



Metaphorical and Analogical Thinking in Urban Design and Planning

Master Thesis (P5) July 2017 Ruiying Liu 4481062 Ryliu2001@gmail.com

Urban Fabrics Department of Urbanism Faculty of Architecture Delft University of technology

Supervisors Dr. ir. Egbert Stolk | Environmental Technology and Design Prof. ir. Frits Palmboom | Van Eesteren Chair

Cover Shed a Light on (Sketches from interviews and own work; collage by author, original materials to be found in 4.5)

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In this book, M-A (short for metaphor-analogy) refers to 1) the mode of thinking comprised of metaphor and analogy, and 2) ambiguous instances of metaphor/analogy. (See 3.1)

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Preface

Metaphorical and analogical thinking is a window for scientific investigation into how human intelligence tackles complex tasks in the built environment. From theories of cities, to analogical design, to concept forming in planning, metaphors and analogies permeates urban design and planning, giving rise to insight, ingenuity, and collective feats. As a way of thinking, metaphor is seeing one concept in terms of another better-known concept, which allows the thinker to conceptualize and reason about the less-known concept. Analogy also compares one concept to another, which allows the thinker to reason about the less-known concept, specifically by mapping analogous features. Together they comprise an important mode of thinking in design & planning, crossing spatial scales and mental processes, as well as the boundaries between design and planning. In this book, "M-A" will be used to refer to 1) complex/ambiguous instances of metaphor/analogy, and 2) metaphor and analogy as one mode of thinking (see 3.1).

This book aims to initiate a wider and deeper understanding of metaphor and analogy as a mode of thinking in urban design & planning¹, by clarifying the cognitive processes² and patterns beneath their diverse phenomena in the disciplinary context. To do this requires a leap connecting the scientific theories to the phenomena in urbanism, which is only possible through a re-interpretation of both. Therein lies the challenge: Cognitive scientists and designers see M-A thinking from different scales. It is like how chemists would study the

¹ Urbanism is used in the European context to refer to *urban design* and *planning* as one discipline. The design and planning activities will also be frequently referred to as one in this book, because in practice they are often intertwined (at the end of this book is also a reflection on their differences, see 6.2).

² The studies of cognition is not only focused on rational information processing (the paradigm of classical cognitivism). Researches on the role of emotion, values and cultural knowledge in the cognitive process have greatly informed this research (see also 1.1.2).

PREFACE

molecular composition of a substance, while material scientists would focus on its physical properties. To understand this substance, both the macro- and the micro-scales need to be examined³.

However, without a unifying framework, researchers focused on different scales find it difficult to understand each other. Similarly, it has been difficult to structure this book that both scientists and designers are used to because of the linear flow of text. Designers would find it difficult to assign relevance to the cognitive mechanisms and favour the discussion of the patterns underlying the phenomena. Cognitive scientists would see the discussion of phenomena prior to a formal theory of mechanisms as flawed reasoning, because scientific researches are often formulated with such theories. Yet on this subject, the mechanisms are also re-interpreted to be responsible for the phenomena. Only when they are compatible, can theories reveal new patterns beneath the phenomena. Between the scientists' "scale" and the designers' "scale", this research is to demonstrate the relevance of one to the other. To complete this journey, the reader is urged to think of the book not as *a tree*, but as a *lattice structure*, or an ensemble of multiple *trees*.⁴

This book starts with phenomena detection and structuring, not because that is where the inquiry really started, but because starting with phenomena facilitates the perspective to go beyond existing theoretical frames.

Chapter 1 summarises the research status and identifies a range of typical forms of M-A thinking in urbanism—dubbed "phenotypes" for their diversity and common cognitive mechanism. Chapter 2 constructs a framework on the disciplinary level, by clarifying the context, roles, and characteristics of M-A thinking. To understand how the different characteristics relate to the roles, we move onto the scale applied by cognitive scientists. Chapter 3 summarises the

³ The different scales of the physical world result in different levels of scientific inquiries, each with its own tools and explanatory mechanisms, such as psychology and neuroscience. Bechtel (2008) argues that the two levels are not only compatible with each other, but mutually constraining.

⁴ The difference between the tree structure and the lattice structure as both spatial organisation and design thinking is most notably explicated by Alexander (1965).



Fig. 1.1 Structure of this book



Fig. 1.2 Book structure as landscape design

cognitive mechanisms of metaphor and analogy, and explains the reasons to study the two as one. From there on, we can get a footing on the middle scale: using the basic cognitive mechanism to reveal the patterns underlying complex M-As in real-world phenomena. This concludes Part I Framework Construction⁵.

Part II Practical Issues aims to address the practitioner's perspective: how can the findings and theories developed in this book be used to analyse, reflect, make and diagnose M-As? How can it serve design education? Finally, Part III Fundamental Questions shares the more personal opinions inspired by this research. Chapter 6 sums up what I learnt/assumed about design and planning in this research. Chapter 7 argues for studying human design intelligence to inform the development of technology.

The structure of this book (Fig. 1.1)—organisation of verbal information—can be likened to landscape design for a villa (Fig. 1.2): Part I lies on the central axis, proceeding from main entrance, courtyard, main building from a distance, and main building inside. Part II is the garden and park, connected to side entrances. In the book, addressing practical topics is providing a kind of user experience of the theoretical work, as the garden and park offer experiences of the villa from a perspective connected to the surroundings. Finally, Part III is made out to be two viewing platforms, one overlooking the cities and the other the forest.

The research behind this book is briefly summarised as follows (elaborated in Academic Reflection).

The research questions range from questions over the phenomena and mechanisms on the subject, to the methodology for the subject, and to the practical purpose of the subject:

⁵ This part is developed into the paper *Metaphorical and Analogical Thinking in Urban Design and Planning—A cognitive-process-based framework for an understanding in the disciplinary context* (Liu & Stolk, 2017, in preparation).

- Why is M-A thinking practised in urbanism?
- How does it meet the various needs in urbanism?
- What characteristics do the M-As of different roles have?
- Why do they have these different characteristics?
- How can the study of M-A thinking address both scientific framework and the phenomena in urbanism equally without assuming a pre-existing theoretical structure?
- What application prospects do the results have?

The approaches come in four parts:

- Applying knowledge from cognitive science, so as to extract from the three sources of design research: people, process and products (Cross, 2006b, pp. 100-103)
- Conducting empirical research to gather cases and opinions from practitioners, so as to base the research in disciplinary context.
- Constructing explanatory framework based on detected phenomena, so as to account for the phenomena and avoid being restricted in a narrow frame prematurely.
- Proposal-making, namely connecting the theory back to concrete phenomena and prescribing practical principles for decision-making.

The results:

- Identified views & trends in research, instances in the processes of urbanism, and the gap between them.
- Empirical research: gathered opinions and cases that indicates why M-A is practised in urbanism, how it helps the design/planning process and how different qualities are evaluated.
- A framework to structure and explain the M-A phenomena in urbanism, and furthermore, using the dynamics observed, to

indicates how to work with M-As.

- Identified three types of cognitive patterns underlying M-As of different roles through three in-depth case analyses.
- A system for practitioners to reflect on the practice of M-A.
- A proposal on how to use the findings in design education.
- By-products: distinguishing the qualities of design and planning; identified how studies of this kind can have implications for technological development in urbanism.

In addition to the research contents, three short articles and part of another project are also included as Interludes. They instantiate some points in the research contents, regarding: the role of M-A thinking, the cognitive patterns in M-As, how designers make M-As, and how M-A can be applied in urbanism studio work. There are three articles, originally published in student magazines (*Bnieuws* of the faculty and *Atlantis* of the Urbanism Department) as I developed the theories. The project, *Arnhem Unmythified* (2015), applies M-A thinking to detect building typology and to portray a spatial history of the city form.

Acknowledgement

I would like to thank my mentors, Egbert Stolk and Frits Palmboom.

Egbert was my tutor for my very first project in this faculty. He constantly challenged me to make qualitative innovations, which resulted in the unique project *Arnhem Unmythified* (see 5.4). Since then he had been preparing me—for almost a year—by guiding me to understand my own work and develop a frame of complexity theories of cities and cognitive science. All of that has laid the foundation of this project. The final piling was his scientific, methodological view on design, which has justified it for me to enter into a research-oriented, meta-design thesis, seeking insight rather than individual products. During the project, he helped me navigate by providing me most of the references, and even suggested that I use interview as method to exploit the "natural resources" of the faculty. Towards the end, conversation with the expert has become our set ritual, as we also put our paper to the test by asking a designer, a planner and a design cognitive scientist to review it. Finally, he has been more than a teacher, as he has been advising me on not just academic contents, but also on strategies for research and for life.

Frits has been the other pillar of my project. He has been the touchstone on practical groundings of all the theoretical development. As a designer, he is extraordinarily open-minded to discuss with me all the issues that are not directly related to specific design. As a mentor, he did not just point directions and make requirements, but rather guided me based on understanding me. And as it turns out, all his questionings and input has critically shaped this work to be more practical and inclusive than the majority of works on this theme. His wise strategy of motivation was also the reason that this book came to be—making it possible for the results of this research to really fulfil their relevance to the urbanism community.

I am indebted to staff of the Urbanism Department, especially Paul Broekhuizen, Leo van den Burg, Wil Zonneveld, Ali Guney, Hamed Khosravi, Els Bet, MaartenJan Hoekstra, Francisco Colombo, Ulf Hackauf, and Andreas Faludi. Giving their time, expertise and materials freely to support my research, they are truly the natural resources that built my "villa".

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Beside my academic support, I would like to extend my sincere thanks to the faculty magazine *Bnieuws* and the Urbanism Department magazine *Atlantis*. Both have been my training ground on writing/interviewing, and provided me the platform to cultivate ideas that eventually went into this book (*Bnieuws 50.06, 50.07*, and *Atlantis 27.3*).

Finally, I thank my greatest sponsor and supporter, my family, who gave me a second chance to indulge in the pursuit of knowledge, who will never read this book, and the thought of whom accompanied every word I typed.



Part I Theory Construction

1 Research and Phenomena

This chapter introduces the subject of metaphor-analogy (M-A) from two sides: research and phenomena in urbanism processes. Precursors of the urbanism discipline recognise metaphor and analogy for their **creative and epistemic roles**. Findings in cognitive science shed light on the cognitive mechanisms, functions and main variables. In their wake, **formal investigations** of M-A emerge in design disciplines: one group focuses on critiquing M-A-related phenomena, the other on the roles and variables of M-A thinking. However, when contrasted with the practical processes, researches are only addressing a **limited scope**. By identifying **M-A instances** by the cognitive mechanism, we can see how pervasive and versatile M-A thinking is as phenomena. The lack of an **overview** of how M-A thinking figures in the disciplinary context is not only a barrier between M-A researches and design practitioners, but also an **obstacle** to a deeper understanding of M-A thinking in urbanism.

1.1 Research

A closed circle meets the scientific revolution, and two lines of inquiry are born.

1.1.1 Traditional views

The research interest in M-A in modern urbanism started early in creative strategy theories in architectural design—a time when urban design/planning are done by architects. Antoniades (1990) lists metaphor as a major creative channel in design practice, evaluating a wide range of major architectural works. But all his empirical cases are detached public buildings; which means their strategies would not apply to everyday urban environment. Referring to the Kantian philosophy, Ungers (1982) argues that analogies and metaphors can lead to insightful interpretation of urban elements and their meaningful transformation. Their educational results strongly support their argument. The development of knowledge in disciplines of the built environment is full of examples where whole lineages of theories, models and design methodologies are initiated by cross-domain M-As (Livingstone & Harrison, 1981; Philip Steadman, 2008). Among them are well-known examples like organicism, and biological analogies. Design theorists are of the view that M-A thinking is justified, or even necessitated, by the ill-defined nature of design problems and complexity of the built environment: Rowe (1982) identifies analogy as a major mode of heuristic reasoning. Renaming metaphor and analogy as displacement of concepts, Schön (2001) explains they are essential to innovative breakthroughs in unfamiliar or complex situations.

In the early 90s, a new trend of design cognition study emerges that side with artificial intelligence to reframe the design activity. If the previous stage's discourse is concerned with teaching the design practice, this stage sees a new focus on reconstructing the design intelligence with the help of computer technology. Although the practical community see little relevance in formalising the design activity, such works have resulted in a much clearer understanding of design creativity and the problem of reductive analytical paradigms.

Addressing morphological design, Gero (1990), Tzonis (1992a) and Roozenburg (1993), all proposed similar schema/frame/pattern of reasoning to capture the process and knowledge involved (Fig. 1.1–1.3). Their three-part frames/patterns show how abstract function/performance is made into concrete forms. Roozenburg focuses on the abductive reasoning nature⁶ of this process; Tzonis

⁶ In science, abductive reasoning is making inference by reasoning from claims about phenomena, understood as presumed effects, to their theoretical explanation in terms of

(form \land actuation) \rightarrow purpose



Function ← Behaviour ← Structure

Fig. 1.1 Roozenburg's pattern of reasoning in design Fig. 1.2 Tzonis' frame for representation of architectural knowledge Fig. 1.3 Qian & Gero's "FBS" path

and Qian and Gero (1996) demonstrate how this schema/frame is the key to analogical design. Tzonis argues that the huge variability and non-verbal nature of forms make accumulating and applying morphological knowledge⁷ problematic in literal terms, and therefore analogical design is inevitable. Qian & Gero further develop a programme to carry out analogical design by using forms of known objects in creating new ones.

underlying causal mechanisms (Haig, 2014). In design, the "claims about phenomena" is replaced by "the requirement/goal", and "explanation" replaced by solution (Roozenburg, 1993). In essence, it is proposing an answer to a given problem by introducing, or "inventing" a causal relation that is not deductible from the given conditions.

⁷ In Tzonis' own words, the frame represents "architectural knowledge"; Qian & Gero, studying design in general, use the term "design knowledge". In the context of urbanism such terms are not nearly accurate enough. Since they both deal with reasoning about and producing forms, I shall call them morphological knowledge, which is not just about the forms themselves, but also the attached causal knowledge about how forms can be used.

Traditional discourse on M-A mentions very little regarding the area of planning. Schön's theory (1993) on the problem-setting role of generative metaphor in social policy is highly relevant. Zonneveld (1991) observes that metaphors with high communicative power are often employed in forming planning concepts. Terms such as corridor, ring and belt have a high frequency in the most basic planning reasoning; concepts like the Garden City, the Finger Plan and the Green Heart, are created to convey planning strategies.

1.1.2 A Scientific boost

In cognitive science a shift of paradigm was started in the 70s: from that of the classical cognitivism, rational information processing, to that of the "second generation", embodied cognition, represented by a number of major works (Lakoff & Johnson, 1999; Varela, Thompson et al., 1993). This has given rise to interests in understanding the less rational aspects about human intelligence—such as emotion, values and cultural knowledge (Damasio, 1999; Heise & MacKinnon, 2010; Thagard, 2008). Theories of metaphor plays a fundamental role in this paradigm shift: by "seeing one thing in terms of another", metaphor even allows us to conceptualise abstract ideas with bodily experiences. It is not primarily a matter of language, but a mode of thought (Lakoff & Johnson, 2008; Ortony, 1993). It effectively argues for the body's role in the making of the mind, and challenges the dominance of rationality.

The shift of paradigm in cognitive science was accompanied with an abundance of scientific studies on metaphor and analogy. Metaphor is seeing one concept in terms of another better-known concept, which allows the thinker to conceptualize and reason about the less-known concept (Fig. 1.4). Analogy also compares one concept to another, which allows the thinker to reason about the less-known concept, specifically by mapping analogous features (Fig. 1.5).⁸ Evidence from neuro- and cognitive science shows that analogies are used

⁸ Although most research address metaphor and analogy separately, analogy can be seen as a special kind of metaphor (Gentner & Jeziorski, 1993). Based on this view, and in





Fig. 1.6 Learning new principles (up) from precedents (down) (Winston, 1982)

to generate inferences and predictions in solving novel problems (Bar, 2007; Holyoak & Thagard, 1996). Analogy also facilitates the abstraction and application of rules, principles, and schemas, therefore it is also a learning mechanism (Fig. 1.6; Gentner & Medina, 1998; Gick & Holyoak, 1983; Winston, 1982). Metaphor is a basic way for the human mind to conceptualise abstract concepts and reason about novel phenomena. It underlies some of the most fundamental aspects of human culture and knowledge (Lakoff, 1993; Lakoff & Johnson, 2008) and scientific advancements (Gentner, 1981, 1983). In social processes, analogy facilitates collective creativity through group communication (Dunbar, 1995). Metaphor and analogy transfer and generate emotions and can greatly influence how the public reason about complex issues (Thagard & Shelley, 2001; Thibodeau & Boroditsky, 2011).

In the wake of scientific findings emerged formal investigation of M-A in design disciplines. The researches have branched into two groups: One group engage in qualitative analysis, using typical M-As as a kind of phenomenological "microscope" to examine and critique the social, cultural and intellectual realities behind them (Gerber & Patterson, 2014). They assemble a range of discussions loosely related by their common entry point of M-A.

consideration of the phenomena in urbanism, we have studied the two as one subject. For more discussion see 3.1.3.

The second group rely on experiments and quantitative analysis to investigate roles and variables of M-A thinking. Their results indicates that metaphor aids problem framing and solution synthesising, and that analogy facilitates solution generating⁹ (Casakin, 2004; Hey, Linsey et al., 2008). Casakin and Goldschmidt (1999) find that effective analogy is closely related to expertise regarding the task at hand, because experts tend to focus on structural relations instead of superficial features. Goldschmidt (2001) underlines the importance of visuality in design problem-solving analogies. Christensen and Schunn (2007) correlate analogical distance to the type of problems.

Proponents of studying M-A relate it to the knowledge development for the urbanism discipline. Verma (1993) points out that M-As is a way of discovering new relations and their study can lead to making explicit the knowledge they contain. Chettiparamb (2006) explicates that M-A thinking is a way to construct theories by drawing knowledge from other domains, and that if not correctly applied, it can create ineffective theories. This shows the importance of studying M-A thinking for the long-term disciplinary robustness.

1.2 Phenomena

More common than practitioners have realised, and more complex than science has grasped.

While researchers are divided in two groups, the practical community is also divided in their attitudes towards M-A. Some encourage the use of M-A for creativity, but fall short of tackling the misuse and abuse of the M-A device; others reject M-A practice and discussion altogether (Gerber & Patterson, 2014). The reality about M-A, however, is not a simple matter of choice. The anecdotes of

⁹ These studies are not done in urbanism, and their conclusions do not specifically address ambiguous and dynamic relationship between metaphor and analogy. As conclusions to experimentation and data analyses, they still cannot be taken as guidelines for actual practice.

famous architects deriving unusual forms from M-As, and the mimetic gestures of attention-seeking designs are not all there is to the subject.

As a mode of thinking, M-A is a mental "carryover" from one concept (the source) to another (the target), constrained by the similarities between them. This allows the thinker to reason about the target concept with the knowledge about the source concept. It is a powerful epistemic channel that allows people to conceptualize and reason about abstract/complex objects with the knowledge of experienceable objects (Lakoff & Johnson, 2008). M-As comparing the city to organisms allows us to reason about the complex urban systems with our biological common sense. A city is not a tree (Alexander, 1965) joins two highly different concepts, forcing the mind to find previously unnoticed properties of the city. City as an Egg by Cedric Price and The Carpet Metropolis by Willem-Jan Neutelings are examples of how designers use familiar objects to capture geographic phenomena. The same range of objects are used to inform their morphological design, as Le Corbusier using bottle racks to design flexible apartment structure for Unite d'Habitation. Planning concepts like the Finger Plan (of the Greater Copenhagen) and the Green Heart (of West Holland) allow various actors to grasp the central idea of the plan. (Fig. 1.7-1.13)

Apart from the above notable cases, M-A thinking is more pervasive in ordinary processes than most realise. The experience of cities is often mentally processed with M-As: Laypeople would describe a highway as a *barrier*. Designers see an undervalued shoreline as potentially *thread with beads* (Palmboom, 2016). Observations of geographic phenomena like Price's and Neutelings' are highly practised as research synthesis (for example, see 0). Describing an area as the new Manhattan (Stil, 2015), is to share a vision with M-A thinking. The American shopping mall with its features like highway access, parking, a certain building type, business combination, etc., has been widely used as an analogue for commercial development. In preliminary phases of a project, reference images are used in place of elaborate case studies, in order to convey the design intention to clients, or to record it for the designer's own later development. Architects extract architectural types from a large number of cases by assigning

1 RESEARCH AND PHENOMENA



Fig. 1.7 Comparing the subway system to human circulatory system body (Ungers, 1982) Fig. 1.8 Alexander's illustration of a tree-structured town planning(Alexander, 1965) Fig. 1.9 City as an Egg (Jauslin, 2015)



them various analogical identities¹⁰ (Liu, 2016; Ungers, Kollhoff et al., 1977). Researchers/theorists use metaphors to import theories from other domains to give structure to phenomena in this domain, such as the use of complexity theories in planning (Chettiparamb, 2006). (Fig. 1.14–1.16)

We would find far fewer instances of M-A if we only search for it as verbal/ visual expression instead of a way of thinking. It is also such intuitive operation that, under less rigorous circumstances, the thinker can carry out the process without identifying it. As argued above, M-A thinking takes on various forms, distributed across levels, scales and agents (everyday users and designers). But they're all based on one cognitive operation, like biological phenotypes of one set of genes.

¹⁰ See also 5.4 for the example of typology study by comparing building types to animals from my project *Arnhem Unmythified*.

PART I THEORY CONSTRUCTION





Fig. 1.10 The Carpet Metropolis (Neutelings Riedijk Architecten BV, 1989) Fig. 1.11 Le Corbusier's concept for Unite d'Habitation





Fig. 1.12 The cover of the Finger Plan (Ministry of the Environment, 2015) Fig. 1.13 The Greenheart Metropolis (Burke, 1966)

Het Parool NONE ANTEREM STAGGES OFFIC En zo wordt Noord het Manhattan aan het IJ





Fig. 1.14 Amsterdam North to be the Manhattan on River IJ Fig. 1.15 Reference image of an Italian square used by Atelier Quadrat for the design of Amstelveen town square



Fig. 1.16 Typology study by M-A (Ungers et al., 1977)

1.3 The Need for an Overview

Scales, levels and perspectives are all dots to be connected, so that we can uncover the true face of the terrain on which urbanism operates.

Qualitative analysis of M-A cases without in-depth discussion of its cognitive mechanisms often direct its reaction only at the phenomena. The quantitative approach focuses on the mechanisms, but tend to be limited to individual design cycles. Their separate focuses are not unlike those of chemists studying molecular level of a material and craftsmen who care only about the general quality of that material. Yet modern building material inventions have brought them together. Bechtel (2008), addressing the division between psychology and neuroscience, argues that the two levels are not only compatible with each other, but mutually constraining. Meanwhile, some practitioners are proponents of using M-A in design & planning, while



Fig. 1.17 A metaphor for the status quo (by author)

others associate M-A with various problems, such as sacrificing functional/economical needs for meaningful images, or imposing the frame of metaphor on the design activity in linguistic, metaphysical or other unclarified terms (as often done in postmodernism). In contrast, the diverse and pervasive phenomena of M-A thinking in the discipline indicate a deeper pattern stemming from the cognitive nature of urban design & planning, which is yet to be grasped by the qualitative researches, or the quantitative ones, or practitioners.

The implications extend to the discipline's evaluation of intellectual works, its focus in education, and the way technology should support design & planning. For example, if human designers/planners must work through certain paths to tackle complex issues, then are only the works that can directly prescribe spatial intervention valuable? If design & planning is not only about the end intervention, but also about observation and keen insights, then what else should educators cultivate in their students? If human intelligence has been relying on its own skills to deal with complex problems, beyond the quantitative tools and absolute rationality, then how do we propagate and enhance those skills?

The formal study of M-A thinking is a window to approach these questions. But aiming for these broad implications requires first an overview on the presence of M-A, the roles they play in the disciplinary context, and the cognitive mechanisms giving rise to the diverse phenomena.

2 Conceptualising the framework

If we see different opinions/focuses not as contradictory, but as different parts of a unified context, then we will begin to find out explanations beneath the phenomena. To gather perspectives and references, design/planning experts in the Urbanism Department are interviewed. By examining the diverse opinions and cases from a cognitive perspective, the dimensions behind different areas of the discipline are articulated. Based on this context, the roles and characteristics of metaphor-analogy (M-A) as a mode of thinking are identified. The *context–role–characteristics* concept is a way to gain a deeper understanding of M-A on the disciplinary scale: The context is satisfied by the roles it plays, and the characteristics are the traits by which the M-As of different roles can be recognised. Together, they answer three questions: Why is M-A thinking practised in urbanism? How does it meet the various needs in urbanism?

The central idea of this framework is that different M-As play different roles to support different (cognitive) processes.

