The Fusion of Architecture and Infrastructure in Tomorrow's Megalopolis

The Relevance of the Metabolistic Collective Form in the Network Era
The Fusion of Architecture and Infrastructure in Tomorrow's Megalopolis

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PROBLEM STATEMENT

In an era characterized by growing networks architecture and infrastructure are increasingly clashing. The construction of new hubs where those two traditionally distinct paradigms meet are a possibility to consider a fusion. The mutual benefits of architecture and infrastructure might provide solutions for the future of urban form and its architecture. Collective Form as formulated by Fumihiko Maki presents a possible fusion of architecture and infrastructure. With Maki’s theory, parallels can be drawn with historical precedents like the habitable bridge, the linear city, and more specific, the relation between architecture and infrastructure in Rotterdam throughout history. Which concepts can we derive from those precedents for the future fusion of architecture and infrastructure?

ABSTRACT

This research shows the possibilities of combining architecture with infrastructure. The investigation considers the fusion of two paradigms that are traditionally distinct. Through the use of theories and built examples, this research tries to determine the framework of an architecture that integrates infrastructure. The point of departure will be the concept of Collective Form as formulated by Fumihiko Maki and the Metabolists. The works of the Metabolists are considered as the first attempt for a new architecture that incorporates infrastructure that acknowledges continuous transformation. To understand the effects of infrastructure on urban form and its architecture, Rotterdam is used as case study. The history of Rotterdam is used to find examples in which infrastructure and architecture is either merged or segregated. Started as a fishers village and developed into a world harbour as found today, the relation between architecture and infrastructure never lost its topicality. Conclusions are drawn from the developments that either reflected the ability or incompetence of meaningful contributions to architecture, infrastructure and urban form throughout the ages in Rotterdam. The combination with the legacy of the Metabolists provides insights for the mutual benefits of architecture and infrastructure. This research is an architectural inquiry that provides a framework for its fusion. It identifies possibilities for a new paradigm in which architecture and infrastructure is combined, providing concepts without prescribing outcomes.

1 The Metabolists presented their first ideas through a pamphlet at the World Design Conference called ‘Metabolism 1960: The proposals for a New Urbanism’ After the World Design Conference the Metabolists considered Takashi Asada as ‘honorary chairman’ of the group. Gatherings with Noboru Kawazoe at Ryugetsu ryokan were well under way when Fumihiko Maki joined the group in early 1960. Zhongjie Lin, Kenzo Tange and The Metabolist Movement (New York, Routledge, 2010). Fumihiko Maki formulated a theory about Collective in 1964 with his ‘Investigations in Collective Form’ (Washington: School of Architecture, Washington University, 1964)

RESEARCH QUESTIONS

Is the notion of collective form compatible with the future of our cities and the production of its architecture?

How can the interplay between architecture and infrastructure be exploited?

SUB QUESTIONS

Can infrastructure be designed as architecture?
Can architecture emerge from infrastructure?
Can the fusion of architecture and infrastructure form a new paradigm?
What are the historical predecessors of the Metabolistic Collective Form?
How does Collective Form relate to the Megastructure?
What was the role of flexibility and aesthetics in the theory of Collective Form?
How is Collective Form related to the idea of Bigness and indeterminate provision in architecture?
What were the most remarkable fusions of architecture and infrastructure in the history of Rotterdam?
What were the most remarkable plans for the separation between architecture and infrastructure in Rotterdam?
What is the maximum architecture can do if infrastructure is integrated?

HYPOTHESIS

The Metabolists were responsible for a paradigm shift with the elevation of the traditional separation between infrastructure and architecture. The acknowledgement of a new paradigm has been underestimated and therefore underexploited. Their approach with Collective Form is still relevant for today’s challenges in architecture and urbanism. The bombardment of Rotterdam marks a turning point in the history of urban form. The belief in infrastructure and segregation has driven a wedge in between architecture and infrastructure that seemed compatible before the Second World War. The theory of the Metabolists and the historical lessons from Rotterdam can provide urban solutions for the future of urban form and its architecture.
INTRODUCTION

A wave of technological revolutions mobilized an entire society\(^3\). The villager is now as connected as the citizen, making them both equally cosmopolitan. The result is a conglomeration where living, working and leisure takes place scattered over an urbanized landscape. A travel through this megalopolis\(^4\) is a journey from the one architectural artefact to the other. From house to office, from train station to university. The in between is designed by large infrastructures of highways and public transport. Commuting became so easy that multiple destinations per day became common good\(^5\). The network era experiences its heydays.

