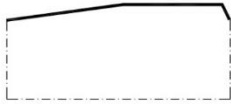


Figure 68 Schematic representation of the slightly inclined roof for the integration of the photovoltaic panels. Source M. Apostolou

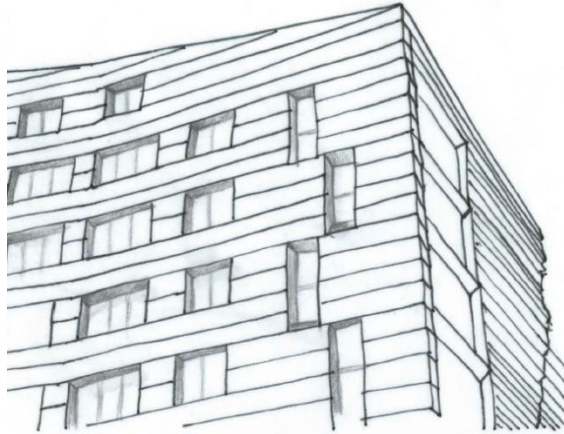
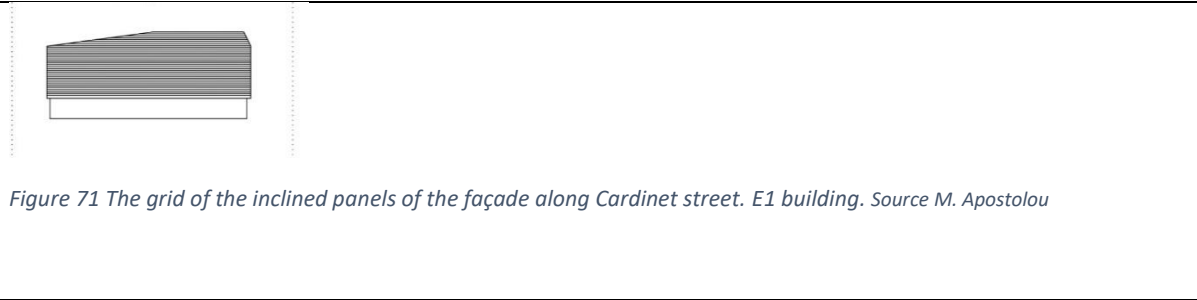


Figure 69 Detail of openings and the façade. Source M. Apostolou



Figure 70 This cladding is made of coloured and translucent polycarbonate panels with three different levels of transparency. The panels are fixed on a secondary aluminium frame that houses the panel support connectors, which were specifically designed for this project, to allow the panels to be installed inclined, usually arranged horizontally or vertically. A coloured breathable membrane is placed in front of the insulation to protect it from rain and to provide a coloured background so as to increase the colour effect of the cladding. Source M. Apostolou



5. Study case, Building E2

« La montée en puissance des attentes en matière de développement durable a été pour nous très naturelle. Elle nous a permis de convaincre plus facilement nos commanditaires des choix que nous proposons depuis plusieurs années (...) La ville, l'urbanisme et l'architecture ont un rôle initiateur pour la qualité environnementale et le développement durable. En réponse aux questionnements et objectifs de plus en plus ambitieux portés par les maîtrises d'ouvrages, nous anticipons ces enjeux dès les premières phases de conception. La démarche environnementale est pratiquée comme une démarche de management de projet, visant à minimiser les impacts d'une opération sur l'environnement. » (Périphériques Architectes, in Gerault, 2015)

5.1. Prologue

In the fifth Chapter the second study case will be explored.

It consists of the first building that was delivered in the east zone of the Clichy Batignolles eco-district in October 2012.

A brief presentation of the architectural team and their work will initiate the chapter.

At first, a description of the building according to the intentions of the architectural team who pursued the study will be presented.

An interpretation of the conception of the edifice will follow, implementing as a viewpoint the tools and concepts that our method of analysis, architecturology, provides.

The sources analysed and interpreted are texts provided by the architects having realised the project,²³⁵ interviews of them, given in diverse contexts (Trottin, n.d.), texts written by journalists/architects in regard to the project (Léglise & Sautot, 2013) (*Clichy Batignolles Fiches Programmes Logements. Lots attribués du côté de l'avenue de Clichy*, n.d.), as well as an interview with the architect D. Trottin, conducted by the author, realised on the 3rd of February 2020 in his architectural agency²³⁶. The citations of the architect, if not mentioned otherwise, are part of this personal interview.

Finally, a focus on the consideration of energy issues in the design process of this case study will tend to intersect the vocabulary of architecturology and its relevance when applied on the energy performant design.

²³⁵ Information from the official site of the agency <http://www.marin-trottin.com/cardinet-quintessence>

²³⁶ situated in 8, Montcalm street, in the 18th arrondissement of Paris

5.2. The architects, Peripheriques

*Périphériques : being around architecture, in order to reach its heart as well as to walk until its borders.*²³⁷

Périphériques Architectes is an agency consisting of Anne-Françoise Jumeau architects and Marin+Trottin architects.

The structure was born in the 1990's 'from the fierce desire to go against the grain of established norms'.

David Trottin²³⁸ started working at Francis Soler's agency with whom he realised their first architectural commission in 1992. Furthermore, they won the architectural competition European in 1994. After having worked on the competition of Quai Branly Museum in Paris (during 1999-2001), Jean Nouvel invited Peripheriques Architectes to participate in the contest for the Atrium of Pierre and Marie Curie University in Paris that they won and realised in 2005. Another significant element in their career path concerns the curacy of the French Pavillion at the 11th International Architecture Biennale Exhibition of Venice in 2008.

They state that their design method relies primordially on organising and managing a multitude of constraints and know-how, independent of the project they are working on.

'For each project, our attitude is to overview and precisely synthesize the request, from context to use, in order to control the operation perfectly. Our aim is to deconstruct the obvious answer, then to offer an unexpected and relevant solution'.

'The aesthetics of our architecture is a conclusion, never a preamble'.

5.2.1. References of the architects

5.2.1.1. Sustainable development

According to Périphériques Architectes, the environmental is the most rational aspect of sustainability's components and thus could be relatively treated in 'absolute' terms ('Périphériques Architectes, 87 logements, Paris 15e,' 2008). On the other hand, economic and

²³⁷ information gathered by the website of the architects E. Marin and M. Trottin http://www.marin-trottin.com/philosophie_marin_trottin

²³⁸ Born in 1965

social components are problematic to handle in practice, as, according to them, architecture is inscribed in a general economic context with defined actors and regulations. ‘Architecture remains dependent on this economy. If manufacturers develop sustainable products, we will use them. If the project managers increase the investment budgets, we will design buildings that are more respectful of the environment.’²³⁹ We could argue thus that their approach on what supposes, constitutes, and implies a context of ‘environment’ when applied into architectural design is a merge of parameters intrinsically interwoven to those concerning economicosocietal issues.

If the environmental question could hypothetically be tackled in a technical, pragmatical or intuitive way during the process of elaboration of a project, Périphériques Architectes seem not limiting their design process in one of them, but rather in a synergy between them, from the first phases of the conception. They claim that the relation of their work with the environmental question is that the latter is mainly included as a fundamental component in their projects, ‘especially in terms of operation and energy consumption’. That is first and foremost linked to the public project management inscriptions they reply to. In a second part, they address the energy efficiency in a way that does not prioritise the retrospective application of technique. ‘The energy performance of a project does not raise preconceived technical solutions that we apply *a posteriori* in an architectural project. The orientation, the volumetry of a building, the choice of materials, the conception of façades, of the ventilation system are addressed in a general manner from the initial sketches.’ On the same time, they demonstrate a concern relying on the constraints that the energy issues are accompanied with, and the ways in which this intervenes in the design process. The objectives being rising with the energy regulations for buildings and the labels of performance being more and more rigorous and demanding, thus architectural design is in a constant confrontation with implementing “pre-fixed” design elements. ‘The problem is that the questions of sustainable development often call for normalised answers. We seek to surpass the normative recipes and to find drivers of invention of original projects.’

²³⁹ Ibid. Personal translation

5.2.1.1.1. Sustainability as a crossover of quantitative and qualitative dimensions

According to D. Trottin, the requirements derived from environmental concerns are redesigning the way architecture is conceived as the requisites are not being limited in the energy efficiency -mandatory but not sufficient condition. That could be translated by a passage from quantitative dimensions to qualitative ones: indeed, notions such as double exposure, comfort, lighting, winter garden, patios, loggias, accessibility for disabled persons, related to the use of an edifice could operate in a broader context as bearers of an environmental performance. As a result, the -quantified-objectives concerning energy performance pass through a conception that values qualitative aspects linked to the performance as well.

In this case we could suppose that it were the imperatives of the ‘HQE environmental quality’ label that took a decisive part in the design of Quintessence building (E2) in Clichy Batignolles, , demonstrating an ‘alchemy between architectural creation and environmental exemplarity’ as prescribed in the eco-district’s cahier des charges.

Table 17 Concepts and references that seem to be mobilised in the design activity of the architect David Trottin

Notion	Inspiration	Action
Locality Common sense	Book Barefoot Architect	
Industrial objects		metaphor of the the prerequisites on technical objects, the use of industrially fabricated objects such as a car
	Closed atrium	Thermal microclimate space
Haussmanian archetype	roof	
Haussmanian archetype	Inner courtyard Parcelar density	Voyeurisme ventilation
Thickness	Building in Nantes	Isolation par l’extérieur
	Dogma movement	

5.3. The building, E2 Cardinet Chalabre²⁴⁰

Quintessence was the first edifice delivered in the ZAC Cardinet-Chalabre, situated in the lot E2. Accomplished in 2012, it consists of 96 apartments and 20 social housing apartments. Figure 74 The compact volumetry of the building, constricted in the boundaries of the trapezoidal parcel, Figure 75 ‘results from an equation between what is already there, the park, the requirements of the photovoltaic roofing, as well as the studies on the housing carried out by the agency since 1997’ (in Léglise & Sautot, 2013, p. 107). As far as the work method followed, the architect stated that he proceeded relying on the context of ‘an urban block partially constructed and a park carrying already a value in use’. (Trottin, D. in Léglise & Sautot, 2013, p. 107) Contrary to projects usually directed by regulations preceding the context, in this case the context- that is the pre-existing surroundings in terms of use and programme- is stated to have played an important role from the beginning of the design process.

5.3.1. Description

5.3.1.1. Implantation

Périphériques Architectes claim having designed a building whose implantation takes into consideration the demands of the prescriptions of the urban Plan of the ZAC Cardinet, that is to ‘open direct and extended views from the depth of the urban island as well as to enlarge the dimensions by providing views towards the interior spaces of the islet’ (*Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009*, 2009, p. 33): they thus affirm having located the edifice in the parcel in such a way so as to ‘let the park enter to the interior of the plot’ (*Dossier initial Projet Clichy Batignolles. Candidature à l’appel à projet nouveaux quartiers urbains. Aout 2009*, 2009, p. 31). Figure 76

²⁴⁰ Fiche Technique : Maître d’ouvrage : Nexity Seeri, Aménageur : Semavip, Architecte : Périphériques – M. David Trottin, Entreprise générale : Campenon Bernard Constructions, Système d’intégration : Adiwatt, Sous-traitants : Charpentiers de Paris (charpente), Enerpur (couverture), Sénergies (électricité), Exploitant de la centrale : Solarvip

5.3.1.2. The morphology-compactness

The building's morphology is presented to have been dictated by the prerequisites in terms of comfort, energy performance²⁴¹ and economy: 'we imagined an innovative building in form, use and operation' (Trottin et al., n.d.) It has a form of a wreath around a courtyard that allows the double orientation of the dwellings. Almost all apartments have transversal views due to the interior courtyard. Figure 77 Figure 78

The sloped roofs coated with photovoltaic panels Figure 79 are designed in such a way to take into consideration the best possible sunshine for the function of the photovoltaic panels. This photovoltaic roof has the characteristic of being integrated in the building and its form. '(...) our famous photovoltaic roof will produce 120 MW per year. We have been set to the ideal inclination for profitability which also allowed us to reinterpret the roof. We did not want the building to be flat; it is a roof that will be seen from the park since we have a hindsight; this roof really belongs to the building.' Figure 80 Figure 81

The triangular crown form presents an optimal compactness minimising the shadows on the neighbouring (future) edifices Figure 82 (Trottin et al., n.d.), oriented in the east/south axis.

For the architects, 'a compact building is ecological and economical' (Trottin et al., n.d.)

In order to respond to the program and consequently the energy performance requirements the group claims having proposed a 'compact and unitary edifice, with apartments organised around an interior courtyard' (Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009, 2009, p. 33) Figure 83

The form is demonstrated to be a choice relying on the Architectural and Landscape Prescriptions Book²⁴² that requires to let the park enter at the heart of the islets (Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009, 2009, p. 33) by creating a building around which the park rolls and thus extends to the back blocks (*Clichy Batignolles Fiches Programmes Logements. Lots attribués du côté de l'avenue de Clichy*, n.d.); this form is also said to support the transversality of the apartments (Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009, 2009, p. 34)

While the triangular ring-shape developed form is said to have been conceived after having examined an optimal compactness that would minimize the shadows carried on the back

²⁴¹ 'un bâtiment BBC plan climat, 50 kWh/m².an, soit le label EFFINERGIE non pondéré, sans recours à l'énergie photovoltaïque d'une production de 120 MWh.an d'énergie photovoltaïque'

²⁴² *Cahier des Prescriptions Architecturales et Paysagères*

buildings, conserve the views towards the park and offer a linear façade on the park of a 70 m oriented East / South., the organization around a bright interior courtyard offers traversing views to almost all of the apartments. (*Clichy Batignolles Fiches Programmes Logements. Lots attribués du côté de l'avenue de Clichy*, n.d.)

Overall, the compact morphology is dictated by an interpretation of the objectives of environmental performance, a reliance on the urban prerequisites as well as an architectural quality.

5.3.1.3. Envelop

The envelop is treated as a 'highly efficient' in order to minimise thermal losses in the building: the exterior and interior skin are treated to limit thermal bridges and allow the integration of the insulation.²⁴³ 'On the outside, a mechanical protection in textured metal comes to dress this skin and on the yard it will be a reflective prismatic cladding made of folded aluminium sheets. Perforated, these sheets work as absorbent baffles'²⁴⁴ to make the common courtyard a pleasant space to live and share. Figure 84Figure 85Figure 86Figure 87

The façade situated on the side of the park opens up with the scattered loggias, installed for the apartments in accessibility (Léglise & Sautot, 2013). The north façade, that of social housing apartments, favours views on the Sacré Coeur. 'The exterior facade, protected by a textured metal facing, is animated to the south by wooden balconies with variable geometry generously open onto the park.' (*Clichy Batignolles Fiches Programmes Logements. Lots attribués du côté de l'avenue de Clichy*, n.d.) Figure 88Figure 89

5.3.1.4. Focus on the photovoltaic roof

The photovoltaic power plant installed on the roof of the Quintessence building²⁴⁵, with a capacity of 96 kilowatts-crête²⁴⁶ (kWc), and a power generation capacity of 96 kWc, entered in service in October 2012. This plant is integrated into the building. Figure 90

²⁴³ Source D. Trottin

²⁴⁴ Source : Architectes Peripheriques

²⁴⁵ designed by Sunvie (designer, developer, integrator and operator of solar photovoltaic projects) and operated by Solarvip, a public / private company (partenariat entre la Semavip (Société d'économie mixte d'aménagement de la Ville de Paris), EDF, la Caisse d'Epargne Ile-de-France et le Crédit Coopératif)

²⁴⁶ Le Wc représente la puissance électrique maximale pouvant être fournie par 1 panneau photovoltaïque dans des conditions de température et d'ensoleillement standard. Grâce au watt-crête, on peut comparer entre eux les rendements de panneaux photovoltaïques de différents fabricants. Pour une même surface, plus le Wc est élevé, plus le panneau est performant.

The initial project involved the integration of the photovoltaic power plant over a sealed steel tank, but safety and control requirements have led Sunvie²⁴⁷ to substantially modify the original project so as to meet the regulatory objectives of the area in terms of energy production, on the one hand, and follow the visual constraints desired by the architect on the other. (Pouthier, 2012) Thus, the company abandoned the idea of a steel tank for a *sur-mesure* steel structure directly attached to the concrete of the roof structure. A peripheral path and a guardrail have been created around the power station to allow secure circulation.

This project is the first photovoltaic plant installed in a roof of a co-ownership building in the City of Paris.²⁴⁸

It covers a surface of 600m². The orientation of the roof takes into consideration not only the production of electricity but the thermal performance of the building as well, so that it can potentially consume the less possible. The energy produced here is sold in the grid of the Electricity of France network but serves to part of the electrical consumption of the collective parts of the building. (Belin, M.-A., in Pouthier, 2012)

The integration of the photovoltaic panels was not total but followed the orientation, inclination and dimension each of the seven sections in which the roof is divided. (Caputo, M. in Pouthier, 2012) Figure 91 Figure 92

²⁴⁷ Company providing solar installations

²⁴⁸ In 2013 a solar photovoltaic power plant of 3213m² with a capacity of 465 kWc was installed in the roof of the Halle Pajol in Paris.
See also the Ginko ecodistrict in Bordeaux.

5.4. Interpretations

5.4.1. The prescriptions forming a space of references concerning the adjacent projects and the parc

As far as the relation with the envioning elements, the architects claim that the building is disconnected from the street, however maintains a dialogue with the adjacent building E1 of Franklin Azzi, joining Francois Grether ambitions on 'the two projects' good articulation and coexistence'. ("Périphériques Architectes," 2013)

The implantation and the form of the building in relation to the parcel in which it is inscribed Figure 93 Figure 94 demonstrates a willingness to take into account the park itself as well as the book of prescriptions concerning the relation between the frame and the park. « The building withdraws backwards. We let the park enter from the sides of the building. It is as if the park is actually sliding into the interior of the plot » ("Périphériques Architectes," 2013)

5.4.2. The prescriptions forming a space of references concerning energy

For Périphériques Architectes the prescriptions of the *cahier des charges* of the design competition oriented evidently towards a conception of a building where the maximal environmental quality objectives were to be one of the design process major driving forces: « It was indeed necessary to integrate (n. in the design) the Climate Plan but also to have a significant energy production » ("Périphériques Architectes," 2013) Thus, their design was primordially motored by a response to the objectives of the prescriptions' book. « We responded to the prescriptions by creating a building as compact as possible while having traversing apartments by creating this building in the form of a ring Figure 95 which therefore left space for a large courtyard that will allow both accessing the various buildings and bringing light to the heart of the edifice » ("Périphériques Architectes," 2013) Figure 96

In order to respond to the programmatic demands in terms of energy performance and energy consumption economies, – that could be primary but not limitedly linked to a technical and economic architecturological scale- the architects most probably conceived their project in reference to a geometric scale -relayed by a juxtaposition of a geographical one, and

secondarily dependant on a functional one. ‘we imagined an innovative building in the form, use and functioning’ (Trottin et al., n.d.) In addition, a symbolic formal scale (‘a compact building, ecologic and economic’ (Trottin et al., n.d.)) finds its reference in the ensemble of a economic (of energy), technical and functional scale that concerns the energy performance and thermal comfort.

The orientation of the housing units is linked to a relevance that concerns their transversality referring here too in an economic (of energy) scale.

The thickness of the façades (exterior and interior skin) takes its measures in reference to an economic (of energy) scale (so as to limit the thermal bridges), and a technical one (the large insulation thickness is integrated for the purposes of a minimum space requirement) convoking an operation of integration. The exterior skin, in other words the mechanical external protection of the edifice, is treated as a covering textured metal, presumably driven likewise by the above-mentioned architecturological scales.

The design of the interior courtyard (its dimensions –‘large’- and materials), are implemented with a reference to a functional scale (related to a technical one), as well as a sociocultural one. It consists of perforated sheets of folded aluminium that « function as absorbent loud-speakers to render the common courtyard a pleasant space to be lived and shared » (Trottin et al., n.d.)

5.4.3. The neighbouring context as a space of reference

5.4.3.1. Generating the implementation of a visibility and optical scale – the Parc

The context of the implantation site, that is the Martin Luther King Park, has been supposedly taken into consideration from the initial phases of the design process. More specifically, the visual scenery that its presence established, generated a space of reference in the design of the buildings around it, calling for a development of a strong visual relationship. Two spaces of reference, merging the neighbourhood aspect and the visual one in relation to the park, have been consequently dynamically present in the conception of the E2 building, implicating dialogue(s) with the existing. ‘The real façade that is created in the project is the MLK park, which suddenly creates a new depth in this district, so it was present by the start of the project.’(Trottin, n.d.) The park, that is a neighbouring element, acts as a trigger element that induces the design of the interior organisation of the building as well as its façades in relation to the interaction with a field of view.

‘The first thing we noticed is the quality of the park which is in front (...) All the buildings situated in the front line take all the views of what is going to be the major point of this place’ The view that the building will have **of** the park is of an utmost importance; the view **from** the park to the edifice is critical as well. The visual and optical scales have therefore most probably been involved in the first place in the implantation and positioning of the building in the plot, influencing the form of the building as well as the form and dimensions of the openings. Figure 97 Figure 98 Figure 99 Figure 100

5.4.3.2. Generating the implementation of a model scale

5.4.3.2.1. The adjacent urban forms and the historical periods they are subscribed to

‘Our proposal was to do the first thing that we said to ourselves (...) to rethink the urban form (...)’ We could argue that the “extremely compact” form of the building finds its reference in a model scale that concerns the urban form as being already constituted in the adjacent urban blocks. On the same time, there is another layer of reading the form, that takes a distance from the past and reclaims a firm positioning in the present, by referring to the future. That is to say, the model scale is generated here in a first place, with a reference to the past, and in a second one, as a tool that anchors symbolically to a ‘sustainable’ form of architecture. The continuity with the haussmanian past of the Parisian urban heritage is not discarded but evolved. We could assume that in this case the “compactness” passes from a semantic to a symbolic scale of form, that refers to the visibility and optical scales linked to the geographical one. ‘This round compactness allows to have visual escapes so that the second front will be able to benefit from light and views of the park.’ In other words, the operations of positioning and orienting the building are driven by the fore-mentioned scales and being present as an act of initialisation during the design process.

5.4.3.2.2. The building they have previously accomplished in Nantes

-the building they have previously accomplished in Nantes

On the same time, the architect’s declaration concerning the application of similar design experimentations with another Batiment Basse Consommation project of them completed in 2010 in Nantes raises the implication of a model scale, with reference to their personal

architectural portfolio. ‘What we were interested in were ideas that we had already tested in the Ruban building in Nantes’ In Nantes, the volume ‘is cut by a series of ramps on the roof surface’²⁴⁹ However, the volumetry, expressed with sharp inclinations, is not produced by implementing the same scales as their building in Batignolles: The Roller Coaster building’s shape choice is directed primarily by a visual scale with reference to a geographical one (the sunlight penetrating the block): the multi-oriented viewpoints of the apartments is the initial objective, materialised by the cutting and orientation of the volumetry angles. It is interesting here to examine the role that energy questionings have played in the configuration of the U-shaped building around a south orientated central garden; especially when the general lines of the design process as presented by them²⁵⁰ has a significant similarity with the one presented for their Quintessence building.

The model scale has been implicated in the constitution of the geometry of Quintessence building and its dimensioning (of the width). More specifically, the apartments being traversing and benefiting a double exposure are articulated in reference to the building being on the same time compact and thin. ‘To create this kind of mixity between the compactness and the small thickness (...) in order to have a traversing housing that will be able to benefit from the double exposure.’ The operation of cut-out and the creation of an interior courtyard, in other words the ring-shaped form of the edifice is implemented proceeding from a scale of model and a sociocultural one: a historic architectural tradition enrolled in Parisian urban blocks, the inner, protected courtyards. ‘We tried to develop (..) something that was also reconnecting with a Parisian tradition that is the courtyard (...) and we have produced a building with a courtyard, very compact, traversing.’ In this case the courtyard is element that seeks to be re-introduced not in the sense of being re-thought or re-invented, but acting mostly in a space of historic references, aiming to be transferred in a ‘modern’ context, establishing a semantic link with the past. Could this reference be an element alimending the architect’s rhetoric by enhancing the architectural narrative and justifying the architectural choices?

²⁴⁹ Source : the architect <http://www.marin-trottin.com/roller-coaster-72-0>

²⁵⁰ Source: the architects’ personal site.

5.4.4. Morphology- The geographical scale as a tool of implementation of the energy performance

5.4.4.1. The roof as a reference to a model scale relayed by an optical one

The **morphology** of the building, and to be more specific the sloped form of its **roof**, has its pertinence being implied by a geometric (inclination) scale, relayed by a geographical one (orientation to the sun for an optimal performance). Figure 101 Furthermore, the relevance that this form relies to can supposedly be found in the application of a scale of model that is carried by a combination of an optical scale that acts upon a symbolic scale of form. That is to say, the typological model of a Parisian roof as known through the history of architecture is interrogated, triggered by a willingness to be emphasized by being shown to be seen. The form of the roof -conveying a symbolism that derives from it being seen from the park as well as the city around it, the inhabitants of the district and the building itself on the same time- could be read as a contrast to the ‘traditional’ form of roofs in the buildings in Paris around, as well as a message-carrying element that bears and energy performance tackling tool.

‘The other totally triggering element of the project result was the request of the developer (ss.) to provide a photovoltaic plant in the roofs of the buildings. So we said: we are going to pass from the Parisian ‘zeng’ roof in a photovoltaic roof; so the building must illustrate and be demonstrative of this.’

In this case we should remind the demand of the book of prescriptions of the project that was referring to an installation of photovoltaic panels to produce electricity, without however imposing restrictive design orders concerning the placement of the photovoltaic cells.

5.4.4.2. The facade’s semantic relevance

What was requested from the City and the housing company Nexity was to conceive a building “with a light façade”. The architects interpreted the “lightness” by implementing a semantic scale in their design proposing that the façade would be light by being “dresses, armed (...) because it must be physically protected; it is like textiles, (...)” The form of their exterior skin that dresses their facade, a waterproof envelope with a kind of metallic membrane, is therefore referring to a semantic scale bearing a notion of protection from the harshness of the exogenous environment. An analogy is being drawn with the textiles supposedly implying the physical

fragility. “a membrane (...) that creates we could say the hardness, the resistance of this facade.”

Furthermore, the loggias extruding from the envelope’s morphology derive from a posterior implementation of a scale of neighbourhood that is being relayed by a visibility one: “then we wanted a building where each dwelling had a strong relationship with the park and the view (...) so we created this facade which is an accumulation of small niches (...) so that we can have a very dense relationship with the park.” The balconies are likened to “niches” -another semantic scale implemented here- that are coming out from a surface. They ensure a rapport and view interaction with the park that lies beneath. Figure 102Figure 103Figure 104Figure 105Figure 106Figure 107Figure 108

Another element that was largely supported to be taken into consideration from the architects in their design concerned the use of wood. For David Trottin of Périphériques agency, the use of this material created an obvious relationship with the essence of the context that participated too in the fabrication of a “*bâtiment nature*”. Figure 109Figure 110Figure 111Figure 112

5.4.4.3. The courtyard – the model scale as a generator of a sociocultural space of reference

The dimensions and form of the interior courtyard of the building do not only refer to a model scale of the Parisian buildings’ courtyard but also to this of an inner yard of a private house as ‘we have the impression of being inside an interior space’.

We could suppose that the courtyard seeks to be a cut-out of the built space so as to imply a continuation of the past re-integrated in a modern environment (time reference) but also a *hôtel particulier* (typology reference) and even a church (program reference). These models scales relied by a sociocultural one in different context and temporalities, are junctioned by a symbolic dimensional scale that gives the impression of enhanced dimensions. The height of the building that surrounds the court, its strongly sloped roof geometry as well as the length and width of the court itself are supposedly depending also on a symbolic scale of form that accentuates the qualitative transformation of this inner courtyard in a space that wants to call for a spirituality, a creation of relations between the apartments and a common space of meeting and exchanging for the users.

“The courtyard, I see it rather as something qualitative and for me it is rather the courtyard of a private mansion (...). The overall ambition was to give this courtyard a real quality of space.

And it's true when we enter inside, we don't feel like we are in an outside, we feel like we are in an inside. And that creates a huge space. So you are not in something next to the building, but you are in a place that is almost like a church, a kind of incredible centrality with a height? , a cut-out on the sky which is absolutely incredible because of the shape of the building and therefore that we had no trouble convincing our project sponsor to accentuate this dimension by working on the ground and on the lighting, a way of dressing and bringing this place to life; so we created inside a kind of receptacle to grow a little vegetation, we have a system of luminous tiles on the ground which enliven the place and which are quite well seen by users today, and therefore this courtyard creates like that a relationship between the housing (...)

(...)"

5.4.5. The model scale re-interpretating a previous spatial organisational structure – inducing a symbol of a new relation to energy

« The design process is a way of bringing the elements of a typology -the idea of a formal structure- into the precise state that characterizes the single work » (Moneo, 1978)

Architecture, as a field of knowledge, is to a large extent shared culturally, including inter alia theories, trends, archetypes, doctrines, architects' monographies. (Claeys, 2013, p. 15)

During the interview, the architect initialised the narration of the cognitive process of the E2 building by introducing certain reference spaces, or recurrent information clusters, such as architectural archetypes and pre-conceptions. In particular, he asserted having used as references the "archetypes" of the "*haussmannian inner courtyard*" and the one of the "*roof*". What will be followed here, through a brief reference on the notions of archetype, type and model in the architectural design, is an investigation of the space of reference in which the presumptions expressed by D. Trottin of Périphériques Architectes in his discourse reside on.

In our case the shape model incorporates the archetype that represents a class of objects.

5.4.5.1. Haussmannian buildings as an archetype

In the Haussmannian design model, the urban block is the tool of density, limiting the ground space consumption to accommodate more inhabitants. Despite the diversity of their volume, the islets of the haussmannian fabric reveal the same built density that is particularly high (Napoletano, U., in Van Eeckhout, 2017). The voids re being enclosed by the buildings, constituted of courtyards.

In this way the haussmannian urban blocks are compact, forming an « aggregate of adjoining buildings but relatively narrow and shallow. » A building's thickness may vary between 7 meters and 13 meters, with the narrowness enabling a double or triple orientation of the housing and thus promoting a natural ventilation and lighting.

The haussmannian buildings can be characterised as the archetypes of the Parisian housing, being built under the same dimensional or façade rules and materials, forming with the frames of their design a certain “unity”.

The haussmannian building was evidently designed and built before the energy issues have been considered with the same required rigorousness as the last decade. However, as far as the thermal point of view is considered, the adjoining buildings participate in a natural or active way when it comes to isolation and inertia, establishing a mutualisation as well between the different entities concerned.

A source of referenciation for thinking and designing the islets and components of a sustainable city could be therefore linked in relation to the proportional and typological characteristics regarding a geographical and a neighbouring scale.

5.4.6. A lecture of the architectural discourse under the prism of the methodological framework that has been set

For D. Trotin, the definition of sustainable architecture is pre-consisting in the definition of architecture itself: *“For me there is no “sustainable architecture” as architecture is sustainable. (...) It is about taking into consideration the context, the materials, the orientation, the dominant winds, the landscape.”* Architecture is intrinsically connected to a context as, according to the architect, designing a building implies a user and a locality. He criticizes the technical normative constraints applied to the architectural conception in the sense that there is

a “*commodification of the fabrication of comfort*”. In this framework, designing a sustainable architecture concerns an approach that is “intelligent”. According to him, it is nothing but the “*re-appropriation of the common sense*”, that includes among others the affiliation in architecture, of elements belonging to the ancestral know-how and the technico-archaic heritage. An environmental architecture could have sense in the case that it would be “*something that we can understand that we admit and that encloses an enthusiasm, an inspiration.*”

The environmental end energy performance approach was omnipresent since the beginning of the design of their project in Clichy Batignolles in 2006, as the book of prescriptions was setting a production of energy and the integration of photovoltaic panels, an isolated building that would prevent thermal losses. Initially, they discussed with Franck Boutté on the insertion of the thermal regulation in the project, something that in their opinion would lead to “post-form” an object already poorly thought out from the beginning. “*So, we said: let’s imagine thinking inversely.*” “*So we said that if we have to design a photovoltaic roof then we have to look for the place where sun is present. And for this reason, we place the roof on the south-west. The second point was that we wanted to fabricate a project that would be a demonstrator of new ways of living; so, we will place all the apartments to be transversal and not mono oriented. And at this point we started thinking about using in this project a system of interior courtyard that would act as a thermally buffer space, enabling pre-heat the air in the interior. This was our third postulate. So, with these steps we developed the first project.*”

The first project submitted by the agency in the competition had a covered atrium in the heart of the building, an element that they have already introduced in other projects as well, as a medium for “*achieving a quality of ambiances*” between the interior and the exterior of the built frame. The inner courtyard, enclosed by a canopy, had the intention to operate/act/ as a circulation space, with natural lighting, that would on the same time make the apartments transversal, having always an exterior façade. Moreover, the inner yard had the intention to perform as a physical space, with a calculated climate that would function thermally. “*We wanted to have preheated air (...) in a way that the air of the apartments would not come out in the volume; arranging so that it is always the air that has been brought in from the exterior that would enter the apartments, and not a “recycled” air*”

“The last element that we wanted to integrate in the design was the “compactness”, as it would enable to have a large linearity of façade”.