There are several cognitive processes central to the design/planning activity. Seen as the range of situations/contexts in which M-A plays certain roles, they provide categories to structure and understand the phenomena. Meanwhile, they are shaped by the social interaction required by design & planning, and by the main types of products of cognitive processes in the discipline. Together, cognitive processes, social scales and products are the three basic dimensions characterising the context of urban design & planning. Within this context, the categories are developed in alignment with the cognitive processes. Then in each category, the roles and characteristics of M-As are elaborated. The *context–role–*

characteristics concept offers a way to understand M-A phenomena in the disciplinary context.

2.1 IN SEARCH FOR A UNIFIED CONTEXT

An overview is based on a unified context of a unified discipline.

2.1.1 An unorthodox approach

How to organise various research focuses into one structured overview? And how to reserve room for those yet unapproached M-A phenomena? The tricky part of an overviewing framework is not M-A itself but rather the disciplinary context. Urbanism is still a very young discipline trying to define its boundaries. But one thing is for sure: since urban design & planning only became specialised due to historical changes in spatial and social scales, context is more important for it than traditional design disciplines.

At the beginning of the research, I was at first somewhat aimlessly gathering cases through literature research. My mentor Egbert suggested I interview the staff the get some perspective. I immediate felt this unorthodox approach was a good idea for such an unfamiliar situation. Since no comprehensive theories exist to guide systematic experiments or surveys, the good old fashioned explorative conversation could be more efficient. So I interviewed a total of ten design/planning experts in the Department of Urbanism. They together represent expertise in a wide range of spatial scales and levels of social interaction in the working process.

Their diverse perspectives were challenging as well as stimulating. Some of them are good at intuitively making M-As; others are more sceptical about their effectiveness. Some bring up cases that are by mechanism not M-A but symbolic. Some hardly use M-A in their work at all—which was an important finding in this research in terms of defining the boundaries of M-A thinking. Some focus on complex, visual M-As; others talk about M-As seemingly so simple that seem self-evident at first sight. I absorbed their perspectives, analysed their cases and followed up on the references they suggested. In the end I realised every different or overlapping paradigm has an underlying purpose for the expert's own context. By piecing together those contexts, with the guidance of literature and some background knowledge, I was able to get an outline of the bigger context.

Table 2.1 A short summary of the interviews (in order of interviews)

1. Paul Broekhuizen

EXPERTISE urban design practice in multi-disciplinary context

HIGHLIGHTS Design of Amstelveen town square and two of its main buildings. M-A in practice and its purposes: paradigm, stereotype, pattern, model case, type. *Parti, type* and *schema* mediate analogical transfer.

REFLECTION Metaphor and analogy interwoven in a project for different functions. Routine analogy can be guided with abstraction schemes. There is a logical pattern to M-A thinking.

2. Leo van den Burg

EXPERTISE Residence design, urban fabric of Dutch cities

HIGHLIGHTS Conceptual design, case-based design, and symbol-computation design. M-A in practice: reference projects/images. The subject rarely uses M-A in his work; rather, he relies on a formal system of theories & rules. Refers to his project of proportion in music and in architectural space.

REFLECTION Two of the three "modes" embrace M-A thinking. Use of formal system (aesthetics, style, and symbol computation) coincides with decreased use of M-A. M-A initiates new formal systems; it is used rarely but plays a pivotal role in his personal works (motif and source of inspiration).

3. Wil Zonneveld

EXPERTISE Regional–national level strategic planning and research HIGHLIGHTS What is the difference between planners' M-As and cases like *Arnhem* *as Mythical Eagles*? Planning is full of M-As, but their socio-spatial implications, roles and criteria are under-researched. M-As travel beyond specific projects, create unexpected influence and are not easy to adapt.

REFLECTION M-As about forms could be mistaken to be superficial, appearancebased because we use maps. M-As can have wide, long-term social impact. A framework that goes beyond typology, is needed to critique M-A for its performance & implications. The role of M-A is rooted in the nature of design, planning and the built environment.

4. Ali Guney

EXPERTISE Architectural design and design methodology

HIGHLIGHTS M and A should be studied together but must be distinguished clearly. Mimesis, simile, association are not M nor A. M-A is about knowledge and the use of it by constraining the thinking with certain rules. The structure of architectural knowledge: *form-operation-performance*.

REFLECTION How to distinguish M & A without forcing a dichotomy? How to define M-A for designers without relying solely on linguistic/cognitive terminology? How to ground theoretical discussions on M-A in practical terms of urbanism? Are there differences between architectural knowledge and that of urban design?

5. Hamed Khosravi

EXPERTISE History and theory of architecture

HIGHLIGHTS A. Rossi: design in general is analogous design. O. M. Ungers: M-A for research & design of urban forms. The subject opposes symbolic gestures planting transcendental "meanings" in architecture; supports architecture-to-architecture (A-to-A) analogies.

REFLECTION "Analogous design" is a effect of representation—reality gap; does not necessarily evoke M-A thinking. Ungers uses M as epistemic instrument and A as cross-case referencing tool. A-to-A analogies introduce concrete features of architectural elements, actual spatial processes, etc.

6. Els Bet

EXPERTISE City-regional spatial planning research and consultancy

HIGHLIGHTS Six projects with central M-A concepts: 1) to narrate spatial relations; 2) to represent place characteristics; 3) to narrate social dynamics; 4) designing after the Carpet Metropolis.

REFLECTION The problem that needs studying goes beyond immediate, specific problems, i.e. how to design. M-A emerges during design as *reflection in action*. Echoing Interview 3: "appearance-based" M-As have more than meets the eye.

Communication to users is important because they enact the plan.

7. MaartenJan Hoekstra

EXPERTISE Semiotics in urban environment

HIGHLIGHTS The research needs to clarify how it distinguish M and A. Signs, including M-A expressions have asymmetric producing and consuming processes. Also consider disadvantage of M-A communication.

REFLECTION Etymology reflect defining characteristics of M & A. The M-A design intention may be perceived otherwise by the user. Elucidate the dis/ advantages of M-A.

8. Francisco Colombo

EXPERTISE Practice in urban design and regional planning

HIGHLIGHTS M-A concepts must be specified with "conditions" (social, economic, demographic, etc.). One project using M-A for communication and morphological design. M-A brings surprises that "makes" a project.

REFLECTION Why is it important to specify "conditions" in making and interpreting M-As? Echoing Interview 2: a large "library" of rule systems reduces the reliance on M-A.

9. Ulf Hackauf

EXPERTISE Urban metabolism and architectural design

HIGHLIGHTS Contemporary criticism on the *metabolism* metaphor. M-A as naming helps channel design intention into the social construction of places.

REFLECTION Need to reflect on the phenomena of M-As in theories. Echoing Interview 3: limitation and adaptability of M-A used on large social scales (in theories). Social place-making by M-A is a communicative performance.

10. Andreas Faludi

EXPERTISE Sociological approach to regional planning research HIGHLIGHTS The Green Heart history; the social, political and economic factors behind the rise and decline of the national planning *doctrine*.

REFLECTION The idea of planning *doctrine* is about having a central concept that coordinates individual reasoning, and bind them to commitment.

A narration on the designers' different M-A thinking tendencies can be found in the article in 4.5.

2.1.2 The basic dimensions

Imagine you are designing a space to accommodate for a diverse group of workers. Should it be a flat layout, like a garden, or a building with three-dimensionally connectivity? It depends on those workers, or rather, their working relationships with each other and the environment. So you put your attention on these workers; you sort them and their resources into types and clarify the interactions. Workers and resources as two groups seem to require a more-complicated-than-two-dimensional space for their relation network. They have many directional relation path; and these directions merge into several large directions. They become dimensions, giving a sense of space, which is shaped by an organisational pattern.

Diagram is essentially no different from plan sketches in design & planning. It helps us externalise abstract thought, assemble them into one, and even find out new relations¹¹. The only difference between diagramming and designing could be a lack of concrete, material constraints—yet, maybe the human scale and material consideration in design is replaced by font size and legibility in diagrams.

Thus as I was processing the diverse information from the interview and the literature, I managed to accommodate them by constructing a three-dimensional "space" in the form of a diagram. Since then there have been several reiterations and suggestions from Egbert before I made explicit the dimensions by defining them in realistic terms (cognitive processes, social scales & products). Presenting the basic dimensions first also helps analytical minds conceptualise this "space" more efficiently.

There are three dimensions to the framework of M-A thinking in urbanism¹². First, cognitive processes (of which M-A thinking is one type) are interrelated; and despite their stand-alone products, they are linked like a chain. Second, dif-

¹¹ As a side note here, good spatial planners/designers might be also be good at visualising complex relations. Their spatial imagination might offer good input to diagramming in other disciplines because space is a natural vehicle for abstract thoughts (cf. Liben, 2001). ¹² These dimensions are also discussed in 6.1 with the characteristics that set urbanism apart from other design disciplines.

ferent cognitive processes are linked to different scales of social interaction. This makes sense because contemporary design/planning has developed to exploit different social conditions. Finally, there are entry points and exit points of M-A as a mode of thinking, namely the products of cognitive processes.

Cognitive operations as processes

Human designers/planners are a universal factor in urbanism. The cognitive operations they perform in dealing with complex tasks in the built environment are deeply similar across all areas of focuses. First, neighbourhoods, cities, and regions are complex, large-scale objects whose mental representation requires special efforts and skills to construct (Fig. 2.1; Stolk, 2015). In other words, the objects of urban design & planning are mentally constructed—an "imagined phenomena" (Healey, 2007). Then the knowledge of forms is called upon in spatial design/planning: interpreting existing forms, and imposing new forms. This knowledge is non-verbal, acquired and applied as *schemas* (see 2.2.2). Furthermore, to realize complex projects, explicit terms for communication (both social and self- communication) are required. The challenge lies in making explicit complex objects and spatial ideas. Finally, regional-scale and long-term projects depend on collective processes to implement; so concepts are needed to coordinate the reasoning and action of local agents.

• Social scales of the processes

The social scale dimension ranges from intra-person to societal, and it has direct influence on the outcome of design & planning processes: Mental representations can be idiosyncratic if not meant for wider sharing. The concept of morphological design is often externally represented to be understood among professionals. In larger-scale decision-making, common sense is applied in spatial reasoning so as to address the public perspective. Maher, Paulini et al. (2011) point out that collective design, a new phenomenon compared to individual and collaborative design, is the key to the next generation of challenging design tasks.

Products of the cognitive processes

By "product" we do not only mean the concrete end-products like finished plans and built forms. The output of cognitive processes are often abstract en-



Fig. 2.1 Five scale levels of relations between people and the designed objects (Stolk, 2015)



Fig. 2.2 The model describing interpersonal interaction with a common reservoir in terms of *representations* (Portugali, 2011)

tities like theories, design principles, and cultural symbols. (For simplicity, we see designed forms as directly implementable as built forms, and group them into one.) These products become input to new cognitive processes, and act as links between cognitive processes and agents (cf. Portugali, 2011; Fig. 2.2). In studying M-A, we need to focus on them as junctions between different cognitive processes, and interface between different modes of thinking. For example, we can examine the rules formed by interpreting M-As to find out how M-A thinking support literal thinking.

2.2 CONTEXT, ROLE, AND CHARACTERISTICS

Different M-As play different roles to support different processes.

Within the disciplinary context, the categories are developed in alignment with the cognitive processes. The framework includes four categories for M-A phenomena (shown in colour in Fig. 2.3 Outline of the framework): metal representation, schema designation, communication and collective process. In design & planning, some categories are based on (or come after) others. This is reflected in the diagram by the partial overlapping between the categories. The inter-category transformations are indicated by arrowed lines, which will be the focus of 3.2). The interchange between cognitive processes and products are also indicated with arrowed lines. The following sections elaborate for each category the more specific contexts, roles and characteristics of M-A thinking. Examples mentioned are summarised in Table 2.2 Instances of M-A in each level of cognitive process to better demonstrate their relations.



Fig. 2.3 Outline of the framework (by author)

2.2.1 Mental representation

In order to explicitly represent the complex built environment, the mind must derives meaningful information from it by deflating vast amount of information, or inflating small amount of information (Haken & Portugali, 2014). In other words, increasing or decreasing abstractness of the representation. The transformation of information is not only in the quantitative but also the semantic sense.

There are several possible situations where a semantic transformation is needed. First, the categories are not suitable to work with. Imagine one visits a new city, where there are many different buildings, and the information too overwhelming to grasp. So they assign categories to the buildings: skyscrapers, compounds, perimeter blocks, etc.—what Miller (1956) calls *grouping* to overcome the limited information capacity of human minds. There are different categorical systems to structure information (for different purposes). In this case it may be focused on the buildings' appearances; on another occasion, office buildings–shopping malls–residential buildings is more for the functions. So from simple clusters of buildings, they are transformed into categorical systems; and from one system, they can be transformed into another, in order to achieve different purposes. Sometimes the ideal system does not exist in its own literally defined area, so we turn to M-A to appropriate systems from other areas. For example, by comparing buildings to animals, the typology of the buildings can be established with the categories in the animal domain (Liu, 2016).

Second, to enhance the structure of the categorical system, we seize onto the emergent features/potentials in the system. A clearer cognitive structure allows a more essential and salient representation¹³. For example, we have many superordinate words in our language system, such as "furniture", "animal", and

¹³ My notion about this kind of structural abstraction shares similarities with the notion *synthesis*: bringing the "undividable" components into a possible whole(s) within their mutual structural and semantic relationship (Guney, 2008). But the term *synthesis* comes with too many connotations yet undefined in solid terms.
2 CONCEPTUALISING THE FRAMEWORK





Fig. 2.4 Portugali's (2011) example on how categorisation reduces the amount of information

Fig. 2.5 "Facade" and "library"

"vehicle". These concepts can only be defined with a number of lower level concepts. On the other hand, we have concepts such as "facade"—made of bricks, windows and doors, "family"—made up of related individuals, and "library" made up of books (Fig. 2.5). Their definition also depend on lower level concepts, but clearly they have a different kind of abstractness¹⁴. The struggle to find the "identity" of an urban area in urbanism has everything to do with this distinction. Good designers/planners do not just sum up everything and put

¹⁴ Portugali (2011) also points out "a novel distinction between categories that humans tend to categorize as having a singular identity and categories that are treated by the mind as having only a group identity". This difference seems to be less appreciated in cognitive and psychological science.



Fig. 2.6 Three sketches by Da Vinci (Tzonis, 1992b)

Clockwise: studies of fortification configuration; studies of shadows for the design of a church; shaping fortification profile with lines of fire

an umbrella term on top of it; they find out the internal morphological and functional structures and name it so that it becomes one single, unique concept. From "a bunch of books" to "a library", by adding something else, the information actually becomes more compact and salient. And if the structural features cannot be captured in literal terms, we use M-As to pinpoint it. For example, by "seeing" a fish gestalt in Rotterdam South, the designer creates a salient representation of spatial structure, function organisation, and ensemble of places (for the case study, see 3.2.1).

On a more fundamental level, the need to transform information may have to do with something other than the capacity of mind: the sensory modality of information. Each modality has its own unique reasoning structure, and the thinker can appropriate the reasoning structure embedded in the other modality with M-As. In other words, M-A can give new perspectives to old concepts, allowing new types of reasoning to be conducted. For example, comparing spatial experience to music allows reasoning about the rhythmic arrangement of spatial experiences (Appleyard, Lynch et al., 1964). Da Vinci sees lines of canon fire as lines of vision (in the perspective drawing), and applies the way light "cuts" the outline of objects to "cutting out" the form of the angular bastion (Fig. 2.6; Tzonis, 1992b).

To construct a mental representation by *recognising* the phenomenon, is literal thinking, matching it to a pre-define corresponding concept. In contrast, when the phenomenon is novel, too complex, or in need of novel perspective, M-A provides a window to represent it with known concepts of suitable abstractness and reasoning structure. It mobilises the thinker's established knowledge in a way literal thinking cannot.

M-As in this level are often partial to describing phenomena. They are often multi-faceted, rich in subtle meanings. They can evoke "knowledge" embedded in our sensorimotor functions, allowing new ways of reasoning. Although they do not directly present compelling arguments to prescribe intervention, they lay the groundwork for potential prescriptions by structuring a perspective.

2.2.2 Schema designation

The core of design is giving forms to materials to achieve abstract needs or purpose (Cross, 2006b). And the move from abstract needs to materialisation is not random, but characterised by certain patterns and involving certain knowledge. Gero (1990), Tzonis (1992a) and Roozenburg (1993) all proposed similar *schemalframel pattern of reasoning* to capture the knowledge involved and the *path* from

purposel performance to concrete structure/form.

A *schema* is essentially a narrative of "something does something that achieves something". Like *frame*, it is a kind of information structure, but is specifically structured to direct responses to given situations. The schemas used in morphological design contains information about **what form operates how to achieve what effect**. Tzonis, for example, speaking of architectural design, proposes the frame *form–operation–performance*. It is the structure with which designers extract useful information from daily objects, thereby learning about forms. And as these schemas also direct morphological design, they are essentially the knowledge of forms¹⁵. Cross (2006a) also refers to it as the *non-verbal codes of design*.

Despite that the path of performance–form can be formalised, the actual knowledge that fits into the "slots" has countless variation, and there is no scientific terminology for description and classification. That is where analogy comes in: In analogical design one extracts the schema of one thing and applies it to the design task. For example, Le Corbusier used the schema of bottle rack to design the flexible structure of the apartment building, Unite d'Habitation (Fig. 1.11; Tzonis, 1992a). Ruijssenaars' used the schema of ship-on-water to design the library building that screens off the impact of motor traffic—water—from the pedestrian square—deck. The *water* in this case is a contextual form (for the case study, see 3.2.2). In literal thinking, the schema of bottle rack is only defined for bottle racks. When most of our morphological schemas are articulated in terms of existing objects, it is impossible to design without crossing the boundaries of literal definition, namely, **using the schema of one thing on something else**.

From Tzonis' analysis of the bottle rack schema (Fig. 2.7; ibid.) we can see how complicated a formal description of morphological schema is. How can designers have such clearly defined knowledge for every form they ever notice? This is also where analogy allows us certain conveniences. Our everyday experience

¹⁵ There are also formal languages and pattern languages to direct form giving (Alexander, Ishikawa et al., 1977; Ching, 2014); but as the more clearly defined rules, they are often used for routine tasks, whereas for novel and complex situations, one still needs to go back to the origin of the knowledge.



with objects are not stacked into a morphological schema database. We have a vague idea about all the forms' potentials. Drawing analogy, or aiming to draw an analogy, stimulates the mind to find the right object and extract the schema. Meanwhile, our mind can **encode the schema** with the source concept—"bot-tle rack", or "ship"—instead of having an expansive body of elements and logic relations like in the diagram. Planners also make use of morphological schemas borrowed from other domains: *Corridor*, for example, refers to the structure that facilitates the linear movement or a continuous set of activities between two major location of resources and agents.

This research recognises one more challenge presented by urbanism in terms of spatial design: the design must become part of the context. Therefore this process of morphological reasoning involves **defining existing spatial features** as forms. The contextual forms, together with the designed forms, will operate in a certain way to achieve certain effect. Defining form can be seen as a "reversed process" of form giving: articulating the forms that underlie observed phenomena. Both form giving and defining depend on the knowledge of forms. They both involve mentally designating morphological schemas, one to achieve, the other to explain. In this research they are together referred to as *form designation*; hence the term *schema designation*.

Here M-A thinking comes with one more advantage for context dependent design. As the new form (system) is seen as composed of the designed and the contextual forms, the analogue used here must also share *similarity* with the situation at hand, in other words, a **matching context**. In contrast, symbolic gestures do not match the context part, rather it is created with arbitrary definition. As the mechanism of M-A thinking stresses the similarity between target and source, it falls outside of M-A thinking (see also 2.3).

Finally, form designation is part of schema designation in urbanism—one that is focused on morphological aspects. Program planning in many projects requires schemas of commercial and logistic organisation, which is not inherently attached with morphological contents.

Compared to the multi-faceted and associative M-As in the previous level, M-As used in schema designation embody clear logic of intentional responses. They are more "tailored" to the situation. This does not mean that for each situation the designer has a ready-made schema to respond with; rather, they are often sharpened out of something vague, such as the M-As in the previous category (see 3.3).

2.2.3 Communication

The complex tasks in the built environment requires collaboration and information exchange. Carmona (2010) identifies several types of constant communication gaps in urban design, including the different expertise of professionals and locals, the different focuses of designer and non-designers (namely, consideration of forms), the difference between abstract representations and the "reality", etc. Even a team of professionals often resort to innovative naming among themselves because they deal with non-verbal ideas and novel phenomena. Multi-phase projects create more and more information as they progress, which needs to be abstracted or synthesised for the later participants to grasp. A multi-disciplinary team need to translate each member's professional jargons to ensure information exchange. Finally, design & planning theory inevitably rely on cross-disciplinary knowledge sources (Chettiparamb, 2006; Livingstone & Harrison, 1981), which can make articulating and understanding the new theories difficult.

From the above range of situations that challenge communication, we can identify some cognitive factors that M-A helps to offset. Firstly, it helps designers/planners **articulate novel and non-verbal phenomena or ideas** to each other. In other words, M-A names or symbols are given to phenomena and forms for communication, such as *corridor*, *ring*, and *belt*. This interweaves with the construction of mental representation and schema coding, because in those stages the thinker already needs to "communicate" to him/herself or to collaborators.

Secondly, it can be used to **bridge the gap of expertise** between designers and laypeople, and between designers and other experts/ theorists, by using concepts from common sense or shared knowledge. Designers must interpret their target users' M-A expressions to understand the local conditions. Theories drawing on other discipline's knowledge often start as metaphors to transfer new structures into urbanism (Chettiparamb, 2006). Many use metaphorical terms like *urban metabolism, fractal cities*, and *DNA and genetic planning* (Wilson, 2010) to structure a perspective for their audience.

Thirdly, M-A can be used to **synthesis information/data** by creating meaningful categories (Miles & Huberman, 1994). This aspect is often overlooked in theories of communication in urbanism. Too much information becomes unusable when it overwhelms the de-



Fig. 2.8 Still Life with Aubergines by H. Matisse used to summarise the study of the inner city of Apeldoorn



signer and the user. Research synthesis, for example, is important for the findings to be communicable to later phases in a project. Fig. 2.8 is from an example of synthesis by M-A: the researcher explains with the Matisse painting that the blend-contrast between hefty modern blocks and fine-grained traditional blocks is the city's spatial character (Bet, Hinterthür et al., 2009).

Fourthly, M-A expressions help enrich, or "rehydrate" abstract visual representations, by introducing concrete/experiential/multimodal elements, so that design ideas are conveyed more wholly. The abstraction of diagrams, plans and sections strips away experiential qualities of reality (or intended reality). As these qualities are designed outside the abstract drawings, designers must find a way for them to reach the audience, not with long texts but with apt M-As, drawing on precedents and daily experiences (Carmona, 2010). Examples include using reference images, calling a tree-lined street a "green tunnel", naming a project as *Garden City*, and using the Manhattan impression to express the vision for Amsterdam North (Stil, 2015). Planners also deal with abstraction of their maps: green areas are conceptualised in the image of nature, and vast areas of grey/red in the image of stressful urban environment. Moreover designers and planners must "talk" to themselves in such M-As so that they can handle these "invisible" aspects.¹⁶

Finally, M-A can **elicit support and commitment** from people with affective/argumentative narratives. It transfers and generates emotions (Thagard & Shelley, 2001). It is undeniably a powerful device in shaping the emotional attitudes of the public and mobilising social resources (Thibodeau & Boroditsky, 2011; Zashin & Chapman, 1974). The Green Heart planning concept of West Holland is an example of gaining public support for preservative policies (for the case study, see 3.2.3 and 3.3). Since emotions and values underpin many design & planning issues today, M-A is a necessary tool in addressing those issues (Sandercock, 2004; Thagard, 2016).

In communication, one good M-A is worth hundreds of words/drawings. Because it can "translate" unfamiliar concepts, frame complex situations, help make sense of vast amount of data, "restore" experiential or other qualities stripped away from abstract representations, and evoke emotional response from the audience. It is like a kind of flexible, compact and intuitive information format. Its drawback however, is that its underlying perspectives can lead to unintended interpretations.

Communicative M-As are, first of all, functional concept for spatial design/ planning, often containing spatial and morphological elements. In other words,

¹⁶ The multi-modal nature of design and planning is often overlooked because of the standard representation formats the discipline works with. In *Multimodal Metaphors* (Forceville & Urios-Aparisi, 2009) present a diverse range of metaphor-making and -thinking practices of different disciplines trying to overcome their own medium limitation.

verbal expressions have underlying visual messages. Then, as communication to the public, they generally contain argumentative narratives aiming for emotional resonance. Therefore, communicative M-As engage different channels/modes, cover various levels of abstractness, and connect specialised knowledge to experienceable concepts.

2.2.4 Collective process

Spatial planning is the collective's conscious action to control/shape its environment. The question is how human collectives, made up of conscious individuals with their own reasoning processes, can form organized action and reflection as one entity. Maher et al. (2011) propose the dimensions supporting collective design are Representation, Communication and Motivation. Van der Valk and Faludi (1997), from a sociological perspective, argues for the role of a central *doctrine* which command actors' commitment.