Travelling through the megalopolis in the network era often is an experience of architectural destinations reached through infrastructural means. The highly spatial journey consists of physical destinies like the home and the office connected through transitional nodes like the train station and the roundabout. Those nodes in the network are more considered as supportive elements, than as opportunistic architectural joints. The infrastructural knots are merely the glue of a web, desperately trying to hold its parts together. The involved congestion is associated with unwanted delay despite of spatial potential. In design there is a traditional separation between infrastructural planning and architecture. Although related, these two paradigms develop independent. Confrontation occurs afterwards. The architect starts with a masterplan, the traffic engineer follows up with the elaboration of the gray lines indicating roads. This results in a reality where one either designs the road or the destination where that road is leading to. The combination of both seems unthinkable, unrealisable, and above all, unwanted.

The idea to combine architecture and infrastructure is nevertheless not a new concept. On the contrary, its fusion has been thought out for centuries already. The theories are abundantly, yet the built examples are scarce. It were the sixties where an all encompassing architecture incorporated both architecture and infrastructure. It were most notably the Metabolists in Japan who not only theorized the fusion of architecture and infrastructure, but also designed it\(^6\). Their legacy of theories seems still relevant for today’s practice. Like true visionaries they envisioned the physical outcome of a network era that would experience its heydays several decades later. Anticipating on the mobilisation of the masses they designed and theorized the fusion of architecture and infrastructure.

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3 With an average of 18 km travel distance from home to work a large amount of people do not live in the city in which they work. Onderzoek verplaatsingen in Nederland (CBS, 2011)
4 Megalopolis started as a term describing American Megaregions. The region hosts ‘so many essential services, of the sort a community used to obtain in its ‘downtown’ section, that it may well deserve the nickname of ‘Main Street of the nation.’ Those characteristic were later applied to European megaregions as well. The Randstad in The Netherlands is one of its examples. Jean Gottmann. Megalopolis: The Urbanized Northeastern Seaboard of the United States (New York: The Twentieth Century Fund, 1961)
5 People in the Netherlands travel to more than 3 destinations per day. Onderzoek verplaatsingen in Nederland (CBS, 2010)
6 Lin, Kenzo Tange and The Metabolist Movement
With the 21st century obsession for connectivity it must be clear that the architecture of infrastructure and infrastructural architecture will play a significant role in the city of tomorrow. The absence of a recent theory brings us back to the theories of the Metabolists who thoroughly envisioned its potential. Driven by a fascination for Fumihiko Maki’s ‘Investigations in Collective Form’, the research will take the concept of Collective Form as starting point. This research analyses the concepts formulated by Maki, relates them to contemporaries of the 1960s and draws parallels with historical precedents like the habitable bridge, the linear town and the skyscraper. The quest for a receptive architecture integrating infrastructure and acknowledging time is the leitmotif of the research. The research addresses multiple scales of architecture and planning. From large to small it considers the region, the city and the building on an infrastructural level and the envelope, the unit and the room on an architectural level. The different forms of linkage between those elements are analysed in their flexibility and rigidity to determine their architectural capacities for future purposes.

The research will inform the design of an occupied bridge in Rotterdam. There is no other city in the Dutch megalopolis with such a dominant infrastructure as Rotterdam. The ‘authentic tabula-rasa’ caused by the bombardments of the Second World War was filled up by large infrastructure and big chunks of architecture. The combination of post-war reconstruction and architectural pioneering has been determining for the urban form of Rotterdam as found today. The city now provides remarkable architecture like the Groothandelsgebouw and the Willemswerf accessible by an infrastructure which looks more like a race circuit than a pleasurable network of streets and boulevards. The well connected network of rivers, highways and railway provides Rotterdam the required connectivity to

7 Maki, Investigations in Collective Form
8 Vanstiphout calls the post-war situation of Rotterdam as the most authentic form of Tabula-rasa. Martin Aarts, Michelle Provoost, Wouter Vanstiphout, Hans van Dijk, Harm Tilman, Jan van Teeffelen, Vijftig jaar wederopbouw: een geschiedenis van toekomstvisies (Rotterdam: 010 publishers, 1995) p. 114.
flourish as a world port since the 16th century\textsuperscript{10}. But although its ongoing role as pioneer in both architecture and planning, Rotterdam suffers from a continuous state of dissatisfaction about its physical form, a persistent inferiority complex since the ending of the Second World War. If neither architecture, nor infrastructure brought the city a comprehensible solution, this research aims to provide the framework for its possible fusion. The investigations will analyse Rotterdam through the historical development of its infrastructure. The research will show the effects of infrastructure on urban form and its architecture in the city.