Another point that seemed sustainably relevant to the architect was to design a form that, being more compact, would permit the natural light to arrive at the depth of the islet, at the edifices

located backwards. “ After having set our building’s orientation, we tried to reduce the masking effect for the edifices located backwards.”

“So these were the three postulates that we implemented...A building with a photovoltaic roof, perfectly oriented on the south, this interior courtyard with the purpose of bringing light to all the apartments, transversality, as well as a natural ventilation (to heat the apartments’ interior air with a pre-heated from the atrium’s volume air)”

After having won the contest and before having obtained the building permit the architect had to pass by a security commission in order to develop the project. At this point, the fire brigade did not provide a permission to construct housing in a covered courtyard, due to safe measures in case of a fire. Forced to find a solution, they proposed a system of a balloon structured with metal threads in the interior, covering the yard, that in the in the event of a fire it would be hit by a hot wire system and be opened completely, “ *having thus an atrium effect, regaining the natural air*”. However, be it impossible for the fire commission to commit to the safety of such a proposal, the idea of a covered atrium was abandoned. “*But we did keep the compactness of the building; as if we had opted for the closed roof, we would have needed to have all the windows as firebreaks.*” Having installed fire-protection windows facing the yard would have annihilated the air exchange that the architect wanted to create between the interior and the exterior. The initial operation remains albeit, this of having windows opening towards the yard, the double exposition of the apartments as well as the transversal ventilation. The main intention and its implementation, that of designing a compact building but at the same time with an interior courtyard that would allow for a natural lighting of the spaces. The architects continued working with the postulates they have set from the beginning except for the interior courtyard that would have to be unprotected. “*We have the photovoltaic power plant on the roof that has remained an element from the beginning of the project. And each time we have a staircase, it gives both outside and gives light to the landing of the building.*”

Another element that seemed to the team of D. Trotin as a fundamental one for a “sustainable” architecture, and that was implemented in the design process of the project is the “fragmentation”. In particular, they claimed having designed “flexible” apartments, in a way that they could have the possibility to get linked in a near future and be unified into a bigger apartment. In the practice, this intention can be identified in the observation of the plan of the apartments. A studio next to a bigger apartment could thus be set in relation, accommodating a new-born child of two adults and their child; or even simply to host an adolescent living next to his parents. “*There are structural concrete veils in the interior, but we let a masonry passage*

in the inside the walls so that we can connect the apartments: we have two passages inside the wall.”

During the interview with the architect D. Trottin, the concept of the inner courtyard in the building seemed to be of an utmost relevance to him, as a means of creating a “community of view” inscribed in the urban context; creating a kind of “voyeurism” that is part of the city’s density. *“When you live in the city, there are people living in apartments situated in front of you, in the other side of the street, but you can very often see where they live; you have thus a kind of visual “relationship”. In the interior yards of the blocks in Paris however, you can see someone in the opposite side but on the same time you cannot know where they live, from where do they enter to their apartment; you don’t know who he is and he respectively does not know who you are... There is a kind of anonymity, the sight becomes a kind of animation.”*

We said that if we want to win this competition, the project must be a manifesto of a way of making an architecture that wants to demonstrate that it captures energy, that it is crossing, etc. That was very clearly the idea that we put forward. Therefore, the form of the building is deliberately quite iconic; we see that something is happening, (...) and we can tell that it would not function as another. This is what we wanted

In his discourse, the architect drawn a comparison between an industrial object (a car) and architecture, when referring to the expression of the form, the truth of the form or of the construction that accompanies some industrial or technical processes. *“You feel the object by the image it conveys”*

“There is somewhere in architecture the adequacy between form, the image it conveys and the meaning it has: they are linked.”

I think that what we do (in architecture) is not a form; we make a sense/meaning which takes form.

So the meaning that takes form, a conceptual postulate of a building, the constructed form will serve this postulate

He claims having worked within this framework, on this logic: *‘The building is transversal; there is a large courtyard allowing the solar gains, we will see that it is there; there are the photovoltaic panels, it (the form) becomes a new Parisian zinc, we can see it, it contributes to the image of the city, it is not just a hidden layer’*

In Roller Coaster, the building they have designed in Nantes in Ile de Nantes, they have been in the same logic of a thin building with 9,5m thickness and the apartments were transversal. It consists of apartments that have a double exposition. There is also this idea of vis-à-vis. In this case, the morphology is dictated by the urban block, that the architects had to align to.

“Often architectural design is largely limited due to a negotiation with the urban constraints that exist”

The idea of vis-à-vis is part of the urban context; living in a city connotes having a relationship with the others. In this respect, asserting that living in a high-density area embodies qualitative characteristics, he declares the design of the yard as a re-use of the codes that an Haussmannian inner yard connotes.

“The demand to move towards a city environmentally more obvious drove us to re-question the urban forms. It was the basis; so when we arrived in situ, we did propose -as we were the first building designed in the east sector- to re-question the form of this building”

“We also wanted to have some vertical circulation so that someone could move over without taking the elevator in the first three levels. We added staircases in the first three levels.”

“The fact that we created a less linear of façade in a compact building, will add in the performance. We wanted the interior of the building to have a more reflective façade in order to get more light inside as well as to heat this “heart” (n. the internal yard) ; this would also allow to “mask” the view: the view would disappear as it would be more blurry.”

The dimensions of the internal courtyard: *It had to be a sufficiently large volume so as the air could be heated inside, for being used in the apartments.”*

The interior façade of the building, the “mirror-façade” initially proposed on the project, was afterwards abandoned by the promoter due to a research of economic solutions. *“Do you think that it is really necessary? It is expensive and I do not know how to merchandise it. In fact, you (architects) are supposed to work on the exterior façade, this is the interior one...”*

Pour D. Trotin, in a certain degree it is normal for the promoters to focus on the cost; *“It is their proper business. I have no value judgement. We just do not have the same values. They defend an Excel table; it is their job.”* On the other hand, he demonstrated a ... as far as the ...of the City is concerned; during the phase of the competition the city of Paris was ultra ambitious in terms of the environmental prescriptions and the architectural quality of the projects.

5.4.6.1. Managing to associate the technique with the architectural form

“If the environmental question is not architectural it is easier to be passed along: if it is technical nobody knows what it is. (...) Because they do not know how it works.” This is the way in which D. Trotin sees the implication of the maitre d’ouvrage in the propositions on a

project: the photovoltaic roof was not refused, as it treated a technical imbrication in the architectural form. However, he expressed his concern on whether the proposal would still be “untouched” if it concerned the treatment of a façade for instance. *“The technique is sparsely attacked. What is easily attacked is the aesthetics.”*

The photovoltaic roof as an industrial tool/instrument/implement

Initially, the photovoltaic panels had to form the impermeability of the roof, that is the roof had to be truly photovoltaic. *“I understood that what we had to do was not just a rooftop; it was an industrial power plant.”* Something that could though induce maintenance problems, obsolescence, accessibility concerns, fire safety issues. In fact, it was to be considered as an industrial tool: a small thermal power plant. This is the view expressed by the architect.

At that point, the architectural team proceeded to a series of discussions with their client on the management, the maintenance, responsibilities and issues that the existence of the photovoltaic panels would raise (managing the leaks, the cost of changing, the permission to entrance of technicians) in relation to the future residents of the building and the degree of their proper implication. It was at this stage that EDF decreased its redemption cost. So the agency took the decision to design a veritable waterproof roof, and have a photovoltaic power plant on it, independent: *“The photovoltaic power plant is inside the volume on the roof, but it is not the roof.”* This design ingenuity carried the following practical advantages from a functional point of view: it made it possible to install underneath a large amount of technical equipment which will thus become integrated into the architecture and which were not visible. Above all, it allowed a management by a third of a technical office entity that is not linked to the building’s waterproofing. It was a design element linked to a preoccupation of the architect to the future function of the building in relation to the users, more specifically his concern on the co-ownership in relation to a management of a technical object. By quoting Frank Boutté, David Trottin highlighted the need of connecting: *“HQE is insulating, insulating, insulating (note: in the terms of isolating), whereas not, on the contrary it should be interlinking, linking, linking.”* The inner idea of the environmental approach could be generalised in a direction that encourages sharing more: this is initiated firstly by the idea of centralising the energy production with all that this implies (more performance, less costs, adapted to needs etc) According to Trottin, this leads to a social kind of interaction and sharing: by designing collective apartments and co-ownership buildings the energy networks that go through them is a means that unifies a collective way of living together; drawing that is an antithesis between the autonomous living as an end in itself. *“That is why we design housing; for being several people and not a few, for living together with others, for having a view of them, sharing with*

them". For him the common energy production and network on a collective housing edifice implies the application of a common sense in relation to the social behaviour of the residents: an environmental approach to design should not therefore encourage the isolation in themselves. To put it differently, there is a contrast being developed indirectly at this point between thermal insulation and social isolation; featuring the central energy production of a building as a means of fostering relations and responsibilities of the residents, going along with the general frame of an environmental approach as well as an urban context.

Furthermore, there is another idea introduced here by the architect: that the relation to the energy production (in this case the production of electricity by the photovoltaic panels installed on the rooftop of the edifice) as well as its evolution through time should not interfere in the detriment of the "simplicity" of the apartment. By being "simple" in the interior, what he intends to evoke here is the decrease of the functional complexity -related to technical manipulations -so that the resident could operate them easily. *"The housing unit should remain a place where the inhabitant can interfere himself without the obligation of being a technician."* For instance, in order to have a good air quality, the installation of individual dual-flow ventilation systems in housing units, calls on the control of the filters by the resident himself. Economically speaking, the individual dual-flow ventilation plant it is more profitable than the collective one, something that have led the manufacturers to advocate in the private promoters. This example is used to reflect the viewpoint of D. Trottin on the implication of the environmental dimension in architecture when being operated by lobbies: mistrust on the products on sale that he *"does not know how it works."* The same goes for the thermal calculations and the insulation, when applied in the initial phases of the design process of the building, during the exchanges with enterprises, consultants etc. *"Everyone shows calculations, balance sheets...(...) They tell you that is the software that produced the result, so it has to be right that."* When it comes to energy management application on the field, for instance the decision on the thickness of the insulation, there is a gap between the solid comprehension of the meaning and the interpretation of a calculation and the calculation as a number itself. There is more and more a receding of the qualitative comprehension of the space by a physical presence towards a rigidly quantitative approach and the application of a body of elements already defined. *"We (note: the architects in general) have to trust the bureau d'études with whom we work. (...) (...) With Franck Boutté with whom we worked on this projects and on others as well, before the standards we could propose things that were not on the norm but they were intelligent."*

“There is a moment when people no longer think. There is a regulation, and they have an objective to achieve. They have been asked to reach a goal, they have not been asked to be intelligent, to find an intelligent solution.”

“I truly believe in the space between those two (note: quantitative et qualitative aspect) I believe that our profession must move towards ethics and not towards the standardization and the moral.²⁵¹ Ethics is more personal, someone defends it with a kind of vision for the others but can be more elastic according to needs; someone can choose one thing over another. The moral...either you are inside or outside.”

“I find that nowadays the environmental procedures are too dry. (...) (...) I have the impression that with the environmental approach we return in a moral (...) where almost religiously you must do specific things to face God (...)”

“In the moment we designed the building we assembled many elements to make a building témoin. There are things that we did not proceed in the end, like the glazed covered yard, the long balconies that shadow.”

“The envelope was designed as a mixture of two things: we had to have an envelope insulated from the outside; so we made a skin insulated from the outside in polystyrene, and then we wanted something that was both solid to protect this insulating skin so we did this metal shape which comes coat the building playing also on the shadows. In other words, there is a lot of work on the thickness of the skin, and therefore there is a shadow effect that is set up. The perception and the readings of the façade change as you move closer or far away. That refers to the Parisian facades where someone can see the game of stones, bosses and reliefs, which create shadows and I find this produces several scales of reading: one the one hand there is the perception when being in a distance of one meter, and at the same time there is the perception of the city. (...) The building plays with the light.”

“I think that the economy is part of the game. (...) There is a logic behind it. But it is the norm that obligates spending money on things that are not qualitative...”

²⁵¹ In his proper interpretation it consists of when someone is told how to think and he must think like this to be correct

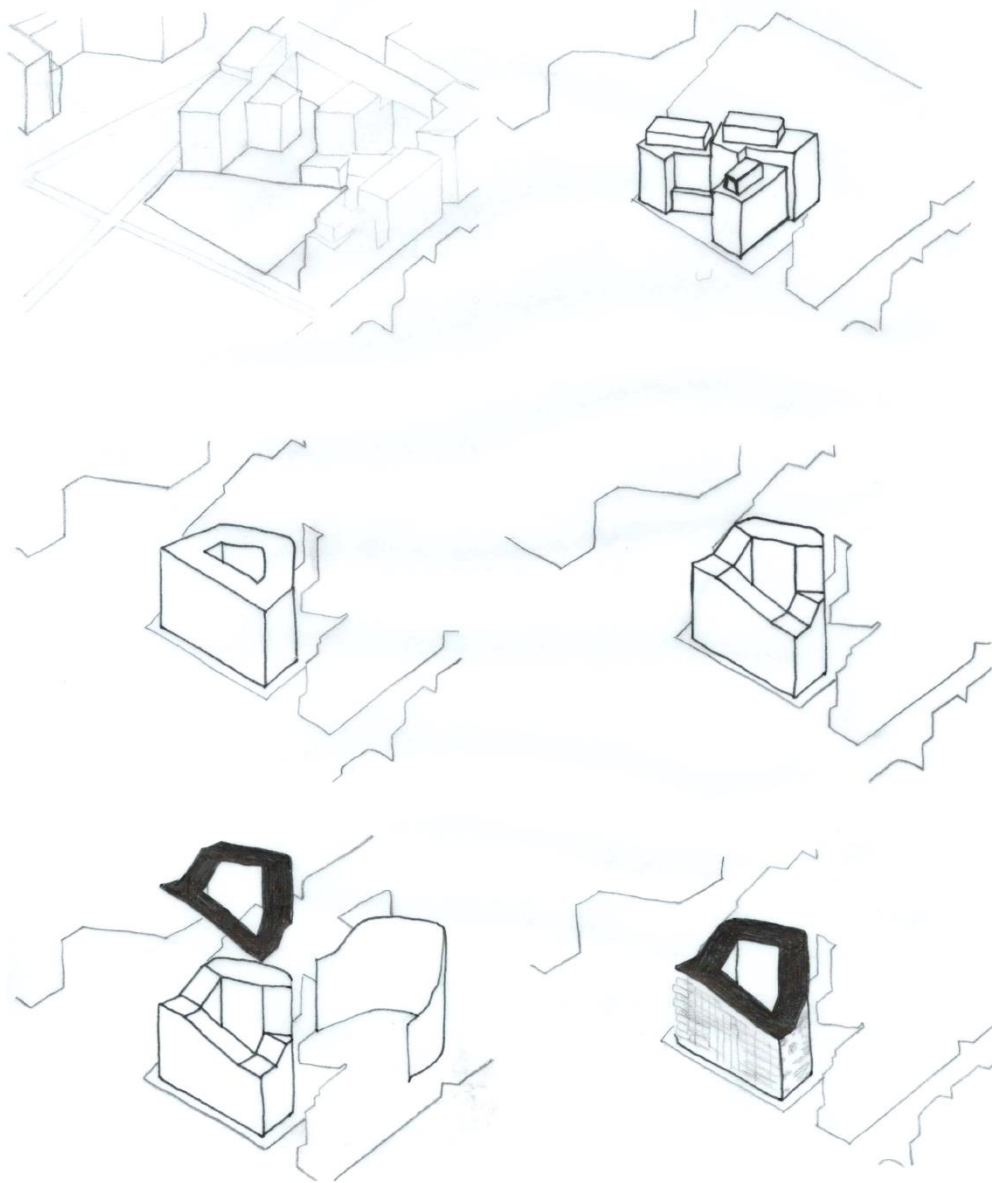


Figure 73 A brief schematic representation of the design process of the E2 building. M. Apostolou according to Périphériques Architectes image

5.5. Architecturological Interprétations of the implication of energy as a parameter in the design process

The courtyard

As a common space

As a microclimate space

As a tool of transversality (double orientation)

As a reinterpretation of a model

As a détournement ou « phagocytage » de la contrainte (substitution vicariance)

As a duality between visibility and optical scale (codetermination des échelles)

The roof

As the form of the building

As a reinterpretation of a model

As a manipulation of a constraint

As a symbol

Making visible the technique

The interior courtyard as a thermic space (that enables a presence of a natural lighting and ventilation as components in the spatial organisation Figure 113) is a pre-existing reference that is being materialised since antiquity. Architecturologically speaking, the interior court as a means of creating a microclimate resides in a metonymic reference (of a syntagmatic order), establishing a spatial continuity. In this specific case, in his discourse, the architect associates this reference to the haussmanian building typology. It is of an utmost importance though, to focus on his proper interrogation of this reference during the activity of conception, as it could be interfering with the sphere of rhetoric on architectural discourse.

5.5.1. Integrating the change : from a covered atrium to an uncovered interior courtyard

After the intervention of the fire prerequisites the ides of a covered atrium proposed at first was not totally abandoned but, in a way, transformed, into an uncovered one. This act during the design process is interesting as it brings to the foreground the interference of a constraint in the activity of conception. In the end, this constraint is claimed to have provoked a modification in

the initial spatial concept that was proven to be “a better choice” by the architects. More specifically, if they could keep the initially designed central space as a semi-closed one, they should integrate the fire-systems and thus keep some windows (of the interior façade of the building, towards the atrium) closed and alter the dimensions of some others. Due to the fire regulations – that is, an imposed restriction- however, they managed to let all the windows facing the courtyard open, a choice that was claimed to be preferable.

As far as the implication of the constraints/restrictions in the architectural design process, they could be parallelised to a *postulate* that comes to be imposed in the cognitive design activity, a priori, or a posteriori in this specific case of the E2 building. Therefore, as here it has led not only the decision of the architects to modify the antecedent idea, but, in a second time to adjust this conversion in relation to their initial priorities, it is pertinent to be included in the provisory model of the design process description as a point of rupture.

In other words, this element that enters in the design cognitive process, even if being of the order of a constraint, ends up by redefining the formerly conceived courtyard, without losing its characteristics (vital for energy reasons), by adopting, absorbing the restriction.

That is, the constraint *cuts* differently the existing elements, it reconstructs them. We could therefore argue that it constitutes a new space of reference or a new context.

5.5.2. A change of program as an introduction to a new space of reference

For instance, in the following examples we can observe how -in a similar way- a constraint that appeared later in the temporality of the design process established a new context.

At Firminy, Le Corbusier had conceived a building in such a way because of a sports field bleacher being next to the plot. During the design process, he is informed that the location of the plot he had to work on was not the current one. However, Le Corbusier kept the form of his building: he did retain the form conceived when being relevant regarding another element than the new one. Evidently this is another case than the E2 building; it does have in common however a change in the program during the temporality of the design process and the adjustment to this modification.

5.5.3. Conclusion – on architecturological scales

The economic (of energy) scale have been acting primordially upon the design of the form of the building that was “dictated by an objective of environmental performance as well as urban and architectural quality”.

The double north-south exposed apartments are probably proceeding of an operation of cutting of the space. Furthermore, an operation of positioning could be implemented when placing the living rooms in the side of the exterior ring-shaped part, the ancillary rooms in the side of the inner courtyard. The introduction of non-load-bearing walls is due to a willingness of a “flexibility” in the design, potentially allowing “buyers of a T2 apartment to enlarge it with a T1”. In this case we suppose that an operation of cutting of the space was driven of a scale of extension, that is a possibility in the future of uniting two spaces into one.

Environmental Qualities

The economic (of energy) with the technical spaces of reference has been most probably implemented in the design of the edifice while responding to the quantitative limits set by the framework on energy consumption. On the same time, the connection to a hot water loop having as an objective to use mainly renewable energy supposes too an activation of the economic (of energy) and technical spaces of reference.

As far as the energy production by the photovoltaic panels applicated in the roof of the Quintessence building is concerned, the operations of positioning, orienting and integrating have been most probably interrogated, proceeding from a geometrical scale (set of roof slopes), a technical (permitting the installation of the panels) and a geographical one (according a favourable sun exposure)

The balconies were designed in a way that would “assure the thermal comfort”

The energy performance of the façade was introduced probably by a juxtaposition of technical, functional, and economic scales, being implemented in an economic (of energy) space of reference. The dimensions and form of the envelop were predominantly driven by a scope of limiting the building’s thermal losses. (economic space of reference) To do so, the thickness of the interior and exterior skin of the building were studied upon, in order to limit the thermal bridges and allow the integration of the insulation in combination with a minimul bulk.

The form of the skin that surrounds the courtyard (a “reflective prismatic covering the folded aluminium sheets”) have been proceeded also by a functional scale relevant to the space being “pleasant” to be used by the inhabitants.

The triangular ring-shaped morphology of the building could find its relevance in an implementation of a geometrical and symbolic scale of form, with a reference to a functional, technical, economic scales. The form of the roof more specifically, wind (visibility, geographical) is directed by a geographical and technical scale (optimal sun exposure), neighbourhood (minimize the shadows on the edifices arrières), as well as of visibility (organising and offering the views towards the park) and optical (offering a linear façade when viewed from the park)

The organisation around a court offers also traversing views, light and wind (scales of visibility and geographical one)

Opération	Dimension	Pertinence	Référence
Orientation	Toiture	Inclinaison sud Éch. géométrique	Profitabilité de soleil Éch. Géographique Éch. Économie d'énergie
découpage	toiture	en 7 morceaux de divers inclinaisons	Orientation soleil (éch. géograph.) Intégration des PV (éch. techn) « manifeste » Symbolique formelle, de visibilité
Dimensionnement	largeur toiture		Intégration des pv
découpage	bâtiment en forme couronne	cour intérieure	Transversalité Lumière et ventilation naturelle (éch géograph) Microclimat thermal (éch économ. énergie) circulation (éch.fonction.) éch sociocult. de modèle
orientation/positionnement	appartements	Transversalité	Vue à la cour et à l'extérieur coté parc éch. Optique éch. géographique
dimensionnement	longueur façade	grand linéaire	compacité performance (éch. économ. énergie)
dimensionnement	hauteur bâtiment	éch. géograph.	Absence d'effet de masque pour le bâti derrière éch. voisinage
dimensionnement	empreinte au sol/plan	lignes convergentes vers la profondeur de la parcelle	La vue vers Le Park des bâtiments à coté. éch. de visibilité et optique qui dépend d'une échelle de voisinage

Table 18 Identification of the cognitive operations of architectural design of the building E2 from the energy viewpoint

Opération	Dimension	Pertinence	Référence
positionnement	fenêtres	Double exposition	Ventilation transversale, lumière naturelle
decoupage	dimensions de l'appartement	Passage en maçonnerie	relier les 2 appartements en 1 (éch. extension)
	matérialité des la façade intérieure	semi-transparence	Relation de vue aux autres appartements Intimité et interaction Échelle de visibilité et optique
dimensionnement	épaisseur 9,50		bâtiment déjà fait à Nantes (éch. Modèle)
	Matérialité de la façade intérieure	réfléchissante	Plus de lumière Chauffer Masquer la vue (échs. Géograph., économ., optique)
dimensionnement	volume de la cour		que l'air puisse se chauffer pour être utilisé aux appartements
Referenciation	La matérialité de l'enveloppe	"solide" (polystyrene) Et grille métallique	"protéger" la peau isolante (technique) "Jeu des ombres" (renvoi aux façades parisiennes) (de visibilité)
positionnement	balcons		confort thermique protection solaire l'été (econom. éner., géograph.)



Figure 74 The E2 Building seen from Cardinet street source M. Apostolou

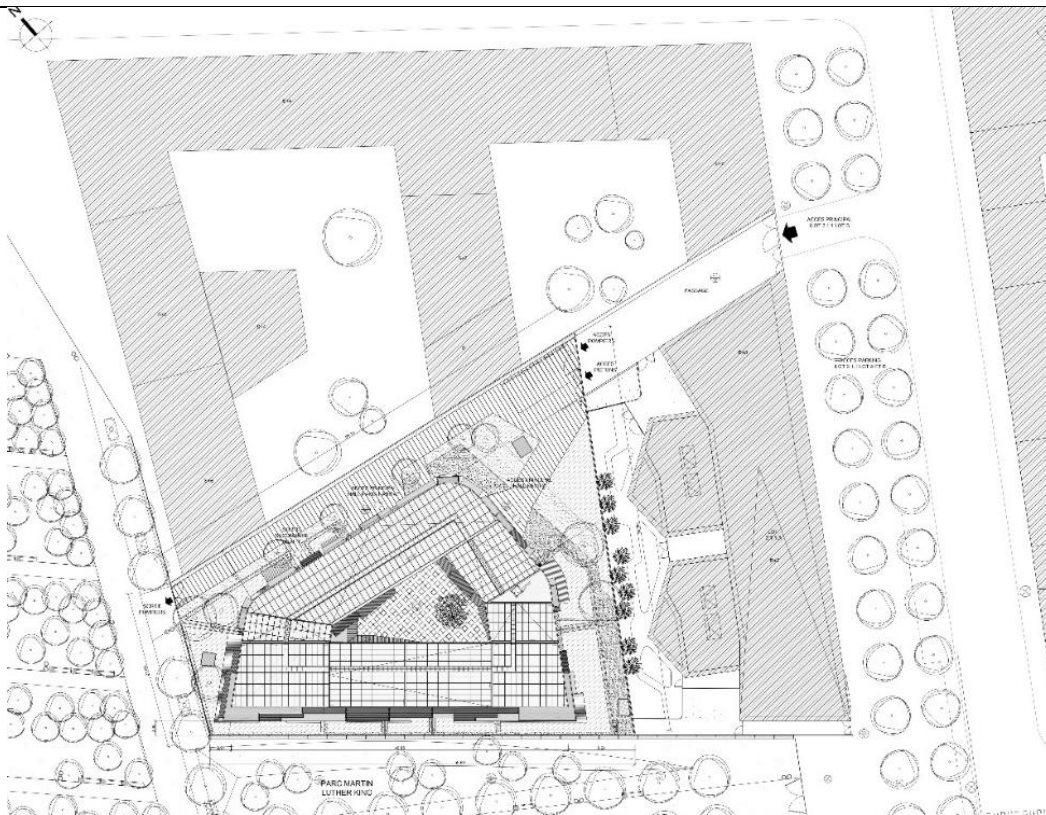


Figure 75 The implantation of the E2 building neighboring with the E1 one. Source David Trotin, Peripheriques Architectes

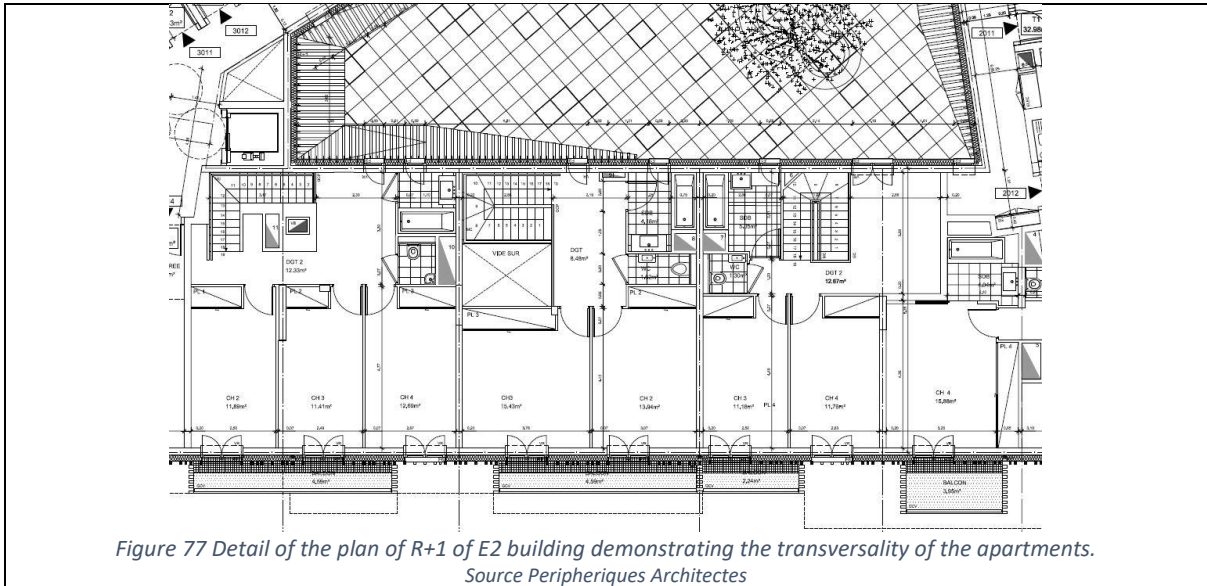
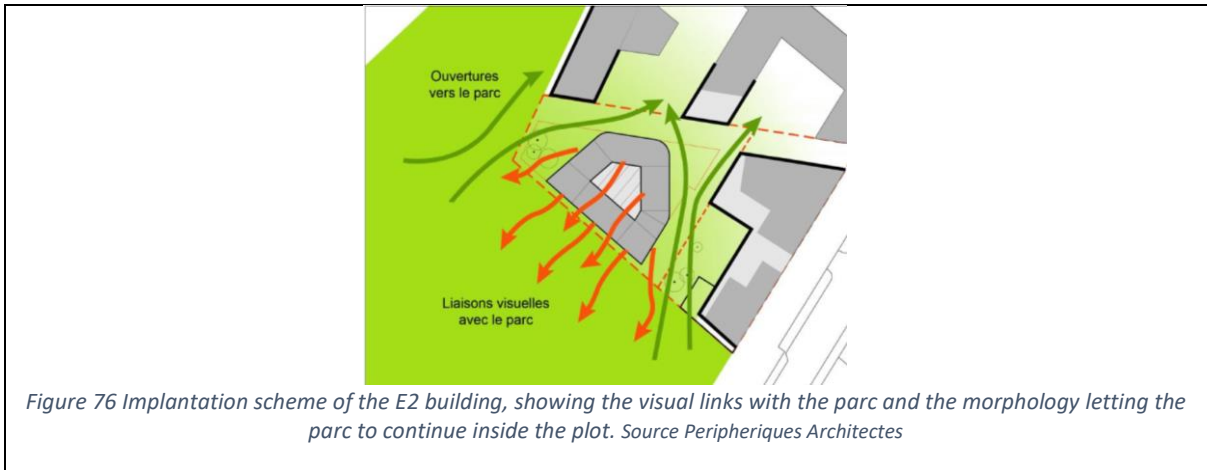