In the case of the Green Heart planning concept (see 3.3, 3.4), the key to such collective action is a concept, which represents the object (the region) and the planning intention. It also serves as a kind of vessel of collective thoughts¹⁷, as it coordinates the reasoning and action of individual agents, and supports continuous public discussion, leading to modified strategies after assessment of earlier actions. The complex nature of cities and regions makes it difficult to saliently represent them in literal terms, therefore M-A is often a necessary vehicle for such objects.

M-As in this level is communicative to begin with. But they have some unique qualities that make them viable as vessel of collective processes. More research is needed to ascertain what these qualities entail.

¹⁷ This research recognises the distinct influence of such concepts as the Green Heart on collective processes, compared to the more ordinary concepts used in design & planning communication. Regarding concepts at work in collective behaviour are many theories, including theories of collective representation (Thagard, 2010). However, a discussion on the exact mechanism or existence of such an entity is beyond the scope of this paper.

Table 2.2 Instances of M-A in each level of cognitive process

Mental Representation	 CATEGORICAL The highway is a <i>barrier</i> between work and home. (Information deflation) The shoreline is not a monolithic whole, but a <i>thread with beads</i> (Palmboom, 2016). (Information inflation) Buildings as <i>animals</i> in Arnhem typomorphology study (Liu, 2016) STRUCTURAL Rotterdam South as a <i>Fish</i> (Fig. 3.5, Appx. A) City as an <i>Egg</i> by Cedric Price ca. 2001 (Fig. 1.9; Jauslin, 2015) The <i>Carpet</i> Metropolis (Fig. 1.10; Neutelings Riedijk Architecten BV, 1989) Spatial experience as <i>music</i> (Appleyard, Lynch et al., 1964) Lines of fire as <i>lines of vision</i> (Fig. 2.6; Tzonis, 1992b)
Schema Designation	FORM DEFINING Site as <i>landscape</i> by Frits Palmboom (Fig. 4.19; Appx. D) Square as a <i>stage</i> of drama where the new building fits in—in Amstelveen town square design (Appx. B) FORM GIVING Building as a <i>Ship</i> (Fig. 3.7 & Appx. B) <i>Hut, ship</i> and <i>bottle rack</i> in Le Corbusier's Unite d'Habitation (Fig. 1.11; Tzonis, 1992a) NON-MORPHOLOGICAL-SCHEMA-BASED American <i>shopping mall</i> as analogue/"model" for commercial facility design

(Table 2.2 continued)

ARTICULATING NOVEL/NON-VERBAL IDEAS Planning terms like *corridor*, *ring* and *belt*

Thanning terms like torritor, ring a

BRIDGING GAP OF EXPERTISE

Urban *metabolism*, *fractal* cities, and *DNA* and *genetic* planning (Wilson, 2010)

SYNTHESIS INFORMATION

Apeldoorn as a Matisse painting (Fig. 2.8; Bet et al., 2009)

ENRICH ABSTRACT REPRESENTATIONS

Tree-lined street as a green *tunnel*

Amsterdam North to be the *Manhattan* on River IJ (Fig. 1.14; Stil, 2015)

City as a *garden* (used to mean a close-to-nature quality)

ELICIT SUPPORT AND COMMITMENT

The Green Heart planning concept (Fig. 3.9, 3.13, Appx. C)

Collective Process

Communication

The Green Heart planning concept (Fig. 3.9, 3.13, Appx. C)

2.2.5 Thinking products as entry & exit points

M-A thinking produce designed forms, and, with physical construction, built forms. Built forms comprises the built environment, which becomes input to new cognitive processes. Cultural symbols are created through conventionalisation of M-As on the collective level.

Design theories can be constructed with M-As—such as typology theories: Through M-A thinking, the morphological characteristics of types are identified and systematised (Ungers et al., 1977). In individual project cycle, design principles can arise as interpretation as a summary of the insights of M-As in literal terms. Theories and principles are both kinds of rules. As Gentner and Medina (1998) argue, similarity-based reasoning gives rise to abstract rules. Through this link, M-A thinking connects to the rule-based mode of thinking.

The development of abstract rules could be an explanation for why some designers/planners don't use M-A, because routine problems can be solved with rules, whereas novel problems activate similarity-based reasoning (Goldschmidt, 2001). One expert interviewed in the research has expressed that although his experience is enough to solve most problems, a truly satisfying and surprising solution is created beyond known rules—often with M-As. Fig. 2.9 Framework of M-A thinking in urban design & planning (by author)



The framework (Fig. 2.9) assembles the contexts, roles, and characteristics of M-A thinking: Each context is satisfied by the roles M-A plays, and the characteristics differentiate M-As of different roles. There are dynamics among the categories, and between the categories and products of thinking. This, set in the larger disciplinary context, provides a way to get a deeper understanding of the phenomena.

Urbanism education is highly focused on the project scale: everything is learnt for making one perfect project. In doing so we are omitting some vital lessons on what make the society-environment system complex. Nor do we teach in history courses how ideas arose from one project, travel across the field and link various actions into "forces" that define forms of cities. We have seen them as phenomena, but they may not be random phenomena, but rather working patterns of the urbanism discipline. Individuals observe, abstract, name and communicate about novel phenomena. Some of their M-As rise above the collective consciousness and become its base of action. All these indicate the need for investigation, and maybe intervention beyond the project. As Schön (1993) and Reddy (1979) argue, problem setting should be considered the crucial process, as opposed to only problem solving. We should not be overly obsessed with "the one perfect project", and discourage intellectual products that do not provide a quick fix on local or currently defined problems.

2.3 Other Paths to Form-giving

Understanding the roles and qualities of M-A thinking by comparison.

When we don't design with M-As, how else do we design?

Parametric design is designing by a set of well-defined variables and rules. If you know how the variables govern morphological transformations, you can input certain values and parameters to generate forms (Fig. 2.10). Or, if you know the interrelations among all the spatial components, you can try out various combinations for the system (Fig. 2.11). This is what can be called computation. But there are endless functions to generate forms with different variables, one has to first decide what variables to focus on. And the combinatorial computation first require the components and relations to be made explicit, because the rules we learn in design & planning theories are far from enough to generate a complete plan. Especially when the problem is multi-faceted, it would be difficult to judge which set of rules/theories apply.



Fig. 2.10 (Left) programmed block morphogenesis with sunlight access as priority (Watanabe, 2002)

Fig. 2.11 (Right) Variations of a school plan by arrangement of the same components (partial) (P. Steadman, 2014)

Therefore, it is imperative to recognise there is a pre-parametric stage that requires abductive reasoning—in other words, the invention of the rule system. Then, "pulling things seemingly out of nowhere" can be a task for M-A thinking. The pivot is to convert the M-A message into a rule system. It requires making absolute clear what properties/relations are highlighted in the M-A. What may start as an intuitively understood metaphor, is transformed into an analogy and pushed towards the extreme of analogous mapping (see also 3.1). An example is the typology study in 5.4, where the variables are explicated at the end of the *building_animal* M-A. The transformation is not lossless. It hinges on focused selection and the ability to make a system coherent by trial-and-error.

Symbolism is a common way of making a work "meaningful". The tendency is sometimes justified with semiotics study in architecture and the built environment. Everything can be made to bear a message to the user that is not derived from spatial/morphological considerations.







Fig. 2.12 The design concept of Kattenbroek Fig. 2.13 The plan of Kattenbroek with "metaphorical" elements Fig. 2.14 Small Worlds VI by Wassily Kandinsky

If the point of symbolism is to communicate a message, then the effectiveness of design should be evaluated by if the communication is achieved to the user, during intended use of the work. Hence we are considering two factors: 1) the language comprehensible to the target user group, which is rooted in cultural matters; 2) how the work would be normally used/experienced, which we can evaluate with the core expertise of spatial design & planning. Take Ashok Bhalotra's Kattenbroek plan for example (Fig. 2.12, 2.13): His message to the user is the qualities of Kandinsky's painting (Fig. 2.14), which can be appreciated as a masterpiece. However, the message is delivered at the scale of plans and aerial photos, which only the designer can experience. So further questions can be directed at: why converge the resources on making these meaningful forms whose meanings cannot be grasped during the intended mode of use (i.e. on eye level)? In order to cultivate a local identity, should not the residents themselves be kept in close contact with these meanings?

The elements like *De Laan der Hoven* (the lane of courts), *De Verborgen Zone* (the hidden zone) and *De Kreek* (the Creek) are first referred to as "symbolic" and then explained as "metaphors" in the book (Wallis de Vries & Borgonjen, 1997). However, only the first claim is true. The Creek, for example, stands for *life is but a dream* from the song *Row, Row, Row Your Boat.* The connection between the physical creek and creek-in-song has no matching elements in their respective contexts, in other words, no similarity to justify the connection as metaphorical. In fact, the arbitrary use of a concrete object to convey the abstract attitude towards like is textbook case of symbolism.

Mimesis—to imitate the appearance or functional structure of another object is another form-giving path in design. The design can imitate animals, plants, and artefacts, creating what Venturi, Brown et al. (1972) call *ducks* (Fig. 2.15). The design can also imitate historical precedents, a phenomena called historicism: the literal copying of classic works (Antoniades, 1990). Bio-mimicry is another kind of imitation: appropriating the functional structures found in the biological domain, through scientific formalisation of the function–structure mechanism (Pawlyn, 2011).



Fig. 2.15 The "duck" and the "decorated shed" (Venturi et al., 1972)

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When the imitation does not include the essential social, economic and spatial environment, it can create spectacles and theme parks. To "borrow the stimulation of sight and the easy peace of pattern without accepting the responsibility that goes with their significance" is not acceptable (Antoniades, 1990; Arnheim, 1977).

M-A thinking can play undertone to mimetic gesture, so that the designed form makes sense because viewers spontaneously connected it to familiar images by M-A thinking. Sometimes blatant literal imitation can generate good effects. Take for example the Giraffe Childcare Centre (Fig. 2.16): the cartoonish scaled-up giraffe figure stands out in its context but at the same time looks harmonious in it. The relation between the scale of the giraffe and the scale of the hefty office buildings around it is like that between an animal and its natural habitat. This spontaneous M-A mapping could explain how a sense of harmony is transferred into the perception of the scene.

Symbolism and mimesis are often mistaken for M-A, contributing to the negative conception of M-A thinking. A definition by the cognitive mechanism would clarify that without the **similarity** justifying a transfer of morphological features, the thinking process is not M-A; or at least, very poor use of M-A. For



Fig. 2.17 Mimesis and M-A image (by author)

example, having a building imitate a duck is not an M-A. An example of M-A could be: this *building* in the middle of a *meadow* is like a *duck* floating in a green *pool*. The similarity between two situations is *a lone thing–on top of–a vast, calm surface*. Then even a duck-imitating figure on the green horizon can be poetic (Fig. 2.17). This is as far as the M-A alone can take the design. Designers who are more sophisticated with materials would further break down the duck concept, so that instead of directly using the form of the duck, they can embed only the key features into the material. Then the building would both display the character of the material, and at the same time appear vaguely poetic—because the concrete image of a duck is now "hidden".¹⁸ (See 6.2 for a further discussion the translation of M-A ideas into material forms).

¹⁸ "The best metaphors and their best uses are those that cannot be detected"; "the new creation must always transcend its visual resemblance to the metaphorical departure" (Antoniades, 1990). To some, this may appear as playing with subtlety, but the reason for "indirectness" is so that the character or strength of the material can assert itself in the final work. Material is an experience at a smaller scale than the distant view of the whole building. A balance between image of the whole and logic of material is in fact making sense in multiple scales of experience.

2.4 INTERLUDE

During this research, there have been many stimuli for me to rethink some of the disputed yet significant concepts in our discipline. This article (now adapted) is originally written for *Bnieuws 50.02*. Its intention is to demonstrate one of the roles played by such concepts, and to call for reflection on their value and the bias towards them.

THE ELUSIVE WIND AND WATER

Although Fengshui played a central role in the making of traditional Chinese cities, its many principles are never centrally recorded and made into one coherent system. It is an idea that has, through the interpretation and practice by the population—sometimes in contradictory ways, imprinted itself in the built environment. In the confusion of various principles and obsessive adherence, nowadays many believe them to be unfounded superstition.

Nevertheless, for the sake of the urban patterns that endured thousands of years across that ancient land, some explanation must be attempted. Yu (1998) has explicated the cultural psychological influence that Fengshui has left on the ideal spatial pattern in the Chinese mind-set. It accounts for the inherited environmental aesthetics, but it still does not explain the logic of the idea.

It is possible that the logic *in* metaphors can only be understood with the logic *of* metaphor. —And Fengshui is born of metaphors.

The flow-form Law

(Before reading further, the reader is urged to forget the modern concept of urban flows for the moment.)

Beneath all the seemingly unfounded rules is a profound hypothesis: the forms and flows shape each other to achieve a long-term, dynamic co-existence. It echoes the Yin–Yang philosophy. Chinese designers are influenced by both to reason about forms in terms of dynamic balance between emptiness and solidness (invisible flows and concrete forms)—just like the black-and-white symbol.

With no means to validate itself through controlled experiments, the flowform hypothesis never could become science. But for those who shape forms by identifying invisible constraints, this idea corresponds to intuition. In fact, in mechanical engineering there is the Constructal Law (Bejan, 1997) : "for a finite-size system to persist in time (to live), it must evolve in such a way that it provides easier access to the imposed currents that flow through it."

Fengshui has terms for different kinds of flows. Qi (literally translate into "air") is flow. *Feng* and *shui* ("wind" and "water") are both flows. Flows are rapid dynamics, and compared to static buildings, they are invisible. They are the powerful, self-sustained forces of nature (including the force of the human masses). Artificial structures cannot go against flows in the long run. So to build a city that will survive among such forces, the ancient society uses Fengshui to pick the optimal spot in the flowscape, to shape large forms to fit and channel flows; and when they must make major changes, Fengshui teaches them how to tweak, bind, convert and reform flows and get away with it.

Scientific studies to validate the flow–form concept are rare and obscured. One study, for example, applies computational fluid dynamics to examine the air flow in Fengshui-guided interior arrangement (So & Lu, 2001). That can be a start.

Metaphors for the invisible

I imagine long time ago, in a rare, history-changing vision, some early thinkers "saw", through time and space, the world in a complex flowscape weaved by endless, ever-changing, violent forces. It dawned upon them that the nature of spatial phenomena is the dynamic interaction between flows and forms. But back then there was no word such as "flow". Nor were there any means to represent the invisible moving continuums acting on and about the solid forms. How do you conceptualise and reason about these elusive things? How do you begin to analyse their interrelations and design based on that?



So the ancient thinkers turned to their metaphorical and analogical faculty. They compared the invisible continuums to wind and water, giving birth to the Chinese "flow" concept. These metaphors bring the strange and out-of-scale objects into humans' familiar cognitive territory of experienceable concepts.

From thereon, they can be understood, reasoned and communicated about. *Wind* stands for the dispersed, the ephemeral and the pervasive; *water* stands for the shape-able, the constant and the concentrated. They embody two different sets of qualities, and are the reference points for the other kinds of flows on the spectrum, including flows of materials, goods, people, and wealth.

A trans-scalar system

Based on the knowledge of the flows-forms dynamics, generations of designers derived their systems to conduct their trade—ranging from town planning to garden design.

On the highest scale, ancient planners—often also scientists and officials would analyse the forms and flows in the landscape to decide where to fit in the town so that it will "endure a thousand years". Then they plan the town for orientation and inner structure, negotiating and shaping flows of wind, resourcFig. 2.18 (Right) the typical Chinese landscape evokes a sense of invisible forces (image by Eric@Flickr)

es, trading, people, etc. With Fengshui as a tool, the ruling class choose their location and shape the flows to ensure their own dominant position.

On a lower scale, inhabitants select and position their households within the combined natural and built context, based on all the flow-form principles used in the planning phase. Flow resources are good; but since flows are endless, too much resource and wealth would overwhelm and destroy an ordinary household. Thus most folk buildings follow a humble and harmonious path.

On the garden scale, the same designer who practice town planning uses the same principles to organise buildings, water and topology within the walls. Heavy rainfall is to be gathered, stored and channelled; artificial mountains are used to trap heat on the south side and block winter winds on the northwest side; the auspicious influences come from the southeast—the direction of sunrise and spring winds; the building cluster should have courtyards to admit air flows; and so on.

Nowadays much appreciated are the natural twisting paths and symbolic Zen images in Chinese gardens, but they are more than those. They are the material expressions of the metaphorical, trans-scalar and holistic idea, Fengshui.

Once more to *flows*

What about a comparison between the contemporary *urban flow* (especially in urban metabolism) and Fengshui? Metabolic studies focuses more on the content of the flows instead of their spatial behaviour. Modern flows are so "insulated" by the industrial chains of infrastructure—including the movement of traffic—that they are almost disembodied from space. Many efforts are made in urbanism to materialise flow dynamics into spatial forms, but true synthesis is difficult to achieve. What is the impact of waste flow on urban forms, one might ask. The other might answer: does not matter; let's collect the waste and ship

them back as fertilisers. This is how you establish circular flow (and all problems shifted onto logistics and industry).

In contrast, without concentrated industries and infrastructure networks, ancient cities are themselves shaped to conduct flows and process them in a distributed manner. Fengshui principles with the spatial dynamics of the flow—direction, strength, containability, dispersal pattern, etc. —and prescribes spatial forms. And because flows and form are trans-scalar concepts, their correspondence can be designed across scales.

Is it in the Chinese design mind-set?

Chinese designers like aesthetic *balancelharmony* between the dense and the dispersed, the *solid* and the *empty*. This "superficiality" to dwell on formal features probably traces back to philosophies surrounding the Fengshui idea. Some like to talk about invisible *forces* of good or bad influences that the design needs to respond to. Others have an obsession with the temporal *behaviour* of apparently stationary urban forms.—For good or bad, these symptoms are a testament to the power of the *wind and water*.

Notes:

As this research progresses, I realised that maybe another article to compare Fengshui with traditional morphological design in western culture is in order. As we will see in 2.2.2, and I will also argue in 5.2.2, the western traditional architectural thinking focuses on form and its operation, but somehow pays less attention to agent flows—the emergent entity out of the constant, large-quantity presence of agents, which is "solid" like forms but amorphous and dynamic.

3 Cognitive patterns of Complex M-As

The cognitive differences between metaphor-analogies (M-As) of different roles are key to revealing how one thinking mechanism fits into various situations, and the manoeuvrability in making/developing M-As. To study that, we need to venture into the cognitive mechanisms behind M-A. In this chapter, the basic model of M-A thinking is clarified, during which, the reason to study metaphor and analogy as one is also explained. Then the basic model is used to deconstruct three complex M-As, revealing three different cognitive patterns that build up complex M-As from basic building blocks. Finally, the inter-transformability between these patterns is demonstrated. The flexibility of M-A thinking relates back to the phenomena framework: M-As are not rigidly confined to one role, but can be transformed/developed through thinking.

We intuitively know how to reason *in* M-A. But if we are to address the patterns beneath the surface and their implications, we need to begin to reason *about* M-A.

The previous chapter is aimed at understanding M-A phenomena on a general level, and this chapter goes further to explicate their inner dynamics and mechanisms. To draw an analogy to design, the framework presented there is like a building seen from the outside at a distance. This perspective reveals the context and how local phenomena fit into a whole. To know its specific inner workings, we need to "go inside the building"—in other words, study and theorise about mechanisms of M-A thinking. The two perspectives are two sides of the same object, both indispensable to a comprehensive theory.

In cognitive science there are abundant theories on the basic mechanisms of metaphor and analogy. From them can be extracted a general model of M-A



Fig. 3.1 The concept of a meso-scale mechanism (by author)

thinking. However, the basic form of M-A thinking is a universal human cognitive capability, so it is insufficient to explain how it can be manipulated to fit into different contexts. For complex M-As, this research proposes, there are higher-level patterns according to which the basic forms of M-As are organised so that they "fit into" specific contexts. This serves as a meso-scale mechanism (Fig. 3.1), between the general cognitive processes (as presented in the previous chapter) and the basic M-A thinking (according to scientific theories).

3.1 The Basic Form

The vague metaphor and the explicit analogy need to be put on one spectrum to capture the dynamic process of idea development.

Researches in design disciplines often either address metaphor and analogy separately, or stress their different roles in design process. Findings indicate metaphor is for problem framing and solution synthesising; analogy is for solution generating (Casakin, 2004; Hey et al., 2008). However, fewer researches deal with how framing metaphors transform into solutions, and how solution-generating analogies are embedded into a bigger narrative frame. There is also a lack of analyses of complex cases, where metaphor and analogy are often interlocked.

Metaphorical thinking is a mental "carryover" from one concept (the source) to another (the target), which allows the thinker to reason about the target concept with the knowledge structure surrounding the source concept. The content carried over can be categorical membership, associated feelings, ambience, etc. (Black, 1979; Glucksberg & Keysar, 1990), such as in *the city is a capitalist machine*. The carried over can be explicit knowledge, including attributes and structural relationships among objects (Gentner, Bowdle et al., 2008), for example: *the city is a living creature, the port being its mouth, industry its digestive system, traffic infrastructure its circulatory system ...*

Analogical thinking is a special way of carrying over knowledge structure from the source concept to the target, namely by aligning and mapping isomorphic structures (Gentner, 1983; Gentner & Markman, 1997). In the analogy *clouds are to the sky as the wool is to the sheep*, the structure *wool–cover–sheep* is mapped onto the *clouds–?–sky*, so that the inference of *clouds–cover–sky* is drawn (Fig. 3.2). Analogical thinking is constrained by *similarity*, *structure* and *purpose* (Holyoak & Thagard, 1996). *Similarity* warrants the alignment of two concepts, such as the *A–cover–B* structure in *wool–sheep* and *clouds–sky*. *Structure* is what binds the mapping/transference to logic. And *purpose* is what characterises analogy as a conscious effort to achieve an end. Analogies whose mapping involves causal relations are more compelling than those based on only surface features or static relations (Gentner & Markman, 1997). Compare *the clouds are like sheep wool* and *he cuts off the wool like the wind blows away clouds*, the latter uses knowledge in a more sophisticated way and is more appealing to the thinker.

Analogy can be seen as a special case of metaphor (Gentner & Jeziorski, 1993). But the difference between analogy and the rest of metaphor is not a simple matter of explicitness. Metaphors that are based on relational structures can be explicated like analogies (Gentner et al., 2008). But once these metaphors are

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Fig. 3.2 Mapping analyses the cloud-wool analogies, by author, after Gentner (1983). This series came from a discussion with A. Guney regarding how superficial, appearance-based M-As can be "tuned" into more sophisticated, causal-relation-based ones.

Analogous features explicated literally Seeing target as source in all senses

Fig. 3.3 M-A as one spectrum (by author)



Fig. 3.4 Basic model of M-A thinking (by author)

subjected to explication, their message is transformed into analogies, leaving the boundary between metaphor and analogy ambiguous. Meanwhile, some metaphors seem to retain their metaphoricity no matter how much they are explicated. Large metaphoric systems are extendable, and defy exhaustive analysis. The knowledge structure involved can be too extensive to be completely extracted from the source concept, so the reasoning process still relies on the environment in the source concept. Examples such as *time as space*, *life is a journey* are cases in point (Gentner, Bowdle et al., 2001; Lakoff & Johnson, 2008).

Clearly, it is necessary to differentiate between metaphor and analogy. Because metaphors can transfer tacit knowledge or biases, and analogies are governed by explicit logic. On the other hand, their interrelation in creative processes should be highlighted. Because metaphors can create perspectives where there are none, and analogies are guided by purpose—which means perspective. Therefore, it should be helpful for the understanding of complex cases in design & planning, to place metaphor and analogy on one spectrum (M-A; Fig. 3.3). One end is "seeing target as source in all senses", and the other end is "analogous features explicated in literal terms". The metaphor end has the richness from which one can extract and make explicit the analogous features. By explicating a limited set of mappings, the M-A is reduced to literal explanations. That is also one way how rules can be developed (for example, see 5.4). The resistance to move from metaphor to analogy is due to the implicit nature of the carried-over content, the complexity/richness of what is involved in the reasoning, and the extendibility of metaphoric systems. The cognitive characteristics of this metaphor–analogy spectrum are: simultaneously involving two knowledge representations; initial similarities between the two representations can be identified or conceived; content of one representation is transferred to the other, transforming the latter; the connection between the two representations is not conventionalized or defined as rules. This model is the basic form of M-A (Fig. 3.4), and more complex M-As can be seen as built by manipulating this form according to higher-level patterns.

3.2 Identifying Cognitive Patterns

The mind encounters the context, and comes up with ways to (re)arrange the basic building blocks to achieve its purpose.

The basic form of M-A thinking is a universal human cognitive capability, so it is insufficient to explain how it can be manipulated to fit into different contexts. Analysing complex M-A cases can help understand how it is purposefully and effectively used.

One major difficulty to systematically tackle complex cases has been the idiosyncratic contexts. The framework from previous chapter has been used to guide this level of study by providing categories of cases and consistent factors to the context. Three complex cases from each level in the framework are analysed here. By decomposing them into the basic-forms, we identify three kinds of higher level patterns according to which the basic-forms aggregate into the complex whole. We propose that these patterns account for the characteristics of M-As in different roles–contexts, and that transformations between the patterns underlie the transition from one role–context into another.