\textsuperscript{10} De Greef, Rotterdam Waterstad 2035, pp 10-23.
ARCHITECTURAL OPTIMISM AND MEGAFORMS
1.1 THE LYRICAL SIXTIES

The 1960s are characterized by an optimism in architecture and planning not equalled ever since. The Americans called it the Space Age\textsuperscript{11}, the Europeans represented themselves through utopian collectives like Superstudio\textsuperscript{12}, the Japanese crowned all progressive efforts in a movement known as Metabolism\textsuperscript{13}. In all continents ideas and projects were fostered by economical prosperity, political liberty and a strong belief in technological innovation. The outcomes were highly distinctive. The Americans built their dreams by, among other, sending the first man to the moon\textsuperscript{14}. The Europeans theorized utopian futures covering cities with space frames and crossing regions with infinite buildings\textsuperscript{15}. It were the Metabolists both theorizing and building their dreams, providing us the most notable manifestation of the 1960s.

At the brink of the network era

Through technological revolutions and the invention of the automobile, luxury goods became available for the masses halfway the 20th century. Considering the Kondratieff super cycles describing history in periods of 50 years, we can distinguish the last 150 years in three comprehensive eras: 1. The age of electricity and steel, 2. The age of the automobile and mass consumption, 3. The age of information technology\textsuperscript{16}. The Metabolists operated at the zenith of an era characterized by automobiles and mass consumption, and anticipated on the emerging era of information technology. The combination of those two technological revolutions can be considered as essential background for their theories. Their architecture and planning theories provided solutions for a society relying on networks beyond the scale of the city. It combined the mobility revolution with the communication revolution, both serving the masses.

\textsuperscript{11} The belief in technology and progress became known as the ‘Space Age’, embodied by the Saturn V and the Vehicle Assembly Building (VAB). Cape Kennedy: Our fantastic space centre off the coast of Florida is full of implications for a new architecture and a new urban technology (Forum, Jan/Feb 1967) pp 50-57.


\textsuperscript{13} Lin, Kenzo Tange and The Metabolist Movement

\textsuperscript{14} President Kennedy committed the U.S. on May 25, 1961 to send a man to the moon and let him return ‘before this decade is out’. (Forum, Jan/Feb 1967) pp 50-57.

\textsuperscript{15} Superstudio presented their continuous monuments in magazines and lectures. Peter Lang, Hans Ibelings, Hilde Heynen, Superstudio: The Middelburg lectures (Middelburg: Zeeuws Museum, 2005)

\textsuperscript{16} ‘A Russian economist writing in the 1920s, Nikolai Kondratieff observed that the historical record of some economic indicators then available to him appeared to indicate a cyclic regularity of phases of gradual increases in values of respective indicators followed by phases of decline ; the period of these apparent oscillations seemed to him to be around 50 years.’ Andrey Korotayev, Sergey Tsirel. A Spectral Analysis of World GDP Dynamics: Kondratieff Waves, Kuznets Swings, Juglar and Kitchin Cycles in Global Economic Development, and the 2008-2009 Economic Crisis (Structure and dynamics 4, 2010)
Region for city

The new mobility of the masses blurred the boundaries of cities. The improved interconnectivity fostered a new urbanism. For the Metabolists an increasing population in combination with technological revolutions all of a sudden made the region as an entity more relevant than the single grain of the city 17. This called for a new attitude towards planning. Collective scale became the new language of an architecture expressing its regional relevance. This acknowledgement of the region as most important apparatus for urban planning was both born out of ideology and necessity. Although the Metabolists applied their theories to designs throughout Japan, they emphasized the broader relevance of their ideas for a new emerging


5. Yona Friedman, Ville Spatiale, 1958

6. Kenji Ekuan, Dwelling City, 1964

7. Kondratieff waves, economic cycles of 50 years

17 ‘Addition of activities to physical qualities in a search for form determinants in the city suggest a new union between physical design and planning. The investigation on group form inevitably leads us to give our attention to regionalism in collective scale.’ Maki, Investigations in Collective Form, p 22.