Figure 80 Building E2, view from the parc. Source M. Apostolou

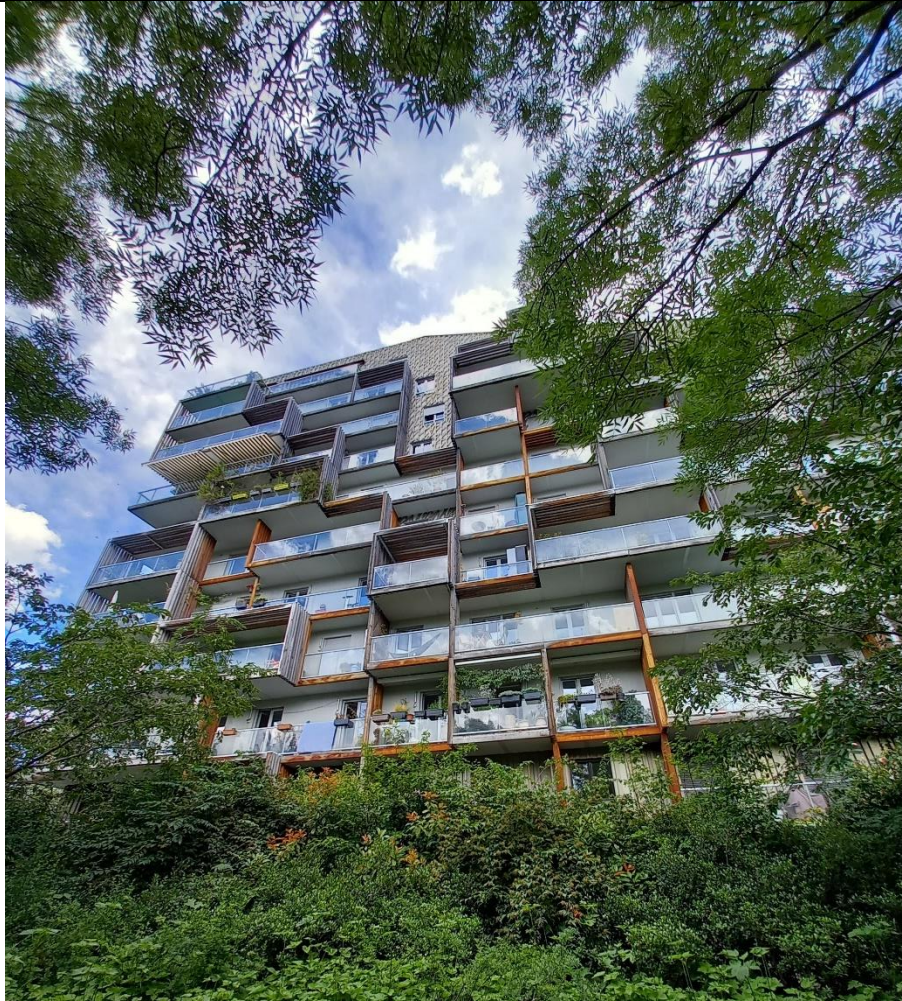


Figure 81 Building E2, view from the parc. Source M. Apostolou

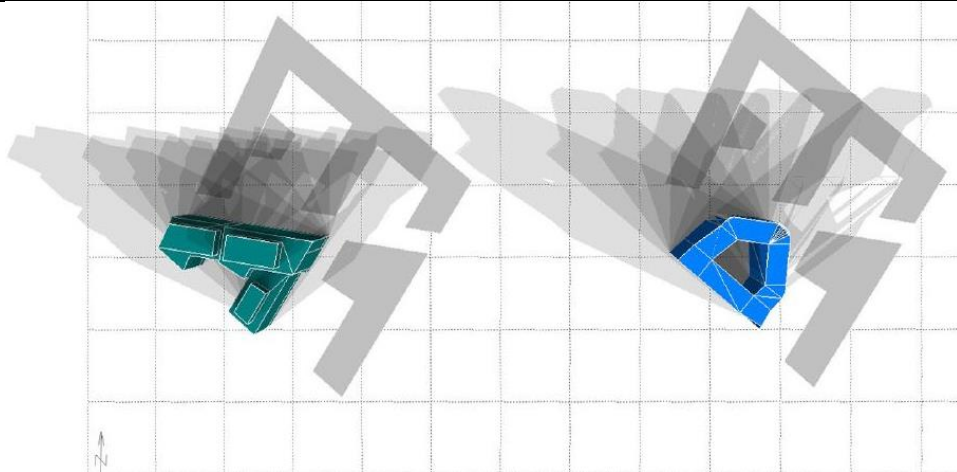


Figure 82 Daily superposed shadows in 21st September. Research of compacity from the architects. Source Peripheriques Architectes

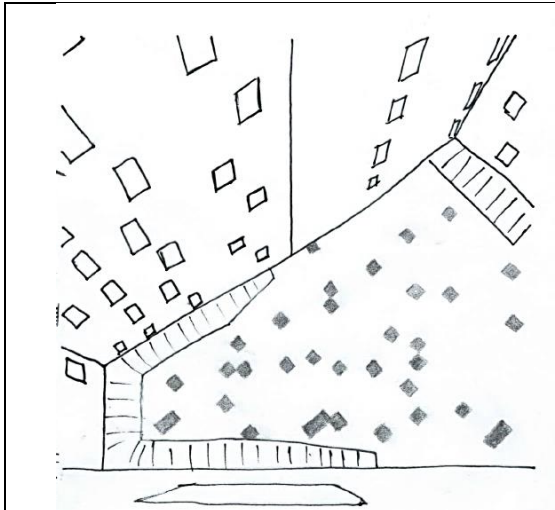


Figure 87 Building E2, the inner courtyard. Source M. Apostolou



Figure 88 Building E2, the pattern of the exterior metallic skin framing the facade. Source Peripheriques Architectes



Figure 89 Building E2, detail of the envelope. Source M. Apostolou

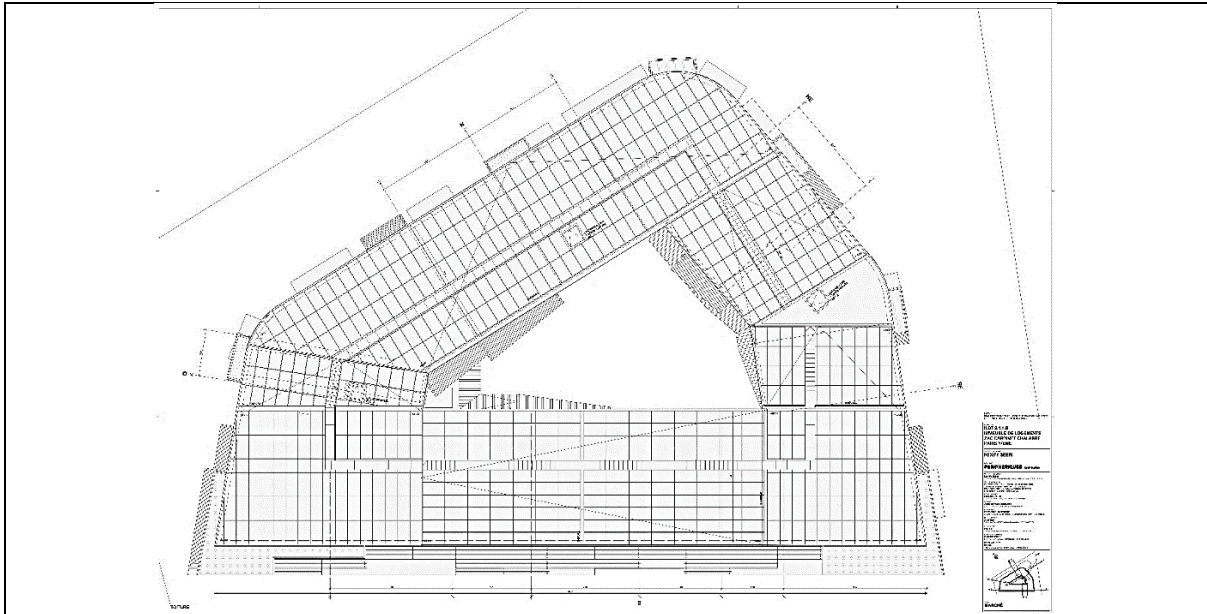


Figure 90 Building E2, roof plan demonstrating the photovoltaic panels. Source Peripheriques Architectes

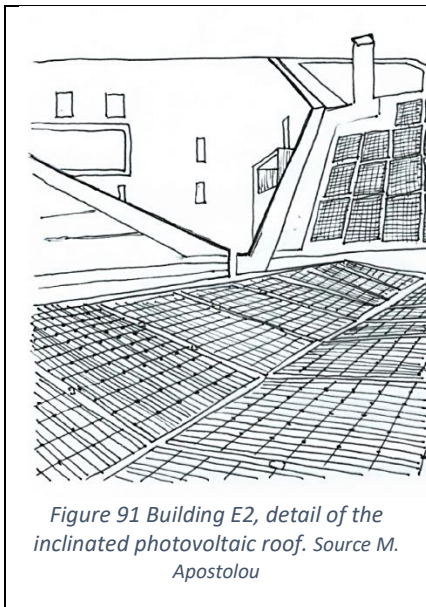


Figure 91 Building E2, detail of the inclined photovoltaic roof. Source M. Apostolou

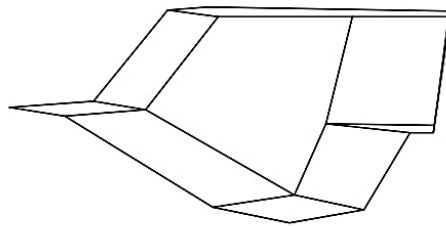


Figure 92 Building E2, detail of the inclined roof. Source M. Apostolou

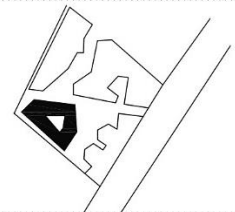


Figure 93 The implantation and positioning of the building E2, in relation to the neighboring edifices. Source M. Apostolou

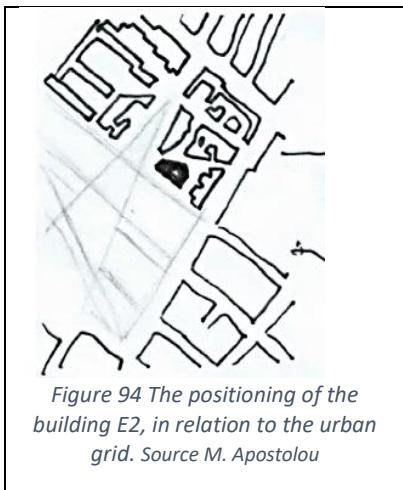


Figure 94 The positioning of the building E2, in relation to the urban grid. Source M. Apostolou

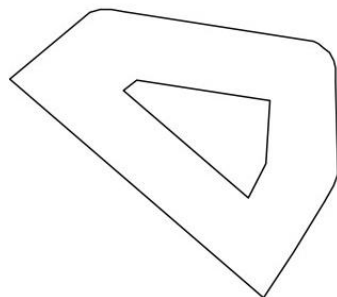


Figure 95 Building E2, in a form of a 'crown'. Source M. Apostolou

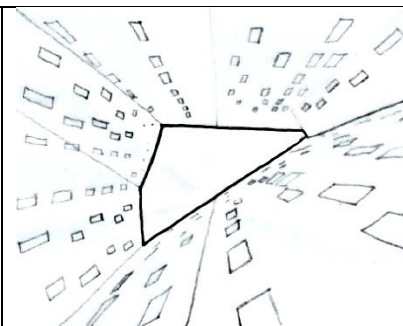


Figure 96 Building E2, view towards the sky from the interior courtyard. Source M. Apostolou

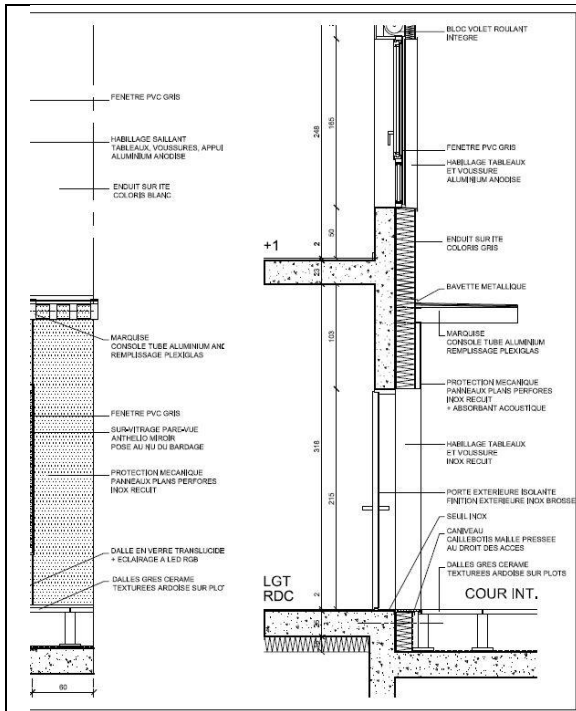


Figure 99 Detail of the opening in the façade of the interior courtyard side, ground floor Source Peripheriques Architectes

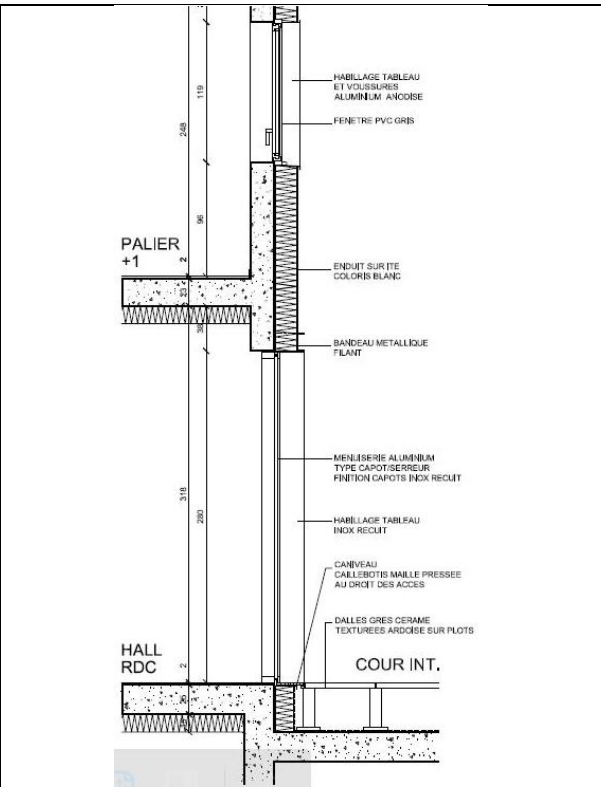


Figure 100 Detail of the opening in the façade of the interior courtyard side, ground floor. Source Peripheriques Architectes



Figure 101 Building E2, the geometry of the roof seen from the façade. Source M. Apostolou



Figure 102 Details, façade. Openings and balconies. Source M. Apostolou



Figure 103 Details, façade. Openings and balconies. Source M. Apostolou



Figure 104 Details, façade. Openings and balconies. Source M. Apostolou



Figure 105 Details, façade. Openings and balconies. Source M. Apostolou

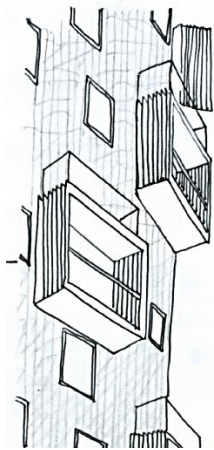


Figure 106 Openings and balconies.
Source M. Apostolou

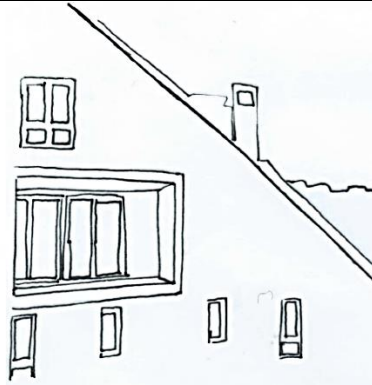


Figure 107 Openings and balconies.
Source M. Apostolou

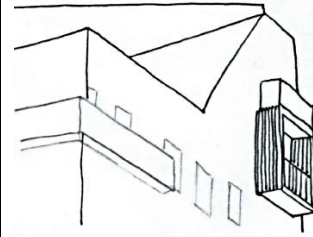


Figure 108 Openings and balconies.
Source M. Apostolou

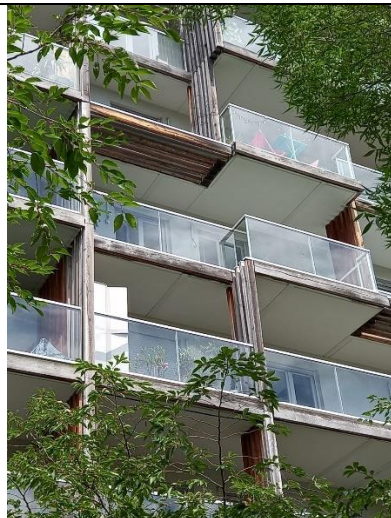


Figure 109 Details, façade. Balconies.
Source M. Apostolou



Figure 110 Details, façade. Balconies.
Source M. Apostolou



Figure 111 Details, façade. Balconies.
Source M. Apostolou



Figure 112 The position of the wood grid in the façade.
Source Peripheriques Architectes

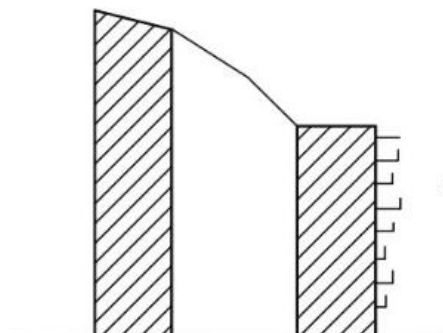


Figure 113 Schematic section of the E2 building. Source M. Apostolou

6. Study case, Building E5

We criticize the stupid and subservient use made of it (n. the environment) by many architects. We want the environment to be the basis, a serious starting place for societal changes. However, the theatricals around a new thing that promotes the sale of equipment or processes that are big winners with moronic architects who palm them off in their projects, thinking they will win an award for that, or with those who, without this, would have nothing to say: no, that is not what we want. Architectural thinking is modified when civil society voices strong, audible and coherent demands or when new materials emerge. The architect develops techniques and forms following these conditions, like in the Renaissance or the 1960s. Although the environment is the only valid idea we think capable of uniting us in a satisfactory manner, for all that, we must not let the wholesalers of the virtuous illuminate us. (Soler, F. in Contesse, 2014, p. 28)

6.1. Prologue

This chapter explores the third study case; it consists of the building *Parc 17*, constructed at the E5 plot and delivered in the east zone of the Clichy-Batignolles eco-district in 2016.

The chapter is initiated by a brief presentation of the architectural office responsible for the design of the *Parc 17* project.

Firstly, the chapter describes the building according to the intentions of the architectural team who pursued the study. Secondly, it interpretes the conception of the edifice, implementing as a viewpoint the tools and concepts provided by the chosen method of analysis.

The sources analysed and interpreted are texts provided by the architect having realised the project,²⁵² interviews of him, given in diverse contexts²⁵³, texts written by journalists/architects regarding the project²⁵⁴, as well as an interview with the architect F. Soler, realised on the 24th September 2020 in his architectural agency²⁵⁵, conducted by the author.

Finally, the seventh chapter focuses on the consideration of energy issues in the design process of the chosen case study. With the aim to explore the ways in which energy concerns have intervened in the conception of this building, the vocabulary of architecturology and its relevance is applied on the energy performant design.

²⁵² <http://soler.fr/projet/cardinet/>

²⁵³ <http://cityscape.fr/fr/batiment/lot-e5-parc-17>

²⁵⁴ (Barani, 2014; Contesse, 2014; “Logements et bureaux Cardinet-Chalabre,” 2014), (“Francis Soler 98 logements et bureaux Paris XVIIe,” 2016), (*Clichy Batignolles Fiches Programmes Logements. Lots attribués du côté de l’avenue de Clichy*, n.d.)

https://archive-clichy-batignolles.parisnetmetropole-amenagement.fr/sites/default/files/fiches_habitat_1.pdf

<http://parc17.fr/>

²⁵⁵ Francis Soler Architectures, 27 rue du Cherche-Midi, 75006 Paris.

6.2. The architect, Francis Soler

'(...) the plans, sections and details of his projects demonstrated uncompromising functional and construction precision, an economy of means, while the volumetry, facades and atmospheres captured the contexts and cultures of the period. This fertile tension, between structuralism and sensuality, and between rationality and poetry, was the basis of his work. (...) In Francis Soler's more recent projects, the strong narrative dimension he began with tends to fade before a more direct and technical representation. It would seem that the proliferation of standards and regulations of all sorts is a driving force in their design. A beneficial opposition to the pervading exasperation to describe the growing number of constraints differently, to recognize that despite it all they are revealing of a contemporary culture, and from this create new architectural material.' (Barani, 2014)

Francis Soler, born in 1949, graduated from Ecole d'Architecture de Paris-Villemin in 1976. Since 1973 he has participated in more than hundred architectural competitions. In 1985 he created Francis Soler Architecture and in 1994 the company Francis Soler Architectures. In 1990 he obtained the prominent french award Grand Prix National d' Architecture.

The project for the Centre de Conférences Internationales de Paris, accomplished in 1990 is said to have enacted the fame and the experience of the agency towards architectural responses of diverse magnitudes.²⁵⁶ The Bons Enfants building in Paris became the seat of the French Ministry of Culture and Communication.

Francis Soler's works and achievements have been reported not only in the in a national (french) scale, but internationally as well.

6.2.1. References of the architect

I am a Mediterranean, and the light, the sun; the wind, and all these are part of things which are I think the most important from the point of view of senses; architecture of the domestic,

²⁵⁶ Source : the agency. <https://soler.fr/francis-soler>

that is to say of housing and the office, it is above all the architecture of comfort, it is to be the best possible for work or for living (Soler, n.d.-b)

Soler often presents his Mediterranean roots as a source of inspiration; a space of references that influence his intentions when designing; a landscape nourishing his viewpoint on what passive architecture is. The geographical orders synthesising such a territoriality are the physical characteristics of the specific context implied: the sun, the wind, the transversality, the view.

To the idea of capturing a language, I prefer that of disposing its words. (Soler, F. in Contesse, 2014, p. 25)

When it comes to architectural expression, Soler affirms being opposed to reproducing the same ordinary and typical characteristics along his projects; he declares preferring instead *isolating words and reassembling them differently*, in a way that each one maintains its self-existence. To describe the way he proceeds, to provide an insight his method ambitions, he drives a parallel with the triptych of the Garden of Earthly Delights by Hieronymus Bosch: *United, they create a perfectly coherent work which remains invisible. So, in the same way each of my projects, although it stands alone, is part of a world of a similar vein.* (Soler, F. in Contesse, 2014, p. 25) He declares thus abstaining from repeating similar architectural series of objects but admits rather using commonly auto-referential elements in different ways and orders.

He describes the design process he follows as a collection of the diverse parameters and given elements, a mixing of them, an observation of the proposal a re-observation, by adjusting, changing, adding elements; without however having started with a given image in his mind. *'With an open mind, a little as if I were suffering from amnesia, I sit down at my mixing table and I install all the data, a world and its limitations. Afterwards I cross-analyse this according to importance and relevance. I set the cursors in my sights, then I look. Curiously, something comes of it, with a specific technical and aesthetic culture, offering an often unusual but detailed result. I like to think that it draws itself. There is no priority between what issues from the function and the technical nature of the space or from an aesthetic quality. The project reveals its advantages, and from one project to another, since the parameters are not the same, these automatically lead to very different solutions.* (Soler, F. in Contesse, 2014, p. 30)

Francis Soler has presented the ways in which his agency works out a project. The initial phase concerns the program's analysis as well as the discussions with the client. After this, the conception phase is developed, merging the diversity of the parameters set.

I evoke and re-evoke. It changes constantly. All of a sudden, something appears. This can have no relationship with the subject but introduces the impetus by which the project emerges.

(Soler, F. in Contesse, 2014, p. 30) Soler proceed with the basic adjustments of the project. During the exchanges and communication with his colleagues, and despite the early stage of the project even from the competition phase, he moves towards a three-dimensional representation and digital modelling of the proposal. At this point the project is dealing with requirements of a technical, functional, plastic and budgetary requirements.

The procedure that follows involves an optimisation of the project.

A meticulous and lyric conceptual approach of the façade seems to characterise his compositions. *Most often the models expand upon facades: they are the site of very personal dramatic structures. (...) Although a building stays anchored to the ground and remains immobile, its perception can change following the way in which it is finished, in the fragile thicknesses of its facades. (...) This enables me to measure the impression an outside wall can provide, depending on whether it is heavy, reflective, a single piece or cut out, in steel or glass, or depending on whether it is seen from far or very far, near or very near. (...) We refer to view availability, depth of field, returned scenes of life, acceptable layouts, and a little less of 'architecture'.* (Soler, F. in Contesse, 2014, p. 31)

Soler have claimed abstaining from a specific style in his architectural design. "I do have self-references, but in the state of mind, not in the form"²⁵⁷ '(...) Depending on the opportunities I take out my concept, an idea, a project which sticks, and then I adapt all the possible techniques.' 'I design buildings that work where they are'

²⁵⁷ Source: the interview given to the author

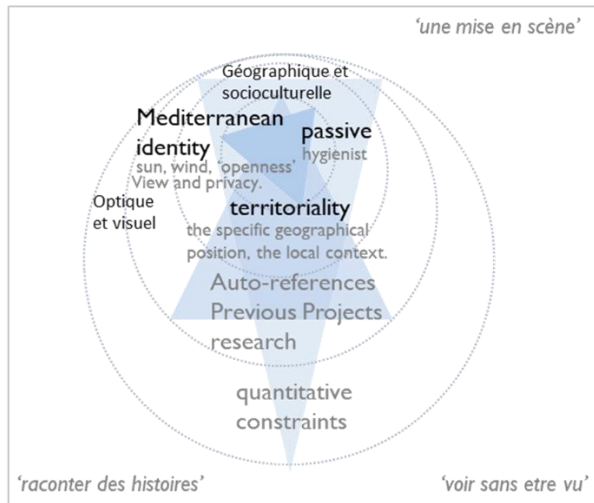


Figure 114 Possible spaces of reference mobilised in the design activity of Francis Soler

6.2.1.1. Environmental approach

6.2.1.1.1. Critical positions against the commercialisation and a sterile labelisation

“Architectural thinking is modified when civil society voices strong, audible and coherent demands or when new materials emerge. The architect develops techniques and forms following these conditions, like in the Renaissance or the 1960s.” (Soler, F. in Contesse, 2014, p. 28)

Soler has publicly expressed his positions towards environmental issues in architecture, having criticised together with Ricciotti the “*subservient use*” of it by many architects. By referring to this latter, he implies the promotion of equipment and processes that are often, according to him, the winners of the ongoing policies. He supports the environmental and energy concerns being viewed as a basis, a starting point leading to social changes, rather than a pursuit of a label or an award. In our words, we could assume that although supporting the environment being an umbrella-concept acting as a uniting parameter, he is situated against the over-use and falsification of it “without having nothing else to say”. As a sign of our times, inscribed in the political agenda too, “environment” becomes consequently a terrain bearing conversions.

*Sustainable is not only the climate. It is the flexibility of the project so as not to demolish them in order to rebuild them, it is the comfort, it is the acoustics, all these things are already taken into account*²⁵⁸

²⁵⁸ Source: interview taken by the author

'I watch, interested by questions of politics in general, but I react when it affects or infects architecture. Together with Rudy Ricciotti, we define ourselves as engaged architects, bound to political questions by a defensive and operational responsibility.' (Soler, F. in Contesse, 2014, p. 26)

6.3. The building, E5 Parc 17

In May 2016²⁵⁹ the 11-floor building of the E.5 plot, situated in the east sector, between the park and Ibis Hotel, was inaugurated²⁶⁰. It regroups 98 private housing apartments and 871m² dedicated to offices²⁶¹ on the third floor, used by the Ibis Hotel.

The first two levels of the edifice are duplexes which are posed on the ground floor. Initially they were destined to be *ateliers d'artistes*; (Soler, n.d.-b); in the end they were designed for residential use.

The project consists of a linear building, with its continuity fragmented into three volumes that remain however attached in a whole. Figure 121«The form of the building is thus entire and complete, easily identifiable. » (Soler, n.d.-a) More specifically, the linearity of the building is interrupted by two « inhabited faults » (*Clichy Batignolles Fiches Programmes Logements. Lots attribués du côté de l'avenue de Clichy*, n.d.), spaces having the function of balconies or winter gardens. Figure 122Figure 123

“this (...) parallelepiped is quite simply the form of the parcel, neither more nor less, elevated to the maximum of its capacity to build. The faults simply extend the continuous balconies by creating intimate spaces, where people can meet each other, therefore outside but at the same time inside the building protected from rain or sun by a tile. But the advantage of this device lies also in the fact that it creates conviviality between the apartments” (Soler, n.d.-b)

As seen above, the dimensions of the parcel are said to have primordially given the dimensions of the building: « *One of the particularities of this project is lying in its geometry. It is enrolled within the strict limits of the plot (85m x 12m), the land efficiency is thus total.* » (Soler, n.d.-a) In that way the length and width of the building are dictated by the plot dimensions. Figure 124The thickness of the building, thus resulting from these measurements, allows in turn the apartments to be transversal, as well as to have a thermal inertia that responds to the requirements of the environmental certifications.

More particularly, on the “constrained” linear plot of 85x12 meters, the architect Francis Soler states having created a « new décor » (*Clichy Batignolles Fiches Programmes Logements. Lots attribués du côté de l'avenue de Clichy*, n.d.) for the park : a façade mixing the reflections of the landscape with the serigraphic printed designs on its proper glass. Figure 125

²⁵⁹ <https://objectifgrandparis.fr/secteur-lecoquartier-clichy-batignolles/>

²⁶⁰ MAR. 2016 / LIVRAISON, SEP. 2013/ CHANTIER, jul. 2012 / PERMIS DE CONSTRUIRE, jun. 2010 - SEPT. 2013 / ETUDES, ma i. 2010 / CONCOURS

²⁶¹ See more in <https://www.pss-archi.eu/immeubles/FR-75056-26573.html>

The two main façades are oriented towards the axe of north-south. As for the north facade, it is rather closed and punctuated mainly by the windows situated on the bedrooms Figure 127; the south one is widely open towards the landscape of the park and accommodates the day rooms and the balconies Figure 126. Almost all apartments are given multiple orientations and private outdoor spaces.

The envelope is said to be compact and respecting the high environmental requirements set for the operation site.

The floor plans are identical, except from some duplexes.

A reduction of the complexity of the structural work and a prefabrication in series of screen-printed elements on glass or printed on sheet metal is declared to result in a more balanced budget. As the French Thermic Regulation RT 2012 required insulation from the outside, the thick aluminium plates aim to protect the rock wool in the facade.

The reduction in the number of parking spaces for bicycle storage, the pneumatic collection of waste and the use of home automation are used as a response to contribute to environmental quality. (“Francis Soler 98 logements et bureaux Paris XVIIe,” 2016, p. 61)

6.3.1. Description

Francis Soler describes the origins of his project at Clichy Batignolles eco-district. He had already conducted a study on this plot, as he had been interrogated by another developer before Vinci was interested in it. *The size of the plot is the size of the building. This is very unusual. We have zero space around, so it's complicated* (“Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014). In this case the plot itself was too constraining, thus imposing in a way the maximum dimensions that the building could have.