Fig. 3.5 The original sketch comparing the area to a fish by Els Bet

3.2.1 Multi-level

The M-As aiming at constructing mental representations for complex cases are often multi-faceted, rich in subtle meanings; specifically, multiple levels of meanings regarding the same objects are superposed. The meanings can be superposed because they have different levels of conceptual abstractness. In Rotterdam South as a Fish¹⁹ (Fig. 3.5), the analysis shows that a multi-level pattern organizes the basic M-A forms (Fig. 3.6).

The sketch is a fish that maps onto the target area (level 0). Its mapping is achieved through identifying geometric similarities between its components and the geographic features of the area (level -1). By this mapping, these features are highlighted, and their struc-

¹⁹ Created by Els Bet in the cultural-historical survey of pre-war neighbourhoods in Rotterdam South for Bureau Monumenten of Rotterdam, 2008

ture as a whole is recognised as a fish skeleton. The fish concept gives meaning to its parts (head, spine, tails, etc.), which is mapped onto the local geographic features, so that different places gains their own identity (level -1). But these three kinds of mapping is not the core that gives robustness to this M-A. The experiential qualities of each part of a fish are also mapped onto the geographic features (level -1.1), for example: The hard and dense quality of the fish head maps onto the area around the metro station, which has the highest built density, covered by hard surfaces. The tail is soft and open to one direction, which maps onto the park with green space, relaxing atmosphere and a view onto the harbour. Furthermore, some emergent features in experiential aspects are also in play on the level of the whole, for example: the main mass of the fish is on the body, and circulation goes mainly length-wise. This maps onto the quality of the area (level -0.1) that most residential units gather around the middle parts, and that traffic mainly moves east-west. Finally, with the background cultural knowledge, the viewer may also perceive the level comparing the harbour city to a natural "master of water" (level 1).

In one image, the M-A highlights the essential geographic features of the surveyed area and their experiential characteristics, combining the geographic structure, experiential qualities, spatial dynamics and cultural background. The mental representation that it evokes has many levels of meanings that can be developed in different directions.



Fig. 3.6 The multi-level pattern in Rotterdam South as a Fish (complete analysis in Appx. A)

3.2.2 Multi-layer

M-As used in schema designation embody clear logic of intentional responses. A schema is a piece of procedural knowledge, with a narrative structure like *something does something that achieves something*. The narrative is mapped onto the design situation, so that a similar effect can be achieved. Design tasks often respond to more than one factor. In the case of Amstelveen town square (Fig. 3.7), the analysis of three rounds of analogical design reveals a tendency to tackle multiple factors with a *multi-layer* approach. The *layers*, as demonstrated in the following diagram, are different objects taking up different roles in a logical hierarchy, forming one narrative. We name it this way so as to distinguish it from the previous pattern, where *levels* have a stacking orientation. Fig. 3.8 is an analysis of second round of design²⁰.

The design aims for a building that contains a library and an underground parking. It would separate the square from the main road, and serve as the link converting between car traffic and pedestrian flow. The design concept compares the building to a ship (layer 0). The morphological elements (bow) transfer happens on layer -1. On this layer are also made the decisions that reconcile the relation between the bow form and the rest of the building. (If there is irreconcilable conflict, the transfer cannot stand.) So far, the *building–ship* analogy does not present a very strong argument for itself. That is because the outer layer of this narrative is yet to be recognized: the ship belongs to a context of flowing water, and the building belongs to one of traffic flow. As the flowing water maps onto the traffic flow, the outer layer narrative is realised (layer 1): Ship allows water to flow beneath it, and its deck is protected from the impact of the

²⁰ This round of design is done by Hans Ruijssenaars and Atelier Quadrat, 1994.


Fig. 3.7 A brief illustration of the Amstelveen town square project (materials provided by Paul Broekhuizen & Atelier Quadrat)

Round One: design of the square

Living room enclosed space for staying, with things to watch, place to sit, cozy carpet and no mess in sight.

Round Two: design of the library *Building as a Ship*







Round Three: design of the residential tower *Buildings as dog vs. cat*





Fig. 3.8 The multi-layer pattern in Building as a Ship

flow; the building converts traffic flow and screens off traffic impact from the square. This justifies transferring the ship's form. The total mapping ranges from layer -1 to 1.

The third round is a design of the residential building opposite the library²¹. It responds the context of the library, and the square that both buildings sit in. The analogy compares this building to a tensed-up cat, confronted by the library, a crouching dog, and the square to a theatre, where this drama takes place. The mapping ranges from layer -1 to 2, accounting for an extra factor in the context (complete analysis in Appx. B). This pattern indicates that each layer of mapping is used to evaluate/justify the layers inside it. For example, if a drama is inappropriate for the square, then the morphological transference from a cat would not stand.

²¹ Done by Liesbeth van der Pol and Atelier Quadrat, 1994.

3.2.3 Multi-unit

M-As in communicative roles usually engage multiple information channels, because communication in design and planning is often concerned with both verbal and non-verbal information. The M-As also convey specialized knowledge with concepts in shared knowledge, or generally experienceable concepts. The analysis of the Green Heart planning concept shows how one M-A can contain multiple units of M-As, each carrying its own message and complementary to one another (Fig. 3.9, 3.10; complete analysis in Appx. C).

The first unit is a conceptual metaphor that gives valence to two categories of objects: that which is green on the map, representing unbuilt areas, and that which is not green (grey, perhaps, depending on the map), representing densely built areas. The green colour is conceptualised the image of green open fields, and the grey colour, in the image of crowded, stressful urban environment. This unit grounds the reasoning about abstract cartographic elements in realistic experience. The second unit maps the morphological schemas of a heart onto the objects. Historically, the schemas come in two steps. At first, planners notice only the relationship between a round object and the object wrapping around it. Years later, the schema of what is inside that round object is added—chambers



Fig. 3.9 The area referred to as the Green Heart (Faludi & van der Valk, 1996) and veins of a heart. This unit carries the basis for it to operate as spatial planning concept. The third unit maps a narrative schema. The source narrative is that "a heart is vital to the well-being of the body, so it must be protected". Mapped onto the target, it becomes "this region is vital to the sustainability of the whole West Holland, so it must be preserved". Without explicating this narrative, the *region– heart* comparison could also be an M-A that carries over emotional associations. This unit has played a key role in rallying support for the preservative policies.

The three units are relatively independent but complementary to one another. The perceptual unit is the basis for cognition of two opposing concepts. The second unit prescribes the spatial structure intended for the region, but is unjustified without the third unit. Finally, the third unit cannot direct spatial planning without a morphological message.

The Green Heart planning concept



Fig. 3.10 The multi-unit pattern in the Green Heart M-A (complete analysis in Appx. C)

3.3 TRANSFORMATION

Design creativity is not just about generating ideas, but also developing half-baked ideas, and transforming existing ideas.

Negotiating contexts requires flexibility. The three cognitive patterns of complex M-A arise in response to different contexts, but their products are not rigidly confined to one role. To be used in other contexts, M-As can be interpreted into literal rules, or, they are adapted/transformed, still M-As, to fill in another role.

Multi-level M-As have too much background information and no clear enough argument to justify action. But designers/planners often study the city and record observations like Rotterdam South as a Fish, before they apply them to new design situations. This involves schematising the M-As: identifying the interrelation among objects, especially how some can serve as context in support for the others. For example, when given a new design task-located on the waterfront, required to accommodate a public transport hub, office buildings, residential areas, and recreational space-one can argue that the Fish arrangement is a proven success dealing with the context of the waterfront and required functions. Thus the Fish arrangement is applied in the pattern of a multi-layer schema. Schema designative M-As can also be turned into communicative M-As when their narratives are made more prominent as a relatively independent unit (of a verbal nature, most likely). This unit cannot be a long text of description, otherwise it becomes an explanation of the M-A instead of part of it. In the case of the Green Heart, it is achieved by extending the schema-based name into an affective argument. Fig. 3.11 is a summary of the identified patterns and the possible ways of transformation.

The Green Heart has long history of transformation (see also 3.4): At first it arose as a multi-level M-A, an observation of a geographic pattern in the land. Then professionals used the concept in their planning document to refer to the area, mainly to denote the spatial relationship between that area and its surroundings. Later the Heart concept gained momentum alongside environmentalist movement, and the narrative *heart–wellbeing–body* was highlighted. This



Fig. 3.11 Identified patterns and their transformations

gave salience to the Green Heart M-A, so much so, that it became a cultural symbol in addition to a planning concept. On one hand, it represents the object (the region) and the planning intention (preservation). On the other hand, it has served as a vessel of collective thoughts—coordinating the reasoning and action of local agents, and supporting continuous public discussions. Such discussions later led to a change in policy, namely the differentiation in policies regarding areas inside the Heart. This called for an elaboration in the schema unit; specifically, the structure inside the round form. Faludi and van der Valk (1996) propose to see the new structure as "chambers and veins" to continue the original narrative. The continuous transformations show how one M-A can be adapted for different





contexts, and can be mapped in the framework (Fig. 3.12)

If the range of contexts are seen as a "problem" to be solved, the set of cognitive patterns could be seen as the "solution" practised by human intelligence. This could give a more sophisticated perspective on problem-solving that is focused on transforming patterns underlying existing ideas, rather than idea generation from scratch. Meanwhile, the meso-scale mechanism of inter-transformable patterns connects scientific theories of basic mechanisms to the macro-scale, general cognitive processes. The macro-scale framework can guide the investigation on the meso- and micro-scale; the meso- and micro-scale mechanisms can explain macro-scale phenomena. There may be other categories, links, and/or underlying patterns that we have not identified in our research. Our work so far is to establish a way to study individual cases on multiple scales to build up a comprehensive theory.

3.4 INTERLUDE

This article (now adapted) is originally written for Bnieuws 50.07. It recounts the history and legacy of the Green Heart in the collective process and search for explanations on the sociological and the cognitive levels.

FROM LEGACY TO LEGACY

When I looked for the Dutch case of powerful, space-forming metaphors, I found the Green Heart. With the help of Prof. Andreas Faludi and Prof. Wil Zonneveld, I was able to reconstruct the intricate network of planning history, societal dynamics, and human cognition, and understand the role of metaphor in all this.

"The Green Heart concept lives on in many ways. In the Dutch national form, and in the Dutch culture. These days people would still be proud to say they live in the Green Heart, close to nature," Prof. Faludi says.

For half a century, the Green Heart planning concept played a central role shaping the Western Netherlands into the Randstad as we know it today. The curious thing is that the Dutch did not, strictly speaking, invent the concept they found it in their backyard, just like people discovered the other side of the moon.

Consciousness

Society wakes up to the environment it finds itself in, and tries to make sense of it and act about it.

When cognitive scientists talk about consciousness, they are interested in what underlies intent, the self, and the mental ability to go beyond immediate circumstances (Damasio, 1999). That makes humans different from smart machines, and human society from natural swarms. Imagine an intelligent being encounters an object never defined to it before—it tries to sort it into its known categories, but finds none that fits perfectly. It refuses to give up and ignore this object, because it lives to think, and thinks to survive. So it picks an old category (A) that partly describes this object, and that it somehow likes in this context (b), and makes a new category (Ab) to contain this object. Thus the object is consigned to memory and knowledge; and the being has recorded its consciousness of the object (otherwise it has to "rediscover" it differently every time!).

The Green Heart was "discovered" this way. Long before it was named, the planning pioneer T. K. van Lohuizen, made a map in 1924 that clearly shows a ring-like urbanisation pattern (van Lohuizen, 1925) in his plea for planning at this unprecedented scale. But no plan came out of it. A decade later (legend has it), the KLM founder, Albert Plesman flew over the region and uttered the name that popped into his mind: a ring metropolis—Randstad (Lörzing, 2004)! And this was important, because planning is acting with intent, and intent requires knowing. Now the region was known by a name. During the post-war period, the heyday of nation-level planning, planners held onto the Randstad pattern and, of course, the inner hollow that defines it. They referred to it as the green heart (without capitalisation). They said, unlike foreign cities, which control growth with green belts, the Western Netherlands is blessed with a green heart. And the nation should build upon this historical heritage (Werkcommissie Westen des Lands, 1958). —The society woke up to the *ruimte* it found itself in, made sense of it, and started to act about it.

It was a pretty neat idea: a half ring embracing a tender heart. The form was clear, the intention was clear (accompanied with an attractive vision), and so, the action was consistent. Before long, international scholars and planners became fascinated with the effectiveness of the Randstad–Greenheart concept (Burke, 1966).

Of course, the green heart is not an extremely sophisticated metaphor if evaluated based on the pattern it describes. Perhaps a six-year-old could come up with it, looking at a map of grey and green. But remember, the function of one mind is easy, whereas a collective "mind" is chaos beyond imagination. A



Fig. 3.13 A timeline of the Green Heart (by author)

concept so unequivocally rising to salience and keeping the societal action consistent for decades, is nothing short of collective feats. Only geniuses or madmen would imagine to engineer another one.

Doctrine

Doctrines are not about truth. They are about compliance and commitment of followers.

Prof. Faludi has been studying planning from a sociological perspective for decades, and the Green Heart was one of his primary cases for the dynamics of planning doctrines (Van der Valk & Faludi, 1997). The term "doctrine" raises interesting questions about the purpose of planning: Can you really implement a plan? How flexible is a plan for changes? To what extent is the plan and the changes still consistent?

When the founding fathers of Dutch national planning established the Randstad–Greenheart as a spatial strategy, it effectively coordinated different



sectors' developments and cross-level actions. As the pressure of growth rose, the contest between environmentalists and developers spread into the planning domain. So the Green Heart was portrayed into a powerful vision for open space preservation: imagine, if the well-being of the body depends on the heart, how can one argue for its destruction? The policy tightened the restriction on construction in and around the Heart in favour of agricultural land use. The doctrine was in full strength.

However, in the late 80s oppositions and doubts emerged. The public was divided into three camps (Faludi & van der Valk, 1996): the fundamentalists (Hands off the Green Heart!), the pragmatists (An ounce less green is not the end of the world!), and the heretics (suggesting various ways to consume the Heart). But the real problem for planners was whether the Green Heart concept could actually address these different opinions. How do you manage such a vast area with clean-cut virtual borders and black-and-white restriction policies? While planners were savouring their green vision, local actors found all sorts of ways to bend the rules. Lörzing (1996) even remarked the Green Heart was downright detrimental to the planning practice. He then suggested replacement for it: archipelago—islands of different characters separated by linear development.

The doctrine was challenged, but not yet beyond maintenance. On the other side of the debate, Prof. Faludi and van der Valk (1996) suggested that, instead of throwing away the concept, it can be further developed to accommodate new needs, guiding development with concepts such as "chambers and veins".

But why all this effort to keep a disputed metaphor? Firstly because despite the complaints, a united vision of national form is indispensable in regulating developments and preventing irreparable damage to the land. That's the necessity of planning doctrines, especially in times of rapid development. It has less to do with absolute truth than the worse (unknown) alternatives. Secondly, if doctrines are necessary, discrediting doctrines too frequently reduce their strength to lead followers.—Or the public may not follow the swift changes. Either way, some degree of continuity is needed with complex systems, and the art of *metaphor maintenance* is a wisdom for that.

Imagine a scenario where a doctrine is missing: Professionals make a regional plan with numbers and lines precise to the coordinates. But plans are not laws, and the benefits in development is just too tempting. You won't go after people when they build half a metre out of lines—because there are too many. The rule defeats itself with its impractical precision. So developers feel secured to negotiate a change of numbers here, a shift of lines there—and local governments don't really see why not, given the benefits. Before long the plan is almost reconfigured.—So what's the point of the plan? On the other hand, a metaphorical doctrine like the Green Heart, albeit without a scientific appearance, is conceptually binding. One can only tweak the shape so much without rendering the heart unrecognisable. Not to mention the emotional resonance in its narrative. By contrast, lines and numbers without backing concepts are almost nonsense for directing human actions.

Information

Passing from hand to hand, the metaphor grows into a socially constructed compound.

"How is the Green Heart different from the metaphors we use to frame design problems or create solutions?" Prof. Zonneveld is an expert in conceptualisation in spatial planning; and he posed this question for my reflection. By comparison, the Green Heart is more for large-scale communication. Its countless information particles travels from person to person and group to group, expanding consciousness or conducting the doctrine. But for all this "performance", how is it different from the rest?

Firstly, it's a conceptual metaphor (Lakoff & Johnson, 2008) by which the thinker sees a map of grey and green in terms of everyday experience of urban stress and natural beauty. The concept "green" does not entail value judgement unless understood metaphorically in terms of these experiences. Secondly, to function as a tool of spatial planning, it contains morphological information. Its first official record refers to the ring–hollow complementary form. For this purpose, other metaphors could have also served—maybe horse-shoe metropolis? But there is a third concern: providing an affective argument for the preservation of the described forms. So, the beautiful heart wins.

The Green Heart isn't one message of a single perspective, but different units working as a whole: The perceptual unit differentiates two opposing concepts. The morphological unit prescribes spatial structure, yet unjustified without the third unit. And the narrative unit alone cannot direct spatial decisions.

Metaphor engages a universal human capability, and it is an incredibly sophisticated information vehicle. The Green Heart weaved an invisible sphere, where individual actors are united into a collective by a shared understanding. Its complexity is the complexity of human intelligence rising up to the challenges of the built environment.

Legacy

"The national level planning dramatically declined after we entered the 21st century, due to changed economic and political circumstances ... This marks the demise of planning doctrines. Now local municipalities are calling the shots," Prof. Faludi said. Meanwhile, Prof. Zonneveld reminded that below national level, some regional actors are still walking the path of the Green Heart (Provincie Zuid-Holland, 2016).

The career of the Green Heart metaphor traces a curious loop of self-referencing. It started as a realisation of the urbanisation pattern in the national landscape—legacy of previous generations. It captured that new consciousness because as a metaphor, it bridges the unfamiliar to the familiar. It rose to the status of planning doctrine and imparted the Randstad-Greenheart pattern on the national form. As a metaphor, it makes a good vessel for doctrines because it appeals to human nature. (And what are we but humans?) It was a socially constructed information compound, binding actors by communication. At the end of its (national) career, it has left its own legacy in the national form and the culture, not to mention an array of studies on planning norms and theories. Who would have thought it for one little metaphor?

Part I Roundup

M-A figures prominently in human cognition. It has been indispensable instrument in dealing with complex tasks in the built environment. Most of current researches on M-A are focused on either on qualitative analysis or quantitative studies. Practitioners hold different attitudes towards M-A thinking in design and planning. Therefore, we propose a disciplinary level explanatory framework for an overview and deeper understanding of the phenomena. The *context–role– characteristics* theory argues that different M-As play different roles to support different processes. We further theorize the mechanism of inter-transformable patterns, which links the basic form of M-A thinking to the diversity and dynamics of phenomena.

With this research we hope to make connections in three aspects: First, reflecting the nature of design & planning tasks and objects while studying the M-As used to deal with them. Second, using a cognitive-process-based perspective to reveal connections across the conventional boundaries between areas of focus in the discipline. Finally, connecting multiple scales of inquiry, from that of phenomena to basic mechanisms. These connections can contribute to forming a more inclusive discussion among designers, planners, researchers and scientists.

Study of M-A thinking has implications for these aspects of the discipline:

Firstly, education and practice. Traditional use of M-A in design education is limited to studio settings and lacks systematic approach. With knowledge of the mechanisms, students can also refine their skills and learn to diagnose problems in M-A reasoning. More importantly, clarifying the context, roles and flexible application of M-A can help students/practitioners critically reflect on their and others' use of M-A. Because M-As can also exert great influence over reasoning (Thibodeau & Boroditsky, 2011), more knowledge in M-A thinking can improved practice related to interpreting and applying M-A theories/ideas. Secondly, general theory construction in the discipline. Many theories, models and design methodologies are initiated by cross-domain M-As (Livingstone & Harrison, 1981; Philip Steadman, 2008). Also, even without being intended as such, many theories have an M-A nature because the thinker do not have the necessary knowledge to understand/articulate the theory in literal terms. This makes studying metaphor a necessity for examining new theories/concepts (Chettiparamb, 2006).

Thirdly, how the discipline evaluate intellectual works, especially imaginative works that do not directly result in a physical artefact. Because of the practical nature of urban design & planning, traditional ways of thinking favour achievements in individual projects, and often neglect the need for the transference of human expertise/knowledge and theory construction. M-A and the cognitive processes they support need to be recognized as indispensable components in design & planning, not because they are visible in the constructed products, but because they make up the effective path to achieve those results and many other basic functions of our discipline.

Finally, how technology support to design & planning. To support cognitive processes, one first needs to understand how they work. Researches of M-A not only reveals about these processes, but also how human knowledge is structured and applied. This could provide valuable insight to how information technology should organized and channel information.

Further researches are needed to gather empirical data towards more rigorous theorisation. Three sources should be included: insightful M-A precedents in the course of disciplinary development; contemporary practices in design & planning processes; use by students during learning and exploring. Combined with experiments, they could offer much insight into M-A thinking and cognitive nature of design & planning. Meanwhile documenting these cases under an explanatory framework would also provide a valuable source for education and design methodology. Part II Practical Issues

4 Working with M-A

This chapter mainly addresses the practitioner's perspective. Firstly, metaphor-analogies (M-As) as often encountered in design works and theories takes critical interpretation to reveal their full implications. Such interpretation can also help designers hone their own emerging M-A ideas into clear design intentions. Secondly, analytical techniques can be used to pinpoint elements in M-A thinking and to refine one's own M-As, Thirdly, aspects in making M-As are explored based on the cognitive mechanism. There the reader can find ways to stimulate creativity and ideas worth exploring. Finally, it discusses the diagnosis of M-As: how to identify problems in—intentionally or unintentionally—confounding statements of and about M-A.

Guitar makers are not necessarily proficient guitar performers; and theories on how M-A works cannot directly instruct how to work with them. One thing is for sure: they should closely inform each other. It just takes extra work to turn theories of M-A into something that can help practitioners explore how to work with M-A.

4.1 INTERPRETATION

Putting ideas to use requires getting a firm grasp on their implications in intended context.

Practitioners often need to start a project from an M-A vision of their clients. They also work with M-A concepts made by experts and theorists. So they must be able to explore the implications of the M-As they encounter, and develop the project along the best path. Interpreting M-As as practice comes with its own benefit for critical thinking. Meanwhile, the skill of making M-As comes from the experience of analysing many good and bad cases.

It is more difficult to judge the outcome of an M-A without imagining how it might work in the situation. Therefore we need to exercise our imagination to explore the implications of M-As. When the M-A is ambiguous, the thinker can develop each possibility by imagining "what if A is B_1 ? What if A is B_2 ? ..." When the thinker fall into fixation over an M-A, they can force themselves to think out of the box by asking "what if A is not B?"

Take the Rotterdam M-A by Frits Palmboom for example: The designers first came upon the idea "urban areas are islands/floes" in his graduation project, Capelse Put, when he realised the site was bordered on all sides by infrastructure (highways, a dike, and industries), almost cut off from the outside. He went on to articulate this idea by mapping the inhabitable areas of Rotterdam, which appear on the map as separate parts like "islands/floes" (Fig. 4.1). This map is an





important demonstration of the impact of infrastructure on local life, and has since been widely cited. At some point the verbal expression, originally using "floes/islands" as source, took on also the "archipelago" concept. In presentation and in written account, the designer uses the three concept indiscriminately, although in later years he gradually shifted the focus onto "archipelago". The separated nature of the city is apparent from the map he made; but the question is: what is to be done about it?

Three intentions may be developed out of this M-A by exploiting the three different source concepts.

- If the area is one of the "islands", the designer would focus on its isolation from the outside, and design for accessibility, as Palmboom did in Capelse Put.
- "Put" is the Dutch word for "pit", because the site is bordered by infrastructure on all sides. The designer resolved this M-A into a set of design principles, which include connecting to the metro station and main road, and creating a route to allow entering traffic through the site. (See also Appx. D)
- If the city is "floes", the designer would focus on their separators (because all the areas are homogeneous). This leads to strategies to bridge across, or remove the separators. This is used in another project by Palmboom, Belvedere in Maastricht.

The Belvedere plan reconfigures the highways that broke up the local coherence: By moving it to a farther position, the old water channel can be restored to serve as a spine of green space, and bicycle & foot traffic. This new component further supports surrounding areas to be developed into diverse high-quality residential areas (Fig. 4.2).

• If the city is an "archipelago", the designer would see the areas as independent but complementary components in a diverse system, and associate with experiences of real archipelagos—intriguing composition and eye-level views. S/he would exploit the separation–diversity relation-







After









ships, and apply the archipelago aesthetics to the design. This strategy is used by Palmboom in the IJburg project.

In the IJburg plan, the form of the islands are shaped in the image of archipelago: diverse forms, layered views, clarity of spatial cognition and local spatial character (Fig. 4.3).

The above also shows that, in the process of interpretation, the relevant elements and relations in the original M-A are made explicit. In other words, the M-A has become more A than M. This gives it a "sharper edge" to cut into the design situation.