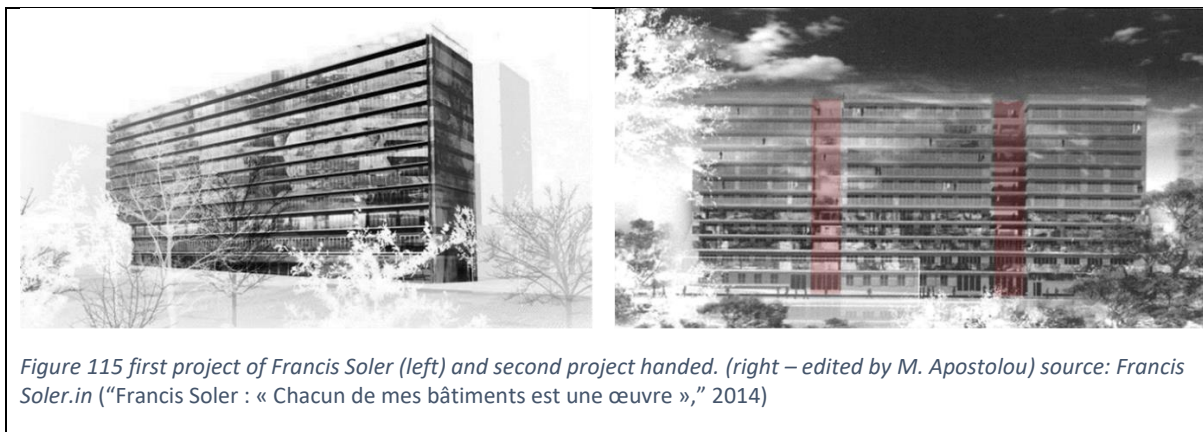
This definition study allowed us to see how we could use this plot that is being wedged between the wall of the Ibis hotel and the park. With the constraints that the city had set, this limited the plot to 10-12 meters thick, which today is not very profitable because a housing building is usually 14 meters thick. (“Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)

In addition to the constraining parcel, the necessary technical ducts²⁶², and the norms to be respected - that is the placement of the fixed parts – led the architect to having a limited possibility to act freely in comparison to the project d’EDF in Saclay, for example. *In a*

²⁶² ducts and conveyance systems (stairs, elevators etc.)

building, there are always the fixed parts. You need a staircase, an elevator, technical ducts, climb ducts, ventilation ducts... Now, these so-called common parts are becoming more and more important because of handicap and, safety regulations... So these technical parts, are taking up space. The difficulty is that the plot imposed a template on us. Right now, I'm doing a project on the Saclay plateau for EDF. I have 8 hectares where I can make the shapes I want, I can go up, I can go down, I can spread out ... With Parc 17, I had a defined width, length and height. From there, once you put the fixed parts, there is what is called "le gras". This is what the promoter sells. And in this building, the gras is very low. ("Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)

The first project proposal that won the competition had initially nine floors -and not eleven as the project constructed; it was an *extremely dense building, a solid bar with no terraces*. It was an edifice composed of apartments around two stairwells. After having won the competition, the architectural agency started communicating more closely with the City of Paris and the municipality. Anne Hidalgo’s remarks were emphasizing a need to render the building more “transparent”. *"I don't want a bar. This building reminds me too much of my young years in the suburbs. Find me elements that allow me to have transparency, fluidity, space ... "*. (“Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)



Francis Soler had to work with the developer that had to manage the balance of the budget along with the extremely thick building. The project had to be consequently discussed among the architect and the developer several times in order to find out an equilibrium between the economic efficiency of it in combination with the architectural quality and comfort offered to the future inhabitants. *So we made six or seven successive proposals until arriving at today's one with breakthroughs that allowed transparency on the loggias. But with this we were losing square meters. So, all that we had lost with the terraces, we had to find it by making two more*

floors. An economic balance had to be found. With the terraces, the linear facades were increased. A building with a full facade, like the first project, costs less than a building with breakthroughs. It's more difficult to build, to isolate... Especially with the City's energy constraints which are very draconian. You have to be in the HQE, in the Climate Plan, it's very complicated to settle. It took us two years to settle all of this and return to an economic balance. In the end, I find that this whole confrontation was very useful. This "battle", as we say today, between the City and Vinci has resulted in a balance, which is the building you know. I clearly prefer this building with these two breakthroughs.

The windows facing the parc open in accordion, a device allowing to fully open them towards the view. The south façade is thus open to the sun; on the contrary the north one is more 'closed', clothed with 1600 aluminium surfaces. *These surfaces were made with a technique constituting on printing on an aluminium sheet which is painted, then varnish a drawing pressed in 200 degrees which comes to be printed on the aluminium sheet to then recompose it on panels of 1m 90cm wide.* (Soler, n.d.-b)

Francis Soler affirms having chosen this material combination of metal, glass and serigraphy, the same as used also twenty years ago²⁶³, as in the context of Clichy Batignolles, it allowed to create a certain confidentiality regarding the people being in the parc: the inhabitants of the lower levels could still open their apartment entirely on the south façade. *So from the park you never see what's going on in the apartments and then from the apartments you can see the outside of the park extremely well.* (Soler, n.d.-b) Furthermore, Soler describes those materials as containing a 'sustainability effect' (Soler, n.d.-b) as maintained easily.

An intention of intimacy, in combination with the parc being adjacent to this side of the plot are said to have led a differentiation between the bottom and the top part of the south façade. Even if it is characterised by entirely glazed elements, when designing the south façade the architect claimed having considered that the building was going to be seen from the parc. *The upper part is in relation to the sky with large glass railings and the lower part is more complex with railings in stainless steel tube and screen-printed elements. It's for a question of privacy.(...) The first four levels are rather hidden behind the screenprints. So people on these lower floors will be able to see outside without being seen at home. On the other hand, from*

²⁶³ at rue Durkeim next to the Library of France

the fifth floor, the glass will reflect the sky and you will never see in the apartments. (Soler, F. in *Les sérigraphies, de l'art pour Parc 17*, 2014)

On the same time, this operation is presented to act not only at a local level but at a global one too, characterising the edifice as a whole. *The higher you climb, the more the reflection will mask the interior. This is all (a travail de mise en scène) that keeps the confidentiality of the low apartments in relation to the park. (...) Driven by the neighbouring of a large open surface and not of a street, the façade is said to contribute to a staging of a fading building towards the sky. Compared to the top, we are trying to make the building more evanescent with pure glass panes.* On the same way, the elements constituting the north façade have taken into consideration the hotel. *The work at the back of the building is more opaque, because of the relationship with the Ibis hotel. The windows are more closed so that hotel guests cannot see the apartments and the apartment cannot be seen from the apartment.*

The screen printing (serigraphie) is a technique that the architect has already used in previously accomplished apartment buildings, in rue Durkheim opposite of the National Library of France, and in allée Paul Signac in Clichy.

By designing the façade cladding, two main prerequisites had to be taken into consideration, concerning thermal systems and exterior insulation. In an economic point of view, the use of sheet metal had been examined; its 'industrial connotation' though, is said to have called for an amendment: the orientation towards an idea of 'desaturated series of prints on sheet metal'²⁶⁴ ("Logements et bureaux Cardinet-Chalabre," 2014, p. 49)

6.3.2. Interpretations

The input material used to base the architectural analysis that follows is composed of a text published in the official archives of Clichy Batignolles eco-district project²⁶⁵, a descriptive text of the project retrieved from the agency of Francis Soler Architects²⁶⁶, a transcription of a

²⁶⁴ Client: Vinci immobilier, BET/consultants: Inex

The necessity for thermal systems and the straightjacket of the exterior insulation made the façade cladding a particularly complex problem. Sheet metal provided an economical solution, but also conveys an industrial connotation. To remedy this, the architect developed the idea of a rather desaturated series of prints on sheet metal, the same as the more vivid ones he applied to the glazing ad low surfaces of the balconies. The reference images (Polnareff, Dali, Botticelli) become abstract by the 'immeasurable decompositions and Brechtlike distance' > in the end, depending on how the lighting changes (natural or artificial, outside or inside), the motif and its shadows will animate the building's surface.

²⁶⁵ Clichy Batignolles Fiches Programmes Logements. Lots attribués du côté de l'avenue de Clichy

²⁶⁶ Texte2, produit par l'agence Francis Soler Architecte,

published interview of Francis Soler²⁶⁷, an interview of Francis Soler on his project²⁶⁸, as well as an interview taken on the 24th September 2020 in the office of Francis Soler Architecture in Paris, a text published in AMC magazine²⁶⁹ and an interview of the architect in Architecture d' Aujourd'hui²⁷⁰.

6.3.2.1. The initialisation act of the plot scale

The form and dimensions of the building probably have a reference to a plot *scale* that operates here at a zero degree level: a given data (the length and width of the parcel) is dictating the dimensions of the edifice, giving him, in other words a relevance of a geometric *scale*. “In reality, this kind of large parallelepiped which rises on eleven floors is quite simply the shape of the parcel neither more nor less mounted to the maximum of its capacity to build.” (Soler, n.d.-b)

In the case of Francis Soler's building thus, a possible questioning of the general volumetry consists in positioning the edifice withing the geometry of the parcel in which it is inscribed. The linearity is presumably an architectural choice responding to plot issues; related also, at a second level, to an economy of energy consideration (concerning the compacity and efficiency). More specifically, the width Figure 128Figure 129Figure 130the building could be possibly related to a functional *scale* (transversality, coherence of the floor plans), a visibility one (multiple orientations from the interior of the space) as well as an economic one (compacity, thermal inertia)

The form of the building is relayed by a symbolic *scale* of form (‘whole and complete, easily identifiable’²⁷¹) that operates in relation to an optical and a neighbouring one. (being able to comprehend the identity of the building and distinguish it from the other envioning elements.) The plot scale could thus possibly bear a connection with a symbolic formal and a geometrical scale. The geometrical *scale* leads in its turn to apply a functional and an economic of energy one.

²⁶⁷ Texte 3, transcription de l'entretien de Francis Soler paru dans <http://cityscape.fr/fr/batiment/lot-e5-parc-17> ,

²⁶⁸ Texte 4, entretien de Francis Soler. <https://parc17.fr/francis-soler-batiments-oeuvre/>

²⁶⁹ AMC 251, mai 2016 p.61

²⁷⁰ Architecture d'Aujourd'hui n. 399

²⁷¹ entière et complète, aisément identifiable

The interruption on the monolithic linear geometry of the building finds its relevance in the creation of two void spaces that accommodate common uses referring to a functional *scale* (balcony and jardin d'hiver)

The parallelepipedal geometry of the building finds its reference in a zero-degree plot scale. The faults are possibly lying their relevance in the prolongation of the balconies running along the length of the building, Figure 131Figure 132with a reference of geometric (disrupting the continuous bar) as well as functional orders (creating more convivial spaces between the apartments) relayed by a sociocultural scale (inhabitants can gather together in an outdoor space that on the same time belongs to the building). It is important to mention here that these faults-spaces are conceived after the first project proposal had been done and demanded by the environment of the city mayor. It initiates thus a new space of reference and implies an operation of a slicing in the compact previous space. Subsequently, this operation of slicing leads to an operation of dimensioning, as the height of the building changes from 9 to 11 floors.

The façade of the building probably lies its relevance in a semantic *scale* in reference to an optical one.

The opening of the French doors (portes-fenêtres) in accordian is a disposition that probably lies in a technical *scale* that is operated with a reference to a functional one (for a maximum opening on the long running balcony) relayed by a *scale* of visibility.

The design of the envelop's form could possibly lie its relevance in a semantic *scale* that is in reference to an optical one: the façade wants to demonstrate a dialogue with the neighbouring park, integrate to the context in which it is positioned and propose new visual interactions ('decoration'): its form, materials and measures are designed in such a way as to be viewed from the parc as a new decorative element in the landscape.

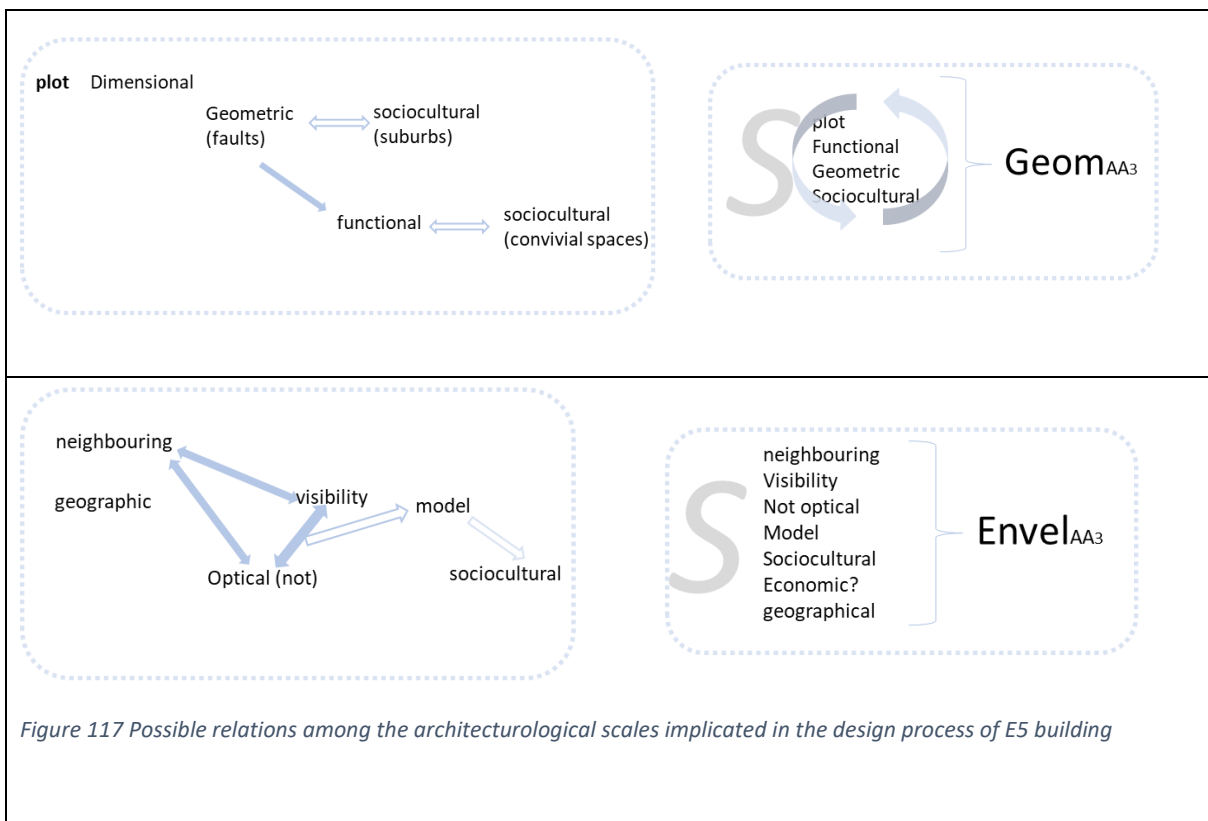
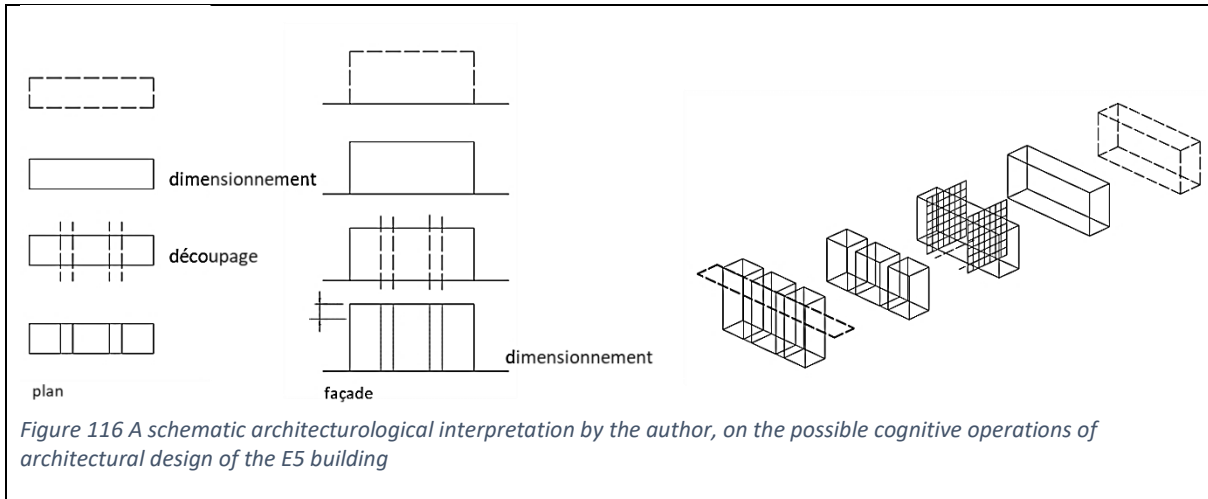
The materials and elements constituting the façade are also in a significant way related to a *visual* space of reference (the users are not seen from the outside, but they can see outside) that is in a constant relation with the *optical* one. This duality is demonstrated by the serigraphic elements applied in the glass and aluminium.

The difference between the surface of openings along with their dimensions in each of the north and south façade are most probably linked to a relevance relayed primarily by a geographical *scale* having reference to the economy of energy *scale*, and at a second level to the neighbouring one. (parc in the south façade, hotel Ibis in the north)

The glazed exterior doors leading on the south façade's balconies (about 4.80m wide) Figure 133Figure 134Figure 135are dimensioned so as to let a large amount of natural light to circulate in the interior space unfolding in 4.80m of length. Therefore, its presence improves energy efficiency. This mechanism holds its reference in a visibility *scale* that takes advantage of the views, relayed by a neighbouring scale (presence of the park) co-determined by a geographical *scale/economy* of energy. The south façade is actually designed differently from the north one, that is less open and to light. Figure 136

The technique of serigraphy and the glass surfaces of the south façade Figure 137along with the aluminium panels of 1.90m Figure 138that are composing the north façade are related to a geographical *scale* (north/south orientation) and view (maintain a certain degree of privacy – being “protected” from being seen from the park / allow to be totally open to the view on the park). In addition, the architect links his choice with a semantic *scale* that derives from the “sustainability” and “sublimation” of these materials. The serigraphy glasses on the metal balconies are referring to a previous project accomplished by the the architect in Durkeim street in Paris, relaying thus a model *scale*.

In conclusion, in the dimensioning and forms of materials chosen in this case's facades we can identify the geographical *scale*, the neighbouring *scale*, the model *scale*, the coexistence of visibility-optical *scales* and a semantic *scale*.



6.3.3. Conclusion – on architecturological scales

Une échelle économique de l'énergie semble avoir passé par les dimensions de la parcelle. Or, c'est l'architecte qui en dimensionnant son bâtiment suivant les dimensions de la parcelle (en ayant comme pertinence les mesures de la parcelle (éch. parcellaire) et comme référence les programmes (échelle fonctionnelle) qui lui ont été demandés) qui amène à identifier des éléments d'efficacité énergétique le caractérisant.

Dimensionner l'épaisseur du bâtiment à 12,5m n'est pas une opération initialisant à la conception pour des raisons d'économie d'énergie, mais c'est parce qu'il y a cette dimension (de la parcelle) que le bâtiment dévient énergétiquement performant.

La faible épaisseur qui résulte de la parcelle est celle qui amène à la bonne inertie thermique et la transversalité des appartements, en réponse aux multiples certifications environnementales requises.

Les dimensions de la parcelle étant déjà très contraignant de tous les fronts, rien ne semble étant changé à cause des contraintes énergétiques, mais les choix ont été revues, ré-constitués, transformés en ne s'éloignant pas de ses propres références mais en même temps trouver les manières à récompenser.

La parcelle étant déjà orienté nord-sud, l'architecte choisi de se baser sur cette exposition pour son édifice et par conséquence éviter la déperdition thermique.

L'architecte a utilisé du béton, isolant et une vêtture. Il a choisi une vêtture en aluminium anodisé sur lequel il a fait de l'impression.



Figure 118 Building of reference. Francis Soler Architecture, 1997. Rue Emile Durkheim, Paris. 94 residential units and a crèche, general view. Source Francis Soler.

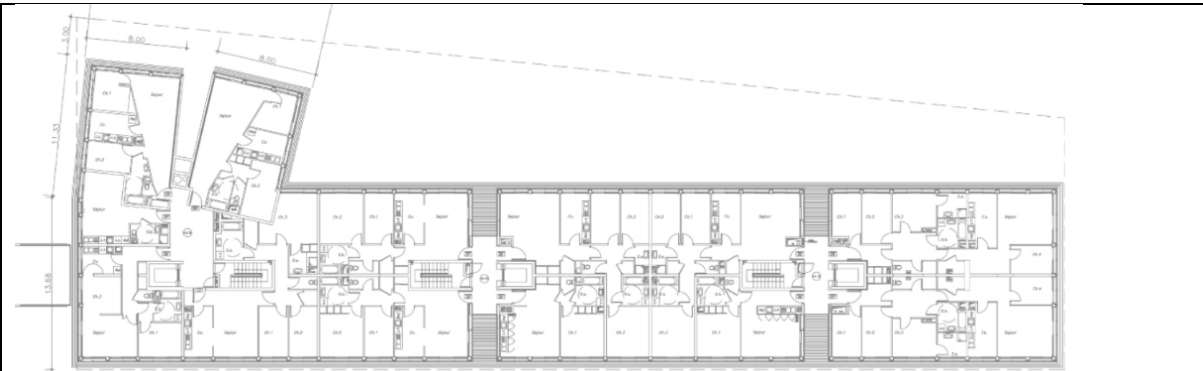


Figure 119 Building of reference. Francis Soler Architecture, 1997. Rue Emile Durkheim, Paris. Plan. Source Francis Soler.

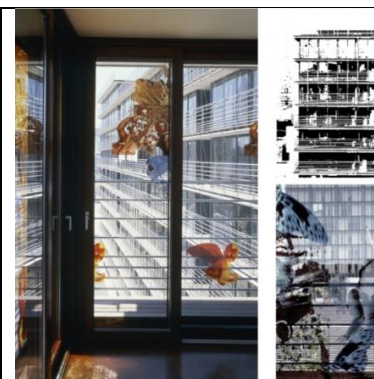


Figure 120 Building of reference. Francis Soler Architecture, 1997. Rue Emile Durkheim, Paris. façade details. Source Francis Soler.

operation	dimension	pertinence	reference
dimensionnement	longueur et largeur du bâtiment	s'inscrire dans les limites strictes de la parcelle (85m x 12m)	les dimensions de la parcelle (90m x 12m) (<i>échelle</i> Parcellaire)
referenciation	la façade du bâtiment coté parc	"une façade de verre où les reflets du parc et du ciel se mêlent au dessin des verres sérigraphiés." Matériaux : <i>échelle</i> optique et <i>échelle</i> visuelle	"nouveau décor" pour le parc (<i>échelle</i> sémantique, <i>échelle</i> optique, <i>échelle</i> de voisinage)
découpage	la forme du bâtiment	la linéarité du bâtiment est rompue pas deux failles (<i>échelle</i> Géométrique)	
	les failles	accueillant de vastes balcons ou des jardins d'hivers (<i>échelle</i> fonctionnelle)	
dimensionnement	l'épaisseur du bâtiment	11m ("faible")	<i>échelle</i> parcellaire
dimensionnement	surface des ouvertures façade nord	"fermée et ponctuée par les fenêtres des chambres essentiellement" échelle de visibilité	<i>échelle</i> géographique, <i>échelle</i> de voisinage
dimensionnement	surface des ouvertures façade sud	"les pièces de jour largement ouvertes sur le vaste espace paysager et les balcons filant en façade." échelle de visibilité	<i>échelle</i> géographique, <i>échelle</i> de voisinage
positionnement	portes-fenêtres	s'ouvrent en accordéon (<i>échelle</i> Technique)	pour un maximum d'ouverture sur le balcon filant. (éch. Fonctionnelle et de visibilité)
positionnement	bâtiment - le plan	s'inscrit dans les limites strictes de la parcelle (85m x 12m) échelle géométrique	à la parcelle (<i>échelle</i> parcellaire)
dimensionnement	épaisseur du bâtiment	faible	à la parcelle. <i>Echelle</i> parcellaire----> Bonne inertie thermique. <i>Echelle</i> économique en énergie (traversalité)
	forme du bâtiment	"entière et complète, aisément identifiable". <i>Echelle</i> symbolique formelle	par rapport aux autres bâtiments, par rapport au parc, par rapport à la ville. (<i>échelles</i> de voisinage et optique)
	longueur et largeur du bâtiment	grand parallépipède qui monte sur onze étage <i>échelle</i> géométrique	c'est la forme de la parcelle (<i>échelle</i> parcellaire) monté au maximum de sa capacité de construire
découpage	les failles	viennent prolonger les balcons filants en créant des espaces plus intimes (créer de la convivialité) <i>échelle</i> fonctionnelle (usage)	Contrainte de la ville 'rompre la barre continue' <i>échelle</i> géométrique
dimensionnement	façade sud - fenêtres	ouvrir les appartements sur 6 travers de fenêtres - quatre mètres quatre vingt de large	pour profiter des vues <i>échelle</i> de visibilité
orientation	façade sud - fenêtres	une façade ouverte, plein soleil, plein peau	<i>Echelle</i> géographique
	façade nord	fermer les murs - plaques d'aluminium	pour avoir moins de lumière – <i>échelle</i> géographique

referenciation	facades	sérigraphies échelle de visibilité (vue) et non optique (confidentialité)	par rapport au parc (échelle de voisinage) et par rapport au bâtiment rue Durkheim (échelle de modèle)
	façade sud	<p>Les quatre premiers niveaux sont plutôt planqués derrière les sérigraphies</p> <p>Par contre, à partir du cinquième étage, le verre va refléter le ciel et vous ne verrez jamais dans les appartements</p> <p>Par rapport au haut, on essaie de rendre le bâtiment plus évanescent avec des garde</p> <p>plus on monte, plus le reflet masque l'intérieur. Un travail de mise en scène. Echelle sémantique, symbolique formelle</p>	par rapport au vue du parc (échelles optique et de visibilité lié au voisinage)
	façade nord	<i>Le travail à l'arrière du bâtiment est plus opaque, car la relation à l'hôtel Ibis n'est pas formidable.</i>	<i>Echelle de voisinage (hôtel) et échelle géographique (nord)</i>

Table 19 Identification of the cognitive operations of the architectural design of the E5 building from an energy perspective

notion	'inspiration' (reference)	action
light	mediterranean identity	Dimensioning of large openings in the south façade A glazed building in the south
hygienism	"openness", traversing, ambient temperature, "capturing light and heat"	Double skin East-west orientation South orientation
Confidentiality and view =To see without being seen	Printed glass	The lower parts are screen printed but not the upper ones.
print serigraphies on the façade	building on Emile Durkheim street	Mixing images of Dali in diverse scales
energy performance	"passive" common sense → climate, territoriality ventilation, good exposure, inertia	positioning, orientating Close to the north to avoid heat loss
thickness	building on Emile Durkheim street	
Light control and intimacy	"modern moucharabie"	serigraphy
	building on Emile Durkheim street	N-S orientation Double skin
"modern tag"	Street art/ form of expression	large-scale printing
Le regard	« décor »	« un bâtiment entière, identifiable »

Table 20 Concepts and references mobilised in the design process of the architecte, Francis Soler

6.4. Epilogue

The plot *scale* could be characterised as an initialising element in the design process of this project: it strongly acts upon the measures and geometry of the building. “The dimension of the plot is the dimension of the building” “I had a width, a length and a height that were determined/defined.” (Soler, F. in “Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014) (Soler, F. in “Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)(Soler, F. in “Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)(Soler, F. in “Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)(Soler, F. in “Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)(Soler, F. in “Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)(Soler, F. in “Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)(Soler, F. in “Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)(Soler, F. in “Francis Soler : « Chacun de mes bâtiments est une œuvre »,” 2014)

The dimensions of width and length seem thus intrinsically related to the ones of the parcel, and the height appears deriving from them in combination with the constraints on height limits imposed by the City of Paris. As far as the geometrical *scale* is concerned, active in the interruption of a massive linearity by the creation of the so-called “faults”, it is apparently a posterior choice, lying on a collaborating communication between the architect and the municipal actors. The height of the building seems therefore dependant not only on a plot *scale* and a constraint but on a functional *scale* as well. This latter concerns the space dedicated to every program (housing and tertiary) that results after the reduction of the private space by floor and the creation of a semi-public one.

The optical *scale* operated in the design process of the Park 17 building, probably acting upon the treatment of the façade. This one is apparently related to a neighbouring *scale*, since the placement of the plot next to the park on the one side and to a hotel on the other influenced the architectural decisions on views. The position of the building seems de facto conditioning it to *be seen*. This status has been presumably taken into consideration by the architect when designing the facades of the building: considering the view of people from the park. Going further, the optical *scale* became possibly intrinsically related to the visibility *scale*, thus synergistically functioning to allow to see outside without being seen. Indeed, the different dimensioning and form composing the south and north facades are due not only to a geographical *scale*, but to a neighbouring that depends on a ‘play’ between optical-visibility ones.

It seems that in this case the implication of energy constraints on the architectural design process did not mobilised specific cognitive operations. The small thickness of the plot and the obligation of an external insulation seem having been inserted in the architect's space of references, activated in a model *scale*. Thus, his previous experience and knowledge, as well as his own references regarding the concept of passive and climate in architectural design apparently played an important role in the approach and integration of the specific environmental prescriptions. His positioning towards the French norms on buildings thermal insulation as well as on the use of promoted materials for an energy performant architectural design is to be mentioned. Even if the photovoltaic panels seem to have been added as an a posteriori element after the basic phase of the project's conceptual approach, an ongoing synergy between the technical studies office was undoubted. The quantitative trials concerning the building's energy performance were also worked on a basis of exchange between them too.



Figure 121 A general view of the E5 building seen from the parc. Source Francis Soler



Figure 122 E5 building, Fault, north façade. Source M. Apostolou



Figure 123 E5 building, Fault, south façade. Source M. Apostolou

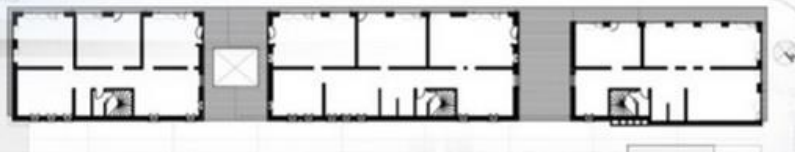


Figure 124 plan of E5 building. Source M. Apostolou



Figure 125 E5 building, image of the serigraph. Source M. Apostolou



*Figure 126 E5 building, south façade.
Source M. Apostolou*



Figure 127 E5 building, north façade opposite to Ibis Hotel. Source M. Apostolou



Figure 128 E5 building, thickness of the building. Balconies.
Source M. Apostolou



Figure 129 E5 building, thickness of the building. Balconies.
Source M. Apostolou

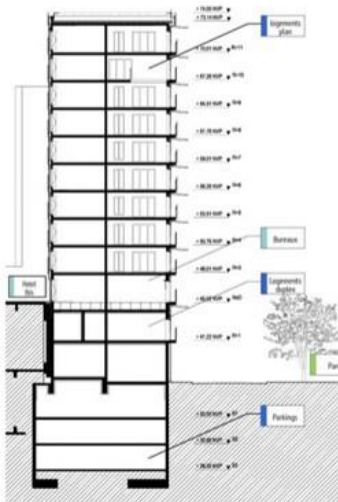


Figure 130 E5 building section.
Source Francis Soler



Figure 131 E5 building, fault, south
façade. Source M. Apostolou



Figure 132 E5 building, fault, north
façade. Source M. Apostolou



Figure 133 E5 building, detail openings south façade. Source M. Apostolou



Figure 134 E5 building, detail openings south façade. Source M. Apostolou



Figure 135 E5 building, detail openings south façade. Source M. Apostolou

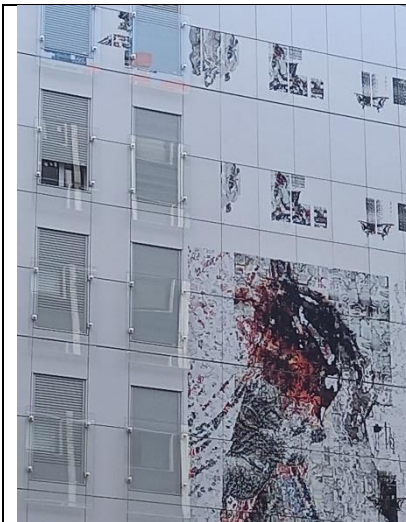


Figure 136 E5 building, detail openings north façade. Source M. Apostolou



Figure 137 E5 building, detail façade. Source M. Apostolou

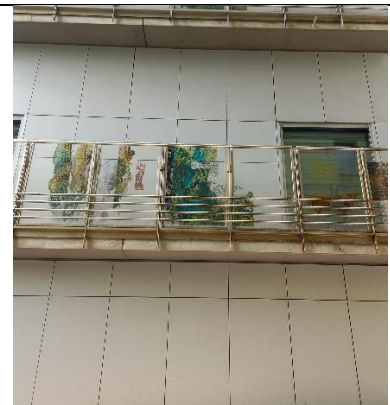


Figure 138 E5 building, aluminium panels in the south façade, detail. Source M. Apostolou

Third Part
Results and Conclusions

7. Models of architectural design – Results

7.1. Prologue

This chapter presents the provisory architecturological models of architectural design for each of the study cases analysed in the Second Part (chapters 4,5,6) More specifically, they consist empirical, hypothetical descriptions of parts of the architectural design process and its cognitive operations. Based on the cases' analysis in the Second Part, the models are drawn in the perspective to comprehend the presence and influence of energy considerations in the architectural design activity.

An overview of the study cases analysis.

7.2. An overview of the study cases analysis.

7.2.1. Building E1

Fiche technique	PRINCIPALES QUALITES ENVIRONNEMENTALES	PRINCIPALES QUALITES D'USAGE
Aménageur Paris Batignolles Aménagement Lot E.1 (2.1.1) de la ZAC Cardi-net-Chalabre	Consommation inférieure à 50 kWh/m ² /an (sans déduction de l'électricité photovoltaïque), (contre 130 kWh/m ² /an en moyenne dans le cadre de la réglementation thermique en vigueur)	A l'exception des T1 mono-orientés au sud tous les logements bénéficient d'une double orientation et n'ont pas de vis-à-vis direct ;
Opérateur Paris Habitat OPH	Raccordement à une boucle d'eau chaude utilisant très majoritairement les énergies renouvelables (objectif visé : 85%) 1000 m ² de panneaux photovoltaïques (en toiture et en façade) produisant 47 000 kWh/an ;	Les cages d'escalier sont en premier jour ;
Maître d'œuvre Architecte : Franklin Azzi / BET HQE : Tribu	Grande compacité du bâti ;	1/3 des logements est doté de balcons généreux de 1,4m de profondeur sur 20m de long
Programme 5 800 m ² comprenant : - 63 logements sociaux une crèche de 66 berceaux - 500 m ² de commerces pour accueillir deux enseignes.	Loggias en structure rapportée pour éviter les ponts thermiques ;	100% des logements sont accessibles aux personnes à mobilité réduite ;
Démarrage Mars 2011 Livraison Janvier 2013	Ventilation simple flux dans les logements / double flux mécanique dans la crèche ;	La crèche bénéficie de très bonnes conditions de confort. Elle est abritée de la rue par un grand hall traité en jardin d'hiver. Elle dispose d'un long linéaire de façades vitrées tournées vers un jardin privatif.
	Dispositif de façade très performant pour une grande performance thermique.	Le vaste hall, qui dessert la crèche et les logements, est traité en jardin intérieur. Il offre ainsi une perspective paysagère qui prolonge l'espace public

The architects stated that they wanted to incorporate an “educational” character to their project so that the public can be conscious of it as related to environmental requirements. Although this assertion most probably belonging to the sphere of a rhetorical architectural discourse, they seem to have drawn a meticulous attention in the design of the building’s envelope.

We assumed that they used the materiality of transparency as a principal concept; that could be driven by the implementation of a technical *scale* and an optical one. The building assumes becoming a symbol itself of the intentions of its architects: its architectural composition’s ambition lies not only in carrying a connotation but in consisting of a specific statement. The architects appear having designed the external facades of the building considering the traditional forms of the existing edifices in the surrounding district and trying to differentiate their building from them, via a model *scale*. The façade seems having been conceived in such a way that *it is seen*, demonstrating in a way a model of an energy efficient object.

In order to meet the environmental requirements and specifications, the architects declare having designed a ‘protective’ envelope that plays the role of an ‘insulating coat’, revealing different layers as a “scientific anatomical illustration”. The envelop, even if intrinsically acquiring the character of a ‘protection’, seems that via an architecturological optical *scale* forms an element designed in a specific way so as to be demonstrated, revelatory of an “ecological” and energy performative nature. The metaphoric referenciation of an insulating coat is related to the thermal performance of the building. It intends to emphasize on a -inherent in any way- relation towards energy exchanges, that is the reduction of heat loss. The metonymic²⁷² referenciation of a scientific anatomical illustration is intended to correlate the visibility of the components of the building’s skin: like a human body, it is reported to consist of different layers and materials.

²⁷² A metaphor uses another type of word to describe a particular word, whereas metonymy uses a related term to describe a specific word. Metaphor is used for the substitution of two words. In contrast, metonymy is used for the association of the two words.

Metonymy is the use of a linked term to stand in for an object or concept. Sometimes metonymy is chosen because it’s a well-known characteristic of the concept.

<https://askanydifference.com/difference-between-metaphor-and-metonymy/>

7.2.2. Building E2

Fiche technique	PRINCIPALES QUALITES D'USAGE	PRINCIPALES QUALITES ENVIRONNEMENTALES
Aménageur Paris Batignolles Aménagement Lot E.2 (2.1.1) de la ZAC Car-dinet- Chalabre	Les logements sont tous traversants et bénéficient d'une double exposition	Consommation inférieure à 50 kWh/m ² /an (sans intégrer dans le bilan le recours à l'énergie photovoltaïque), contre 130 kWh/m ² /an en moyenne dans le cadre de la réglementation thermique en vigueur ;
Opérateur Nexity Seeri	Les pièces de vie sont disposées sur la couronne, et les pièces secondaires sur la cour	Raccordement à une boucle d'eau chaude utilisant très majoritairement les énergies renouvelables (objectif visé : 85%)
Maître d'œuvre • Architecte: Périphériques Architectes • BET HQE: Franck Boutté consultants	Les logements sont flexibles, grâce à des parois non porteuses. Cette flexibilité peut permettre, par exemple, à des acheteurs d'un T2 de s'agrandir avec un T1 ;	une production de 120 MWh/an d'énergie photovoltaïque. Un jeu de pente, en partie supérieure du bâtiment, permet d'intégrer des cellules photovoltaïques dans le plan des toitures selon une exposition très favorable
Programme 7 400 m ² comprenant - 96 logements en accession, - 20 logements sociaux ven- dus en VEFA à Paris Habitat OPH	La plupart des appartements bénéficient de vues agréables sur le parc	Dispositif de façade très performant. Un travail approfondi est mené sur l'enveloppe, essentiel pour limiter les déperditions thermiques du bâtiment. Les peaux, extérieures et intérieures, sont traitées en façade légère, ce qui limite les ponts thermiques et permet d'intégrer une épaisseur d'isolant importante pour un encombrement minimum. Sur la cour, cette peau est habillée d'une vêtue prismatique réfléchissante réalisée en tôles d'aluminium pliées. Perforées, ces tôles fonctionnent comme des baffles absorbants pour faire de la cour commune un espace agréable à partager ;
Démarrage des travaux été 2010 2e trimestre 2012		Balcons étudiés pour garantir le confort thermique.

7.2.3. Building E2

Peripheriques Architects have designed a building in a form of a wreath that declares ‘letting the park enter’ to the interior of the plot, responding in such a way in the related ambition of the prescriptions’ book.

The design of its morphology seems having been significantly dictated by the environmental performance goals in terms of comfort, energy performance and economy in energy consumption.

Thus, the design of the sloped roof is meant to take into consideration the best possible inclination for the photovoltaic panels.

The triangular crown form, oriented in the east/south axe, appears to present an optimal compactness minimising the shadows of the neighbouring buildings. The envelop, the exterior and interior skin, seems having been treated so as to limit thermal bridges.

For the architects, a compact building is synonym to an “ecological” and “economical” one.

In this case, the *operation* of slicing, applied on the roof, could probably serve two purposes.

The first one is related to the building’s energy performance. The second one could concern its differentiation from the haussmanian roof typology, that is a model of the past. The concept of this specific design appears oriented towards a research on becoming a symbol of its times.

Furthermore, it seems that an *operation* of slicing connects the interior courtyard to the exterior urban green by abstaining from the parisian tradition of the 20th century courtyard where the vis-à-vis relations had been excluded.

The division of the form’s continuity could probably be a semantic act too: a centrality with a significant height cuts the sky. Consequently, someone gets the impression of being in an indoor space instead of an outdoor one.

7.2.4. Building E5

Fiche technique	PRINCIPALES QUALITES D'USAGE	PRINCIPALES QUALITES ENVIRONNEMENTALES	
Aménageur Paris Batignolles Aménagementlot E5 ZAC Cardinet Chalabre	Des vues sur le parc préservées ;	Consommation inférieure à 50 kWh/m2/an (sans intégrer dans le bilan le recours à l'énergie photovoltaïque), contre 130 kwh/m2/an en moyenne dans le cadre de la réglementation thermique en vigueur ;	
Opérateur Vinci Immobilier Résidentiel	Des vues directes sur les logements existants limitées	Raccordement à une boucle d'eau chaude utilisant très majoritairement les énergies renouvelables (objectif visé : 85%)	
Maître d'œuvre Francis Soler / BET HQE - INEX	80% de logements traversants ou à double orientation avec terrasses et balcons	1 510 m2 de panneaux photovoltaïques ;	
Programme 8 790 m2- 99 logements privés, - 800 m2 de bureaux dédiés à l'hôtel Ibis	Des espaces verts collectifs en cœur d'îlot.	Un dispositif de façade garantissant une grande performance thermique.	
Démarrage 2e trimestre 2012 Livraison 3e trimestre 2014			

One of this project's peculiarities is said to be found in its geometry: the building's form appears being inscribed within the strict limits of the plot (85mx12m). In other words, the form seems dependent on the restrictions drawn by the form of the parcel. Thus, an architecturological plot scale is seemingly initialising, defining the form and measures of the building (zero degree level). The *operation* of referenciation presumably plays in this case an essential role: an element from the past seems to be also re-interpreted here in a different context: the moucharabien, frequently used in the Arab traditional architecture could be the one reinterpreted in a serigraphy technique. However, the initial function of this model, related to ventilation, is detached, and interpreted differently with respect to the view from and towards the surrounding elements. In this case the architecturological scale of visibility (to see) apparently undertakes the "zero degree" characteristic, that is, total inclusion, whilst the optical one (to be seen) attains the measure of total exclusion. The design of the façade seems to carry connotations of functional and economic orders, as well as of aesthetical and socio-political ones. Energy considerations do not seem related to specific forms and measures of this building. However, a model space of references appears to participate actively in the design process.

7.3. Provisory architecturological models of architectural design

« Une modélisation se donne pour *une représentation dont l'objectif est d'ouvrir la voie à la connaissance*. Un modèle est un instrument qui permet l'interprétation d'un phénomène. Rappelons que le phénomène qu'il nous importe de modéliser est l'espace de conception. Un modèle de la conception architecturale ne vise donc pas à indiquer comment sont les objets architecturaux mais comment ils ont été pensés. (...) (...) » (Boudon et al., 2001, p. 97)

The theoretical models that follow allow a description of phenomena specific to the design work of each of the case studies presented in the previous part, under the prism of energy considerations. Instead of being a description of a reality, they tend to provide a representation system that aims at producing knowledge.

7.3.1. Model, building E1

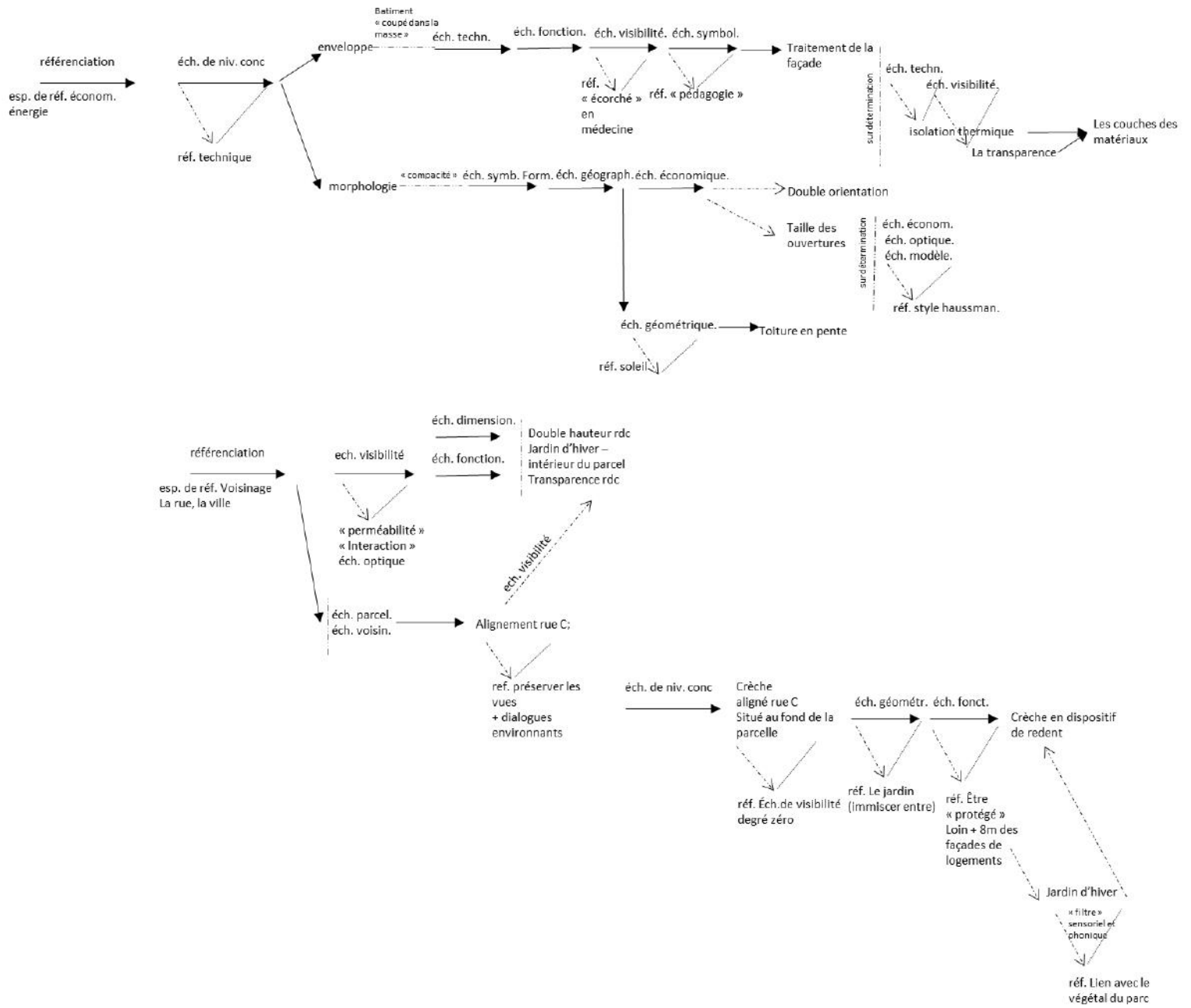


Table 21 Provisional architectural design modeling of the analyzed case E1

An economy of energy *space of reference*²⁷³ seems to be involved in the architectural design of building E1, leading to operations related to its energy performance.

A geographical *space of reference* seems to be at the origin of the morphological considerations. The positioning, dimensioning, cutting and referencing of the building stem from these morphological studies.

The form of the building seems to be conceived from a formal symbolic *scale* when the architect gives the building a linear and continuous form of a certain thickness; one could associate this to a certain research of "compactness". It involves considering the climatic data and the orientation of the cardinal points: this sends to the implication of an economic *scale* and a geometric one.

An economic *scale* of energy seems to operate as for the dimensioning of the openings and the positioning of the apartments in double orientation (exposure) aiming at an energy performance.

The dimensioning of the openings (visual *space of reference*) has been implemented proceeding from visual and model scales (degree zero) overdetermined in relation to the openings of the Haussmannian style buildings.

The geometric *scale* was involved in the design of a roof whose shape and measurements are given in such a way as to maximize the available surface for PV integration as well as to pursue an ideal tilt with respect to a given sunlight.

A technical *space of reference* seems to be the source of the dimensioning, cutting, referencing and integration operations leading to a treatment of the façade considering its energy performance. It proceeds from a functional *scale* that interprets the adaptation of the envelope as a climatic coat. (relevance: integration of technologies, reference: energy savings)

Then, by the implementation of an optical *scale* referring to "une écorché en médecine" the architect thinks about how the envelope will be seen. This action also designates a semantic²⁷⁴ *scale* because the envelope wants to become an educational reference.

Putting the insulation so that it is seen implies probably a technical *scale* relayed by an optical one. It is manifested by the choice of material (polycarbonate) and its characteristics not only

²⁷³ in combination with *spaces of reference* involving technical/geographical/visual architectural models orders.

²⁷⁴ Perform referencing operations enabled/suggested by words or verbal expressions in order to attribute to an object characteristic properties referencing it

of insulation but also of transparency. Thus the layers of materials (concrete veil, joinery, external insulation, vapour barrier, glazed frames, external skin in polycarbonate.) are given such a form and position so that they are seen, demonstrating the consideration of the environmental dimension.

A neighbouring *space of reference* is implemented proceeding from a *scale* of visibility and a plot *scale*, as to the alignment to the street Cardinet, the positioning of programmes (crèche, commercial and residences) and their relationship towards the street and the garden.

7.3.2. Model, building E2

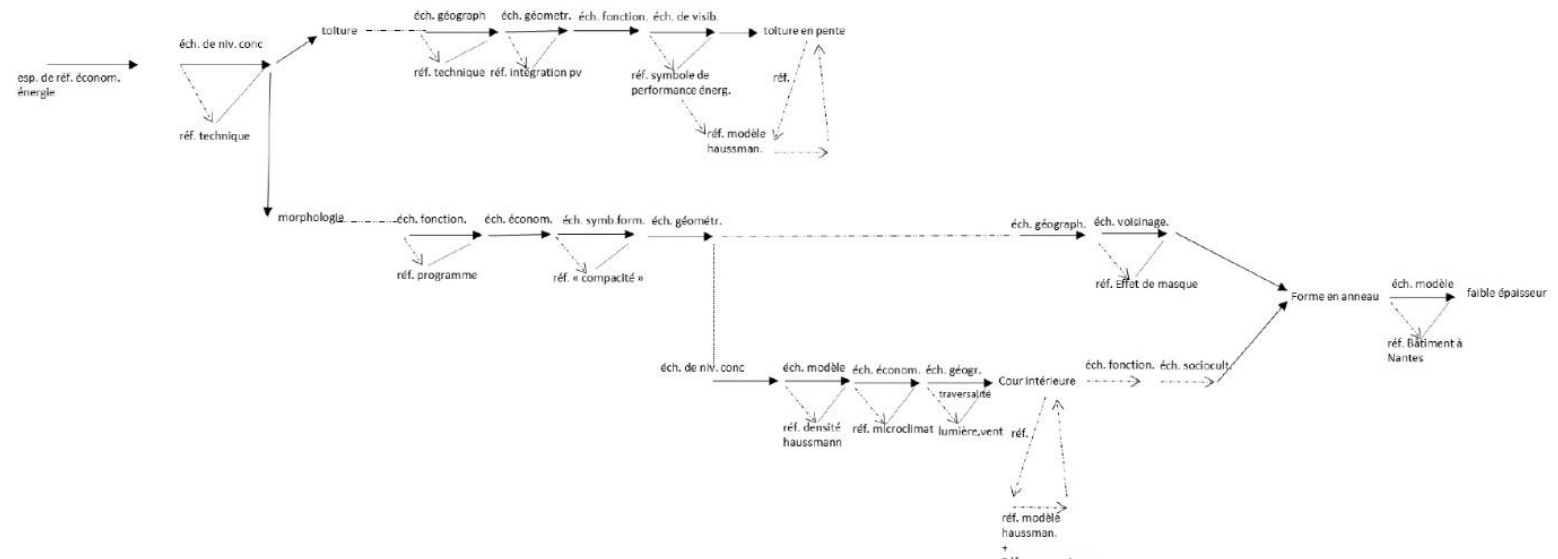


Table 22 Provisional architectural design modeling of the analyzed case E2

An economy of energy *space of reference* appears to be operative through the implementation of cognitive operations of dimensioning, cutting, orientating and referencing. These operations are probably manifested in the form and measures of the roof and envelope, in the dimensions of the courtyard and the building.

Roof

The architect will use geometric considerations to cut out parts of the architectural space that are geographically relevant and technically referenced²⁷⁵.. A geographical *scale* of technical reference proceeds probably from a geometrical *scale*

Then, seems to derive a functional *scale* of economic reference: the form of the roof is adapted in correspondence to its use as a place of electricity production. This then leads, probably, to the involvement of an optical *scale* combined with a formal symbolic *scale*: giving shape to a part of the architectural space intervening in the modalities according to which it is seen symbolizes the consideration of energy performance)

²⁷⁵ integrate the photovoltaic panels and orient them ideally

The resulting sloping roof, a zero degree of the model *scale*, has a neighbouring reference: the architect probably sought to differentiate his building from the roofs of the Haussmannian edifices in the vicinity, by demonstrating its "contemporaneity".

The morphological considerations of the building are not inseparable from the form of the roof.

First, a functional *scale* taking into account the programs that will be followed seems to organize the space by cutting it. Then, the implication of an economic *scale* derives from a reference on energy performance leading to a formal symbolic *scale* which in turn refers to the "compactness". Then, the implication of a geometric *scale* has the relevance of a ring shape.

This seems to be done through the following procedure:

A division of the design space (espace de conception) into subspaces is initiated by a scale of levels of design (échelle de niveau de conception). A model *scale* (local effect) referring to the density of the urban Haussmannian typology, acts on an economic *scale*. The economic *scale* seems to have a geographical relevance (creation of microclimate). It leads to the creation of an inner courtyard (relevance: transversality) passing through a geographical *scale* that refers to the circulation of light and wind.

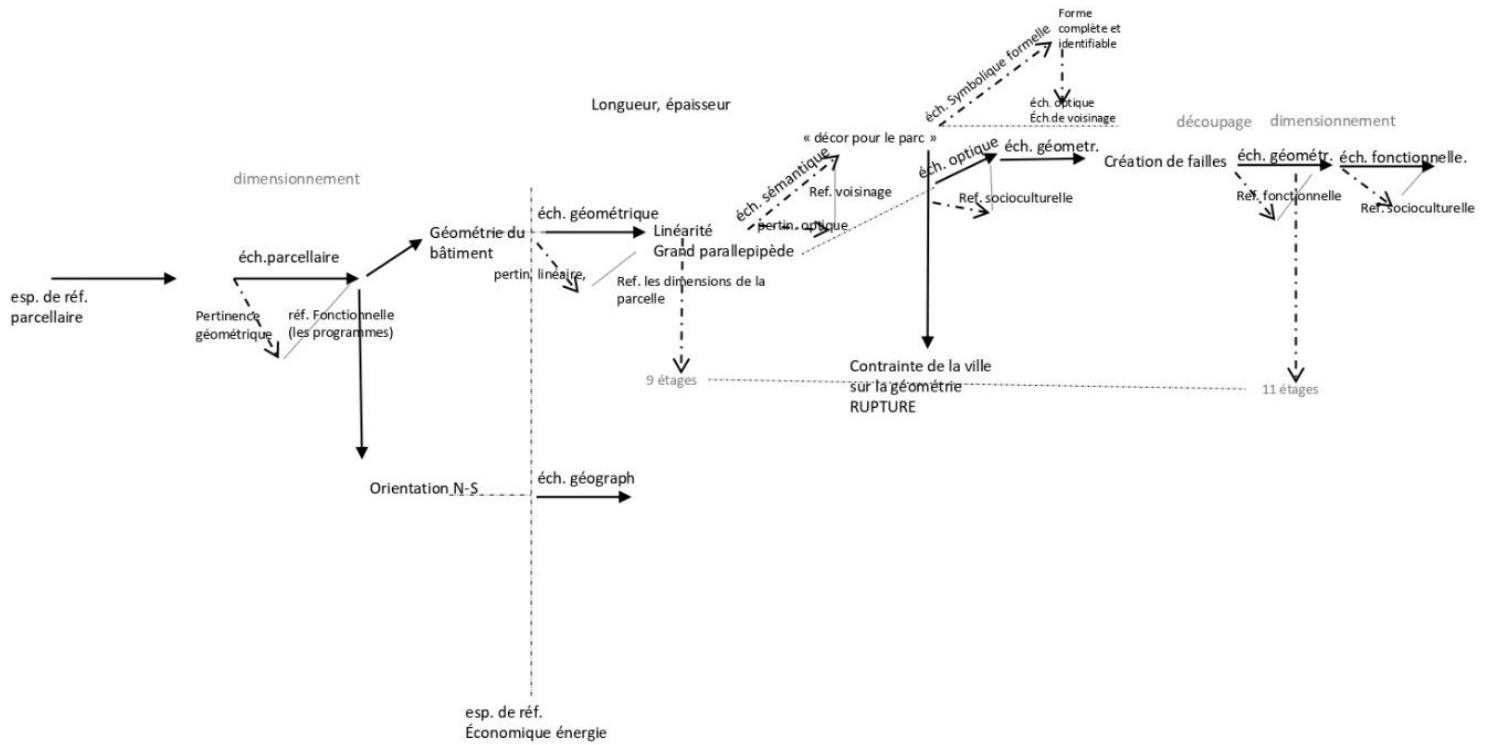
The inner courtyard refers to an Haussmannian typology and therefore to a visual and optical *scale* ("voyeurism"). It then seems to imply a dimension of function (use: kitchen) which is related to a socio-cultural *scale* and allows both the existence of openings for the ventilation of the space as well as facilitating exchanges or potential communication between the occupants.

At the same time, a geographical *scale* (consideration of the sun and shadows contributions) refers to a neighbourhood *scale* (masking effect of adjacent buildings)

In this ring form seems then to be involved a model *scale*: the building in Nantes already designed by the architect. There is also a symbolic dimensional *scale* that refers to energy considerations (related to the small thickness)

7.3.3. Model, building E5

Table 23 Provisional architectural design modeling of the analyzed case E5



A parcel *space of reference* seems to operate as an initializer to the design. A cognitive operation of dimensioning is implemented proceeding from a plot *scale* (the building has the dimensions of the parcel and the height takes the maximum capacity as an extrusion) of geometric relevance (linear, parallelepiped) and a functional reference (include the programs requests)

This operation acts on the geometry of the building as well as its orientation, introducing an economy of energy *space of reference* since the low thickness acts on the energy performance.

In a first place, a geometric *scale* operates to the length, thickness and height of the building (85x11.5x27m initially). It is relayed by a semantic *scale* ("a decor for the park") of an optical relevance (to be seen) and a neighbourhood reference.

Then, a request from the City concerning the continuity of the building imposes a rupture to the design space. A cutting *operation* is implemented. A geometric *scale* is therefore, again, operative, in order to create faults and break the continuity of the "complete" form. Then, this acts on the height of the building - in relation to a functional *scale* (adjustment to accommodate all the m² of the requested programs) - which increases from 9 to 11 floors according to a dimensioning *operation*.

This leads to a use of a functional *scale* of a socio-cultural reference acting on the new spaces created, which are thought to accommodate balconies, terraces and common spaces of the inhabitants.

7.3.4. Synthetical interpretations

An economy of energy *scale* is considered to be initializing and principal in both buildings E1 and E2. It is supposed to be co-determined with the technical and functional *scales*.

The geographical *scale* could be posed as structuring in the design of the E2, while in the design of the E1 this role could be implemented by the *neighborhood* scale along with the plot one.

Regarding the energy issues there is in both cases a deep work on the design of the envelope.

In building E1 however, the envelope design appears temporally earlier than in building E2; it has an initializing characteristic.

We could say that the visibility *scale* holds in both cases the role of a meta-scale. Hierarchically, it appears just after the main *scale* of economy, in order to demonstrate that the building is "ecological".

It is overdetermined with the *technical* scale (to make the technique visible) in the case of the building E1, relayed by a semantic *scale* ("scientific ecorché", "pedagogy") and implemented by the materiality of the transparency of the succession of the layers of materials.

On building E2, the *scale* of visibility is overdetermined with a formal symbolic *scale* having as reference the model (degree zero) of Haussmannian roofs and thus implemented rather by an accentuated and inclined morphology. More specifically, the orientation of the roof becomes the form of the building that is intended to be seen.

The design on the orientation of the roof seems to appear temporally earlier in building E2 than in building E1.

In both projects the referencing of historical typologies (here the "archetype" of the Haussmannian building) is probably related to the model *scale*. It is said to be used in the succession of full and voids and the reduction of openings to the facade of the building E1. It is probably used in the design of the inner courtyard as a thermal space of microclimate as well as a space of views in the case of E2.

The concept of "compactness" is essentially present in both discourses.

Moreover, the model *scale* that exists in both cases does not concern the re-taking of a previous model but an expression of the aim of producing new architectural or functional models. (degree zero)

As an exception, in building E2 the courtyard is related to the inner courtyards of the dense Haussmannian urban blocks.

The technical *scale* -which is presented as the base of various inventions aiming at answering the objectives of optimization of energy consumptions/production - invites here to think of new processes which, in fine, have consequences on the choices of the forms and measures of the architectural space proceeding inevitably of an economic *scale*.

8. The consideration of energy issues in the architectural design process

*L'imagination imite ; c'est l'esprit critique qui crée.*²⁷⁶

*(...) l'œuvre qui nous paraît la plus naturelle et comme un produit spontané de son époque est toujours le résultat d'un **conscient** effort. Croyez-moi: il n'y a pas de bel art sans conscience, et conscience et esprit critique ne font qu'un*²⁷⁷.

Nous sommes esclaves des lois pour pouvoir être libres.

Cicéron

²⁷⁶*Nouveaux Prétexes: Réflexions sur quelques points de littérature et de morale*, De André Gide, Publié par Editions du Mercure de France.

²⁷⁷ Another version can be found in *The Critic as Artist. With some remarks upon the importance of doing nothing* by Oscar Wild. Accessed in http://rebels-library.org/files/the_critic_as_artist.pdf, page 12

8.1. Prologue

This chapter explores the ways in which architects consider energy issues in their design activity.

More specifically, it produces knowledge by relying on the systematic analytical work generated on the Second Part. In other words, it responds to the questions initially set and present the results of this research study in relation to the methodological analysis previously conducted.

8.2. Results and interpretations

This subchapter presents a series of resulting elements that derive from the analysis of the case studies. Firstly, it deals with the potential ways of implication of energy considerations in the architectural design process, building knowledge on the research questions set on the first part. Secondly, it manifests some further outcomes of the study, concerning the emphasis often involved in the representation of a building's visually perceived energy performance. Thirdly, it introduces the existence of a political dimension often implicated in the implementation of energy considerations in architectural design, in relation to the research pursued. Fourthly, it refers to the energy constraints' frame. Finally, the chapter draws a conclusion, interpreting the results.

8.2.1. Ways of implications of energy considerations in the architectural design process

A *space of reference* linked to energy has been studied in relation to the spaces of references of each architect.



Figure 139 Merging spaces of references

As for the realization of an architectural project, energy issues very often appear to be treated as a "result", expressed in "check boxes". In terms of architectural design, however, as we saw in the second part, energy goals do not seem to be able to be reduced to a list to be achieved. In terms of marketing the building, of its performance validation by labels in line with political choices, the architectural design is often restricted, stripped of its complexity.

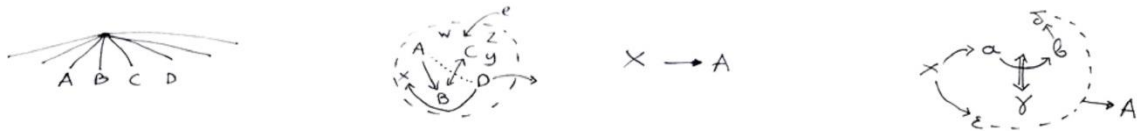


Figure 140 Energy goals expressed in bullet-points or check lists entering to the complexity of architectural design process

As the analysis has shown, the energy performance objectives cannot be taken into account exclusively as such, because, sometimes, other orders, apart from energy, lead to a choice which then has an impact on the energy level. For instance, the E5 plot dimensions directed a particularly small building thickness, impacting thus the thermal inertia and the transversality of the building, and consequently, the edifice's energy efficiency.

Attributing forms or measures by adopting certain elements that are prescribed, or even imposed to be incorporated in an undisputed way in the design, such as the use of wood or bio-based materials as building materials, does not participate actively in the cognitive process of the architect. Yet, as shown before, even if they are necessarily respected in this framework, these elements seem as not always being external to the cognitive operations of conception, but seem to be adopted. And this happens by integrating, adjusting to the *space of reference* specific to the architect. For the architects of E2, the obligation of energy production acted as a base for a conceptual experimentation. The photovoltaic roof became the image of a building with a deliberately unstructured shape.

An energy constraint could mobilize ways to design a proposal other than the one initially planned.

As we saw in the case of E5 building, the obligation to use exterior insulation for thermal reasons was said to be a driving force for the architect in order to think of a way of experimenting. It seems that, despite this declaration rather entering the sphere of rhetoric, this constraint has activated a way of doing things differently - not on what is imposed but on what this imposition causes: to design thus a kind of garment for external insulation. This was intended to function more than a material, and rather as a demonstration still being inscribed in the architect's own references (and a model *space of reference*).