And what **if** infrastructure **is not** a divider of the city? Different infrastructures create different levels of division. Some even attract people as facilities (stations) or work places (industries). These would become the converging spots of surrounding areas. For TODs (transit oriented development), the transport infrastructure is not a divider but the umbilical cord that feeds the growth of the area. Imagining these possibilities help the thinker acquire a more balanced understanding of the message in the M-A.

The dialectically thinking *What If* and *What If Not* is a mental ritual that can stimulate a thorough digestion of theories/statements. Such critical thinking is needed in practice as much as in theorisation. Our discipline is rich with cross-domain M-A theories, like *urban ecology, urban metabolism*, models of complexity theory like *fractal cities*, and so on. Most practitioners do not have systematic knowledge in ecology, material flow computation, or complexity science. For them, these theories will remain metaphors (Chettiparamb, 2006). They will have to make specific analogies to ground the theories in their situations. If theoreticians compare the city to a human body with all its circulatory systems, should their practical audience imagine the city with centralised metabolising organs? Does that mean the city should rely on centralised recycle industry instead of material reuse as business mode, or initiative at community and household levels?

Philip Steadman (2008) also points out another more entrenched effect of M-As on the design activity. Functional determinism as a design philosophy/

attitude, for example, can be traced back to the M-A comparing artefacts to organisms in the Darwinist evolution theory. The M-A overlooks the intentional and inheritable improvement in, especially intelligent species, as advanced by the Lamarckian theory. This led to what Steadman calls "the biological fallacy", the idea that "the forms of designed objects are conceived as being wholly the product of their 'environment', the functional context in which testing or 'selection' acts", in other words, the disappearance of the designer behind the so-called objective/rational methods.

In the end, it is up to every practitioner (including practical researchers), as much as the theorists, to control the boundaries of ambiguous theories/statements, by scrutinising the M-As they and their colleagues make with their own practical knowledge.

4.2 Analysis

Programmes analyse for results; humans analyse for knowledge.

One misconception about M-A thinking is that as a simple human capability, it can be effortlessly interpreted to the same extent by everyone. The meanings in a basic form M-A may seem self-evident, but not in complex cases. It is not easy to move from M to A, making explicit analogous features, with the context and the purpose as guidance. Most complex cases are a mixture of both M and A, which even varies from listener to listener. In a multi-level M-A, for example, not everyone see all the levels and the full potential of the M-A. Those who only see the fish shape in Rotterdam South as a Fish matching some streets would judge the M-A a superficial comparison of appearance. Those who glean only the humour in *master of water—harbour city* lose sight of the design & planning information in it. In a morphological schema M-A, novices see only the visual likeness, whereas experts apprehend the multi-layer logic structure behind it. In making a communicative M-A, novices could be seduced by a "nice story" and forget that it should first and foremost capture the spatial strategy.

Cognitive scientists first established methodical analysis of M-As, because



of the need to deconstruct M-As to demonstrate theories about M-A thinking mechanisms. For that purpose they often use semantic network or its variants to represent each concept and highlight the transferred part (Fig. 4.4, 4.5). This requires manually parsing the concepts into basic linguistic units. Under the influence from artificial intelligence, many scientists have shifted to building analogising programmes to prove their theories²². For that they need to structure the representation with even more restricted categories—attributes, objects and relations (Fig. 4.6, 4.7).

Design disciplines have run into a dilemma in their own M-A studies. The scientific practice of analysis works with simple narrative structures, but falls short of tackling the most typical M-As used by designers. The visual aspects are almost impossible to convert into verbal representation, the interlocking levels of meanings seem lose all essence when reduced into basic linguistic elements. In fact, seldom do designer-researchers publish analysis on M-As. The result is a lack of attention and tools for methodical reflections in and on practice, and practitioners do not share researchers' perspective on M-A. But if practitioners can be guided to effectively analyse M-As, they will find in doing so they can work more clearly with M-As, stimulate critical thinking, improve communication and savour good M-A cases more deliberately. They can even use such a tool to give themselves a push when they get stuck in their mental process.

The first consideration in analysing M-As is the representation of the concepts. Complex M-As, especially those concerning spatial schemas can be effectively clarified with visual representations (cf. Goldschmidt, 2001; Fig. 4.8). Consider the cases studied in Chapter 3: the Fish form and the target area both contain multiple parts, and every part has relations with all the other parts and the whole. It would not be practical to explicate every one of these relations as in the scientific practice. Meanwhile, even when there are fewer parts, such as in the Ship on Water schema, the morphological elements are still visually denot-

²² Such as Structure-Mapping Engine by Falkenhainer, Forbus et al. (1989) and Analogical Constraint Mapping Engine by Holyoak and Thagard (1989).

ed in the end. Although the part of the analysis can be replaced by words, the thinker work with the visual image in the mind. In some cases of spatial reasoning, as Tzonis (1992b) demonstrates, visual representation is the key to applying spatial constraints and producing a form (Fig. 2.6). Therefore, designers need to use visual representation for spatial M-As as much as possible, and only symbolise ideas with words when they are to be referred to as a whole.

The second consideration is extracting the essence/gist/underlying principles of the source and the target concepts. To clarify the logic underlying their M-As they need to question the role of every part in their representations. In this process, they would abstract the two representations down to the most relevant features, and establish clear analogical mappings—what in the source maps onto what in the target and how that mapping is supported by or supports other mappings. These abstract representations are similar to what designers call "design concept"; except in this case, we distinguish two different concepts to examine the M-A. A crucial difference between the human thinker and programmes is that the abstracting process is simultaneous with the mapping process. The thinker decides what features to retain in the abstraction while s/he works out the mappings, by evaluating each move in the context and with the purpose.

The third aspect is tackling large M-A systems. I will use the landscape M-A in Capelse Put as a case (Fig. 4.9, Appx. D). The landscape concept system is a *frame* applied to restructure the information in the target. The frame needs to be analysed as a whole, because sublevel M-As are all bound together, and the intention of the *landscape-site* M-A can only be accounted for at the frame-level. My analysis starts with an inventory of sublevel M-As and their hierarchy, clarifying: which are the trigger of this framing action, which are essential to the system, which are added to resolve incongruities and which are extended to fit into the situation, or, increase aptness of the M-A (Fig. 4.10). In the original project, after constructing this M-A frame the designer moved onto extract and apply a partial landscape schema to his design, which is focused on the *mountain-lake-sea* combination (Fig. 4.11). This is the process of extracting schemas out of ambiguous M-As as discussed in Chapter 3.



Fig. 4.9 Depicting Rotterdam east as a landscape by F. Palmboom



Fig. 4.10 The landscape–Rotterdam east frame (by author)

peatland historical peatland (site) railway.....railway



14

Fig. 4.11 The mountain–lake–sea schema applied to the design (by author)



4.3 The Making of M-As

There are no rules to creative thinking, but one can sometimes use a push.

When practitioners get stuck with their M-As, reflecting on some key aspects may be helpful. For that, the basic model of M-A thinking provides a foundation to work out something more than a checklist of random tips. M-A thinking is like a mental leap that carries an idea from a familiar concept to the new situation at hand (Holyoak & Thagard, 1996). Specifically, there are four components in the basic model (see 3.1): the source, the target, the similarity and the directional carryover from the source to the target. Therein are the links that can be examined: How do we find a source analogue? Are there methods to make routine M-As efficient? Are the two representations—the source and the target—dynamically developed or still rigidly static?

4.3.1 Source hunting

Cognitive scientists describe the leap with analogical distance. To practitioners, their conclusions imply that to solve certain types of problems, or in order to get certain kind of inspiration, you need to leap certain distances (Christensen & Schunn, 2007; Dunbar, 1995; Stolk, 2015, pp. 190-197). The distance grading may be useful for laboratory quantification, but the human thinker cannot navigate their multi-dimensional knowledge system with that one variable. They do not think in terms of how far to look for the source analogue; rather, many "feel" their way to the source, and the more they understand their knowledge, the more efficient their source searching is. Through this research, I have found three kinds of frequently made connections between knowledge:

When the thinker is constrained by literal concepts and relations in their efforts to articulate something, they could appropriate terminology of another domain. Terminology is a kind of declarative knowledge²³. The similarity between source and target that initiate the M-A are found in their respective relations with other concepts in their own "networks" (*structural similarities*, see 3.1). For example, the city and its dynamic processes, bears a strong, explicit similarity to the organism and its living processes.

When the thinker is trying to structure a complex idea in more salient perspectives, they could search for categories and relations in other domains with similar affordances. Affordances are not as explicit as terminology, and often only with imagination can they be evoked. For example, Dieberger and Frank (1998) propose to use "city as metaphor to navigate information spaces". The advantage is that the city afford navigation as complex structures, and information spaces need the schema underlying city navigation to be more navigable. My interviews with the design experts suggest that designers use a range of analogues with similar affordances to tackle their areas of focus (see 4.5).

Finally, on the (sensory) experiential level it is more difficult to consciously invent a connection. As we receive information in different modalities, the raw information and their respective reasoning structures are more divided than affordances and terminologies. Their connection is forged through experiences. For example, the way missiles fly through space (conceptual) is similar to the way light travels (visual); and Da Vinci applies the way light "cuts" the outline of objects to "cutting out" the form of the angular bastion (Tzonis, 1992b). The experience of the spatial sequence of a garden (locomotive) shares similarity with the experience of music (auditory); so designers could use music rhythm to structure movement space (Appleyard et al., 1964). And imagine, certain uncomfortable forms (visual) could be linked to bitter taste (gustatory).

In theorisation one draws often on terminologies—declarative knowledge. Many M-As designers/planners make are triggered by affordances, in a half-intuitive, half-conscious way. Through the interviews with design experts, I acci-

²³ Stillings, Weisler et al. (1995) put forth a classification of knowledge, including the category of "declarative". But my purpose is to point out three most typical situations related to different kinds of knowledge, which do not all fall into their proposed categories.

dentally stumbled upon the different preferences of designers of which areas to search for source analogues. The preferred range of sources seem to be related to their affordances, and the general objective the designer aims for with M-A (see p. 109).

M-A making ability can be developed if the thinker pays attention to these aspects of their knowledge: structure of terminologies²⁴, and abstract qualities of objects/concepts/experiences such as affordances and dynamic patterns. When they need to tackle aspects regarding the rich, immediate experiential world, they might also get inspiration by intentionally seek out trans-sensory analogical connections.

4.3.2 Methods for routine M-As

When the thinker frequently makes a kind of "leap", they can summarise a general schema/frame. It tells them what aspects to focus on during abstracting and mapping between two complex situations. For example, when the designer uses one building as a reference case to make a new design, s/he draws on the general schema of typology. A building type generally contains aspects like: units & structure, circulation, functions, repetition pattern, etc. (e.g. Ungers, Kollhoff et al., 1977). These aspects can be taught and learnt, so that when the designer needs to "borrow" the type of others' design, s/he can effectively extract the relevant essence.

Such study of precedential artefacts is highly relevant for the designing artefacts of the same family. Because they are made with similar purpose and to operate in similar ways, the core qualities can be generalised into a common frame. For abstracting the city, the five-element-system (path, edge, node, landmark and district) by Lynch (1960; Fig. 4.12) most clearly grounded the meaning of each element in spatial and cognitive processes. Practitioners use their personal systems, which are mostly similar to Lynch's (Fig. 4.13). The *parti* is applied to

²⁴ Cf. level of expertise in Casakin and Goldschmidt (1999).





Fig. 4.12 Abstraction of Boston (Lynch, 1960)

Fig. 4.13 Abstraction of Barcelona by Frits Palmboom (Palmboom, 2016)

Fig. 4.14 Parti abstraction of Alvar Aalto's Vuoksenniska Church (Clark & Pause, 2012)





abstract architectural form by Clark and Pause (2012; Fig. 4.14), however unlike Lynch's system, the meanings/roles of parti elements are not explicated in terms of actual processes.

One point worth notice is Clark and Pause's definition of the parti: "the dominant idea of a building which embodies the salient characteristics of that building [...] the essential minimum of the design, without which the scheme would not exist, but from which the architecture can be generated." But what defining characteristics a building possess depends on the viewer as well. The fact that architects extract a certain parti for one building does not mean a sculptor would generate the same abstraction. S/he could have a different general frame, which probably focuses not on how units are arranged together, but on the outline of the whole, the distribution of mass, the main viewpoints, and so on.

The parti as a frame for form description, is further incorporated into the *form–operation–performance* frame, which describes the logic of using forms to meet abstract needs in architecture (Guney, 2014). However, urban designers/ planners also need to consider the constant presence of agent movement, and such an element is missing in that frame.

Therefore, despite that a general frame makes routine tasks more efficient, it could also limit practitioners. It may help them think out of the box to temporarily let go of their rules and try others' perspectives.

4.3.3 Constructing the two representations

When we say M-A is a leap from source to target, we often overlook the fact both the source and the target are mental constructs, which can be unstable, incomplete or transformed. Consider, we transform the target representation as we incorporate the knowledge transferred from the source. We also abstract the source, in other words, highlight its certain features to focus on and let the rest fade into the background. The interaction theory (Black, 1955, 1979) even argues that both "subjects" involved in a metaphor are both changed as a result of "interaction". For example, "if to call a man a wolf is to put him in a special light, we must not forget that the metaphor makes the wolf seem more human than he otherwise would."

As design & planning deal with novel and complex objects, there is no guarantee that we would find a good analogue in conventional concepts for our purpose. Cities, for example, have become polycentric and pluralistic, and behaving in new ways not totally like anything we know. We are aware of this, but our conventional concepts could would only capture its partial images. That's when some conceptual innovation is needed.

In my project to portray the city Arnhem (Liu, 2016), I started out with the idea of the city as an eagle: the port is like a beak that captures the resource, the activity centre is like the head, the main mass is like the torso, and extended areas are like the wings. But as I moved through frames of history, I realised the city as one single eagle is an organicist ideal, and that the source had become insufficient to account for the target. So I moved beyond concepts in the common sense into myth. A mythical creature can have multiple heads, limbs and bodies; which may seem absurd for real world phenomena, but the city is exactly like that in essence, as a multi-strata, polycentric and pluralistic whole (Fig. 4.15). In this case, I stuck to the goal of portraying the phenomena, constructing a source analogue from normal concepts.

This is no novel phenomenon, especially in literature. Writers often use the formula: "A is like B in this aspect, but is different from B in that aspect." So A is in fact B_t , a transformed B. They also use multiple analogues, in such a formula: "A is like B_1 in ... like B_2 in ... like B_3 in..." So A is in fact B_{1-2-3} . The listener has no problem with constructing a representation of B_t , or B_{1-2-3} , even if such concepts do not previously exist in conventional knowledge. For example, Holyoak and Thagard (1996) cite Chuang Tzu's multiple analogies on how to tutor an unruly prince, first comparing the tutor to a successful tiger trainer who understands and follows along with his tigers, not going against them, then to a horse lover who is careless about hurting his horse. The listener constructs a new image of what a tutor is, which is also a process of learning. Holyoak and Thagard (ibid.) point out:


Fig. 4.15 Arnhem as a mythical creature

Creative construction of source analogues can also be aided by using multiple analogues. More generally, the use of multiple analogues has been suggested as an antidote to fixation on a single misleading one [...] little is understood about how source analogues can be combined to help with a complex target without producing an incoherent mess [...] Human use of analogies can involve operations of chunking, reorganization, and transformation that are only hinted at in current models.

Meanwhile in analogical design, we evaluate results of possible transformations. Because the target is a very empty slate, there can be different ways to map various contents from the source onto it—some more literal, some more subtle. And the best way to decide if the transfer of knowledge is effective, is to mentally construct the transformed representation and evaluate it. Such construction happens throughout the M-A operation, and the target representation is a dynamic testing prototype. To summarise: the ongoing construction of both representations is a sophisticated skill indispensable to creative M-A thinking. Constructing the source helps to avoid fixation on one concepts and confinement to conventional categories. Constructing the target helps to timely evaluate the M-A. It is to take better advantage of the flexible knowledge system and the creative mind.

4.4 DIAGNOSING

The good, the bad, and the bullshit?

The experience of M-A in urbanism is confused by many mistaking/ misclaiming other kinds of thinking for M-A, and biased by ineffective uses of M-A. Many theories invoke the concept of M-A only to use it in ways very different from common sense and theories based on cognitive facts, and give no clear definition on what their conception of M-A is. Thus their M-A becomes a mystical idea, useless or distracting for tackling practical issues. This section intends to use theories in this research (especially the basic form in 3.1) to diagnose a range of problematic cases for their roots in unclear thinking related to M-A.

I will first address the semantic problem of the *architectural works are met-aphors* statement. Then I will illustrate more systematically a range of typical symptoms. Hopefully this can clear up some shrouds over certain topics, and further illustrate what M-A thinking really is.

4.4.1 Architectural works are metaphors

Architecture is a language; architectural works are metaphors; architecture is the making of metaphor. (Fez-Barringten, 2011; Jencks, 1991)

Böhme (2014) asks: If architecture is a language, then what does it talk about? What are its metaphors for? These questions are crucial to clearing up the confusion cast by claims or decontextualised quotes that architecture (or any design activities) is making metaphors. The design works used in Part I to illustrate the

roles of M-A in creative design are **results** of M-A thinking, not the M-A nor its medium. In other words, they **make** the architecture/urban forms. If we applied to these works *architecture is the making of metaphor*, or *architectural works are metaphors*, it is to put the aim in the place of means, and means the place of aim. Böhme also argues if architectural elements are primarily treated as signs, then architecture renounces its original task that is to design and construct spaces.

But consequences aside, what does it mean, *architectural works are metaphors*? The formula *X is a metaphor* can mean two things: 1) something is the source in a metaphor; 2) something is the expression of a metaphor that compares two other things. The latter is more precisely called *the expression presenting a metaphor*. This formula does not applied to the following kind of situation: When a user experiences a building and gets reminded of something else, s/he makes an M-A about the building; or, a critic uses M-As to capture some features of the building. The M-As in this case are the user's thought and the critic's M-As, is the target that they use other sources to reason about.

If one takes X is a metaphor to mean that X is the source in a metaphor, imagine:

A says: The lion is a metaphor. B says: No, the lion is an animal. Then A rephrases: The lion is a metaphor *for* the warrior Achilles. And B replies: I see your point ...

A metaphor only stands in certain context. The lion is not a metaphor, except in Homer's description of Achilles. The context contains the source (the lion), the target (Achilles) and the *similarity* (stated/implied by the situation of one attacking another). Only then the metaphorical operation—the carry-over—happens: the ferocious quality is transferred onto Achilles. Spelling out, or at least indicating the three basic components are essential to justifying the identification of metaphor. Because the very concept of metaphor has an inherent semantic structure, just like many other concepts used in urbanism. "Representation", for example, concerns two objects and the relation of one representing the other; any of the three components missing or mis-assigned would make the utterance incomprehensible. Likewise, "metaphor" concerns a source,

a target, their similarity and a carryover motion.

Therefore, claiming something to be (a source in) a metaphor, without providing the target, the similarity (or the context with which to figure out the similarity), is a **semantically defective** statement, and should not be analysed as a message. *Architectural works are metaphors* is like *the lion is a metaphor*, at best indicating the potential of something to be made into a metaphor. But not everything that **can be** made a metaphor **is** a metaphor (yet); otherwise, one might as well say everything is a metaphor, every seed is a tree, and every egg is a chicken.

Statements like these can corrupt the logic structure linked to normal timespace and trigger antagonism against using metaphor to talk about architecture/ the city. Indeed, saying *the city is a metaphor* serves no one, since it is an incomplete message. If one intends to say the city is *perceived* in a metaphorical way, then the city is the target, and it should be put in a different position: Y is a metaphor (*for* the city). If the intention is indeed that the city is the source in some metaphor for another concept, then that concept, along with the context in which similarity emerges, is necessary for the statement to make sense. Otherwise, one has to suspect if the speaker has any message to deliver, or is deliberately distracting the listener.

Consider the two examples where *al the city* is actually the source in a metaphor. 1) *Amsterdam North will be developed into the new Manhattan* (Stil, 2015). The context is clear: the speaker is talking about spatial and economic qualities (and **not** social problems, or political structure). The reader is then oriented to focus on these aspects to find the similarity, and transfer qualities from the source to the target: the prosperity, high density and the skyline impression. 2) *City as metaphor to navigate information spaces* (Dieberger & Frank, 1998). The context is also clear: navigational challenges and strategies of complex systems. The reader can then identify the similarity between *the city* and *information spaces*: both are complex structures of vast amount of cognitive materials. But one of them is easier to deal with, so the strategy of it can be transferred to the other.

They certainly stand in stark contrast to generalising claims along the line *ar-chitectural works are metaphors*. Both cannot be the paradigm of M-A thinking.

If X is a metaphor means that X is the expression of a metaphor:

There is abundant use of metaphorical expression in the arts. For example, *One Flew Over the Cuckoo's Nest* presents a metaphor about certain societal problems. The actually metaphor compares the way individual freedom is repressed by authorities (the target) to the way patients are subjected to restrictive treatment in the mental institution (the source). The film/book guides the viewer to make this connection, to understand and infer about *the societal problem* with the model of *the metal institution*. Therefore we can say the film/book is the expression of the metaphor between two other things. It is the **medium** carrying the metaphorical message. Can this be the case for *architectural works are metaphors*?

If architectural works are **medium** of messages, then the actual metaphors they carry would take something other than architectural knowledge to discuss about; just like the printing industry, or the film industry, cannot be able to claim for its own expertise the messages it delivers. If for any purpose the metaphorical content is discussed, it should not be presented as design theory, because the runaway discussion would obscure the real design knowledge that is the execution of expressing.

It is not uncommon that architectural works are made a medium of message for commercial or cultural reasons, such as the *ducks* or *decorated sheds* (Venturi et al., 1972). But when design theorists proclaim architecture as language in sweeping, generalising terms, without specifying the context, it presses the assumption that language is **all** that architecture is and should be. The consequence is that, like Böhme says, the discipline is distracted from its original task that is to design and construct actual spaces—and experiences, I would add.

But proponents of serious M-A thinking should not doubt the value of seeing architecture metaphorically as a language. The key is to recognize that a language is not all about metaphors, because without defining the literal, there is no talking about M-A. To have a firm base of literal reference, theorists should only claim the message of an architectural works as M-A when the specific intention/effects cannot be accounted for without involving the mechanism of M-A. Furthermore, if designers subscribes to the belief that their work is using *the language* to express/communicate, then they should focus on the art of using the language (including addressing the audience) as much as the content of the message. In the very least, they should grasp the distinction among symbolism, metonymy, synecdoche, metaphor, analogy and so on in order to substantiate that belief.

4.4.2 General symptoms

I propose that the reader try and come up with their own "kaput" M-As to instantiate the following categories. They will find how difficult it is to go wrong, and how strange that there are so many problematic cases.

1. Target/source missing

As explained in the previous section for architectural works are metaphors, statements missing the target concept is semantically defective. Metaphors, for what? The very concept of M-A hinges on four components including a target concept, like a "box" must at least have four sides. Moreover, because M-A thinking primarily guides or helps with the reasoning about the target, keeping it from the reader indicates a cryptic attitude about the intention of that statement.

When the source is missing, the message is not faulty—just incomplete. Imagine you read a sentence *the city is perceived metaphorically*: you might think of instances of city metaphors, and instinctively try to fill up the gap with M-A thinking. Or you just might not—this statement itself can be understood literally. But it will need specific examples to be informative, otherwise the message remains vague. Consider Secchi's (2014) claim that there are metaphors that "speaks of the city in terms of an abstract concept: continuity, regularity", and so on. He then goes on for several pages about the supposedly existing metaphors without giving an example of exactly what these metaphors are, wearing out any suspension of disbelief on the reader's side. Eventually the reader can only either surrender to the idea that a metaphor without a source is still a metaphor, or imagine for him/herself that the actual metaphor is something like *the city is continuity*. And what a metaphor is that? One can no more call this a metaphor than *the apple is sweetness*. (More about this in 4.)

2. Similarity (or the context with which to establish similarity) missing However distant two concepts are, our mind always seem to find a common ground to make their comparison make sense. But sometimes even the best thinker can fail to extract any sense out of a decontextualised M-A. And without giving context, the producer of the M-A risk losing control of his/her own message. Imagine if I were to say *the line is a lion*, it would sound preposterous both literally and metaphorically. But if I were to complete the expression saying *the line is a lion among circles*, or *the line ravages the flock of circles*, a concrete message would come through, because there is a context regarding momentum, strength, number and so on that gives rise to certain similarities between the geometric line and the animal lion.

Generalising claims like *architecture is the making of metaphor* or *architectural works are metaphors* are vague about the context. As demonstrated in previous section, it can be construed quite differently: architecture is the source concept or architecture is the medium. Many readers had in mind to find out *how architecture is perceived metaphorically* from these theories, but this does not even fit into the syntax *X is metaphor*.