In the three cases, depending on the opportunities or not of the context which limits it, the architects seem to have referred to their own concepts, that is, to have thought of a project which then would have been adjusted to the possible techniques.

We saw how energy is used as a constraint which restricts the universe of possibilities in the work of architectural design but can also be assimilated / associated / understood in a more

indirect way to the operations of dimensioning, orientation, cutting of architectural space and employed by referring to previous works of the architect or by inventing in-situ.

A referencing operation or the implication of a model *scale* which act on the thermic orders can be implemented independently of an energy order.

We have seen in case E5 that the architect's own experience in thermal engineering along with the accumulation of knowledge led him to not consider the question encompassing energies as a primary. However, it was assimilated at the same time or later, when the other parameters have already activated operations. Therefore, he designed in the context that exists, with the constraints that are at stake, by stimulating his own references but not only stopping at a threshold of criteria.

A choice made for other reasons, by fitting into another *space of reference* than energy may impact it latterly and play a role in performance without being initially intended as such. The result of applying a dimension or form may be unrelated to the original idea of its use. The architects of E2 designed the interior garden to be open, after considerations about the fire incident. This design was then re-evaluated at an energy level for the building through the creation of a microclimate.

We saw how an architect can have a "central idea" (inscribed in a *space of references*) at the beginning and then decline to transform its more specific characteristics while respecting the rules of the energy order. As for the E2 case, the idea of an interior courtyard was set as a reference from the start of the design process, yet its measurements and shape were reworked during the diachrony of the design.

On the contrary there is the possibility of a lack of a "central idea" guiding the design. The exterior insulation being mandatory opened the opportunity for the architect (E5) to choose how to cover it and use it as a canvas to then build his facade device. The architect of E1 seems to have designed in-situ using the given context.

The order and priority with which each architect considers an energy issue results in dividing up his design space in a different way.

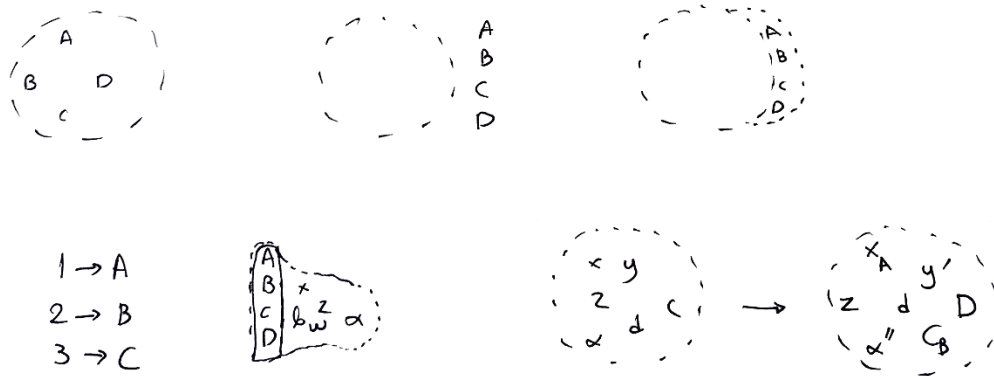


Figure 141 Integrating energy

The architects of the E2 building seem to have integrated the energy requirements from the start of the design phase. The architect of the E5 does not seem to consider them in a way specific to his design but rather encompasses them during the diachrony (and with the assistance of the technical teams) or towards the end of the project design. Energy-related design operations are often difficult to be understood independently of other parameters (technique, programs, neighborhood, etc.) because each change leads to the consideration of the future of others.

Some architects seem to have started their design process by focusing on energy standards and the parameters they encompass, working out how to meet them. They therefore use these constraints as data initializing the design. (E2) The "atypical" morphology of the E2 building seems intended to be the result of an alchemy of ideas allowing to "transmute a problem into an effective and efficient project" (see <https://www.batiactu.com/edito/couronne-logements-posee-a-clichy-batignolles-34452.php>)

Others seem to start by integrating them in parallel with the other types of constraints in their spaces of reference. (E1)

Some seem to start with their own preconceptions, as they would do with another project as well, that does not have this specific energy framework, and later adapt the energy constraints. (E3)

The architectural design oriented towards energy considerations does not appear to be limited only to a normative vocabulary or to a threshold of calculations to be respected. The studies of the Second Part allowed to consider how the energy considerations are used, transformed, adjusted in their own complexity as well as that of the architectural design, without the resolution of a problem being one-dimensional. There seems to be no single reason for giving

shape or size to architectural space; there are reasons, of various natures, treated at the same time, as the overdetermination of architecturological scales has shown.

Thus, « the compactness (...) induced by the «crown» becomes the emblem »²⁷⁸ of E2's design. Limiting energy losses, promoting natural lighting and ventilation in transversal apartments is implemented by the specific architectural design.

The role of the architect involves crossing the constraints. The architect seems to understand the purely quantitative part as such, by being thus in synergy with the technical design offices. However, he but carries out cognitive operations without having as only goal the respect of the imposed standards: the consideration of thermic is involved in the design as a referencing operation. This happens by including a socio-cultural and geographical relevance deriving from the context and not from calculations, in the sense of "logic", of the good use of ventilation, of the good exposure which are part of a good inertia. Without being prescribed as a standard, the flexibility and mutability of design operations, as the codetermination of architecturological scales have demonstrated, can lead to a consideration of multiple parameters, and not only on the specific constraints. This could be translated in adjusting them globally and then coming back if necessary, without energy constraints taking precedence over others.

Each architect seems to consider energy issues in relation to his system of space of references, implying socio-cultural models and concepts. These concepts can be related to architectural objects already realized, or to his professional experience and his theoretical affiliations. The way in which he interprets the energy / climate / environmental dimensions and its formal or dimensional expressions does not treat energy solely as a constraint. Energy seems to be rather approached as a more general concept. It is the relationships of architecturological scales that highlight this complexity and simultaneous interdependence, reflected by the concept of overdetermination.

On the other hand, the application of the quantitative elements of energy performance to the architectural design implies the levels of interaction with the other actors of the design (the technical design office, the environmental advisor, or even the actors of the State) as well as the use of digital tools and energy modelling (software for calculations, environmental assessment, simulation of thermal systems, energy simulation, etc.).

²⁷⁸ <https://www.batiactu.com/edito/couronne-logements-posee-a-clichy-batignolles-34452.php>

8.2.2. Aiming at a visual perception of the energy performance

As observed in two of the cases studied in the second part (E1 and E2), the architects claimed having intended to designate the energy performance of their building as visually perceived. This implicated probably the application of an optical *scale* in their design process, its relevance being differentiated in each case. In the E1 building, a semi-transparency through the selection of materials called for a metaphor of ‘pedagogical’ purpose accompanying the design of the facade. In the E2 building, the energy performance would be visually perceived in the form of the building, with a slicing and orientating operations on its roof so as to accommodate the photovoltaic panels. The energy production, affiliated to sustainable energy performances in buildings, is deliberately turned visible, whilst remaining quite inactive in the architectural design process of the E5 building.

The photovoltaic roof of the E2 is not designed neither as an added element nor to be hidden. Its presence and positioning are enhanced by the form of the building and the orientation of its parts. It is the architectural design that turns the panels visible from the level of the street as well as from the surrounding buildings via the declivity of the surface.

8.2.2.1. The facade in relation to a sociocultural context of modernity

In the third case study, the intention of the architect of the E5 building seems to be away from a demonstration of the energy considerations through the implementation of an optical *scale*. What we identified however, is that the optical *scale* probably acted primary in relation to the identity of the neighbouring aspects, deriving from a sociocultural context; that of metamodernity (‘tag’). Thus, the edifice, as a “decor”, dialogues with the surrounding programmes (parc and hotel), the geography (n-s, e-o orientations) as well as with the sociocultural characteristics describing its times. In this case the “contemporaneity” has not a direct relation to a demonstration of awareness and action on energy issues in design, but this latter is consequently implied indirectly at a second level, as an additional layer. The use of external insulation seems acting as a trigger that leads to an application of a model *scale* (previous buildings of the architect) so as to deal with the constraints (aesthetic and material quality) imposed by this obligation of insulation.

The energy's visual "identity" could in this edifice derive from a metaphor *in absentia*²⁷⁹ as it relies on the comprehension and distinguishment of the building in relation to its neighbouring context, in a further temporal reference. We could suppose that the consideration of the energy issues in this design process is already present, inherently, in a similar way as in the previous projects of F. Soler. Still, this consideration does not initialise here the design process, as it is already inscribed in a *space of references* relayed by the model *scale*: the vocabulary of "passiveness" as a general approach on housing.

8.2.3. Implementing energy considerations as a political tool

Undoubtedly, the architectural projects of Clichy-Batignolles district were inextricably linked to political ambitions aiming at an application of sustainability and energy factors in the architectural design, as set and promoted by the public authorities. The implication of such a political dimension could not but influence not only architects' rhetoric discourse, but their positioning and focus driven on alike considerations in their design process as well. Nevertheless, the hierarchy of the decision-making concerning building's energy performance was, as revealed by the cases examined, diverse.

8.2.3.1. Consideration of energy issues in compliance within a given politicoeconomical context of 'modernity'

8.2.3.1.1. Optical and technical scales

As far as energy efficiency and its quantitative characteristics are concerned, Paris municipality's policy was reflected in most of the specifications to be followed in the architectural design of the study cases. Nevertheless, as having previously observed, reducing an architectural design process to a series of 'lists' to be checked, is a consideration that could *in fine* limit/confine the spectrum of potential architectural design methods and approaches. Whereas a consent in terms of energy efficiency results could seem anchored in rather technical or economic scopes, it may also rely on a strong political ambition that the urban authorities

²⁷⁹ For info on the term look:

<https://www.unige.ch/lettres/framo/enseignements/methodes/frhetorique/fr021000.html>

promote towards ‘sustainability’. For instance, reproducing practices that imply and reflect an eco-friendly design as adopted in the public opinion, would be promoted. Under these circumstances, a superposition of the optical and technical *scales* would be leaning towards an iconological approach of energy in architecture.

For example, as seen in the third case, an automatic incineration that could allow to compensate for water and draining or a system of photovoltaic cells that could allow the valorisation of renewable energy were encouraged to be let visible, even if they did not serve a technical purpose (as not plugged in, at a second time), or even if not needed. (considering the calculations)

What we could thus observe, is an intention to demonstrate the elements of a technical order - related to energy production- as a means of illustration of energy having been taken into consideration.

In addition, we could assume that some of the technical systems used for energy production or management (cooling, ventilation, space heating) (in our cases principally the solar panels) were treated as ‘images’ of reference, implying energy connotations. In other words, their installation was at a first time related not to their functional properties but to a metaphoric significance they bear towards an energy *space of reference*. For example, the positioning of the solar panels destined for electricity production on the second case study (E2), seems to be destined mostly to manifest the link with a potential ‘energy awareness’, rather than to its use as an object that produces energy. The point developed here can be demonstrated by the fact that the panels had ordered an essential direction of the architectural design -by their orientation- and not by their production rates, which were too poor compared to those initially planned.

Although the function of a technical object is not always visible to the public -remaining in a way merely unfamiliar- it is the visibility of its presence that creates publicly a link to the energy issues. However, in the first case study the demonstration of elements of technical order such as materials (layers of insulation) usually not intended to be visible, were said to have deliberately been decided to become apparent, for a similar reason of demonstration of the meaning they entail.

In other words, in the same way as vegetation could visually refer to ecological considerations, technical appliances related to the energy identity of the building seem to be promoted by the public authorities and at a second point adopted in different ways by some architects.

Energy in this case seems to be taken into consideration as an element exterior to an architect's proper design process, not generated/emerged directly from his own '*space of references*' as it belongs *a priori* to a pre-constructed system of prescriptions. It thus seems to reside in the more general socio-political context, acting as a constraint, a target that needs to be met.

Even though the responses to these constraints may appear numerous, they sometimes do not provide the possibility of multidimensional perspectives to be envisaged by the architect: if the use of external insulation or the installation of photovoltaic panels is prescribed, their integration could follow diverse ways; their presence however is unequivocal; they can be either seen or not seen; their positioning can either be accentuated or not at all. A geographical *scale* is interacting with an optical one, enabling an implication of the architect, even if too reduced.

The interest do not residing anymore in their primary reference to the use and function of energy production, circulation and thermal relevance, the risk is that the technical energy appliances would become a rather decorating element that do not serve neither a fully functional purpose, nor an architectural one.

8.2.3.1.2. The imperative to include renewable energy

As far as the use of the so-called alternative energy sources in architectural design is concerned, it seems to be a rather mandatory prescribed dimension. Residing in the general ecological factors imposed to be applied in the architectural design²⁸⁰, this criterion seems to be an exogenous guideline entering the sphere of the architectural design process. Their inclusion in the project does not thus rely on a choice of the architect. However, the degree of its implication in the form or the facades of the building remain a decision to be taken. Consequently, even if the presence of such an appliance plays the role of a constraint in the architectural design, the way of its implication could be multiple - although limited because of the technical standards required. In each of the case studies analysed, the integration of a series of photovoltaic panels followed a different chronological order. In the third study case explored, it appears that the installation of the PV was treated as an 'annexation' in the design process. It appears as an additional aspect, added *a posteriori* in the design process, rather than activated, after the

²⁸⁰ (dealing with various aspects, from biodiversity to a life cycle analysis)

architect has given form and measures in the building, and thus reducing its relevance. This integration appears to have emerged during the end of the design process timeline.

8.2.3.1.3. Technical appliances

The technology emerged at the three temporalities -the one of the prescription's definition, the design process and the construction/finalisation- of the project do not match. Hence, as the time of the construction is different from the time when the specifications are determined, the technology of some of the appliances gets outdated²⁸¹. This appears to have led to the implementation of the PVs more as an accessory element rather than an active technical energy-related component. It could be supposed that it stands there rather as an evidence, as a proof of the architect being up-to-date to an environmental conscious political and societal imperative. The architect of the third case study often referred to the PVs as an absurdity promoted by the municipality, fabricated by politics and the media. The building's energy consumption in the third case study was essentially independent to the energy production of the panels. The panels seem having been treated as complementary objects, lacking a direct relation with the core of the design process -in contrast with the second case study where their orientation, positioning and referenciation seem participating actively from the initial phases of the design process. When the demonstration of the PV is becoming a priority over its function, thus an optical *scale* being structuring²⁸², we suppose that the function is turned into an image.

« Mais ce n'est pas seulement de tourner un bouton de radiateur. C'est réguler l'espace qui consiste à vivre de manière climatique adaptée à chacun. On n'a pas les mêmes températures, ma voisine, toi, mon cousin, on ne ressent pas les mêmes choses dans la même pièce. L'idée à c'était de proposer des systèmes climatiques qui permettaient à chacun d'évaluer sa façon de recevoir un climat et ensuite de l'adapter. Ca c'était l'origine. » Francis Soler, entretien

Each architect seems considering energy-related issues in regard to his own system of *space of references*, inscribed however in a larger one, this latter required by the regulations along with

²⁸¹ For this subject see the text of (Halloy et al., 2020)

²⁸² *Structurante* : une telle échelle ordonne le système des pertinences à l'œuvre dans un cas donné de conception. Elle peut être le produit d'une multiplicité d'échelles.

the political ambitions²⁸³ envisaged by the developers. The models and concepts arising seem multidimensional. They may refer, among others, to previously accomplished architectural objects of every architect, to other architects' projects, to intuitions gained by his own professional experience, to his theoretical architectural education, to his political and socio-ecological affiliations, to the ways he acknowledges and interprets sustainability in architecture, the ways of using digital tools during the design process, the levels of co-existence and interaction with the other actors and team members during the design process.

In a second lecture, the Second Part allowed an insight in the role of the architect in the times of sustainability imperatives. It seems that an architect although having limited influence on the quantitative character of an energy performant building, he may take a critical distance upon the political and technical debate surrounding energy considerations in architectural design. His design choices influence thus the overall qualitative character of the project that can at a second level be interpreted in a numerical result.

²⁸³ Since the three case studies were inscribed in the Clichy-Batignolles project whose Maîtrise d'ouvrage was Paris Habitat OPH and Aménageurs : Paris Batignolles Aménagement, related thus to public authorities

8.2.4. Constraints

« *Building being an only and settled production, it is subjected to specific site constraints. Knowable ex ante, those constraints explain why design remains the hard core of architect's professional expertise, in spite of the increasing success of negotiate activities.* » (Raynaud, 2001)

« Les bâtiments épais marchent mieux d'un côté. La logique est que plus tu descends plus les bâtiments sont fins, pour permettre moins d'inertie thermique. Ce qui conte est le plancher. Che la lumière, le climat rentre dans ton plancher, la dalle devient ce qu'on appelle ton radiateur horizontal qui se charge en calories, et suivant que tu es à Marseille ou à Paris, la nuit est plus court l'été, le chaud re-sort par le plancheur. Donc la première idée que moi j'ai eu à rue Durkheim, c'est pour ça que j'utilise (...) un bâtiment de 14m d'épaisseur au lieu de 12 mètres. Pourquoi ? Parce que l'inertie du bâtiment permet de conserver les calories qu'elle n'a pas le temps de rendre pendant la nuit qui est trop courte l'été. (...) Donc elle garde l'inertie, elle garde de la chaleur. Cela est très important. L'épaisseur d'un bâtiment est très importante. J'ai expérimenté un de premiers bâtiments à rue Durkheim qui jouait cet effet de masse inerte. A la rue Cardinet je n'ai pas eu le choix. On m'a demandé de revenir à 12m d'épaisseur parce que la parcelle faisait 12m. » Francis Soler, entretien

In the analysed examples of the current study, energy constraints concerned quantified objectives,²⁸⁴ norms to be respected²⁸⁵ and actions to be implemented²⁸⁶. In the environmental prescriptions book²⁸⁷, the comfort, energy needs, energy supply and energy consumption had to be taken into account, along with other considerations as well (materials' environmental characteristics, envelop thermal performance, exterior spaces' quality, building's form and orientation). Thus, recommendations related to thermal and visual comfort of occupants; to characteristics of ventilation, lighting and heating equipment; to the source of heating energy and production of renewable energy along with recommendations concerning the control or monitor equipment of energy consumption, were present in the design activity.

²⁸⁴ For example 'puissance maximale des ventilateurs=0,6W/m³/h'

²⁸⁵ For example 'la cible 7 du référentiel 'Bâtiments tertiaires-Démarche HQE 2006' devra être dans un souci de performance'

²⁸⁶ For example 'systématiser l'utilisation de thermostat d'ambiance avec horloge a programmation'

²⁸⁷ source : (Tardieu, 2015, p. 318)

In our case, we identified how a design constraint, deriving from a consideration on energy performance, can create a new space of references for the architect's design activity to be placed to.

Designing with the constraints without ending at a threshold of criteria. Rewarding otherwise; repairing instead of creating

The required energy objectives appear to act as another additional group of constraints in the design process setting a restrictive framework. They could be parallelised to a 'material' that must be used and put the emphasis on, without although oversubscribing the qualities of the overall architectural design. In this context, it seems that architects integrated them at a temporality depending on their proper way of perceiving the constraints. Their experience and common way of proceeding during architectural design in general, seems playing a role too. That is, energy constraints appear being treated not only in a different way, according to every architect, but also at a different moment in the timeline of the design process. Even if the restrictive framework limits the creativity and design proposals of the architect, the approach, tools and methods each one use may lead to a diversity in terms of constraints' appropriation, interpretation, settlement and respect.

8.3. Conclusions

The subchapter presents an insight – that the use of architecturology has allowed to identify on the manners with which architects express the application of energy-related elements to their design process.

The main qualitative results that can be derived from the point of view that the analysis has set are outlined as followed.

8.3.1. Research conclusions

- A global *space of reference* (linked to the energy transition) leads to a cutting of the design.

During the diachrony of the design, the energy re-cuts the process.

Architects must consider issues related to the energy transition as defined in their specifications. This impacts their design process.

- The insertion of a new *space of reference* (change due to programmatic or technical constraints) supposes a re-design of the place of energy in the project.

Other constraints lead the architect to modify the way he has integrated / thought energy

- The variety of architectural responses to the architectural competition testify the diversity with which architects organize measurement operations in their design process, so the quantitative constraints related to energy have not resulted in an automatic solution.

It is not only the architectural projects that are diverse, but it is the design processes adopted that have been different. The architects analysed the constraints differently, respecting the specifications and the checklists but with the freedoms that they allow themselves to introduce.

- A study of the design of energy efficient objects seems to move away from the reduction to a solution or an answer to a quantitative question. On the contrary, it encourages taking into account a complexity that is difficult to dissect as a whole.

- The energy question seems to lie in the plurality of responses and not in one model. Architecturology as a method allowed to highlight the absence of a unambiguous answer.

In the cases studied we have seen how form can follow function, energy or fiction at the same time, each one not dissociated from one another. This leads us to argue that an approach that does not derive from the traditional dichotomy between art and science, constraint and freedom, technique and poetry could be better applicable to the study of the design of energy efficient architecture today. A purely technical space of reference entering the design sphere does not seem to reduce the complexity of the relationships between the cognitive operations of architectural design. The considerations related to the thermic of a building appear to be treated in synergy with the other parameters considered, or, where appropriate, in relation to them. These considerations do not always lead to a single operation, and vice versa . In other words, a design operation is not always applied only to meet an energy criterion.

Regarding the comparison between the case studies analysed, we showed how the architects seem to consider elements referring to the same questions or constraints, but with a different hierarchy in the diachrony of their design process. In addition, such requests appear to be handled with diverse choice and expression.

Consequently, the architecturological scales, geographical, plot, economic, functional, model, technical and neighbourhood *scales* (as on Lecourtois studies on sustainable urban design - see chapter 2) appear to be present and interlinked, but not as an automatic combination produced by a computer or a program. This leads us to deduce that even if the initial question on energy consumption and energy behaviour is set in quantitative orders, the complexity of architectural design remains, despite of the use of machinery and technical appliances. Surely, we must not neglect the fact that while the cases of buildings examined were positioned in an urban fabric, the design procedure followed was specific to the perimeters the eco-district have set. Thus, the level of freedom or the restrictions set on certain parameters (ex. existing elements, adjacent buildings etc) were manipulated in ways specific to Clichy Batignolles project.

8.3.2. Epistemological conclusions

In the current study the theory (architecturology) was used as a medium. The study in its essence questioned the instrumentalization of the theory. The contemporary architectural discourse often tends to justify the integration of the energy dimension in architectural design and the vocabulary used by architects is not their proper. It is rather deeply influenced by the political, economic and environmental frameworks of the society in the given time. The study seeks to understand to what extent this language is linked to the cognitive operations of architectural design of the object produced and not to the object itself. By creating this point of view, a critical distance was acquired, mobilizing the theory in order to identify the articulations and effects generated. That is, the analysis of an architectural production tends hereby to be put in relation with the theory evoked.

In general terms, in architecture, the practice is often apt to be justified by the theory, whereas on the same time the theory is constructed from the practice/activity.

Instead of placing the theory at the service of the practice, the study aimed to demonstrate an interaction between theory and practice. That is achieved by the catalytic role given to

architecturology, and the architecturological scales as analysers, in order to objectify the forementioned relationship.

9. Meta-Conclusion

Lorsque nous parlons du problème de l'énergie (...)

*c'est en fait tout le fonctionnement politique et social qui est impliqué,
et tout le mode de vie contemporain.*

*La crise de l'énergie n'a de sens comme crise, et n'est crise, que par rapport au modèle
présent de société.*

*(...) la crise de l'énergie est,
en un sens, crise de cette société*

Cornelius Castoriadis²⁸⁸

²⁸⁸ Castoriadis, C. et D. Cohn-Bendit et le public de Louvain-la-Neuve, 1981, *De l'écologie à l'autonomie*, Paris, Seuil, 126 p. [réédition : Castoriadis, C., D. Cohn-Bendit, 2014, *De l'écologie à l'autonomie*, Le Bord de l'eau, 106 p.] p. 34

9.1. Prologue

This chapter takes a relevant distance from the study and questions it on a broader level. On the same time, it re-examines the initial positions set, drawing a circular link with the First Part.

To widen the research directions, it poses general thoughts about the topic examined. By constructing links with elements derived from the study cases it triggers discussions on a larger theoretical architectural background.

It attempts to demonstrate how architectural design is a response to the specific socio-political context of its times. Can we assume an analogy with the concepts developed in architecture historically and those of today, assuming a semantic continuum in architecture?

9.2. Drawing further correlations

Some elements of the discourses and synthetical approaches analysed in the studies of the Second Part (Chapter 4,5,6) as well as the results (chapter 7 and 8), will be further explored. Based on an observation of the analysis outcome, we draw relations broadening the set field of vision.

More precisely, we acquire distance with respect to the previous outcomes and the structure of their methodological language. We thus attempt to consider from an additional perspective some elements having taken part in the design process and evaluated as meaningful for a further interpretation. To do so, we create links with the case studies and other concepts, introducing for instance the concept of vicariance. This would therefore extend the interpretations of the architectural design influences taking place in the times of energy transition.

9.2.1. The Substitution of an *Operation* aiming at the same purpose

9.2.1.1. The Vicariance

Peripheriques Architectes, in the E2 study case, have moved from a conception of a covered atrium to an uncovered courtyard (chapter 5).

Under this prism, we tend to consider the act of *substitution* in light of the concept of *vicariance*, as presented in the work *La Vicariance, le cerveau créateur de monde* (Berthoz, 2013) of the neurophysiologist Alain Berthoz. The concept of vicariance, highlighted recently by Berthoz, is applied to the domain of neurosciences and psychology.

A vicar is, in the catholic religion, the person that acts as a priest of a parish in place of the rector; vicariance embodies this idea of something that acts in place of something else, that is of something that can substitute, take the place or perform the function of something else.

In *Figures “vicariantes” de signes de la conception architecturale* (Boudon, 2019), Philippe Boudon describes how architects mobilise signs that can be understood as symbolic, or other times as iconic. He extends therefore the domain of application of vicariance to semiotics, dealing with the question of *vicariance de signes* and arguing an “iconic-symbolic hybridity of architectural representations”.

*Note that I assimilate here the fact of taking the place of and fulfilling the function of. This should not be a problem, as it is possible to indicate fulfilling the function by using the metaphor to take the place of or, more simply, to replace.*²⁸⁹

According to Poincaré space is not an abstract notion but it depends on the ‘feeling space’ of the moving body. (Berthoz, 2017, p. 84)

In his essay entitled ‘La Grenouille et l’espace’ Poincaré (Poincaré, 1906) says that

Quand une grenouille est décapitée, et qu’une goutte d’acide est déposée en un point de la peau, elle cherche à essuyer l’acide avec la patte la plus rapprochée, et si cette patte est amputée, elle l’enlève avec la patte du côté opposé.

*Voilà bien cette double parade dont je parlais tout à l’heure, permettant de combattre un mal par un second remède, si le premier fait défaut. Et c’est cette multiplicité des parades, et la coordination qui en résulte, qui est l’espace.*²⁹⁰ (Poincaré, 1906, p. 8)

For Poincaré ‘space means action space, and the vicarious duplication creates the space’ (Berthoz, 2017, p. 85)

We suppose that the modification on the architectural composition of the building E2 (Chapter 5) could be referred to as a *vicariance*, or a parallelism to the frog in the Space of Poincaré. While energy performance was initially approached through the conception of a closed courtyard, it was finally achieved through another element -though intrinsically related to its precedent. This constitutes a substitution. This substitution induces a new *space of reference*. Albeit the new context created, this substitution has led to a similar result as far as the energy question is concerned (creation of an interior thermal microclimate).

²⁸⁹ On notera que j’assimile ici le fait de *prendre la place* de et celui de *remplir la fonction de*. Cela ne devrait pas poser de problème, tant il est possible d’indiquer *remplir* la fonction de par la métaphore prendre la place de ou encore, plus simplement, *remplacer*.

²⁹⁰ “With each of the blows that may strike us, nature has associated one or several parries which enable us to protect ourselves against them. The same parry may answer to several blows. It is thus, for instance, that the same movement of the right arm would have enabled us to defend ourselves at the moment *a* against the object A, and at the moment *b* against the object B. Similarly, the same blow may be parried in several ways, and we have said, for instance, that we could reach the object A equally well either by a certain movement of the right arm, or by a certain movement of the left.

All these parries have nothing in common with one another, except that they enable us to avoid the same blow, and it is that, and nothing but that, we mean when we say that they are movements ending in the same point in space. Similarly, these objects, of which we say that they occupy the same point in space, have nothing in common, except that the same parry can enable us to defend ourselves against them.

It is this complex system of associations, it is this distribution board, so to speak, that is our whole geometry, or, if you will, all that is distinctive in our geometry. What we call our intuition of a straight line or of distance is the consciousness we have of these associations and of their imperious character.

(...) (...)As soon as the cells were no longer merely in juxtaposition, as soon as they were called upon to give mutual assistance to each other, some such mechanism as we have been describing must necessarily have been organised in order that the assistance should meet the danger without miscarrying.

When a frog’s head has been cut off, and a drop of acid is placed at some point on its skin, it tries to rub off the acid with the nearest foot; and if that foot is cut off, it removes it with the other foot. Here we have, clearly, that double parry I spoke of just now, making it possible to oppose an evil by a second remedy if the first fails. It is this multiplicity of parries, and the resulting co-ordination, that is space.”

The initial fundamental concern of the architects to include the environmental and energy prescriptions in their concept could have been achieved with both approaches.

Artistic approach and technical objects implicated in architectural design

Francis Soler correlates art and architecture (Chapter 6) by stating that he *worked as a technician rather than an artist*. : he does not consider the architect as an artist, nevertheless he admits an artistic talent in what an architect does. The time of the “artist” architect and “capricious” works is over (...) *The time of the architect « artist » and « capricious » works is over (...)*²⁹¹

Francis Soler’s architectural practice often drew references to Renaissance or contemporary art.

In the third case study analysed (Chapter 6), Soler has demonstrated how the positioning of the serigraphs on the south façade was primary linked to visual interactions with the level of the street, as well as with the adjacent programmes. However, he affirmed having placed the serigraph parts at the top level of the edifice for ‘aesthetical’ reasons as well. Even if he had declared being opposed to ‘style’ in architecture²⁹², we can observe how in this case a technical process, that of screen-printing, has acquired an aesthetical significance too. Although not being directly related to an energy consideration at a first level, this decision had provoked an indirect questioning of another technical element, that of the use of external insulation.

At this point, the technical, visual and optical architecturological scales are superposed, whereas a dialogue between technique and art emerges as well.

Such an interaction could be omnipresent in architectural design but also, as previously observed, in the energy-oriented design. The PV panels are part of a power system designed to supply energy. For instance, the placement of the photovoltaic panels -required for the buildings of Clichy Batignolles district- in a certain position assigns them indirectly a referential identity. This identity refers either to the object as a purely technical one, complying with its function, or to the visual and symbolic aspects of the object, linked to the form and

²⁹¹ Franklin Azzi, interview published in *Le nouvel Observateur*, du 11 au 17 avril 2013, 17e Demain les Batignolles

²⁹² As declared into the interview taken by the author

geometry of the building. The former approach is identified in the third study case (Chapter 6), and the latter one in the second case study (Chapter 5).

A technical *scale* could be thus interweaving with other *scales* (fundamentally but not limited to the economical, functional and optical *scales*). When integrated into the architectural design process, an initially purely technical object can acquire symbolic and visual dimensions. The operation of *referenciation* is thus present. The *relevance* of the *operation* of positioning seems expanded and not limited to geographical criteria.

The attempt to refer to the architectural design either from an artistic approach, or from a technical one, conveys issues that concern, among others, the relations between art and technique.

« *La technique et l'architecture sont ontologiquement liées. L'architecture est bien sur technique car en prise avec le réel, mais la technique déconnectée de son contexte devient vite objet d'idolâtrie. (...)*

J'aime ce glissement signifiant de l'équipement considéré comme technique vers l'ouvrage d'art au sens noble du terme.» (Weizmann, L. in Marie, 2019, p. 162)

9.2.1.2. Boudon's 'Génie technique et Génie artistique'

In his text « Génie technique et Génie Artistique : Une même échelle ? » (Boudon, 2002c) Philippe Boudon touches upon the question of the *scale* in both technical and artistic terms. He demonstrates that defining art and technique remains a difficult task. A differentiation can be however determined between a technical and artistic *object*, between technical and artistic *thinking*.