3. Wrong relation between the target and the source

"A metaphorical statement involves a rule violation: There can be no rules for "creatively" violating rules." (Black, 1962) But there are still some implicit rules: not any pair of things can be made a metaphor—father and son, the representation and the represented, the chicken and the egg ... Their relations are entrenched in the very fabric of language, and unless the speaker beforehand present them in a way that considerably distract the listener from such connections, an M-A cannot be established. (I have to admit I cannot imagine an example of a successful distraction—however you do manipulate people to think of *the egg* as a metaphor for *the chicken*?)

When the discourse is not about daily concepts, but theoretical concepts, theorists seem to have free play twisting the common sense. However, the known relation-although less apparent behind a barrage of perplexing elements-still exists and keeps preventing the discourse from making sense. Take for example My Home is My Symptom (Binotto, 2014): The essay begins with a (contradicting) section about metaphor: the metaphor is a symptom (with the symptom is a metaphor directly above this line). This is argued in two parts: 1) Medical symptoms are indexical of medical conditions, just like C. S. Peirce's "veering of a weathercock" is an index for the blowing wind. The author has illustrated the indexical relation, or plainly put, the presumed causal relation. 2) In psychoanalysis the symptom is linked (to the cause) arbitrarily, just like how the Saussian signifier is linked to the signified. The point is further developed: the presumed causal relation is fallible. Immediately after these two parts, the author declares: to speak about metaphors means speaking about symptoms. How can symptom-cause, a causally-related pair be construed as a metaphor?²⁵ As we intuitively know, and clarified by philosophers and scientists, metaphor is a carryover of ambience and semantic structures from one concept to the other. What can be carried over from the egg to the chicken?

In short, some pairs of concepts cannot be made into an M-A when their other relations are also salient in the discourse. Such relations can be constructed by the discourse, like *a map of the city* and *the city* (the concept *map* itself does not have a relation with the city

²⁵ An alarming indication of where this symptomatic statement comes from can be found several lines above: "the symptom in psychoanalysis is not an index, but always remains an ambiguous metaphor". Is something a metaphor simply because it is ambiguous?

that prohibits metaphorical relation); some are rooted in the concepts, like *father and son, chicken and egg*, etc.

4. Carryover failure due to abstract construal

The previous paragraph has indicated that existing relations between two concepts can interfere with the realisation of M-A carryover. This paragraph talks about the carryover failure even when there is no prohibitive relations between the concepts. This may sound quite rare, because metaphor can bring almost any two things, however distant and unrelated, together, and be illuminating. However, the distance is not the problem here; it is the richness of the construal of the source concept-or rather, its mental representation. Abstract concepts often make ineffective sources because our representation of them is not a system with semantic structure but one single idea. Black (1955, 1979) repeated stresses that the source must be a system; and scientific theories on M-A have expounded the mapping is between something in the source and something in the target (Gentner et al., 2008; Lakoff & Johnson, 2008). How can this happen, if the source is one monolithic idea? How can one "speaks of the city in terms of an abstract concept" (Secchi, 2014) if it is but one term?

The city is continuity and apple is sweetness mentioned above in 1 can be more plausible rephrased as city is the symbol of continuity and apple is the symbol of sweetness. Granted, some symbols are metaphors in their "previous life"—born through conventionalisation of those metaphors, but symbols are also born from metonymy, synecdoche and historical events. Symbolism stresses the symbolised abstract concept, not the concept at hand (the symbol); M-A stresses the concept at hand (the target), and not the source. They have completely contrary purposes of reasoning. Therefore, we cannot see symbolism and M-A as one thing. Only when there is a metaphorical carryover from one concept to another is the connection a metaphorical one. *Continuity* is not carried over to *the city*, **it is a quality that a city**

can possess: the city has/has not continuity.

Just to have no doubt that it is not the preconceived symbolic relation that causes the carryover failure, let us try to imagine another pair of concepts where one cannot stand for the other and the one used as the source is too abstract. How about *courage is happiness*?

So how do you fix such a carryover failure? The key is to "expand" the abstract concept into a semantic system. Secchi's *continuity* is not about the temporal, but the socio-economic dimension: "for instance, the infinite subdivision of land at the origin of the middle-class demand for property rights and its market value". We could imagine an M-A expressing such an idea without even using the word *continuity*: *The city's wealth was no longer one fruit on a high branch, but reclaimed by the earth whence it comes from*. Later in the essay, *continuity* is about the cultural dimension, met with "anxiety over the idea of a society reduced to a continuous and homogeneous mass". For that we could think of another M-A: *Flooded by modern culture, local cultures are surrounded on their ever shrinking islands*.

In Ashok Bhalotra's Kattenbroek (see 2.3), he designs a creek to evoke the abstract attitude towards life from a song. This is to assigns a symbolic connection between the physical creek and the message of the designer, and even when the creek idea from the song is made literal in material, it can hardly be called metaphorical transference. Fitting it into the shoe of metaphor would only make it seem a crude instance at best in light of contemporary theories.

In summary, the purpose of M-A is to help understand/illustrate/reason about the target concept, in other words, to construct better mental representation of it. If the source representation has even less structural richness than the target, then the M-A cannot happen, just like water cannot flow from a low pressure point to a high pressure one. The thinker needs to re-evaluate his/her claim for it as an M-A, or change for another source, or focus on first enriching its mental representation by imagining a context, and/or researching about it.

5. Undermining the purpose (or in other words, the discourse goes much clearer without mentioning M-A)

Purpose is one of the basic constraints of M-A thinking (Holyoak & Thagard,

1996). In many problematic cases, the application of M-A confuses the reader needlessly and distract them from the central message of the discourse.

Binotto (2014) compares Le Corbusier to an impulsive and misinformed psychoanalyst that thought removing the symptom would "cure" the city. Introducing progressive thinking in psychoanalysis, he argues that symptoms are coping mechanisms, and likewise, the chaos and flaws of the city deserve consideration and delicate treatment. This is a very illuminating perspective generated by his own M-A thinking. However, his execution of M-A framing is questionable. As mentioned in 3, his pivoting point is identifying that the symptom is a metaphor and the metaphor is a symptom. Both statements are hard to follow and seem unrelated the design context. It only becomes apparent when taking his essay as a whole, that the M-A is not the symptom but between psychoanalysis and architecture: the former is used to inform the reasoning about the latter. It seems the symptom as metaphor or vice versa statements are installed to justify his connecting the two fields. But as we know from the cognitive mechanism, M-A justifies itself with the similarity component, which in his case is the similarity between fixing the city and curing a patient. Misidentifying symptom as metaphor is therefore unnecessary and distracting.

The turning point in Secchi's essay is his identifying a kind of metaphor that "speaks of the city in terms of an abstract concept: continuity, regularity [...]". The author never makes explicit what the metaphor or metaphors are, and seems to take *the city is continuity* as the actual metaphor. As demonstrated in 4, this is a very problematic case to be identified as an M-A. Meanwhile, according to him, throughout the centuries the metaphors shifted in meaning, so naturally there should be various **specific metaphors**. The absence of any examples reflects a confusion between the **general theme**²⁶ and actual metaphors. It follows

²⁶ Black (1962) proposes "to distinguish what is identified merely by a formula like *the metaphor of A as B*, without further specification of its contextual use, as a metaphor-theme regarded as an abstraction from the metaphorical statements in which it does or might occur. A metaphor-theme is available for repeated use, adaptation, and modification by a variety of speakers or thinkers on any number of specific occasions." It shows the importance of specificity in the presenting and understanding of metaphors.

it is doubtful if such a thematic group of metaphors actually exist; and when there is none, *the city is continuity* is better presented as symbolism, or an ideal, or an idea. In fact, if we replace *metaphor* with *ideal* in his discussion on this topic, it would run much smoother.

There are mainly two kinds of application of M-A in structuring theoretical works: 1) making up specific M-As between certain phenomena and something else to shed light on that phenomenon, like Binotto did; 2) identifying phenomena as M-As or a type of M-A to reveal certain patterns or generate solution, like Secchi intended. For the first kind, *A City Is Not a Tree* is a classic example (Alexander, 1965). *The tree* concept captures/articulates the typical pattern of designers' conception of the city's spatial processes. For the second kind, Chettiparamb's (2006) evaluation of using complexity theories in urban planning is an excellent example. She first identifies that seeing the phenomena of one domain through the terminology of another is M-A thinking, then uses the principles of M-A to diagnose problems in such thinking. Both author have made explicit what the exact M-As are. In the second case, identifying the four components supports the identification. In both cases, the invented M-A and the identification of M-A are both central to clarifying the topic and essential to forming the final solution or the readers' comprehension of the solution.

The design & planning process is also full of M-As. Some uses focus on appearances instead of deeper relations, leading to ineffective problem-solving (Casakin & Goldschmidt, 1999) and/or literal imitations (Antoniades, 1990). Some uses are only intended as rhetoric and sales-pitch, and are not rooted in effective spatial strategies. A systematic diagnosis of such phenomena would no doubt be instructive for educators and students. But collecting these flawed, instructive cases is another enterprise that I have to leave for another projects.

4.5 INTERLUDE

In my interviews with the design experts, I found that different designers have tendencies to make M-A with certain range of source analogues. I speculate that it has to do with the general goal they set for their work, their personal knowledge and disposition. This triggered me to make a horizontal comparison among them, which resulted in this article (originally published in *Atlantis, 27.3*; now adapted).

ANALOGUES AND THE SOURCE BLOOD OF DESIGN Mindspotting of urbanism designers

Birds, tulips, hands and knees—the creative process of designers/planners are full of analogies and metaphors. Often they are not systematically investigated except wrapped around the design portfolio like a theatrical cape, or tucked away like entertaining anecdotes along with napkin sketches. In doing this, our field has not done right by designers nor design ...

The core of design is to create forms to fulfil abstract requirements, or purposes (Cross, 2006b; Roozenburg, 1993). The knowledge of forms links the spatial composition to its possible performance. It arises from our everyday encountering with forms. But the mind cannot analyse and inventories every form, in preparation for every new task (Tzonis, 1992b). It is by metaphorical and analogical thinking that good designers turn everyday experience into knowledge that they can use on new tasks. So how do the designers in the Urbanism Department make analogies?

P. B. —Zen and the Art of Interfacing

His random analogies during the interview reveal a profound naturalist tendency: cocoon, tulips, trees, etc. In his leisure time, he paints trees like marshmallows and zen-ish abstract symbols. "I see myself as the urban designer who facilitates the conversation and collaboration among other professionals with a spatial framework ... while some designers like making bold gestures, I'm more of a harmonising tendency." — Indeed, complexity and harmony is the hallmark of nature.

L. B. —the Crystal Mind

At first look there is no metaphor or analogy in his portfolios, which are filled with pages and pages of arduous combinatorial calculation. But a second look reveals that all the symbol computation traces back to a long-standing personal quest linked to one metaphor, whose influence manifests throughout his many finished and unfinished projects. "The pyrite represents for me the crystal clarity of human mind seated within the rich and chaotic world."—So his is the pursuit for transcendental *perfected*ness, set against the organic *jungle*ness of the physical reality.

F. C. —the Form Handler

Just like the way he speaks, his sketches are very intuitively relatable. Hand, knee and boxes—the random examples he gives all happen to be objects with which we have direct experiences of bodily interaction. Given theories of embodied cognition (Lakoff & Johnson, 1999), it is possible that designers conceptualise the agency of shaping and organising large-scale spatial entities by imagining them to be something "shapeable"—that is, objects that can be physically handled.



Fig. 4.16 Sketches by P. B. Cocoon-like house; tulip-like railway connected development and building typology; beauty in the landscape of machines.







Fig. 4.17 L.B.'s source image pyrite, echoed in a series of residential design





Fig. 4.18 Sketches by F. C.

Fig. 4.19 Drawing by F. P. depicting his site as landscape. (Two other examples are Fig. 4.1 & 4.9: Rotterdam city as islands and Rotterdam east as a landscape.)



F. P. —the Landscape Poet

Unlike the flat and fragmented city, landscape harbours multiple perspectives: we experience walking in it as well as directly seeing it as a whole. An intuitively cross-scale concept, with conceptual simplicity and spatial complexity, it is a perfect sandbox for urban designers to construct their mental models for cities. But more than functionality, it is poetic: it attracts the good intentions to the mind's surface despite the problematic urban conditions. 36 years ago, F. P. conceived of the metaphor *rivers-mountains-islands* for the east of Rotterdam. "It was the first time I felt my mind set free."—And it has been free ever since.

E. B. —Master Narrator

Her M-A examples are tiny seeds of narratives: to present a situation, suggesting a direction to search for solution. "They help me reflect on what happens in my own thinking as well as help the clients see the situation." So how do you capture the narrative of a situation? The answer, as proven by all writers is a complicated one if not all together a professional secret; still, E. B. has revealed something for me: all but one, the analogues are animated beings—beings with independent agency. Such analogues already have the makings of an intriguing story.

H. K.—The Block Recycler

Transcendental messages and symbolic gestures are not healthy entry point for everyday architectural design, which should be down-to-earth, grounded in qualities of real architectural spaces and social processes. "What would be useful, is analogy, architecture-to-architecture ... Imagine there is a smaller courtyard with lively social and spatial qualities. By analogical thinking, you can 'copy' the spatial elements that support these qualities into a block of 100 by 100." In other words, stick to the terms of architecture, do not waste time on imagining what shells or sails means for a building. And there are enough good precedents in the built environment to be "recycled".

PART II PRACTICAL ISSUES

Fig. 4.20 Sketches by E. B. *Helmond as a Lady with Flowery Hat* narrates of the complementary relation between the city and its surrounding villages *Rotterdam South as a Fish* highlights the essential spatial and functional features in the area

Zoetermeer as a Spider in the web reveals the relation web in The Hague–Rotterdam region, suggesting that Zoetermeer should not rely only on The Hague.

Fig. 4.21 A sketch by H. K.: from 20x5 to 100x100



Metaphorical and analogical thinking is a way the human mind mobilises knowledge to deal with new situations (Holyoak & Thagard, 1996; Lakoff & Johnson, 2008). The mind find analogues in past experiences, and in a mental leap, transfers what it knows about them onto the things at hand. Does the mind go randomly in search for the suitable analogue, or does it follow certain patterns? My interviews with these design experts suggest that the mind does know what it is doing. As each subject has different personalities and experiences, and tackles different areas of problems, they also draw on a focused range of analogues. Whereas some might see metaphor and analogy as an irrational form of thinking, there may be a logic after all. By studying them, we can reveal the nature of the object of design as well as sharpen our tools to deal with them.

Notes: the names of the designers are given in initials for readers—mainly those familiar with the department—can guess who they are by their "signatures".

5 A Source for Urbanism Education

This chapter discusses how the results of this research can be applied to urbanism education. First, an overview is given on the ways metaphor-analogy (M-A) has been used in design education: four lines of thinking focusing on different aspects of M-A, and teaching it in different ways. Unifying their contents into one framework can make a valuable agenda. So with the framework as reference, I propose a series of central questions that the education on M-A thinking can help students answer and explore. Then I outline a course that can take students through these questions, specifying the teaching focuses, study materials, exercise and goals. Finally, the end of the chapter summarises the value of such education: it can enhance students' ability to use M-A, to learn by M-A thinking, and to conduct similarity-based reasoning.

Metaphor and analogy have been observed as a creative design strategy by practitioner-educators : Antoniades (1990) names metaphor as a major creative channel to create meaningful architecture. His work has identified several key elements in architectural design metaphors, and put forth evaluation criteria for learners. Ungers (1978, 1982) stresses the epistemic role of M-A, in addition to its inspiring effects in form giving. The works of him and his colleagues, although not proposing systematic approach, have demonstrated the value of M-A in studio settings. Rowe (1982) observes that analogy is a mode of heuristic reasoning for ill-defined problems in design. In this line of thinking, M-A is an intuitively practised creative strategy.

In the area of design methodology, the mechanism of analogical thinking has been combined into morphological design theories: Daily objects and precedential artefacts are analysed and abstracted according to *parti* (an abstract visual description of forms) and the *form-operation-performance* frame; the abstracted piece can be transferred onto new design (Clark & Pause, 2012; Guney, 2008; Tzonis, 1992a). It has been implemented by Guney in architectural design courses, but its performance in guiding students, and scope of application is not further assessed in theoretical works. This line of thinking focuses on formalising the process of using precedential artefacts in routine morphological design tasks, in other words, developing an efficient design method out of M-A.

Emerging in recent years, design cognition researches focus on the variables of M-A thinking in the design process. Christensen and Schunn (2007) have found correlation between analogical distance and the type of problems. Visual representation and level of expertise are major factors for the effective use of analogies (Casakin & Goldschmidt, 1999; Goldschmidt, 2001). With lower level of expertise, novices tend to focus on surface features instead of structural relations when making analogies, but guidance can improve their performance (Casakin & Goldschmidt, 2000). This line of thinking regards M-A thinking as a process that can be monitored and coached according to individual conditions.

Finally, another line of thinking argues for the importance of M-A for the general knowledge—not just knowledge of forms needed in design and planning, because many complex issues in the disciplinary discourse are articulated with M-A. The prevalence of M-A in architecture and urbanism stems from the unstable disciplinary boundaries and its elusive object (Gerber & Patterson, 2014). Verma (1993) proposes that M-A be used to reveal and extract the knowledge structure behind innovative, especially cross-disciplinary planning ideas. Chettiparamb (2006) has demonstrated that certain flaws in planning theorisation are in fact rooted in unclear metaphorical thinking. This supports that the knowledge about M-A thinking, in addition to its practice, should have a place in design education. The above lines of thinking, with their own focuses, all argue for the relevance of M-A in design education. They also have demonstrated/suggested ways to implement it in education. Every line leads to part of the answer. With the overviewing framework developed in this research, we can absorb them into one educational plan.

5.1 CENTRAL QUESTIONS

Question to lead learning and exploration

The framework from Chap. 2 can structure and ground the study of M-A in design/planning contexts. By learning to appreciate M-A phenomena in their various contexts, students can one begin to evaluate, diagnose and fix M-As, and their own M-A making naturally becomes more sophisticated. Given the cross-cutting nature of the subject, an educational plan can be formulated more clearly with a series of central questions:

Why is M-A thinking practised in urbanism? How does it meet the various needs in urbanism? What characteristics do the M-As of different roles have? The framework in Chapter 2 can serve as a portal to answering these question and prepare students with a broader view before engaging specific areas.

Observation and reflection on urban phenomena can be channelled into mental representations through M-A. Modern designer/ planner further deal with research-gained information/knowledge. How to synthesise knowledge in correspondence to phenomena with M-A? Further, many would consider these M-As too descriptive to guide interventions, but the insights they hold should be assigned value. So how to interpret them, and develop them into design intentions?

The design of forms makes use of morphological schemas. We know the source is daily objects including precedential artefacts, and

that the perspective of the thinker influences the focus of the schema, which is to say, urban designers/planners have different kind of schemas than, say, architects. So what are the general focuses in their schemas? How do they develop and use them?

In the aspect of communication, cross-disciplinary knowledge exchange comes in the form of M-As, like *urban metabolism*, *fractal cities*, and *DNA and genetic planning* (Wilson, 2010). They are intuitive and reasonable, but only within certain limits (Pickett, 2013). How to interpret them critically and find out their limits? Meanwhile, designers and planners need to overcome their abstract visual representations and convey the "invisible" aspects in their plans to others. They also need to essentialise their diverse strategies into one leading idea/concept so that others can grasp the plan. The central idea must find its root in shared knowledge or common sense. So how to synthesise plans to channel intention and strategies to the target audience?

On the level of collective processes are some widely shared M-A concepts at work, coordinating individual actors to create large-scale urban patterns, like the Green Heart. While the collective thinking and action might not be engineered, students of design/planning need to pay attention to the complex societal results of M-As. What historical precedents do we have on societal level outcome of M-A concepts?

Finally, an over-arching theme is how the M-As of different categories can transform into, or take on another category. The comprehensive mental representation can be shaped into design schemas, and further polished to communicate itself. So how are M-As transformed to support various cognitive processes?

These questions can be used to introduce the relevance and scope of the subject. They can also provide focal points for teacher–student discussion. Table 5.1 Central questions

Why is M-A thinking practised in urbanism? How does it meet the various needs in urbanism? What characteristics do the M-As of different roles have? How to synthesise knowledge in correspondence to phenomena with M-A? How to interpret descriptive M-As and develop them into design intentions? What are the general focuses in schemas of urban designers/ planners? How do they develop and use them? How to interpret cross-disciplinary concepts critically and find out their limits of validity? How to synthesise information in correspondence to design/ planning intention? What historical lessons do we have on (un)anticipated societal outcome caused by M-A interpretation?

How are M-As transformed to support various cognitive processes?

Teaching focuses

Study materials

Exercises

Objectives

5.2 Outline of a Programme

Teaching focuses, study materials, exercise and objectives

The programme begins with the central questions listed above and gives an overview of its relevance, scope and goals. Then it takes up five modules one by one, in alignment with the framework.

5.2.1 Mental representation of phenomena

Mental representations are based on cognitive **categories**, and emerging **structure**/gestalt of the categories. A **synthesis** differs from a compiling/ superordinate/umbrella concept because of the emergent structure. M-A transfers categories, and/or structure of other concepts to help us grasp complex objects.

Geographic researches are in their element when it comes to applying complex M-A systems to convince the reader of the existence of a certain pattern or entity (for example, (Porteous & Smith, 2001)). Urban/ regional studies by consulting companies are often summarised with visual M-As, for example *The Carpet Metropolis* by Neutelings. Design/ planning project reports often conclude their research results with an M-A concept that acts as a pivot between research and plans.

Identify M-As in study materials, analyse for the categories and structures the M-As impose on the phenomena; try to convert the M-As into literal terms. Practical exercise is visiting an urban area without maps and producing one frame of representation of that area by using M-A and combining words and drawing.

Able to analyse and identify the categories and structure in M-A concepts; able to construct one-frame representation of complex phenomena based on clear categorisation and multi-level structure appropriated from existing concepts/tropes (rather than defined all by oneself). The one-frame idea actually comes from the "city portrait" assignment in the Urbanism studio *Analysis and Design of Urban Form* (AR1U090). It trains the student's ability to bind different lines of research into one representation. My own work of city portrait depicts Arnhem with systematic M-As from the spatial history perspective (see 5.4).

5.2.2 Morphological schema designation

The abstract logic underlying morphological strategies is termed morphological *schema*. Each form can be described with a specific schema, which is the **transferrable** content in morphological analogies. There are **types** of schemas, i.e. schemas with the same general structure. Urban design & planning use **a different type** of schema compared to architecture as it focuses on different elements¹.



Teaching focuses

Design/planning projects that use forms of precedents and objects from other domains to formulate their spatial strategies.



Objectives

Summarise what factors in the plans are dealt with by what forms from what precedents/objects. Then work in groups to generalise a frame for the design & planning type of schema. There are two practical exercises: First, students need to "fit" a certain city/urban area, say Delft, into an object from another domain, such as an orange, a cup, and a bedroom. Then they will go in a reverse direction, by translating the city into another family of objects. In both exercises they must maintain the elements and relations in Delft, identified by the schema they developed earlier.

Able to identify and represent essential morphological elements and their multi-level relations in urban fabrics; able to reconstruct them across material media.



Fig. 5.1 Black's examples: thinking of the Star of David in three ways 1) as an equilateral triangle set upon another of the same size; 2) as a regular hexagon, bearing an equilateral triangle upon each of its edges; 3) as three superimposed congruent parallelograms.

The two practical exercises are aimed at drawing out the underlying schemas of urban fabrics by deep transformations. The schemas are essentially what researchers of M-A call structural relations; and Casakin and Goldschmidt (1999) repeatedly point out that focus on structural relations rather than appearance features is key to effective M-As in design. Meanwhile, Stolk (2015) speaking from the urban design perspective, proposes that design creativity could be unlocked by probing analogical distances. The two exercises make use of the classic formula of metaphor: *thinking of Object X as Delft*, and *thinking of Delft as Object(s) Y*. Black (1979) gives some illuminating examples of what it means to *think of A as B* (Fig. 5.1), demonstrating how such thinking trains the mind to see underlying relations.

The theory that urban design/planning requires a different type of schema is inspired by my finding that there are types of analogies in morphological design that considers spatial relations on different levels.

On the level of single forms are works like Le Corbusier's Unite d'Habitation, expounded in Tzonis' case study (Fig. 2.7). This kind of analogy focuses on the operation and performance of that one form.

On the level of form-form relations, the design of residential tower on the town







Fig. 5.3 Buildings as a family by Jaap Bakema Fig. 5.2 Buildings as dog vs. cat by Liesbeth van der Pol



Fig. 5.4 Building as Ship on Water by Hans Ruijssenaars

Fig. 5.5 Tree "box" for wind shelter by Francisco Colombo





Fig. 5.6 Le Corbusier's M-A comparing architectural plans & automobile and the human body (Philip Steadman, 2008; © FLC/ADAGP, Paris and DACS, London 2008)



Fig. 5.7 Figure-ground before and after (Kollhoff et al., 1978) The landscape garden concept is used for hosting diverse places in a sparse manner, allowing each place its own character, and "gluing" them together with its own texture into a poetic whole.



square of Amstelveen by Liesbeth van der Pol considers the relation between the tower and the library building opposite it as a confrontation between a tensed-up cat and a crouching dog (Fig. 5.2; see also 3.2.2, Appx. B). Another example is Jaap Bakema's sketch comparing buildings to figures in a family (Fig. 5.3; Bakema, 1964).