A technical object assures a principal function; the shape, form and operation of its internal parts are relevant only to the extent that they allow its function: they can thus be replaced. In addition, this object is dismountable and analysable; limited by its own function.

An artistic object can be split in terms of materiality, but not in the same way as the technical one: after the "cut", every part of the artistic object will still refer to its wholeness.

According to Boudon, applied to spatial planning, a technical mode of thinking takes into consideration the relation with the immediate surrounding environment to a limited extend, and

that essentially when the latter holds a functional relevance²⁹³. The technical object can be thus described as an object enclosed to itself: any reference belonging to the object's exterior, is interior to the technical system that contains both. On the other hand, an artistic object can be potentially related to exterior and adjacent elements in many ways. Boudon attributes a « paradigmatic value » to the technical object and a « syntactic value » to the artistic one.²⁹⁴

9.2.1.3. Le Corbusier's 'Les techniques sont l'assiette même du lyrisme'

In his lecture "*Les techniques sont l'assiette même du lyrisme*" (Techniques are the very basis of poetry) (Le Corbusier, 1960), delivered in Buenos Aires in 1929, Le Corbusier focused on a drawing to explain his idea of architecture to the audience. Three elements, the economical, sociological and technological one, are forming the basis of the drawing. Above them, separated with a line is indicated the word "lyrism". Le Corbusier interprets lyrism as the "individual creation" where he identifies "eternal values that always light the flame in people's heart"

*"Ladies and Gentlemen, I begin by drawing a line that can separate the domain of material things from that specially reserved to spiritual ones. Below the line, what exists, above, what one feels. (...) I shall no longer speak to you of poetry, of lyrism. I shall draw precise reasonable things...I shall talk "technique" and you will react "poetry". And I promise you a dazzling poem: the poem of the architecture of modern times"*²⁹⁵

²⁹³ « an industrial zone is technically an industrial zone if it attains the function of industrial zone»

²⁹⁴ « le visible continue de fonctionner techniquement alors qu'il n'est plus visible. Le paradoxe est à son comble : la conception n'est pas technique, elle est artistique, et cependant elle reste non visible, et techniquement elle reste non pensée. » (Boudon, 2002a, p. 158)

²⁹⁵ The lecture is published in Le Corbusier, *Precisions: On the Present State of Architecture and City Planning*, Paris: Crès et Cie, 1930; English trans, Cambridge, MA: MIT Press, 1991, p.35

Les techniques sont l'assiette même du lyrisme

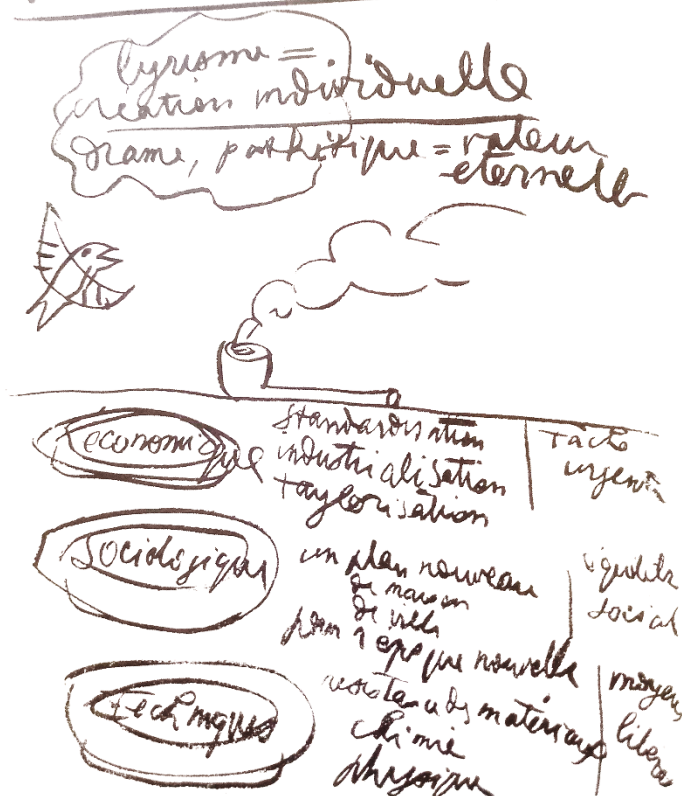


Figure 142 Le Corbusier, *Les techniques sont l'assiette même du lyrisme*. source (Le Corbusier, 1960, p. 39)

For Le Corbusier, lyrism should coexist with technique; he declared desiring to create -via lyrism- an architecture that serves the human spirit (Hitomi, 2018, p. 37). He asserts that creativity would be placed above the techniques.²⁹⁶

Dean Hawkes draws a correlation between Le Corbusier's *technique* and *poetry* and Kahn's *measurable* and *unmeasurable*²⁹⁷, suggesting that the relationship of technics and poetics in works of architecture is interdependent (Hawkes, 2013, p. 135).

²⁹⁶ 'Ici, on voit son attitude ambivalente qui voudrait surmonter le modernisme et respecterait en même temps la science et l'économie comme résultat du modernisme. Le lyrisme de Le Corbusier évoque Apollon qui est le dieu tutélaire à la fois de l'intelligence et l'ordre et de la musique. Il refléterait le retour à l'ordre du purisme' (Hitomi, 2018, p. 37)

²⁹⁷ I only wish that the first really worthwhile discovery of science would be that it recognised that the unmeasurable is what they're really fighting to understand, and that the measurable is only the servant of the unmeasurable; that everything that man makes must be fundamentally unmeasurable (Kahn, 1969 in Ronner, H., Jhaveri, S., Louis I. Kahn: Complete Works)

9.2.1.4. Does energy consumption influence architectural style?

Dean Hawkes, in “Technics and Poetics in the architectural environment” (Hawkes, 2013) examines relations between what he calls *environmental design*²⁹⁸ and the language of architecture, setting the question of the relation of energy and architectural style in a broader historical background.

By referring to environmental aspects in buildings of the 20th century - Le Corbusier (Villa Savoy²⁹⁹), Alvar Aalto (Ville Mairea); Louis Kahn (Richard Medical Research Building³⁰⁰), Carlo Scarpa³⁰¹, Peter Zumthor (Kunsthaus Bregenz, Therme Vals) -, he demonstrates that the environmental purpose is a matter of a correlation between *technics* and *poetics*, in other words, Louis Kahn’s *measurable* and *unmeasurable*.

« There are clearly particular constraints that follow from observance of the objective, *measurable* factors of building physics and technology in relation to energy processes in buildings that have a significant bearing on the form and materiality of a building. This is the realm of *technics*. But these factors are, of necessity, deeply conditioned by cultural and aesthetic judgements, the unmeasurable (*italic*) and the poetic (*italic*), and “style” - a tricky word- should in its deepest and most significant sense be the product of interpenetration of these two realms. ” (Hawkes, 2013, p. 135)

For Dean Hawkes, the biggest part of what we describe as “sustainable” lies in the *structural* approach as defined by Banham³⁰², that is a growing interest drawn to the energy use and the environmental properties of the building’s envelope.

²⁹⁸ “I believe that *sustainable* design, *low-energy* design, or any of the numerous other synonyms of these terms, should be regarded as a specific instance of the wider domain of *environmental* design in architecture.” (Hawkes, 2013, p. 135)

²⁹⁹ Fenêtre en longueur ; respiration exacte ; conversion of tectonic to lightness

³⁰⁰ Distinction between « served” and “servant” spaces

³⁰¹ « environmental primitism”

³⁰²...”almost half a century ago Banham distinguished between two broad possibilities in creating the “well-tempered environment”, the “structural” and the “mechanical”. This classification continues broadly to define the basis of contemporary practice – maybe even of theory” (Hawkes, 2013, p. 148)

9.2.1.4.1. Mechanical services and systems as a visible and expressible function of a building

Since the 19th century, the mechanical systems of environmental control have had a place in buildings (Hawkes, 2013, p. 142). For Rayner Banham, the truthful manifestation of function and the aesthetic determination of modern architecture are to be discussed.

The architecture demonstrative of its mechanical services (exposure of the air handling system on the ceiling on the United Nations Building for instance), turns the mechanical services to an expressible function of the building.

Banham cites Marco Zanuso's Factory for Olivetti, Franco Albini's Rinascente store and Luis Kahn's Laboratorie in Philadelphia to demonstrate a class of modern building where the mechanical services are functions given a precise expression

“Far from being a determinant of form, environmental machinery has tended more and more to become the stimulant or excuse for experiments made possible by the liberating effect of the products of these environmental machines. In freeing architecture from local climatic constraints, mechanical environmental management techniques have given carte blanche for formal experimentation.” (Banham, 1969, p. 239)

The structural range of the environmental design has been broadened by the evolutions in building technology. The diversity characterising the contemporary practice of environmental design can find its basis on the “relationship between the environmental function of form and fabric of a building and its mechanical service systems.” (Hawkes & Forster, 2002, p. 39) As stated by Hawkes and Forster, initially the “form and fabric” were determining an adequate order between the exterior and the interior climate of a building. The implementation of the mechanical service systems (machinery for heat, cooling, ventilation, lighting), during the 19th and 20th century contributed to achieving and controlling the comfort of an interior environment. They suppose that the contemporary environmental architectural practice is highly varied, mainly based on transformations of this historical aspect, derived from two modes of environmental control: either by managing “form and fabric” in relation to

mechanical systems, or by employing the latter ones in the internal environment after having detached them from the external one.³⁰³

9.3. Horizons of the present thesis

9.3.1. A parallelism with Modern Architecture

While Modern Architecture has 'rejected' the past by adopting, among other, new materials, new technologies, approaches and visions, contemporary 'sustainable' architecture could be said to not only accept the past and its practices, but also being inspired by it, creating connections between past and future. In parallel, she is experimenting with new materials and new technologies.

We hereby propose a possible parallelism with the Modern Movement, its terms and conceptual language, to base a perspective of a semantic continuum in architectural discourse and practice.

*« si les maisons étaient bâties industriellement, produites en séries comme un châssis automobile, il serait beaucoup plus aisé de créer une esthétique forte avec une précision surprenante ».*³⁰⁴

« Une maison est une machine à habiter », proclame Le Corbusier. « Une maison doit être comme une auto, conçue et agencée comme un omnibus ou une cabine de navire. Il ne faut pas avoir honte d'habiter une maison sans comble pointu, de posséder des murs lisses comme des feuilles de tôle, des fenêtres semblables aux châssis des usines. Mais ce dont on peut être fier, c'est d'avoir une maison pratique comme sa machine à écrire. »³⁰⁵

A possible analogy with the 20th century could be born through the symbols of this époque; industry, standard, series, technological progress. Architecture pretended to resemble to airplanes or cars. Does history repeat itself? Is the 21st century finally at an analogous point, with ecology and the connotation she carries, playing this role? Is there somewhere the possibility of passing from an ecology of greenwashing to an operating reality?

³⁰³ The categorisation by Dean Hawkes determines two modes of environmental control, the selective and the exclusive one. (in "Building shape and energy use" Hawkes, 1996)

« This classification distinguishes between designs that, in *selective* mode, *selectively* accommodate and filter the ambient environment as their primary strategy and those that, in *exclusive* mode, configure and construct the building enclosure to achieve maximum *exclusion* of the external climate in order to minimize the demands places on environmental plant. " (Hawkes & Forster, 2002, p. 40)

³⁰⁴ Vers une architecture, Le Corbusier, 1923.

³⁰⁵ Vers une architecture, Le Corbusier, 1923.

From Existenzminimum associated in the second CIAM³⁰⁶ to a ConsommationMinimum des norms energetiques d'aujourd'hui, from Modulor to an energy-driven analogy, from a 'machine à habiter' to a 'machine à consommer' do the context and norms of a collective order share common foundations under a broader questioning? Is the 'optimal' of a contemporary energy efficient house accompanied by similar references to vernacular architecture?

From 'I am a Monument' of Venturi to 'I am an ecological building', how can the conception of the image of a space be translated from a search of m² to this of kwh/m²?

9.3.2. Postures of an architect

It is the multiplicity of the theoretical and methodological references prioritizing an aspect of the process over another that leads to the studies on architectural design (conception) being so diverse.³⁰⁷

As seen in Chapter 2, Christopher Jones have published the three figures of the designer (in Broadbent & Ward, 1969). It consisted of the "Designer as a magician" (the black box), the "Designer as a computer" (the glass box) and the "Designer as a self-organizing system" (the box in the box). « Developed at a time when what is sometimes called the Third Industrial Revolution was emerging, these three caricatures represent an abstract distinction between three theoretical figures of the designer of architectural projects » (Claeys, 2019)

Claeys have re-questioned the figures of Jones, setting them in the context of the 21st century. In his article entitled « Trois figures architecturales post 1969 : Les concepteurs immergé, externalisé et en réseau » Claeys proposed three new ones : the submerged designer (the body in a box), the externalized designer (the box external to the body), and the network-designer (the body is a box within a box array).

In the time when 'sustainable' and energy-efficient architecture has emerged as an imperative, could we suppose an architect-hybrid in-between the postures of Jones?

³⁰⁶ Congrès International d'Architecture Moderne

³⁰⁷ See (Pousin, 1996)

Based on the results and conclusions of the current study (Chapter 7 and 8) could we suppose that the architect in this case would be a mixing of these figures? By attempting to superpose them, the complexity of architectural conception tends to be approached. In each architect, the combination of the synthetical figure would work differently: one level-figure would be more present than the other one, one other less active etc.

Our proposition comes to an opposition with Callon's regard concerning architectural design. « C'est parce qu'il n'y a pas de créateur mais des groupes qui discutent par schémas ou maquettes interposés, qu'il y a conception. (...) L'ordinateur ne vient pas se substituer à l'architecture puisque l'architecte n'existe pas. Il s'inscrit dans un processus collectif qui distribue et redistribue les compétences. » (Callon, 1996, p. 29)

Moreover, we concluded that sustainable energy architecture seems not being solely a resolution to a problem set. This would reduce the complexity it entails, even within a constraining and quantitative framework, to an automatic solution given by a machine or a robot. In the present study, the explorations of architectural design, under the prism of a society oriented towards an energy transition and impregnated with environmental preoccupations, are incompatible with the considerations of Simon, who has approached design process as a problem-solving activity³⁰⁸.

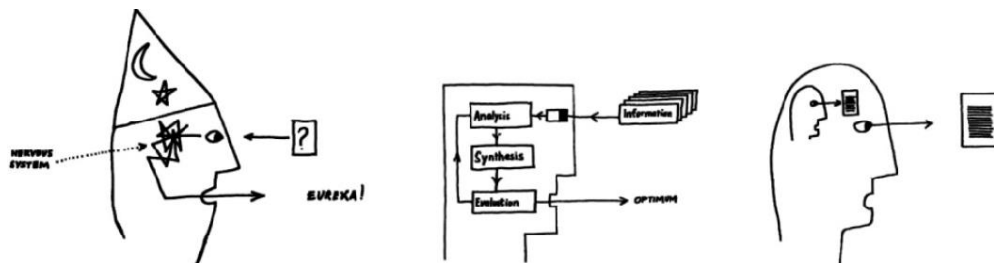


Figure 143 The three postures of Jones. The designer-magician, the designer-computer and the auto-organised designer "Designer as a magician", "Designer as a computer" and "Designer as a self-organizing system". Redessinés d'après les trois caricatures originales de J. Christopher Jones (1969, pp.193 -19 7).

³⁰⁸ See Chapter 2

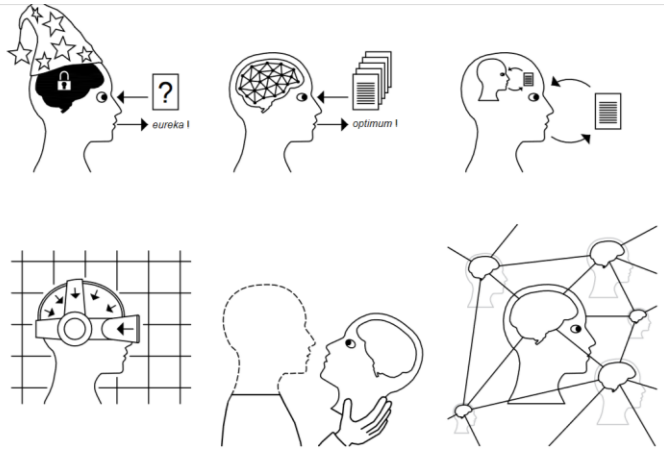


Figure 144 The postures of Jones revised by Damien Claeys. The submerged designer (the body in a box), the externalized designer (the box external to the body), and the network-designer (the body is a box within a box array) source Damien Claeys (Claeys, 2019, p. 34)

*'It seems that the fact that the world is round and that it rolls is not up for debate anymore. What is up for debate, instead, is how to live on it.'*³⁰⁹

The message from Superstudio sounds relevant still after half century. We can even adapt it in terms of the nowadays society characterised by the energy transition:

*'It seems that the fact that the world is round and that its **climate changes** is not up for debate anymore. What is up for debate, instead, is how to live on it.'*

Thus, how can we inhabit a world with limited resources? How can this challenge be integrated into the architectural design and how this could be measured and evaluated over time?

According to Camus the question could even be oriented not towards the change of a given situation but rather towards the avoidance of the change. *"Chaque génération, sans doute, se croit vouée à refaire le monde. La mienne sait pourtant qu'elle ne le refèra pas. Mais sa tâche est peut-être plus grande. Elle consiste à empêcher que le monde ne se défasse"*.³¹⁰

³⁰⁹ 'Sur le fait que le monde soit rond et qu'il tourne, il semble qu'il n'y ait pas matière à discuter. Ce dont il faut encore discuter, par contre, c'est la manière de vivre dessus.' (Superstudio, "Design d'invenzione e design d'evasione", Domus, 475, juin 1969 [1967])

³¹⁰ - Albert Camus, Discours d'acceptation du Prix Nobel, 10 décembre 1957 (Conférences et Discours / Gallimard)

9.4. Epilogue

In order to widen the directions of the research this chapter took distance from the results and conclusions of the Chapters 8 and 9. Based on elements deriving from them, it posed some general reflexions, constructing further links.

This Chapter, set as reference points aspects from the case studies and expanded them. More specifically, it drew a correlation with the concept of vicariance. Furthermore, it briefly referred to the implication of the notions of art and technique in architecture.

At a second level, by driving a parallelism with the Modern Movement and its terms the chapter proposed a lecture that supposed a semantic continuum of

Finally, the epistemological position supported the existence of a multiplicity of models and not of a specific one, when it comes to ecological architecture. In contrary to the approaches developed by Simon and Callon, we did not interpret ecological architecture solely as a mere (re)solution to a problem posed. Consequently, we proposed a posture of an architect-hybrid, under the superposition of the postures of Jones.

Towards new research perspectives

The objective of this study concerned an empirical exploration of the architectural design in the time of energy transition, aiming in parallel to constitute a new perspective compared to existing research on this topic. The point of view set in the current research can be considered to add knowledge on the scientific studies conducted by Caroline Lecourtois on sustainable urban design, as well as on the epistemological architecturological studies of MAACC laboratory in France. Other research and university laboratories related to similar explorations and research in architecture (as for instance Université de Liège or Université Catholique de Louvain) could be eventually linked to the findings and approach adopted here.

Besides, based on the analysis and conclusions of the current study, provisory possibilities of new studies can emerge.

On the one hand, at first, an additional examination of the Clichy Batignolles district read under a global scale in the west sector and a scale of levels of conception in the east sector could provide knowledge. An epistemological or even architecturological study of the influences of the collective design approach of the west sector in the architectural design process could be added to the studies on collective design done so far.

The theoretical modelling of the architectural design process of low energy consumption buildings could nourish the knowledge on the domain and contribute to diverse comparisons and interpretations.

Another possible path could concern a more thorough investigation of the use of architecturological scales, their relations and properties in alike projects, under the prism of energy efficiency. The triptych of economic-technical-functional *scales* along with their interactions with other *scales*; the role of a model *scale* in the architectural design of an energy efficient building; the optical *scale* as a means of demonstration of the performance and environmental ‘excellence’, the passage from an economy *scale* to an economy of energy one, constitute possible paths to be further investigated.

At a second level, the investigation of the use of metaphors, as showed by the current study, references on concepts, interpretations of archetypes used in the rhetorical architectural discourse, could lead to new experimentations seen under the energy transition prism.

A symbolic approach on the lecture of visibly connotated performance could merit a further insight.

On the other hand, the difficult task remains for architects to acknowledge, identify and describe the cognitive operations and mechanisms active in their proper architectural process. Like every theory, architecturology has her limits. It would be interesting to apply other theories and methodologies and acquire diverse viewpoints on the question.

Finally, other studies could possibly investigate the ways with which the role of digital tools, the participation of inhabitants in the process, or the collaborative design, influence the energy efficient architectural design, aspects which were out of the perimeter of the current research.

En réalité, chaque lecteur est, quand il lit, le propre lecteur de soi-même. L'ouvrage de l'écrivain n'est qu'une espèce d'instrument optique qu'il offre au lecteur afin de lui permettre de discerner ce que, sans ce livre, il n'eût peut-être pas vu en soi-même.

Marcel Proust, *Le Temps retrouvé*

Bibliography

- 10 agences d'architectes retenues pour finaliser le futur quartier situé entre le parc et le paysage ferroviaire. (2013). Retrieved from <https://archive-clichy-batignolles.paris-metropole-amenagement.fr/10-agences-darchitectes-retenues-pour-finaliser-le-futur-quartier-situe-entre-le-parc-et-le-paysag-0.html>
- A park in the heart of the city. (2019). *Architecture d'Aujourd'hui Hors Série / Projects. L'éco-Quartier Clichy-Batignolles*, 4–11.
- Abrieu, L. (2018). L'architecture de Franklin Azzi. *Milk Decoration n. 25*, pp. 70–73.
- Alberti. (n.d.). *On Painting*,.
- Alejandro Aravena remporte le prix du développement durable 2017 à Göteborg. (n.d.). Retrieved from <https://fre.architecturaldesignschool.com/alejandro-aravena-wins-2017-gothenburg-prize-38123>
- Architect's Journal. (2015). *Sustainability is a defining challenge of our generation*. Retrieved from <https://www.architectsjournal.co.uk/news/opinion/hadid-sustainability-is-a-defining-challenge-of-our-generation>
- Architects' Council of Europe, 2015 Annual Report & 2016 Outlook*. (2015). Retrieved from https://www.ace-cae.eu/uploads/tx_jidocumentsview/ACE_REPORT_2015_EN.pdf
- Architecture d'Aujourd'hui Hors Série / Projects. L'éco-quartier Clichy-Batignolles*. (2019).
- Ardenne, P. (2014a). *In, out : Franklin Azzi architecture* (A. prima Archives d'architecture moderne, Ed.). Retrieved from http://catalogue.bpi.fr/tout/document?search_group=g1&filter=&sort_value=relevance&search_type=keyword&search_input=franklin azzi &page=1&page_size=25&log_ctx=async_search&search_operator1=AND&search_input2=&search_type2=keyword&search_operator2=AND&s
- Ardenne, P. (2014b). *In Out Franklin Azzi Architecture* (AAM/Ante Prima, Ed.).
- Ardenne, P. (2014c). Logements Cardinet Chalabre, Paris. In A. prima Archives d'architecture moderne (Ed.), *In, out : Franklin Azzi architecture* (pp. 109–121). Retrieved from http://catalogue.bpi.fr/tout/document?search_group=g1&filter=&sort_value=relevance&search_type=keyword&search_input=franklin azzi &page=1&page_size=25&log_ctx=async_search&search_operator1=AND&search_input2=&search_type2=keyword&search_operator2=AND&s
- Ayers, A. (2018, March). Franklin Azzi. *L'Architecture d'Aujourd'hui*, pp. 21–23.
- Azzi, F. (2014). *No Title*. Retrieved from <http://www.franklinazzi.fr/projets/cardinnet-chalabre-7be00f18-af34-4a08-8888-d236a370c823>
- Bachelard, G. (1934). *La formation de l'esprit scientifique* (Alcan, Ed.). Paris.
- Bacon, F., Urbach, P., & Gibson, J. (1994). *Novum Organum* (Open Court). Chicago.
- Banham, R. (1969). *The architecture of the well-tempered environment*.

- Barani, M. (2014). The art of opposition. *Architecture d'Aujourd'hui*, (399), 33.
- Bejaoui, A. (2017). Caractérisation des opérations cognitives spécifiques à un style collectif d'une agence. *Seminaire Du MAP 2017*.
- Bejaoui, A., Allani Bouhoula, N., Guéna, F., & Lecourtois, C. (2018). The Process of Collective Architectural Conception: Characterizing Cognitive Operation of Conception Specific to an Agency. In Y. Luo (Ed.), *Cooperative Design, Visualization, and Engineering, 15th International Conference, CDVE 2018, Hangzhou, China, October 21–24, 2018 Proceedings* (pp. 94–101). Retrieved from <https://books.google.fr/books?id=G3hvDwAAQBAJ&pg=PA96&lpg=PA96&dq=architectureology&source=bl&ots=cIDxIOuQz7&sig=ACfU3U2tMsge5uP71VVrSsooMyZ3-bbY6w&hl=fr&sa=X&ved=2ahUKEwjQ167U5tvnAhUIJhoKHTfjCY44FBD0ATADegQlChAB#v=onepage&q=architectureology&f=false>
- Belogolovsky, V. (n.d.). *Changes are Coming*. Retrieved from <http://www.mascontext.com/tag/peter-eisenman/>
- Ben Rajeb, S. (2012). *Modélisation de la collaboration distante dans les pratiques de conception architecturale : Caractérisation des opérations cognitives en conception collaborative instrumentée*. Université Paris-Est.
- Ben Rajeb, S. (2013). Conception collaborative distante instrumentée Étude architecturologique pour la caractérisation des opérations cognitives. *Interfaces Numériques*, 2(3), 509–530. Retrieved from <https://www.unilim.fr/interfaces-numeriques/2106>
- Ben Rajeb, S., Lecourtois, C., & Guéna, F. (2010). Operations of Conception in Architectural Collaborative Design. *FUTURE CITIES [28th ECAADe Conference Proceedings / ISBN 978-0-9541183-9-6] ETH Zurich (Switzerland) 15-18 September 2010*, 687–695.
- Bernigaud, A. (2018). *Low-Tech is the new High-Tech*. Retrieved from <https://www.climateforesight.eu/energy/low-tech-is-the-new-high-tech/>
- Berthier, S. (2019). Architectures post-carbone. *D' Architectures*, (276).
- Berthoz, A. (2013). *La Vicariance Le cerveau créateur de mondes* (O. Jacob, Ed.).
- Berthoz, A. (2017). *The Vicarious Brain, Creator of Worlds* (Harvard University Press, Ed.).
- Bihouix, P. (2014). *L'Âge des low tech Vers une civilisation techniquement soutenable* (Seuil, Ed.).
- Bonzani, S., Durand, M.-A., & Teyssou, S. (2017). *Matières & constructions premières*. Retrieved from http://www.clermont-fd.archi.fr/images20171212/meplivretexpoworkshop_v03 DEF.pdf
- Borasi, G., & Zardini, M. (Eds.). (2007). *Sorry, Out Of Gas: Architecture's Response to the 1973 Oil Crisis*. Montreal: Canadian Center for Architecture.
- Borne, E. (2019). Editorial. *Architecture d'Aujourd'hui Hors Série / Projects. L'éco-Quartier Clichy-Batignolles*, 1.
- Bouchareb Bellagha, F. (2014). Pratiques et représentations dans la conception des intérieurs chez Matali Crasset et Zaha Hadid. *Communication et Organisation*. <https://doi.org/10.4000/communicationorganisation.4734>
- Bouchouchi, C. (2013). 17e Demain les Batignolles. *Le Nouvel Observateur*.
- Bouchouchi, C. (2015). Un bâtiment doit-il être moche pour être écolo ? *Le Nouvel Observateur*. Retrieved from <https://www.nouvelobs.com/planete/cop21/20151210.OBS1126/un-batiment->

doit-il-etre-moche-pour-etre-ecolo.html

- Boudon, P. (n.d.). *Complexité de la conception architecturale : conception et Représentation*. Retrieved from <http://www.intelligence-complexite.org/fileadmin/docs/0811boudon.pdf>
- Boudon, P. (1971). *Sur l'espace architectural. Essai d'épistémologie de l'architecture* (Dunod, Ed.). Paris.
- Boudon, P. (1975). *Architecture et architecturologie*. Paris.
- Boudon, P. (1978). *Richelieu, ville nouvelle : essai d'architecturologie* (Dunod, Ed.). Paris.
- Boudon, P. (1992). *Introduction à l'architecturologie* (Dunod, Ed.). Paris.
- Boudon, P. (2002a). *Echelle(s)*.
- Boudon, P. (2002b). Eléments pour une "simulation" scientifique des "opérations" de conception (ou peut-on rendre "analysable" une compétence majeure de l'architecte, la conception). In Mardaga (Ed.), *Cognition et création Explorations cognitives des processus de conception* (p. 50).
- Boudon, P. (2002c). Genie technique et genie artistique: une meme échelle ? In *Echelle(s)* (pp. 153–159).
- Boudon, P. (2003). *Sur l'espace architectural. Essai d'épistémologie de l'architecture, nouvelle édition revue et augmentée* (Parenthèse).
- Boudon, P. (2007). La recherche face à l'architecture et à la socio-anthropologie de l'espace. In Recherches (Ed.), *Architecture espace pensé espace vécu* (pp. 73–81).
- Boudon, P. (2014). *De Quelques fondamentaux en architecturologie*.
- Boudon, P. (2019). Figures "vicariantes" de signes de la conception architecturale. Retrieved June 1, 2020, from dnarchi.fr website: <https://dnarchi.fr/analyses/figures-vicariantes-de-signes-de-la-conception-architecturale/>
- Boudon, P., Deshayes, Philippe Pousin, F., & Schatz, F. (1994). *Enseigner la conception architecturale : cours d'architecturologie*. Paris: Editions de la Villette.
- Boudon, P., Deshayes, P., Pousin, F., & Schatz, F. (2001). *Enseigner la conception architecturale Cours d'architecturologie* (Editions de la Villette, Ed.). Paris.
- Boudon, P., & Raynaud, D. (1997). *Les sciences de la conception sont-elles énonçables et enseignables ?* Retrieved from <http://www.intelligence-complexite.org/fileadmin/docs/1102dossier12TOTAL.pdf>
- Braham, W. W. (2013). Introduction: architecture and energy. In *Architecture and Energy Performance and Style*. Routledge.
- Broadbent, G., & Ward, A. (1969). *Design methods in architecture*. London: Lund Humphries.
- Building Energy Efficiency in European Cities Urbact II*. (2013). Retrieved from https://urbact.eu/sites/default/files/import/general_library/19765_Urbact_WS6_ENERGY_low_FINAL.pdf
- Callon, M. (1996). Le travail de la conception en architecture. In *Les cahiers de la recherche architecturale no. 37* (pp. 25–36).
- Canguilhem, G. (1968). *Études d'histoire et de philosophie des sciences (Problèmes et controverses)* (J. Vrin, Ed.). Paris.