Meanwhile, designers consider form-agent relations. When there is a constant presence of considerable number/strength of agents, they become sort of a fluid and dynamic "form" that cannot be accounted for with the *form-operation-performance* frame Tzonis uses. For example, the *Building as a Ship* schema responds to the water element, which is the traffic flow (Fig. 5.4; see also 3.2.2). Francisco Colombo's tree box for wind shelter concept in a responds to the wind factor (Fig. 5.5).

Finally, designers "jump" levels, by seeing an ensemble of forms and agent flows as one system with its own performances or qualities. The system itself is one morphological entity, i.e. it becomes a single form that can be considered under the principles of (1). Le Corbusier's *architecture as human body* analogy (Fig. 5.6) clearly assigns roles and morphological features to different architectural components. Ovaska (Kollhoff, Ovaska et al., 1978) proposes to use the landscape garden as model for re-structuring Berlin—a city of shrinking population at the time—so that the disintegrating urban fabrics could be made a whole again with the garden image (Fig. 5.6). Palmboom's *site as a landscape* also traverse levels although not explicitly identifying it as a functional entity (Fig. 4.9; see also Appx. D).

However, as designers use objects familiarised by physical contact, the scale disparity becomes a tricky issue. Does a form of the bodily scale still have the same performance/quality when it's hundred times as large? The element that can actually map onto individual people may not exist in the source frame: For example, the *water-agent* flow mapping considers the emergent entity of agents but molecules of water does not make sense to map onto people. In the city as garden analogy, the visitors walking in the garden should really map onto cars on the city level according to their mobility in the garden. Clearly, designers need to "patch up" their design with the individual experience after using cross-domain M-As.

5.2.3 Communication

Teaching focuses

Study materials

Exercises

M-As are used to bridge the **gap of expertise**, synthesise information for **efficient communication**, compensate for the **abstract visual representations** of design & planning, and address the **emotional aspects**.

Academic literature that introduce cross-domain theories into urbanism with M-As; design/planning/regional study reports that employs everyday terms or well-known concepts to convey professional contents, or influence the audience's opinions with affective arguments.

- Identify M-As in the materials and their respective communicative function. Try to translate them into literal terms, interpret their implications and evaluate the necessity/aptness of their use.
 - For M-As that synthesise information, student can further analyse on which level they play their role: as descriptive vocabulary, or as guideline phrases, or as title/slogan/name.
 - For M-As that compensate for abstract visual representations, further analyse what sensory/experiential qualities they restore.
 - For the emotional M-As, further analyse who the target audience are, what narratives/arguments they present, and the generated effect.
 - Students practise using M-As to describe/name/"sell" an unfamiliar work to each other, and critique each other's use of M-A.

Able to identify, analyse and evaluate the use of M-A and their communication goals; able to achieve these goals with or without M-A.

This module aims to familiarise students with existing phenomena of communicating by M-A—the good, the bad and the bullshit, too. Only with a wide range

Objectives

of references can they acquire a sense of standard and focus on the real challenges of communication. We should also recognise not everyone command the art of M-A speech and they can make up for it with other strategies. Therefore the objective also states "achieve these goals with or without M-As".

5.2.4 Collective process



At the centre of planning and implementing large-scale spatial patterns are **design/planning concepts** that coordinate individual actors' reasoning and action. A lot of these concepts are M-As. From one concept to societal scale phenomena is a complex process, the **causality** of which can be explored through historical **precedents**.



Exercises

Objectives

Design trend studies, planning reports, literature of design/planning history

Identify the M-As that have large-scale impact in the literature. Analyse for the effects and causes that can be located in their qualities as M-As. Compare those with non-M-A concepts. Construct scenarios of different concepts, or the same concepts but with changed circumstances.

Understand the differences between M-A and non-M-A design/planning concepts, including their roles in creating spatial patterns. Able to distinguish the causes of certain effects in their qualities as M-As and in the circumstances.

Many design and planning concepts, especially those encouraged by the government, come to generate their own spatial patterns. The Green Heart as analysed in 3.2.3 and 3.3 is an example of the device used by a central planning agency to enforce and receive feedback about its plans. In the recent decade in China, many municipalities encourage building "the garden city", and the guideline/ slogan sometimes translate into literally filling up available urban spaces with flower beds and other sorts of greenery. Many suburb parks pop up in the middle of farmlands to compensate for the insufficient green ratio in the inner city, but these parks are often underused. This popping up of seemingly irrelevant "garden tissues" all around cities is also a kind of peculiar spatial pattern, channelled through planning and design, originating from a primary M-A concept. Anyone would be hard put to it to spot the future from one concept; that is why diverse case studies in the international context should be used to help the students understand the wider implications of the design/planning action.

5.2.5 Transformation

Teaching focuses

Study materials

Exercises

Objectives

Ideas are **flexible and developable**. M-A ideas of each category have their own **patterns** and the same basic **components**. Knowing the patterns and components, transforming them does not have to be random trials.

All the previously involved materials and students' own works.

Identify the transformation of M-As that connects two or more categories, or goes outside of M-A mode of thinking, in both long-term cases and short-term design cycles. Identify the changes of the role and characteristics of M-As and the influence on the work they are used in. As final assignment of the whole programme, students are to imagine and portray the continuous transformations of each other's M-As by constructing scenarios.

Understand the flexibility of M-A ideas. Able to transform M-A ideas of others for one's own context, in other words, able to interact with the structure of others' thoughts.

The term "flexibility" centres on the changing context and the transformation of the object's inner structure. Because the structure of M-A thoughts are more clearly delineated (in scientific theories and in this research) than other kinds of similarity-based reasoning, it is a good candidate subject to train flexible thinking with. The ability to transform and interact with someone else's thoughts can also reflect back on the individual's ability to make use of his/her own thoughts. For example, the ability to transform what s/he recorded in a previous excursion into an effective design schema.

The programme is an exploration and discussion as much as teaching and training. It is a means to probe empirical data with the help of students, and test the theory by assessing the students' results and feedback. Given the practical nature of M-A thinking, theoretical research can only go so far without a broad, diverse input such as one can obtain from an interactive educational programme.

5.3 Three Kinds of Educational Value

Learning to **use**, learning to **learn**, and learning a mode of **reasoning**.

The first kind of value is obviously honing the skill to use M-A for creative design and related communication. The reason why it could be more effective than previous effort aimed at the same goal in studio settings is because: First, it provides a wide context in which the roles of M-A are clarified. In learning to appreciate these varieties and the underlying pattern, students can more consciously construct or shape their M-A thoughts. Second, it methodically trains the student to focus on the structural relations underlying concepts instead of appearance features. According to Casakin and Goldschmidt (1999), this is a major factor in effective use of M-A in design.

The second kind of value is demonstrating how M-A thinking facilitate learning processes in design/planning. There are different kinds of "learning" when it comes to design/planning: First is the accumulation of structured information about a specific project, up to the point where a vision can be developed, and further, to support decision-making. M-A gives perspectives to complex situations, and helps establish such a "structure" for the intake of information. By analysing the arguments in design/planning reports, literature and their own works, they can acquire a sensitivity for such a structure. This is in line with proponents of using M-As as epistemic instruments(Schön, 1993; Ungers, 1982; Verma, 1993).

Another kind of learning is the acquisition of spatial design/planning skill, namely, the general frame of the schemas applied to this field of practice. In other words, one cannot learn all the specific schemas as if building a database, but one can have a tool to fashion one's own schemas on demand. This is in line with the proponents of M-A as design method (Guney, 2008; Tzonis, 1992a).

The third kind of learning is the acquisition of design-related knowledge. It usually comes from literature and others' speeches, which are both full of M-As. An understanding of how the M-A "language" works is essential to extracting knowledge from these sources. This is in line with the proponents of using M-A research to understand design/planning theories and discourses (Chettiparamb, 2006).

The fourth kind is deepening one's comprehension of known ideas. As we know the quantity of knowledge is not enough, without deep understanding of each piece in it. Such understanding sometimes comes with the transformation of an idea linking it to new situations, i.e. suddenly knowing how it can be used in new ways. The theory and exercise to transform M-A ideas accentuate this kind of learning.

Finally, the programme trains students' similarity-based reasoning. According to Goldschmidt (2001):

[...] the primacy of rule-based reasoning is no longer universally accepted as an absolute truth, and researchers are interested in the relationship between the two modes of reasoning: rule-based and similarity-based, in both children and adults [...] researchers have advanced the view that [...] two systems of reasoning [...] are equally important to processes of problem solving and learning (i.e. Gentner and Medina 98).

Scientific disciplines stress rule-based reasoning, while design disciplines have unequivocal need of similarity-based reasoning. Although it is believed this type of reasoning is intuitive, the materials gathered in this research indicate room for improvement. Design & planning education needs to go beyond implying and encouraging the intuitive use of this mode of reasoning, because when complex tasks are involved, explicit knowledge and practice is key to sophistication. The field of design cognition has already begun to approach how it can be monitored and adjusted. This research also supports that it can be explicated and guided. As students of science are trained through maths and logic in rule-based reasoning, do not students of design need a special medium to enhance their similarity-based reasoning?

5.4 INTERLUDE

This project is from the the Urbanism studio course *Analysis and Design of Urban Form* (AR1U090). It is a cross-scalar study of urban forms on the city level. Students take on four different approaches, among which is the typology study of city-wide architectural forms. The final assignment is synthesising a "city portrait" from the different knowledge gained. I was tutored by Egbert, and applied M-A thinking to typology study and synthesising the "portrait".

ARNHEM UNMYTHIFIED

Typology & the City Form

Hybrid Temperament

People intuitively sort buildings into categories. Their feelings about buildings are results of not just architectural elements but also the users that enact them. The user modifies the building; the spatial logic of the building structures the user. The two become one, which is the real object of a typology investigation: a hybrid entity. The task then, is to extract and make explicit the hybrid temperament. My first step is detecting typology by M-A (Fig. 5.8).










The intuitive detection by M-A thinking is just a beginning. The crucial step that will turn it into usable information is clarifying the analogous features, and defining the underlying variables into a coherent system. Here I (1) identified four factors/variables from the *building–animal* M-A as dimensions between two poles, (2) defined them in terms of actual spatial elements and social processes (Fig. 5.9), and (3) resolved the possible ambiguities in applying them as criteria for categorisation (Fig. 5.10). This is the process of developing a rule system out of an M-A.

Fig. 5.9 Four variables and their definition







Fig. 5.10 Resolving the ambiguities (partial)













Story of Arneym —a Portrait of spatial history

If the city is half-human, half-built, then why not consider it as a hybrid entity with a private story? Its historical dynamics certainly appear to be highly behaviroural if we relate the social, economic, natural factors to the built outcomes in a causal narrative. Such a narrative needs to portray both the story and the spatial aspects. Hence I need something that's animate and has a dynamic form as a vehicle. The origin of the name Arnhem is "home of the eagles". That, and its predatory action on its surrounding landscape during phases of rapid expansion, triggered me to work with the eagle concept.





During the process I had to expand the eagle concept into a mythical creature with multiple heads to adhere to the pluralistic phenomena I observed. I also encoded the architectural types in the depiction of the creature to incorporate the historical emergence of new types. The final product is a 21-frame animation made from black-and-white line drawings, narrating the city's story from the egg to its current complexity of multiple bodies and conflicting psyches (Fig. 5.11).

In the project report, I further analysed, by the frame, the underlying analogical mappings with which I constructed the M-A (Fig. 5.12). It demonstrates how intuitive metaphors can be developed into relational analogies.





Part III Reflection

6 What can be learnt about planning and design?

The first section clarifies how urbanism is different from other design disciplines, in terms of object scale, object context, social dimension, and products. The second section distinguishes design and planning as two types of mental action: They are both spatial thinking, and concern morphological elements, but are different in the presence/absence of realistic elements. Both types of action are present in the subjects called design and planning, and are central to urbanism—the reason why they are addressed often as one in this research. The final section argues that both types of action require "tangible" imagination, and not unbound imagination or purely realistic thinking.

If researchers of cognitive processes take the characteristics of planning and design for granted, then their messages may not get through to the urbanism community—(imagine) *what is science to judge design and planning, when it does not even know what they are?* But in fact, the cognitive perspective can tell us much about what design and planning are.

6.1 The Defining Characteristics

Let's not get too comfortable, using **complexity** to explain everything, shifting the responsibility onto **self-organisation**, and sweeping half-understood struggles under the **ill-defined** category.

Physicists discovered complexity; theorists made the connection between the self-organisation of urban systems and that of natural systems. Ill-defined prob-

lems are identified in artificial intelligence and cognitive science. How much has the planning and design community done to substantiate the claims that are increasingly used to define who we are? Have we leveraged these findings to advance our own discipline? Not quite enough. Instead of being developed and tested, those terms have become useful words tugged into the urbanism dictionary, while those wielding the quantitative arsenal do not yet realise they are limping forward with one leg. Observing this trend, I have made it my central objective to understand what exactly makes things complex, facilitates society's self-organisation, and leaves our problems ill-defined.

Design cognition researchers have expounded the differences between disciplines of design and disciplines of science & humanities from the cognitive perspective. Cross (2006b) identifies design abilities as the abilities 1) to resolve ill-defined problems, 2) to adopt solution-focused/appositional cognitive strategies, 3) to employ abductive or appositional thinking and 4) to use non-verbal modelling media. However, design cognition studies are united under scientific-analytical frameworks, and address design more as one concept rather than consisting of different kinds of design-engineering design, industrial design, architectural design. This undoubtedly does not facilitate a close relationship between design and planning in urbanism. While design cognition researches are substantiating claims about design thinking, and delineating variables to capture creative phenomena, they are often limited to experimental settings. For example, the conclusion that different analogical distances correlate to the type of problems, are of limited help to practitioners. The pivot of the creative design from discipline to discipline. So if researches of design cognition are to be instructive for the practising community, they need to get a "user perspective" and engage with the specific kind of design and its factors.

This research has clarified some aspects where urbanism differs from the other design disciplines.

Object scale

Cups, sofas, rooms, buildings—objects of industrial design, interior design, architectural design—are the objects with which humans can have direct sensory experiences. A building is different from a neighbourhood also in the sense that

it can be seen (almost) as a whole from the outside. Neighbourhoods, cities, and regions are of larger scales where direction experience as a whole is impossible, so their mental representation of these objects requires special efforts and skills to construct (Stolk, 2015). In other words, the objects of urban design & planning are mentally constructed, an "imagined phenomena" (Healey, 2007). This research has found many instances of metaphor-analogy (M-A) that serve to construct a salient representation of complex phenomena, and that have played important roles in urbanism progresses. What is the point of Cedric Price's *City as an Egg*, and Willem-Jan Neutelings' *The Carpet Metropolis*? Not only for fun, certainly.

• Object contextualisation

The products of urban design and planning constantly need to fit into complex-and every time different-contexts (here I only address the spatial). The forms of urban fabrics respond to its surrounding landscape features, facilities, infrastructure, traffic movement and so on. Successful design concepts generally have a two-part "syntax": the first part compares the context to something that is open to improvement; the second part compares the design to another thing that resolves any tension in the first part. To be fair, industrial design also has an inescapable context—the human body. One must study ergonomics to make sure the designed form make sense for that context. It is, however, comparatively a limited range of variations, and one that is intimately known. Urban designers/planners must overcome the challenge of (re)cognising the context as a form system that their newly added part would complement. But if this context is always changing, how can there be made any rules on the fitting of forms with context? That is where typology and M-A come in. Block X has a certain way of organising different functions in relation to its surroundings; now the design task has a context similar to that of X, so by analogy one can attempt a solution by using Block X's organisational principles to design the new block.

Social dimension

The large spatial scales of urbanism tasks are mirrored in the social scales involved in their implementation. The social processes is not only an afterward consideration, but a major factor weaved into the urbanism processes and products. Viewed from the level of the built environment, plans and policies are all middle products rather than end products. As such they are profoundly oriented by the links before and after them. Increasing cross-discipline and cross-sector collaboration in urbanism practice also reinforces the social dimension in the design and planning process. As noted in scientific practice, analogies has a communicative role in collective creativity (Dunbar, 1995). Urbanism has a far less developed terminological and methodological system than science, and relies heavily on M-A communication.

• Middle products

As argued above, the output of design/planning thinking is often middle products. A regional research by a consulting company would aim at providing summary and guidance for whoever will design/plan in that region in the future. This is different from building a quantitative system like GIS, where information is compiled but not summarised²⁷. The research must pass on comprehensible, concise conclusion to the next phase. There, designers/planners will also be aiming at a communicative product for civil engineers, construction professionals, stakeholders and others who will implement and enact the plan. In other words, they will be taking in one middle product and producing another middle product, on the chain of social transaction of knowledge. The urbanism discipline runs on a diverse range of middle products. It is therefore important to examine design thinking in terms of its input and output. (This research has considered theories/rules/design principles, cultural symbols and designed & built forms.)

²⁷ Cf. Minsky (1974): "Number-like magnitudes can form the basis of decisions for immediate action, for muscular superpositions, for filtering and summing of stimulus features, and so forth. But each is a "dead end" so far as further understanding and planning is concerned, for each is an evaluation—and not a summary."

6.2 Comparing Planning and Design

Planning and design are two types of **mental action**, characterising, but not monopolising, the two **subjects** divided in practice and practical knowledge.

At the early stages of my research, I found that planners tend to make simple, common-sense-based M-As: easy to understand, easy to refer to, catchy, narrative, etc. It seems like any journalist's job. Designers, on the other hand, makes complicated M-As: some abstract like philosophers', some realistic like engineers'; some do not care for comprehensibility at all, like napkin sketches; but mostly they do struggle with how things (should) work beneath appearances. Imagine designers would dismiss planners' M-A catchphrase while planners think designers employ a most irregular tools for the main body of their work because they don't have a systematic way of thinking. Such unspoken preconception is not hard to find in the discipline these days. But fortunately the spirit of this faculty is to join design and planning, which gives me the opportunity to find out how things come to where they stand. The conclusion is that the differences between designers' and planners' M-As indicates they are have more in common than most would think, and differ only in very few aspects (from the cognitive perspective).

From Part I, we can see that both planning and design involve mental representation of phenomena. Designers are more concerned with constructing visual representations, while planners sometimes do not need visual ones to proceed, if the issue is not primarily of a spatial nature. Both involve designating morphological schemas, but designers' schemas often come from more concrete/realistic (as opposed to abstract) objects, and have a greater diversity. Both involve synthesising their solutions into communicable concepts. As long as the solutions have a spatial nature, the concept should entail a description of the morphological schema, whether in design or planning.

The main distinction revolves around abstractness vs. concreteness. Planning is very much like symbol manipulation in math, in the sense it is about figuring



Fig. 6.1 An instance of the symbol usage in planning diagrams (Devolder, Wilms Floet et al., 1993) Fig. 6.2 An instance of the design plan (still in progress) by Frits Palmboom (Palmboom, 2010)

out the relations between objects. Spatial planning then, specifically concerns itself with spatial relations. Design gives material form to abstract ideas (Cross, 2006b). Things drawn on the design plan depicts realistic objects in a real context. For example, a circle on a design plan can be a tree, a round square, or another round object with realistic assignment. In contrast, a circle on a planning diagram is most likely an abstract symbol representing something whose shape is not circular (Fig. 6.1, 6.2; Liu, 2017a). In this sense, planning and design are different types of mental action. But they are both present, and needed, in the two subjects we call "design" and "planning". When designers figure out how to organise functions and circulation, where goes the water and where the mound, what sequence of experiences should take place and so on, they are planning. When planners start thinking what concrete embodiment is a line connecting two circles-a highway, a rail line, or a bus route-they are designing. Often planners need to leave this decision to others, so their abstract lines may not get designed after all. (But if they do not imagine the possible designs, how do they know if it is feasible?)

sheifers

Let us take a step back and make an inventory of the cognitive elements involved in spatial design & planning (Fig. 6.3). First I propose we make distinction between spatial thinking, morphological thinking and realistic thinking²⁸. Any thinking concerning spatial features or relations can be called spatial thinking. But not all of it has morphological elements. Imagine when you learn for the first time The Hague is to the northwest of Rotterdam, Amsterdam to the northeast of The Hague, Utrecht to the southeast of Amsterdam, you envision the spatial relations among them, but you don't know what they are as a whole. But you will get some idea from the name *Randstad* ("rim" city). Also, consider a computer programme tracing the image of a tree: it does not know that the tree form is about support, contact and transportation of substances.

Form is an emergent concept relating spatial features to their operations and performances. The form is in the middle on the abstract-concrete scale. Being abstract allows it to be *transferrable*: The rim can be applied to regions; the tree form can be applied to cities; and a turning disk inspires (the invention? understanding? of) the roundabout. It has a certain level of context. Imagine the morphological characteristic "roundness": It means the object rolls (on a surface), or does not easily hook onto something (when moving/ moved against other things), or the movement (of agents) at any point on its surface has an equal relation with it. The "round" form has countless possible, but **imaginable**, operations and performances. Being attached with context makes its application to situations evaluable: Thus a rim, but not a sickle, applies to the Randstad; the

²⁸ Morphological thinking is one kind of thinking based on schemas. In planning and design, other kinds of non-spatial schemas are also important, such as those related to how urban facilities function. For example, "green belt" invokes a morphological schema, "brain port" (Hoog, Balz et al., 2013) invokes a functional schema about how cities serve as knowledge exchange nodes.



Fig. 6.3 An inventory of the cognitive elements in design & planning (by author)

tree applies to linear development of large systems and not of body limbs; a heart is not precisely round, but it can be applied to include some roundness, so long as it is about being surrounded by other tissues. The same cannot be said about geometric shapes, which are purely abstract and their application is harder to evaluate in terms of realistic implications.

Realistic thinking is thinking in terms of realistic experiences, objects and processes. On realistic design plans, a line depicts something concrete: a row of trees, an edge of a street or a route according to which buses operate. Abstract ideas are translated into realistic objects embedded in a specific context with a fixed scale. Through this translation, they exert influence in real-world processes. It is also the key to establishing the feasibility of abstract ideas—if a square form turns out to be 100-by-100, then the designer cannot realise it as a room. When designers make morphological M-As with source analogues that have realistic features that can be directly applied to their design, then this M-A brings the de-

sign closer to realisation/concretisation. Consider the Ship on Water M-A: the designer cannot directly use the real form of the bow for part of the building, and has to find proper architectural expression for it—an arched-back roof. In a building-to-building analogy, the entrances really map onto entrances, corridors map onto something close to corridors (linear movement space), etc. Apparently most cross-domain M-As do not introduce realistic elements in themselves. The designer must discern what can be literally used as architectural expression, what needs "translation", and how to appropriately translate it, otherwise it turns into naive symbolic gestures.

I have used the metaphor of language, calling the process of converting an abstract goal into material construction "translation". But it is not unique to the linguistic domain. Moving from abstract goal to realistic terms is abductive reasoning, prevalent in many aspects in human cognition. However, there is also feedback influence of the material on the (gradual) specification of the goal. Frits Palmboom underscores that the realisation of abstract goals must be negotiated with the material, embracing and exhibiting the character of the material, and not forcing the abstract one-way on the material. This negotiation–translation component is what I find crucial to turning M-A ideas into sophisticated, elegant work of design (see also 2.3).

Going directly from abstract needs to realistic expression without consulting morphological aspects is possible. Craftsmen adhere to realistic elements, and their work has a kind of self-unawareness and unaffected quality. But large-scale design & planning work with abstract representation, and therefore has to reason in more abstract terms, such as forms. Morphological thinking is the art of spatial organisation. It generates the clarity and coherence behind spatial arrangements. It is also an important stage for design imagination: with concrete thinking constrained by reality, abstract symbol manipulation constrained by rules/conventions, morphological thinking roams throughout experiences and precedents for solutions—largely metaphorical and analogical (see 2.2.2). An important note is that morphological thinking is not exclusively for design. Planning concepts like *belt*, *ring* and *corridor* refer to morphological schemas and are central to spatial reasoning in planning.

When the two types of mental action are decomposed into basic cognitive processes, they appear to share the same elements—they are both guided by abstract needs/requirements/purposes, work with morphological schemas, and turn the more abstract elements into realistic objects and processes. Planning has more work to do on formulating a feasible abstract requirement; it sketches out the morphological and maybe some realistic expressions, to ascertain the requirement can be carried out. Design has more work to do on fulfilling an abstract requirement with proper forms and materials; it modifies the requirement to negotiate a better fit with the morphological and realistic constraints.

6.3 "TANGIBLE" IMAGINATION

The creative kind of imagination is not floating in the clouds or shackled to the earth, but a dynamic force that moves in between.

The pattern of reasoning underlying converting an abstract goals into realistic measures is central to design, observed by many design theorists—it has been labelled directly as "design" (Eekels & Roozenburg, 1991), named "innovative" abductive reasoning (Roozenburg, 1993), "productive" reasoning (March, 1976) and so on. On the other hand, as argued in Chapter 2, the ability to abstract and represent phenomena is also an indispensable creative skill in urbanism, we are also justifiably concerned with what it means to "see gestalt" in complex phenomena. It is similar to scientists' working out a theory based on observation. As (Haig, 2014) points out, the conjuring up of an explanatory pattern for realistic phenomena is also abductive reasoning—similar to the "innovative" kind of abductive reasoning.

However, the pattern of reasoning is not the main focus here. For now, we can rest with the conclusion that whatever label this kind of reasoning is under,

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in design it is about moving between the more abstract and the more realistic, on a continuum connected by many-to-many relationships, which complicate things and requires imagination. Then I propose we find a specific term that names the quality of the cognitive elements in this kind of reasoning, so that we may discuss and evaluate the performance of that reasoning. For now I will call it "tangibility".

"Tangible" does not equal to "realistic", but rather having groundings in common knowledge, precedents or other terms defined by realistic things. Tangible ideas are verifiable because of such groundings. The verification helps designers reflect on their own reasoning coherence, and to enhance design argument. On some occasions, one might also call it "sensible", as being able to be sensed by another mind because of its groundings in realistic terms. But this favours the realistic part and obscures its dynamic, elusive quality. So again, I have to settle for "tangible"—like lightening, concrete but elusive. Not confined to realistic terms, driven by imagination, and in contact with abstract ideas. The design creativity is then in the motion connecting the two, like a discharge between two different levels.

Tangible imagination underlies the abstraction of complex reality in creating a mental representation, not through symbolisation and encoding but through transformation and synthesis²⁹. It drives the search for morphological solution in our vast experiences and accessible knowledge, so that our work is not limited to reciting codes of craft. It creates the best match between materials and ideas, breathing life into one and giving strength to the other.

It is also important for social and collective processes. The effectiveness of a plan much hinges upon how much it invoke compliance and commitment in the actors. The case of the Green Heart indicates that the "heart" M-A has much to do with its planning effectiveness. It

²⁹ Cf. Non-representational theory (Thrift, 2008).

has a tangible narrative that motivates the preservation of open space, and a tangible morphological message that stresses the wholeness of the round open area. In contrast, precise plans consisting of numbers and coordinates, without backing concepts, might actually result in a more chaotic outcome. This is because the lower level actors do not see the reason for enforcing numbers so precisely, and therefore engage in (unguided) negotiation with interested parties. In this sense, the tangibility of a communicative concept is about having groundings in shared knowledge. It enables understanding between designers/ planners and actors, and facilitates the implementation the plan in its essence.

Whether the aim is to achieve realistic construction or social communication, tangible imagination seems to be the key to creativity in design and planning. It is not about confining thought to realistic terms or existing conventions, but about commanding and wielding the rich body of knowledge to introduce concrete possibilities into the situation.

As I have argued in this book, a good M-A idea justify itself with the component of similarity, namely the matching conditions to the carryover from the source analogue. These matching conditions also lay down a retraceable path along the process of idea development, so that it can be grounded in certain realistic/conventional terms even after transformation. As such, it is a good channel for tangible imagination.

7 Why do we study human intelligence today?

The study of human intelligence can aid its own propagation—education—and can inform the development of technology, because only through a humanised technology can human intelligence advance.

Smart technology is becoming part of the urban reality that designers and planners must work with. It has also planted itself in design and planning methodology as tools and strategies. These tools and strategies are often limited to specialists, while the main body of practical tasks are being solved by less advanced means. In universities, the trend of smartification is diverting more and more students from completing the traditional path of the spatial art, causing questions whether the technological and quantitative means is again threatening to replace down-toearth qualitative design. Critics may find sympathetic voices in design cognition, where the confrontation of quantitative/scientific vs. qualitative/artistic in design has been a central issue since its beginning. Design cognition scientists hold that the natural/human intelligence deserves recognition for its role in tackling complex problems-which by its very nature, cannot be solved by analytical/scientific/technological means alone. By exposing the ineffectiveness of analytical thinking in the complex arena, and delineating the patterns underlying human design reasoning, they have demonstrated the human design intelligence as unique and irreplaceable. Metaphor-analogy (M-A) as a mode of thinking is a major aspect of human intelligence. It does what analytical thinking and current data technology cannot.

However, the confrontation of science vs. design, analytical thinking vs. design thinking, and technology vs. human intelligence, is not enough to establish the true value of studying human intelligence. Science is not purely rational, and smart technology need not contribute by replacing human intelligence in urbanism. Technology can be, and has been a powerful extension to human intelligence. To take a page out of the book of urbanism values—dispelling preconceptions,

comprehending the context, and positioning changes towards progress—we need not derive the value of design cognition studies from criticism on analytical thinking and technological means, but rather try to identify some progressive, common ground.

My belief is that technology is created in the image of human intelligence, and it is meant to enhance the talent of human intelligence. Sometimes it fails to fulfil that role, because we only have an incomplete image of ourselves. That is why the knowledge about human intelligence can do more than winning recognition for itself—it can adapt and advance itself through technology. Such advancement does not happen frequently but has always been essential. Our writing systems, various types of diagrams, and cartographic systems are all forms of technology. Satellite mapping as technology has expanded our visual faculty, and only through it are we conducting large-scale design and planning. They give us a sophisticated interface with the complex world, and are irreplaceable instruments that put our knowledge and reasoning ability at today's height.

Artificial intelligence is literally an offspring of human intelligence. Since the beginning, human intelligence has been the reference for smart technology. For a period in history, cognitive science and artificial intelligence are basically one discipline. As both fields' scientists would agree, human **knowledge system** far exceeds artificial databanks in complexity. So do the ways the human mind can manipulate that knowledge. And it still holds much knowledge regarding how data can be structured, collected, retrieved and combined. The **complexity of concepts and flexibility of its structure**, as we have seen in the workings of M-As, is what smart data has yet to achieve.

A recent challenge our discipline is grappling with regards data. Smartification, including trends like Big Data and Internet of Things, is no less a reality created by the deluge of data activated in the information age. Much of the data we must take into design and planning decision-making is technologically generated and stored. Consider, in the early days of urbanism, designers and planners are their own cartographers—like Th. K. v. Lohuizen, who made the population density mapping of the Randstad region that first gave the insight to the rim-shaped urban agglomeration. There is a difference between selecting data selectively collected

by technicians, and defining one's own variables and extracting data from the source: The latter is an active process that can lead to further discoveries and a revision of one's definition of priorities. Been confined to selection has seriously impeded **the creative feedback loop that joins observation (mapping) and intervention (design/planning)**. Although practitioners conduct on-site observation, there is much information that cannot be gathered by physical senses. Contemporary data technology offers limited access to our natural faculties. Human intelligence can only assert itself via the link of visualisation (which has become a new field of study). We need to rethink the **distinction between data, information and knowledge**, and ascertain their roles in design & planning. And then we may realise, as much as we need data/information, we also need more effective cognitive interface or even structure. It is about gaining an agency in effectively perceiving the reality we work on. We cannot all become geomaticians or get a second degree in data science.

The truly smart technology should amplify the abilities of human intelligence, embedded into the links/processes of human cognition. Designers and planners should not have to tackle complex problems relying on only their natural faculties; and scientists should **interface technology better with its users' form of intel-ligence**. There are precedents of applying human knowledge structure to data structure in design disciplines, especially in the heyday of methodology studies. The architect Tzonis (1992a) proposed a morphological knowledge³⁰ database by studying analogy in architecture. The fact that it never came to be realised should not discourage continued exploration to learn about human cognition to create/ inform technology.

Meanwhile, although with a different goal, education actually shares a common cause with artificial intelligence and smart technology, i.e. they both require explicit knowledge of cognitive phenomena. Education cannot only teach; it also needs to teach about, in other words, explain the phenomena and present possibilities so that students can build their own reasoning structure. This requires

³⁰ Tzonis' own words are "architectural knowledge".

understanding of cognitive processes on the level of explicit communication and reasoning. As Chapters 4 and 5 demonstrate, such understanding can be an effective instrument in clear theoretical discussion and systematic teaching of creative strategies. On the other hand, just as artificial intelligence refers to the phenomena of human intelligence, the knowledge construction in urbanism needs to refer to the expertise of experienced practitioners. *People* is one of the three sources of design research (Cross, 2006b); to "mine" that body of potential knowledge systematically, the knowledge in basic and design cognition is indispensable. More efficient knowledge extraction means more efficient knowledge transaction for design education. And not to forget is the valuable source of students building up their own expertise, which can further the understanding of design cognition.

Therefore, the study of human intelligence can aid its own propagation—education—as well as guide the development of technology. This idea has greatly motivated my research. It differs from existing treatment in design disciplines that enters from a methodological or phenomenological perspective, in that it aims to deepen the understanding of human intelligence not merely to **argue for its recognition**, **but also to extract the transferrable patterns**. In the long term, I hope such understanding of how human intelligence works can have an influence on how data, information and knowledge is created and used in the urbanism discipline. This would dissuade potential quantitative revolutionists from rigidifying knowledge systems into reductive data slots, and encourage creative designers/planners to participate in building sustainable, truly smart knowledge/data systems. Part IV Acedemic Reflection

8 Goals, Methodology, Process and Results

My research project Metaphorical and Analogical (M-A) Thinking in Urban Design and Planning (urbanism) emerges out of many interacting frames: complexity theories of cities, design thinking theories, my own education and practical experience, etc. But first and foremost, it is about learning urban design and planning.

In Q1 I was confronted with the problem of gathering and synthesising information into a holistic representation; in Q2 the challenge was to sharpen that representation into a decision-making basis; in Q3, the two previous problems was compounded by multiple scale navigation. The ultimate question for this journey of education has become: how are they related and why are they so difficult? In other words, after my own unconvincing success in passing all three tests (in this master program and my previous practical experience), I want know the true face of what designers always struggle with.

There remain two options for my graduation project: First, to choose a site-specific topic and again struggle through the three tests, proving once and for all I have mastered the three lessons. I would become a specialist in a high-relevance topic with first-hand experience. Second, to find out the various ways to cope with the problems from proven cases and experts, and conclude them into something that can be borrowed and checked by anyone else. I would not become a specialist in a hot topic by graduation, but I would have learnt what I needed to become one for the rest of my career.

Both options are appealing, but the second one takes some unique circumstances to happen, which happen to be present in this faculty: the experts I need as my subjects, their first-hand account of the cases, and interested mentors willing to guide me on it. This is an opportunity that I have decided to take.

Finally, the first difficulty of learning about design is to find an entry point. Design thinking is addressed in many works as a whole. Design theorists seem to contradict the distinguished designerly approach of propositional thinking

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to understand ill-defined problems (Cross, 2006b; Lawson, 1980) because they dwell on abstract, general theory construction. So, in my own manner of propositional thinking, I take up metaphorical and analogical thinking as a testing ground—to probe the unarticulated "problem" behind all efforts to theorise about design (specifically, urbanism).

THE RESEARCH IN ESSENCE

This research started as an exploration. It took many iterations to define the relevant scope, observe and articulate the patterns. The patterns reveal to me what questions can be posed and answered by the data I have collected. And after that, I still needed to sharpen both questions and answers against the larger context, based on other experts' opinions. Finally, I need to go beyond theories and attempt some proposals about more concrete things, such as practice and education. By doing this, the theories I am testing and consolidating my theories, and also providing others a perspective to evaluate my work. Here I summarise the essential aspects of this project: research questions, approach, the underlying perspectives/assumptions, and the results.

The research questions:

- 1. Why is M-A thinking practised in urbanism?
- 2. How does it meet the various needs in urbanism?

Basis: M-A as a design strategy is disputed, because it seems to have no systematic principles and highly idiosyncratic. But the fact remains it is widely practised. Neglecting it makes it an unevaluable rogue element in design/planning process. It can aid design practice and theory, or can be counter-productive (Casakin & Goldschmidt, 1999; Chettiparamb, 2006). People also think in M-As unconsciously. To evaluate its use and make it more effective, the reason for its use, and its roles must be clarified.

- 3. What characteristics do the M-As of different roles have?
- 4. Why do they have these different characteristics?

Basis: The previous two questions identifies categories, but they are empty if the framework does not have directions on how to identify cases. Various M-As have different levels of clarity, and more rational thinkers tend to judge the more ambiguous ones harshly. But there are reasons for their differences. The more ambiguous ones may have more subtle in sights, and more potential to inspire imagination. To find out why, the characteristics need to be summarised, and their corresponding cognitive patterns that make sense for the situation should to be identified.

5. How can the study of M-A thinking address both scientific framework and the phenomena in urbanism equally without imposing partial theoretical structures from one on the other?

Basis: All experiments are based on assumption of certain theories. Only then can one specify the parameters and variables. Although science has many theories on M-A thinking, as a designer myself I know they are far from covering everything we encounter in urbanism. But the discourse in urbanism on this subject does not have a theoretical structure to guide a systematic study. To overcome this dilemma, this research starts from providing an overview, and constructing a framework of the phenomena.

6. What application prospects do the results have?

Basis: This research started as an exploration to understand phenomena. I did not know what the findings would be, even less what they can be used for. Only when the findings develop an outline can I begin to tailor it down to applicative situations. And the ideas on what situations they could apply to also have a feedback influence on the structure of how the findings are presented. To apply in education/practice the research needs to focus on the thinkers' perspective. To have any implication for technology it needs to identify the transferrable mechanisms. And both requires making explicit patterns underlying phenomena.

The approach consists of the following components:

1. Applying knowledge from cognitive science

As Cross (2006b, pp. 100-103) points out, design research draws on three sources: people, process and products. To derive consistent understanding from all these three, reference to cognitive science is inevitable. Otherwise, M-A can also be addressed in more idiosyncratic, eclectic or experiment-based manners (Casakin & Goldschmidt, 1999; Fez-Barringten, 2011; Gerber & Patterson, 2014; Ungers, 1982).

2. Empirical research

Scientific studies of M-A thinking in design disciplines mostly take up experiment-based and protocol analysis approaches (Casakin, 2010; Casakin & Goldschmidt, 1999; Christensen & Schunn, 2007; Hey et al., 2008). These approaches tend to de-contextualise design activities, and create isolated categories of knowledge. They are limited to explain complex real-world phenomena. Therefore this research gathers cases and opinions in a broader scope to support a knowledge framework integrated in urbanism itself.

3. Framework construction

Research question 5 points to a knowledge framework that connects different perspectives and practices. The framework construction therefore takes a "catholic approach" (Moudon, 1992), and aims to account for the various phenomena encountered in the empirical stage with a coherent logic; in other words, a meta-structure informed by cognitive science, complexity theory of cities, and designers/planners' perspective.

4. Proposal making

Propositional thinking is a designerly quality, which I have tried to honour in this research project by venturing outside my comfort zone and make some statements. Research question 6 suggests the results be used to inform practice and education. To do that I need to connect the theory construction back to concrete phenomena and prescribe principles for decisions. This is also an opportunity to address the contending views that gave rise to question 1 & 2, by clarifying my own view on evaluating criteria, practical principles and so on.

Underlying my research questions and approach is a series of **perspectives**/ **assumptions** (see also report Part III). Regarding the content: • Design thinking research should inform real-world design process (including research practice) besides explaining design behaviours. It can do so starting from connecting to the specific objects and tasks of the design activity instead of hiding behind the generalising term "ill-defined problem".

• The claim that design is solution-focused and science is problem-focused (Cross, 2006b; Lawson, 1980; Marples, 1960) must be re-examined in current context. Urbanism can no longer afford to operate on the ad hoc level of individual projects due to the need of sustainability. "The problem" must be studied. This calls for a systematic approach on a meta-project level in order to build up structured knowledge of the discipline.

• The study of human intelligence can aid its own propagation education—and guide the development of technology. A humanised technology can advance human intelligence. Therefore this research does not aim only to argue for recognition of human intelligence, but to extract the transferrable patterns. As such they can be appropriated by both design educators and scientists.

Regarding the approach:

• Urbanism has a different context compared to traditional design disciplines. It can offer unique insights into design thinking that would undoubted be lost, if studied only with the experiment-based and protocol analysis approaches as applied in other design disciplines. Therefore a phenomena-oriented approach is needed.

• Scientific terminology can offer the coherent frames to be used for systematic investigation in urbanism. They incorporate the timely progress to inform design research. The research is also careful not to import scientific theories literally; instead, it aims to adapt, instantiate and clarify them for further verification within urbanism.

The results:

1. Identified views & trends in research, instances in the processes of urbanism, and the gap between them.

2. Empirical research: gathered opinions and cases that indicates why M-A is practised in urbanism, how it helps the design/planning process and how different qualities are evaluated.

3. A framework to structure and explain the M-A phenomena in urbanism, and furthermore, using the dynamics observed, to indicates how to work with M-As.

4. Identified three types of cognitive patterns underlying M-As of different roles through three in-depth case analyses.

- 5. A system for practitioners to reflect on the practice of M-A.
- 6. A proposal on how to use the findings in design education.

7. By-products: distinguishing the qualities of design and planning; identified how studies of this kind can have implications for technological development in urbanism.

CHALLENGES

This research is aimed to initiate a wider and deeper understanding of metaphor and analogy in urbanism, by clarifying the cognitive processes and patterns beneath their diverse phenomena in the disciplinary context. To do this requires a leap connecting the cognitive theories to the phenomena in urbanism, which is only possible by re-interpreting both sides' contents. Therein lies the challenge: cognitive scientists and designers see M-A thinking from different scales.

Such a problem of scale has also bothered science community since its early days. Some scientists study the molecular composition of a substance, say, water, while others focus on its physical properties. To understand it and innovate its application, both scales must be examined. For example, from molecules it is difficult to predict the phenomena of freezing and melting. But from the macro-scale, it is impossible to explain why ice has an increased volume than its liquid state. Without a unifying framework, researchers on different scales find it difficult to understand each other. "Alchemists" stay on the macro-scale, while micro-scale scientists threaten to come up with theories ill-suited to the complex reality (like the spatial science movement in the '60s).

Similarly, it has been difficult to structure the paper/report of this research in an order that both scientists and designers are used to, constrained by the linear flow of text. Designers could find it difficult to assign relevance to the cognitive mechanisms and favour the discussion of the pattern underlying the phenomena. Cognitive scientists could see the discussion of phenomena before proper definition as flawed reasoning, because normally definition should be introduced before the scope and phenomena. But for the subject of M-A thinking, the definition also needs re-interpretation so that it can properly address the phenomena. Only when definition and phenomena are compatible, can scientific theories be applied to reveal the patterns beneath the phenomena. Between the scientists' scale and the designers' scale, this research is to demonstrate the relevance of one to the other. To somehow complete this circular event, the results must be presented to the reader not as a tree, but as a multi-dimensional structure. The "story" in this book starts with gathering and structuring phenomena, not because that is where the inquiry really started, but because starting with phenomena facilitates the perspective to go beyond existing theoretical frames. This is in line with the abductive theory of scientific method (Haig, 2014), which moves from phenomena detection, to theory construction (further divided into generation, development, appraisal).

VALUE

As an investigation into human intelligence in design, this research is relevant for education, practice, and technology development. For education, learning about M-A can help students critically interpret existing M-As; and from good M-As they can gain insight into the subjects in urbanism. For practitioners, knowing the mechanisms of M-A and analytical techniques to help improve the effect of using of it, and even intentionally make creative M-As. For technology developers, it delineates important patterns of human cognition, and can help in creating better interfaced technology/tools of design. (See also report Chapter 7.)

From the perspective of design phenomenology, it reveals how human agents relate to the built environment and how they apply their mental and social instruments to shape it. This would inform design/planning processes, such as research synthesis, product communication and so on.

From the perspective of design epistemology, it enriches the approach and source of design research. It uses scientific terminology to investigate urbanism phenomena and to structure its knowledge, without "scientising" it—as was dubbed the design science movement in the '60s. It adds another approach to the experiment–protocol analysis repertoire.

Finally, this research has tried to connect different perspectives and processes, to reveal conventional categories and to update those categories. This can be evaluated by returning to the beginning of this project: research of M-A thinking is a way to probe "the problem"—the constraints that together express the context of urbanism as one discipline (see also report Chapter 6). This map of basic constraints contains:

- The nature of human cognition and psychology. Because cities is built by humans and for humans, both the design activity and the design decisions cannot escape how humans perceive, process, express and implement ideas on their environment.
- The nature of cities. Because cities are large-scale, collectively modified artefacts that evolve with their own long cycles, engaged in interaction with other slow-evolving entities (social collectives, as revealed in this research).
- The social process of urban design and planning. This is reflected in the multi-disciplinary approach, project phasing, multiple actors, cross-scale execution, open-endedness, etc. It emerges as a mechanism for the large spatial and temporal

scales of urban design tasks. This means communication and information processing are to be formal areas of research instead of only practical issues in urbanism.

- The set of abilities that characterise design thinking. As claimed by many studies, these abilities are distinguished from those that dominate science and liberal arts: they tackle ill-defined problems, are solution-focused, engages innovative abductive thinking, and manipulate non-verbal modelling media with their own system of "codes" (Cross, 2006b; Lawson, 1980; Rittel & Webber, 1973; Roozenburg, 1993).
- Knowledge of forms, or the system of "codes" that translate abstract needs into physical artefacts (Cross, 2006b; Hillier & Leaman, 1976). The design knowledge system is, at its core, knowledge of forms (Tzonis, 1992a). But this knowledge is seldom made explicit and is only called upon in action.
- In urbanism, researches are done in different directions to probe and apply each constraint, creating various frames of theories. This research captures the widespread M-A thinking like a kind of visualising reagent, and the context in which the various frames are all bound, is beginning to reveal itself.

THE FINAL PRODUCTS

The final product of this research was originally planned to be a journal paper. For many scientific researches such a product would suffice. But a paper has a limited breadth in discussing a subject that implicate so much context. The scientific terminology is new to designers/planners working on this subject in our discipline; the phenomena-oriented approach is also new to scientists who are familiar with this subject. This work seems to be in a most awkward position, struggling to find a justified footing for its line of reasoning. The paper therefore suffered many restructuring; every time it is like telling the same story in a different way. With so many repetitions, the story teller came very close to lose the essence of the story. But this process also turns out to have strengthened the contents, so that at some point, I came to realise the paper content was not the source of the debate anymore. It is already the best I can make, and what else I must achieve has to be done in another way.

So I set out to find a format that would allow me to address all the implications my theories come with. All the while I was motivated by the words Frits said to me: imagine if I want to thank the staff members that helped me with my research, by presenting them with the results of my work, how would I materialise it?

I would want it to be readable, digestible, flavoured and colourful. And there are many different topics that they care about, that can be (partially) answered with my research. So to assemble all these qualities together, it takes a book.

To find the answer is (another) challenge; and so is executing it. A book takes planning of its rhythm: the way the content is distributed among its chapters is not only about a line of reasoning but also the pace of reasoning. One can also call it a sense of proportion (and literally so). Various distractions are employed to keep the reader concentrated: short articles, summaries, informal highlights and so on.

EVALUATING THIS RESEARCH

Most graduation projects of physical design are never constructed. So they can only be evaluated by experts based on: the coherence of their reasoning and final visualisation; the experts' knowledge of forms (the implicit "codes" of design). This research cannot be "built" either. Its evaluation will similarly depend on 1) its coherence and groundings, and 2) the extent to which it conforms to experts' shared knowledge of urbanism. The final product, now a book, consisting of explorations in both theory, phenomena and practical issues, can be subjected to both types of evaluation.

The scientific terminology in this research is not used to produce calculable scientific data as its core argument. If this were the case, then there would be good reason to question whether this research belong to the design discipline. However, the scientific terminology is used to structure the research approach and findings. The final results are grounded in design phenomena, and related to the knowledge that belong to the expertise of this discipline. For example, to demonstrate the implications and potential of the theories I develop, I have constructed several subplots: proposals on how practitioners can work with M-As, and how M-A thinking can be applied in education; summarising what we can learn about design and planning; discussing the technological potential of such researches. Therefore this research is not only evaluable by the discipline of urbanism, but also should be evaluated as such.

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APPENDIX **B**

Analysis of the M-As in the three rounds of design of Amstelveen Town Square

Based on the work by Atelier Quadrat, Hans Ruijssenaars, and Liesbeth van der Pol, 1994 (provided by Paul Broekhuizen).



Round 2 The design of the library (and underground parking) building conceives the building as a *ship*.

APPENDIX B (CONTINUED)

Round 3

The design of the library (and underground parking) building conceives the building as a *ship*.



APPENDIX C



Appendix D

A summary of the design process of Capelse Put

Based on the master thesis of Frits Palmboom (1981): the task is to design a residential area in the eastern edge of the city Rotterdam, where the ground conditions are complicated with infrastructure such as dikes, highways, railway yard, and industries.



Long before "complexity" was a scientific term, human intelligence was tackling complex issues of the built environment. One of its tricks is metaphorical and analogical thinking.

Is it indeed a sophisticated mechanism applied to handle design & planning? What would that mean for our evaluation of intellectual works, our focus in education, and the way technology should support us?