- Catsaros, C. (2019). A park in the heart of the city. *Architecture d'Aujourd'hui Hors Série / Projects. L'éco-Quartier Clichy-Batignolles*, 4–11.
- Chupin, J.-P. (2010). *Analogie et théorie en architecture : de la vie, de la ville et de la conception, même* (In Folio, Ed.).
- Claeys, D. (2006). *Mots théoriques et choses architecturales, Opérandes et opérateurs de la conception*. Retrieved from http://www.arcamoo.be/IMG/pdf/060724_Boudon-2.pdf
- Claeys, D. (2013). *Architecture et complexité : un modèle systémique du processus de (co) conception qui vise l'architecture*. Université catholique de Louvain.
- Claeys, D. (2018). Discontinuités des processus de conception architecturale: Crises de la représentation? *Acta Europæana Systemica*, (8), 19–36.
<https://doi.org/https://doi.org/10.14428/aes.v8i1.56203>
- Claeys, D. (2019). Trois figures architecturales post 1969 : Les concepteurs immergé, externalisé et en réseau. *Lieuxdits*, (17), 25–35.
- Clichy-Batignolles the eco-district. A reference in sustainable urban development in Paris.* (2017). Retrieved from https://archive-clichy-batignolles.paris-metropole-amenagement.fr/sites/default/files/bd_cb_dossierpress_en_060317.pdf
- Clichy Batignolles, Interview Franklin Azzi et Pablo Boisier. (2010). *Semavip/Meanings/Neyrac Films*. Retrieved from www.franklinazzi.fr/publications/clichy-batignolles-interview-franklin-azzi-et-pablo-boisier
- Clichy Batignolles Fiches Programmes Logements. Lots attribués du côté de l'avenue de Clichy.* (n.d.). Retrieved from https://archive-clichy-batignolles.paris-metropole-amenagement.fr/sites/default/files/fiches_habitat_1.pdf
- Conan, M. (1990). *Concevoir un projet d'architecture* (L' Harmattan).
- Conférence Secrets de Fabriques : Philippe Madec - "L'architecture frugale."* (2018). Retrieved from <https://www.paris-valdeseine.archi.fr/a-la-une/conference-de-philippe-madec.html>
- Conniff, R. (2010). *Coming to Ecological Terms in Architectural Design*. Retrieved from <http://environment.yale.edu/magazine/spring2010/coming-to-ecological-terms-in-architectural-design/>
- Contal, M.-H. (2014). *Ré-enchanter le monde: l'architecture et la ville face aux grandes transitions* (Alternatives, Ed.).
- Contesse, A. (2014). Francis Soler L'art du contre-pied. *Architecture d'Aujourd'hui* 399, 22–31.
- Creaschi, M. (2019). Un urbanisme pluriel pour les transitions. *Urbanisme n. 415*, 45.
- Cross, N., Dorst, K., & Roozenburg, N. (1992). *Research in Design Thinking*. Delft University Press.
- Cross, Nigel. (1984). *Developments in design methodology* (Wiley, Ed.).
- Cross, Nigel. (2002). Comprendre la pensée du concepteur. In Mardaga (Ed.), *Cognition et création Explorations cognitives des processus de conception* (pp. 36–37).
- Da Cunha, A. (2011). Les écoquartiers, un laboratoire pour la ville durable : entre modernisations écologiques et justice urbaine. *Espaces et Sociétés*, 144–145(1), 193–200.
<https://doi.org/10.3917/esp.144.0193>
- Danon, J.-F. (2019). Avant-propos. *Architecture d'Aujourd'hui Hors Série / Projects. L'éco-Quartier*

Clichy-Batignolles, 2–3.

- Darke, J. (1979). The Primary Generator and the Design Process. In *Developments in Design Methodology* (pp. 175–188). Chichester: John Wiley & Sons.
- de Boissieu, A. (2013). *Modélisation paramétrique en conception architecturale : Caractérisation des opérations cognitives de conception pour une pédagogie* (Université Paris Est).
<https://doi.org/10.13140/RG.2.2.29966.51521>
- de Boissieu, A., Lecourtois, C., & Guéna, F. (2010). Modélisation paramétrique partagée, Le cas de l'utilisation de Digital Project lors de la conception du Pavillon de la Fondation Louis Vuitton pour la Création (Gehry Partners) sous l'angle des opérations de découpage. *Scan 10 Espaces Collaboratifs*. Marseille.
- de Gravelaine, F. (2014). *L'Atelier des Batignolles, Une nouvelle fabrique de la ville* (Gallimard).
- Delaveau, A.-S., Guéna, F., & Lecourtois, C. (2009). Digital as a Tool/Reference for Architectural Conception Examples from Two Agencies: Ateliers Jean Nouvel and Jakob+MacFarlane. *Proceedings of the 27th Conference on Education in Computer Aided Architectural Design in Europe ECAADe 27*, 197–204. Retrieved from http://papers.cumincad.org/data/works/att/ecaade2009_064.content.pdf
- Deshayes, P. (1986). Modèles a priori et modèles a posteriori du travail de l'architecte. In Parenthèses (Ed.), *La recherche en architecture, un bilan international* (pp. 93–96). Marseille.
- Dossier initial Projet Clichy Batignolles. Candidature à l'appel à projet nouveaux quartiers urbains. Aout 2009.* (2009). Retrieved from <http://www.didierfavre.com/Parc/2009-Nouveau-Quartier-Urbain-Projet-Clichy-Batignolles.pdf>
- Ecoquartier Clichy Batignolles Dossier de Réponse Mars 2009.* (2009). Retrieved from https://archive-clichy-batignolles.paris-et-metropole-amenagement.fr/sites/default/files/clichybatignolles_23-3-9_0.pdf
- Farel, A. (1995). Conception d'un bâtiment : l'organisation d'un travail collectif. In R. Prost (Ed.), *Concevoir, Inventer, Créer*. Paris: L'Harmattan.
- Fernandez, P. (2002). Approches méthodologiques et modes opératoires dans le processus de conception architecturale. In Mardaga (Ed.), *Cognition et création Explorations cognitives des processus de conception*.
- Ferrier, J. (2008). Architecture pour une société durable. In Editions A&J Picard (Ed.), *Architecture = durable : 30 architectes, 30 projets en Ile-de-France* (pp. 8–13).
- Fleming, S., & Reynolds, M. (2006). Timely Timelessness: Traditional Proportions and Modern Practice in Kahn's Kimbell Museum. *Nexus Network Journal*, 8, 33–52. <https://doi.org/10.1007/s00004-006-0003-0>
- Foucault, M., & Trombadori, D. (1991). *Michel foucault Remarks on Marx: Conversations With Duccio Trombadori* (Semiotext(e), Ed.).
- Fraioli, P. (2012). *Reinventing the city: An interview with architect Rem Koolhaas*. Columbia University's Journal of International Affairs,.
- Francis Soler : « Chacun de mes bâtiments est une œuvre ». (2014). Retrieved from <https://parc17.fr/francis-soler-batiments-oeuvre/>
- Francis Soler 98 logements et bureaux Paris XVIIe. (2016). *AMC n. 251*, 61.

- Franklin Azzi, l'archi-talentueux. (2018). *Infrarouge n. 201*, 16–17.
- Franklin Azzi, l'insatiable. (n.d.). *The Socialite Family*. Retrieved from <https://www.thesocialitefamily.com/journal/franklin-azzi-architecte/>
- Füzesséry, Stéphane Roseau, N. (2012). La ville équitable. Les apories de la ville durable (2). *Métropolitiques*. Retrieved from <https://metropolitiques.eu/La-ville-equitable.html>
- Galiano, L. F. (2001). *Fire & Memory On Architecture & Energy*. MIT Press.
- Gerault, M. (2015). *Le Biopôle : entre Architecture Durable et Made In France*. Retrieved from <https://youmatter.world/fr/biopole-architecture-durable-made-in-france/>
- Ginn, S. R., & Lorusso, L. (2008). Brain, Mind, and Body: Interactions with Art in Renaissance Italy. *Journal of the History of the Neurosciences*, 17(3), 295–313. Retrieved from https://journals.scholarsportal.info/details?uri=/0964704x/v17i0003/295_bmabiwairi
- Gonzalo, R., & Habermann, K. J. (2008). *Architecture et efficacité énergétique: Principes de conception et de construction* (Birkhäuser, Ed.).
- Grether, F. (2015). *Aux Batignolles, une nouvelle butte parisienne*. Retrieved from <https://archive-clichy-batignolles.parisetmetropole-amenagement.fr/node/804.html>
- Groat, L., & Després, C. (2013). The Significance of Architectural Theory for Environmental Design Research. In *Advances in Environment, Behavior, and Design* (p. 31). Springer Science & Business Media.
- Guéna, F., & Lecourtois, C. (2009). Aided Architectural Sketching with markov Models: Dromies and Recognition. *Proceedings of the 27th Conference on Education in Computer Aided Architectural Design in Europe*, 745-. Retrieved from http://papers.cumincad.org/data/works/att/ecaade2009_066.content.pdf
- Halin, G. (2004). *Modèles et outils pour l'assistance à la conception Application à la conception architecturale* (stitut National Polytechnique de Lorraine). Retrieved from <https://tel.archives-ouvertes.fr/tel-00101454/document>
- Halloy, J., Nova, N., & Monnin, A. (2020). Au-delà du low tech : technologies zombies, soutenabilité et inventions. *Ritimo*, (21), 120–128. Retrieved from <https://hal.archives-ouvertes.fr/hal-02950609>
- Hawkes, D. (1996). *The Environmental Tradition: Studies in the architecture of environment* (E. . F. N. Spon, Ed.). London.
- Hawkes, D. (2013). Technics and poetics of the architectural environment. In Routledge (Ed.), *Architecture and Energy Performance and Style* (pp. 133–150).
- Hawkes, D., & Forster, W. (2002). *Architecture, Engineering and Environment*. Laurence King Publishing Ltd.
- Hitomi, U. (2018). Transformation et significations de la notion du lyrisme : A propos des théories de l'art dans les années 1919-29. *Aesthetics*, (22), 29–39. Retrieved from http://www.bigakukai.jp/aesthetics_online/aesthetics_22/text22/text22_udahitomi.pdf
- IEA. (2013). *Transition to Sustainable Buildings Strategies & Opportunities to 2050*.
- Ionescu, C., Baracu, T., Vlad, G.-E., Necula, H., & Badea, A. (2015). The historical evolution of the energy efficient buildings. *Renewable and Sustainable Energy Reviews*, (49), 243–253. <https://doi.org/10.1016/j.rser.2015.04.062>

- Isaacson, W. (2017). *The Nature of the Human Body*. Retrieved from <https://medium.com/s/leonardo-da-vinci/the-nature-of-the-human-body-e7b27b494051>
- Jencks, C. (2000). Jencks' theory of evolution, an overview of 20th Century architecture. *Architectural Review*, 76.
- Jencks, Ch., & Kropf, K. (2006). *Theories and Manifestoes of contemporary architecture*.
- Jund, A., & Blanc, M. (2011). Les quatre défis des écoquartiers : entretien avec Alain Jund. *Espaces et Sociétés*, 144–145, 201. <https://doi.org/10.3917/esp.144.0201>
- Jung, C. G. (1954). *Les racines de la conscience : Études sur l'archétype*. (2008th ed.; H. (coll. Références), Ed.). Paris.
- Kahn, L. I. (1969). Silence and Light. lecture given at ETH, Zurich. In Birkhäuser (Ed.), *Louis I. Kahn: Complete Works* (1987th ed.). Basel.
- Kant, E. (1869). *Critique de la raison pure* (Germer-Bai).
- Kay, J. J. (2001). On complexity theory, exergy, and industrial ecology: some implications for construction ecology. In *Construction Ecology: Nature as the basis of Green Buildings* (p. 79). Routledge.
- L.V. (2018). Franklin Azzi. *L'Express*, 32–33.
- L'Atelier Batignolles. (n.d.). Retrieved from <https://archive-clichy-batignolles.paris-metropole-amenagement.fr/latelier-batignolles.html>
- L'Atelier de conception de Clichy-Batignolles Premier bilan d'une expérience novatrice de conception urbaine*. (2013). Retrieved from https://archive-clichy-batignolles.paris-metropole-amenagement.fr/sites/default/files/cahier_central_int_24p_web.pdf
- L'éco-quartier Clichy-Batignolles, Une référence de développement urbain durable à Paris, Lauréat 2016*. (2017). Retrieved from https://archive-clichy-batignolles.paris-metropole-amenagement.fr/sites/default/files/exe_cb_dossierpresse-fr_220217.pdf
- Le Corbusier. (1960). Les techniques sont l'assiette même du lyrisme. In *Précisions sur un état présent de l'architecture et de l'urbanisme. Écrit en 1930* (pp. 37–67). Paris: Ed. Vincent, Fréal & cie.
- Lecourtois, C. (2004a). Conception de l'espace et espace de conception. *Travaux de l'Institut de Géographie de Reims. Les Nouvelles Approches de l'espace Dans Les Sciences de l'homme et de La Société. Regards Disciplinés, Regards Croisés, Transdisciplinarités*, 30(119–120), 79–97. Retrieved from http://www.persee.fr/doc/tigr_0048-7163_2004_num_30_119_1481
- Lecourtois, C. (2004b). *De la communication sur l'espace : espace conçu et espace perçu de l'architecture et de l'urbanisme*. Université Paris 10.
- Lecourtois, C. (2006). Apprentissage d'un regard architecturologique pour un enseignement de la conception architecturale. In P. Boudon (Ed.), *Conceptions. Epistémologie et poïétique* (L'Harmattan). Paris.
- Lecourtois, C. (2007). Architectural qualities and local identity. In J. Al-Qawasmi, A. Mahmoud, & A. Djerbi (Eds.), *Regional architecture and identity. In the age of globalization, The Second International Conference of the Center for the Study of Architecture in the Arab Region (CSAAR 2007), Volume II* (pp. 819–833). Tunis.
- Lecourtois, C. (2010). META-COMPLEXITE ARCHITECTURALE et assistance informatique. *Actes Du*

Colloque International Francophone « Complexité 2010 » La Pensée Complexe : Défis et Opportunités Pour l'éducation, La Recherche et Les Organisations – Lille (France) Mercredi 31 Mars et Jeudi 1er Avril 2010.

- Lecourtois, C. (2011). From Architecturology to Architecturological research. *AE Revista Lusófona de Arquitectura e Educação - Architecture & Education Journal*, (5), 9–26.
- Lecourtois, C. (2012). Eco-Conception and Architecturology. *EURAU12 Porto | Espaço Público e Cidade Contemporânea: Actas Do 6º European Symposium on Research in Architecture and Urban Design*. [https://doi.org/ISBN: 978-989-8527-01](https://doi.org/ISBN:978-989-8527-01)
- Lecourtois, C. (2013). Modèle de la conception urbaine durable. L'écoquartier ? *Rencontres RAMAU 2013, Savoirs et Modèles de l'urbanisme et de l'architecture Durables*. Retrieved from https://ramau2013.sciencesconf.org/conference/ramau2013/pages/Resumes_RAMAU_2015.pdf
- Lecourtois, C. (2014a). Conception des formes urbaines : Eco-conception, vers une échelle écologique ? In CTHS (Ed.), *Actes du congrès Compositions Urbaines*. Retrieved from <https://hal.archives-ouvertes.fr/hal-01044884>
- Lecourtois, C. (2014b). Conception des formes urbaines : Ecoconception, vers une échelle écologique ? In *Formes et échelles des compositions urbaines* (CTHS, pp. 19–30). Retrieved from <https://hal.archives-ouvertes.fr/hal-01052920>
- Lecourtois, C. (2015). Un modèle de connaissance de la conception urbaine durable. Le cas des écoquartiers. In *Architecture et urbanisme durables Modèles et savoirs* (pp. 100–115). Retrieved from <http://www.ramau.archi.fr/spip.php?article911>
- Lecourtois, C., Ben Rajeb, S., Guéna, F., Mayeur, A., Darses, F., Leclercq, P., & Stéphane, S. (2010). Interprétations collaboratives : Usages et implications du Studio Digital Collaboratif en situation de conception architecturale. *Activités Collaboratives SCAN 10*. Marseille.
- Lecourtois, C., & Guéna, F. (2009). Eco-conception et esquisse assistée. In PUF (Ed.), *Conception architecturale numérique et approches environnementales, Actes de SCAN 09*. Retrieved from https://www.researchgate.net/publication/259800055_Eco-conception_et_esquisse_assistee
- Léglise, F., & Sautot, D. (2013). Clichy-Batignolles Premier Mouvement. *Architecture d'Aujourd'hui, Issue 395*, 92–117.
- Les sérigraphies, de l'art pour Parc 17*. (2014). Retrieved from <http://parc17.fr/les-serigraphies-de-lart-pour-parc-17/>
- Li, F. (2019). *Conception des jardins de Suzhou : Étude de cas du jardin du simple politicien du XVIème siècle à nos jours : Dans quelles mesures pouvons-nous rendre compte du travail de conception réalisé sur le jardin du simple politicien ?* Retrieved from <https://hal.archives-ouvertes.fr/hal-02180893>
- Loftness, V. (2013). Environmental Surfing, Delight and nature's renewable energies. In *Architecture and Energy Performance and Style* (p. 92). Routledge.
- Logements et bureaux Cardinet-Chalabre. (2014). *Architecture d'Aujourd'hui*, (399), 49.
- Lopez, F. (2010). *Déterritorialisation énergétique 1970-1980 : de la maison autonome à la cité auto-énergétique, le rêve d'une déconnexion*. Université Paris 1 – Panthéon- Sorbonne.
- Lot E.1 Franklin Azzi Architecture*. (n.d.). Retrieved from <http://cityscape.fr/fr/batiment/lot-e1>
- Magriet, R. (2020). *Zaha Hadid Architects sur le rôle de la durabilité en architecture*. Retrieved from

- <https://cgconcept.fr/zaha-hadid-architects-sur-le-role-de-la-durabilite-en-architecture/>
- Mandoul, T. (2012). Climat(s) : nouveau paradigme pour l'architecture ? *Raison Publique*, (17), 141–161. <https://doi.org/https://doi.org/10.3917/rpub.017.0141>
- Mantziaras, P. (2014). L'architecture est-elle une discipline ? *Cahiers de La Recherche Architecturale et Urbaine*, (30/31), 5-10.
- Marie, J.-B. (2019). *Architectes et ingénieurs face au projet* (Le Moniteur, Ed.).
- McMahon, A. P. (Ed.). (1956). *Leonardo da Vinci. Treatise on Painting. (Codex Urbinas Latinus 1270)*. Princeton University Press.
- Ménard, R. (2018). *Energie, Matière, Architecture*. École d'architecture de la ville & des territoires Paris-Est.
- Moe, K. (2014). *Insulating Modernism: Isolated and Non-Isolated Thermodynamics in Architecture* (Birkhauser, Ed.).
- Molina, G., Musy, M., & Lefranc, M. (2018). *Les professionnels du bâtiment face aux défis énergétiques et environnementaux - Compétences et pratiques en transition* (ISTE, Ed.).
- Moneo, R. (1978). On Typology. *Oppositions*, (13), 22–45.
- Moreno Sierra, A. (2012). *Intégration des aspects énergétiques dans la conception du projet architectural : une approche méthodologique* (UNIVERSITE DE BORDEAUX 1). Retrieved from http://ori-oai.u-bordeaux1.fr/pdf/2012/MORENO_SIERRA_ANDRES_2012.pdf
- Mosconi, L. (2016). Architecture et Climat: Au-delà de la crise, vers un récit collectif. *Architecture d'Aujourd'hui*, (411).
- Mosconi, L. (2018). *Emergence du récit écologiste dans le milieu de l'architecture en France. 1989-2015: de la réglementation à la thèse de l'anthropocène*. Université Paris-Est, Ecole doctorale Ville, Transports et Territoires.
- Mostafavi, M. (Ed.). (2016). *Ecological Urbanism*.
- Mourato Vaz, J. (2014). *Analysis of the Architectural Design Based on Architecturology in Modern Buildings A route between São Pedro de Moel and Manuel Tainha's Architecture* (Instituto Superior Técnico Lisboa). Retrieved from <https://docplayer.com.br/16128513-Analise-da-concepcao-arquitectonica-a-luz-da-arquitecturologia-em-edificios-modernos.html>
- Moutarde, N. (2012). ZAC Clichy-Batignolles : un atelier de conception pour le secteur Ouest. Retrieved from Le Moniteur website: <https://www.lemoniteur.fr/article/zac-clichy-batignolles-un-atelier-de-conception-pour-le-secteur-ouest.1269604>
- Moutarde, N. (2013). *Le secteur Ouest de la ZAC Clichy-Batignolles se dessine*. Retrieved from <https://www.lemoniteur.fr/article/le-secteur-ouest-de-la-zac-clichy-batignolles-se-dessine.1492369>
- Neuberg, M. (1990). La contrainte. *Dialogue*, (29), 491–522.
- Osty, J. (2013). *Voir et vivre la nature au cœur de la ville*. Retrieved from <https://archive-clichy-batignolles.parisetmetropole-amenagement.fr/voir-et-vivre-la-nature-au-coeur-de-la-ville-460.html>
- Périphériques Architectes, 87 logements, Paris 15e. (2008). In *Architecture = durable : 30 architectes, 30 projets en Ile-de-France* (pp. 184–189).

- Périphériques Architectes. (2013). Retrieved from Paris & Métropole aménagement website: <https://www.youtube.com/watch?v=-a5qOioZjzk>
- Perysinaki, A. (2014). *Evolution du processus de création en architecture face aux impératifs du développement durable*.
- Peuportier, B. (2008). *Eco-conception des bâtiments et des quartiers*. Transvalor - Presses des mines.
- Peuportier, B. (2013a). *Éco-conception des ensembles bâtis et des infrastructures*. Transvalor - Presses des mines.
- Peuportier, B. (2013b). *Livre blanc sur les recherches en énergétique des bâtiments*. Transvalor - Presses des mines.
- Peuportier, B. (2019). *Vers une approche globale de l'éco-conception du cadre bâti*. Retrieved from <https://hal.archives-ouvertes.fr/hal-02201463>
- Picon, A. (2019). Du défi technologique à la refondation disciplinaire. *D'Architectures* 277, 77–80.
- Pieczara, M. (2019). Archetypes in contemporary architecture. *Technical Transactions*, (4). <https://doi.org/10.4467/2353737XCT.19.044.10356>
- Poincaré, H. (1906). La relativité de l'espace. *L'Année Psychologique*, (13), 1–17. Retrieved from https://www.persee.fr/doc/psy_0003-5033_1906_num_13_1_1285
- Pousin, F. (1996). Trois points de vue sur la conception. In Parenthèses (Ed.), *Les cahiers de la recherche architecturale no. 37* (pp. 43–50).
- Pouthier, A. (2012, October). La plus grande centrale solaire photovoltaïque de Paris mise en service. *Le Moniteur*. Retrieved from <https://www.lemoniteur.fr/article/la-plus-grande-centrale-solaire-photovoltaïque-de-paris-mise-en-service.1428274>
- Powell, O. (2012). *The Choreographic Imagination in Renaissance Art* (Columbia University). <https://doi.org/https://doi.org/10.7916/D81834MZ>
- Quinton, M. (2017, November). Franklin Azzi Architecte hybride. *Ideat Hors Série*. Retrieved from <https://ideat.thegoodhub.com/2018/03/23/franklin-azzi-architecte-hybride/>
- Ragheb, A., El-Shimy, H., & Ragheb, G. (2016). Green Architecture: A Concept of Sustainability. *Procedia - Social and Behavioral Sciences, Volume 216*, 778–787. Retrieved from <https://www.sciencedirect.com/science/article/pii/S1877042815062552>
- Rahm, P. (2019). Comment le CO2 est en train de refonder la discipline architecturale sur elle-meme. *D'Architectures* 277, 72–76.
- Raynaud, D. (1999). Le schème: opérateur de la conception architecturale. *Intellectica - La Revue de l'Association Pour La Recherche Sur Les Sciences de La Cognition (ARCo)*, 29(2), 35–69. Retrieved from <https://halshs.archives-ouvertes.fr/halshs-00006158>
- Raynaud, D. (2000). Conception architecturale / conception industrielle. In *Rapport d'activité LAREA*. ENSA Paris La Villette.
- Raynaud, D. (2001). Compétences et expertise professionnelle de l'architecte dans le travail de conception. *Sociologie Du Travail*, 43(4), 451–469. [https://doi.org/10.1016/s0038-0296\(01\)01175-x](https://doi.org/10.1016/s0038-0296(01)01175-x)
- Raynaud, D. (2002a). *Cinq essais sur l'architecture, études sur la conception de projets de l'atelier Zö, Scarpa, Le Corbusier, Pei*. L'harmattan.

- Raynaud, D. (2002b). Schema as an architectural design operator: the case of the transformation of the morphological model. *Nordisk Arkitekturforskning*, (15), 7–26. Retrieved from <https://halshs.archives-ouvertes.fr/halshs-00005917/document>
- Raynaud, D. (2004). Contrainte et liberté dans le travail de conception architecturale. *Revue Française de Sociologie*, 45(2), 339–366. <https://doi.org/10.3917/rfs.452.0339>
- Raynaud, D. (2017). Échelles et raisons d’agir dans la conception architecturale. *Sciences Du Design*, 1(5), 131–144. Retrieved from https://www.cairn.info/article.php?ID_ARTICLE=SDD_005_0131&contenu=article
- Revedin, J. (2017). La Ressource Illimitée du temps Démarche Processuelle vs Tabula Rasa. In Alternatives (Ed.), *Sustainable design 5 : vers une nouvelle éthique pour l’architecture et la ville* (p. 8).
- Revedin, J. (sous la direction de). (2018). *Construire avec l’immatériel* (Alternatives, Ed.).
- Ricciotti, R. (2013). *HQE - La HQE brille comme ses initiales sur la chevalière au doigt*.
- Ristori, D. (2015). *No Title*. Retrieved from <http://www.dailymotion.com/video/x3gdghs>
- Romo, E. V. (2015). *Processus de conception énergétique de bâtiments durables*. École Nationale Supérieure d’ Arts et Métiers.
- Roth, L. M. (editor). (2020). *America Builds. Source Documents in American Architecture and Planning*. Routledge.
- Rougé, N. (2015). Clichy-Batignolles: Where urban planning meets the climate. *OECD Observer*, (304), 53–54.
- Safin, S. (2011). *Processus d’externalisation graphique dans les activités cognitives complexes: le cas de l’esquissenumérique en conception architecturale individuelle et collective* (Université de Liège, Belgique). Retrieved from <https://orbi.uliege.be/handle/2268/110740>
- Sequeira, J. M. de. (2011). Architecture & Research: a possible structure. *AE Revista Lusófona de Arquitectura e Educação - Architecture & Education Journal*, (5). Retrieved from [file:///C:/Users/n_abudieh/Downloads/architecture research structure.pdf](file:///C:/Users/n_abudieh/Downloads/architecture%20research%20structure.pdf)
- Seres, A. (2011). Une voie ferrée va balafrer le nouveau parc des Batignolles. *Le Figaro*. Retrieved from <https://www.lefigaro.fr/actualite-france/2011/10/17/01016-20111017ARTFIG00695-une-voie-ferree-va-balafrer-le-nouveau-parc-des-batignolles.php>
- Simon, H. (1969). *The science of the artificial*. MIT Press.
- Soler, F. (n.d.-a). CARDINET / PARC 17. Retrieved from <http://soler.fr/projet/cardinet/>
- Soler, F. (n.d.-b). Lot E.5 | Parc 17 Francis Soler Architecte. Retrieved from <http://cityscape.fr/fr/batiment/lot-e5-parc-17>
- Stals, A. (2019). *Pratiques numériques émergentes en conception architecturale dans les bureaux de petite taille Perceptions et usages de la modélisation paramétrique*. Université de Liège, Belgique.
- Tardieu, C. (2015). *Transition énergétique dans les projets urbains : conditions de mise en œuvre. Analyse des cas Paris Rive Gauche, Clichy-Batignolles et Paris Nord Est* (Université de Lille 1). Retrieved from <https://ori-nuxeo.univ-lille1.fr/nuxeo/site/esupversions/12ba8453-763c-4ea0-885c-d8d352e80f7c>
- Tardieu, C. (2017). Approvisionnement en énergie des projets urbains : échelles et acteurs. Analyse

- des cas Paris Rive Gauche, Clichy-Batignolles et Paris Nord Est. *Développement Durable et Territoires*, 8(2). <https://doi.org/10.4000/developpementdurable.11819>
- The future of buildings lies in sustainable architecture with Frank Heinlein*. (2016). Retrieved from <https://medium.com/thebeammagazine/frank-heinlein-10a308300975>
- Thomas, S. (2015). *Energy efficiency policies for buildings*. Retrieved from https://bigee.net/media/filer_public/2015/02/06/bigee_broschuere_energy_efficiency_policy_in_buildings.pdf
- Till, J. (2007). *Architectural research: three myths and one model*. Retrieved from https://jeremytill.s3.amazonaws.com/uploads/post/attachment/34/2007_Three_Myths_and_One_Model.pdf?utm_medium=website&utm_source=archdaily.com
- Toubanos, D. (2018). *Les projets de logements en Europe à l'aune du développement durable : adaptations, transformations, innovations et obstacles dans la conception architecturale (2005-2015)*. Ecole doctorale Ville, Transports et Territoire – ED 528 (Université Paris-Est).
- Trottin, D. (n.d.). Lot E.2 Cardinet Quintessence - Périphériques Architectes. Retrieved from <http://cityscape.fr/fr/batiment/lot-e2-cardinet-quintessence>
- Trottin, D., Marin-Trottin, E., & Jumeau, A.-F. (n.d.). 117 Logements ZAC Cardinet Chalabre, Paris. Retrieved from <http://www.marin-trottin.com/cardinete-quintessence>
- Van Eeckhout, L. (2017). *L'urbanisme du Paris d'Hausmann, modèle pour la ville durable ?* Retrieved from https://www.lemonde.fr/smart-cities/article/2017/02/01/l-urbanisme-du-paris-d-hausmann-modele-pour-la-ville-durable_5072553_4811534.html
- Vitalis, L. (2019). *Modéliser le processus de conception architecturale à l'aune d'une « conception de la réception » : étude épistémologique* (CNAM, Paris). Retrieved from <http://www.theses.fr/fr/2019CNAM1260>
- Vitalis, L. (2020). *De la conception architecturale biomimétique : Essai de modélisation à partir du cas du National Beijing Stadium "Bird's nest" de Herzog & de Meuron*. Retrieved from <https://hal.archives-ouvertes.fr/hal-02492364>
- Vitalis, L., & Guéna, F. (2020). Considérations formelles sur la relation recherche-projet en architecture dans le contexte des interrogations sur la recherche. *Les Cahiers de La Recherche Architecturale Urbaine et Paysagère*. Retrieved from <https://journals.openedition.org/craup/3201>
- Vitalis, L., Li, F., Apostolou, M., & Guéna, F. (2020). Une analyse non-substantialiste de l'architecture et du paysage. *Arts et Sciences*, 20(4), 47–66. <https://doi.org/10.21494/ISTE.OP.2020.0575>
- Wippler, J.-L. (2018). *Une approche paradigmatique de la conception architecturale des systèmes artificiels complexes* (Université Paris-Saclay). Retrieved from <https://pastel.archives-ouvertes.fr/tel-01997661/document>
- Zedin, T. (2020). *De la mécatronique de conception vers la mécatronique de construction : à la recherche d'une genèse pour la conception de la robotique sur chantier*. Paris, HESAM.

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Explorations de la conception architecturale au temps de la transition énergétique

Résumé

Cette recherche exploratoire s'intéresse aux manières dont les architectes prennent en compte les questions énergétiques. Plus précisément, elle observe l'implication des considérations énergétiques dans le travail de conception architecturale.

L'objectif est d'interroger et d'analyser des activités impliquées dans la conception d'espaces énergétiquement performants en vue d'arriver à la construction des modèles de connaissances sur les manières dont l'énergie influence le travail de conception.

Pour interroger ces activités de conception nous avons choisi de mobiliser les concepts du modèle architecturologique. L'architecturologie est utilisée comme un moyen permettant le développement de niveaux de compréhension à travers une distance critique.

Nos cas d'études ont été choisis pour leur compatibilité avec le sujet. Ils sont extraits du projet d'éco-quartier de Clichy Batignolles situé dans le 17^e arrondissement de la ville de Paris.

La méthode d'analyse consiste à appliquer la grille architecturologique sur un corpus constitué de trois bâtiments. Leur récit architectural est décomposé en identifiant les opérations prenant part à leur conception. A partir de ces analyses, des modèles théoriques de la conception architecturale de ces bâtiments sont produits.

Les résultats sont ensuite exprimés dans une réflexion synthétique.

Mots-clés : architecture durable, architecturologie, conception architecturale, éco-quartier, énergie

Résumé en anglais

Explorations in architectural design at the time of energy transition.

This exploratory research is interested in the ways in which architects take into account energy issues. More specifically, it observes the implication of energy considerations in the architectural design activity.

The objective of the research is oriented towards questioning and analysing the activities involved in the design of energy efficient spaces in order to construct knowledge models on the ways in which energy influences architectural design activity.

To interrogate the design process, we have chosen to mobilize the concepts of the architecturological model. Architecturology is used as a means for the development of levels of understanding across a critical distance.

The method of analysis consists of applying the architecturological grid to a corpus constituted of three buildings. Their architectural story is decomposed by identifying the operations involved in their design. From these examinations, theoretical models of the architectural design of these buildings are produced. The results are then expressed in a synthetic reflection.

Keywords: sustainable architecture, architecturology, architectural design, ecodistrict, energy