18 Maki, Investigations in Collective Form, p 23.
era. ‘In any event we predict that in a coming decade the investigations of regional expression in collective scale will become one of the most important and fascinating issues of architecture and planning’. Their preview is striking when read today.

**Constant flexibility**

Technological revolutions not only accelerated the mobility of the masses, but also involved a new rate of change. The emerging theory from the Metabolists was strongly tied to Japanese culture. Their ideas drew inspiration from Buddhist philosophy and biology. The city and its architecture was conceived as a living organism undergoing a continuous process of change and transformation. The ability of living organisms to transform while maintaining their structure was taken as the analogy for an adaptable architecture. The relation between technology and man was considered symbiotic, using technology as the extension of mankind. This not only involved the functional consideration of the architectural parts, but also their meaning. The belief in semiotics was used to signify the invisible for the creation of identity. ‘An architectural vocabulary is formed through a combination of ‘signs’ corresponding to autonomous units of meaningful space’. The notions about growth, change and identity lacking in modern architecture can be considered revolutionary. Not the fusion of architecture and infrastructure through technology, but the application of constant flexibility and symbiotic relations distinct the Metabolists from other precedents. The combination of technology, biology, philosophy and modernity was the base for a unique movement embodying both past and present, providing a valuable vision for the future of architecture.

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1.2 UTOPIAN VOCABULARY

Utopian scales and forms
The optimism of the 1960s brought a new kind of architecture that generated its own vocabulary. A variety of terms was first used by Fumihiko Maki in his 'Investigations in Collective Form'. In his research Maki uses the terms *Megastructure*, *Megaform*, *Masterform*, *Group-form*, *Compositional Form* and the all encompassing *Collective Form*. Reyner Banham attributes Maki the introduction of those terms in his 'Megastructure: urban futures of the recent past'. In his book Banham emphasizes the relevance of the *Megastructure* through a quotation from John Cook in conversation with Paul Rudolph. When Cook asks for the dominant tendency in architecture since Mies van de Rohe, Rudolph answers: 'after Mies, the megastructure'. To analyse the *Megastructure* and the multiplicity of its appearances it is useful to define the vocabulary through Maki's theory about *Collective Form*.

**Collective Form**

'Collective Form' represents groups of buildings and quasi-buildings - the segments of our cities. Collective form is, however, not a collection of unrelated, separate buildings, but of buildings that have reasons to be together. *Compositional Form*, *Group-Form*, *Megastructure* and *Megaform* are examples of Collective Form.

**Masterform**

The *Master Form* is an urban principle. Through the acknowledgement of a time factor in the masterplan, a 'more elastic and enduring... dynamic approach' is achieved resulting in the Master Form. Examples of the *Master Form* are the *Megaform* and *Group-Form*.

**Megastructure**

'The *Megastructure* is a large frame in which all the functions of a city or part of a city are housed. It has been made possible by present day technology. In a sense, it is a man made feature of the landscape.' A *Megastructure* is a large container of architectural elements.

**Megaform**

A *Megaform* is a contextual megastructure. A *Megaform* is by default a megastructure. Like the megastructure, the *Megaform* is a large container of architectural elements. A megastructure is not by definition a *Megaform*, since not every megastructure is contextual.

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21 Maki, Investigations in Collective Form
23 Banham, Megastructure: urban futures of the recent past, p 12.
24 Maki, Investigations in Collective Form, p 5
27 Kenneth Frampton, Megaform as Urban Landscape (New York, The University of Michigan, 1999)
Compositional Form
‘The elements... are preconceived and predetermined separately. ...they are often individually tailored buildings. Proper functional, visual, and spatial (sometimes symbolic) relationship would be established on a two-dimensional plane\textsuperscript{28}.’

Compositional Form is united through the composition of several elements without an all encompassing roof.

Group-Form
‘Group-Form... evolves from a system of generative elements in space’. Those elements are often characterised by ‘consistent use of basic materials and construction’, ‘wise, and often dramatic use of (human scale) geography and topography’, and finally the ‘sequential development of basic (repetitive) elements\textsuperscript{29}’. Like compositional form, the unity of Group-form is derived from the separate elements that compose the whole. Contrary to megastructure and megaform, there is no all encompassing roof.

\textsuperscript{28} Maki, Investigations in Collective Form, p 6.
\textsuperscript{29} Maki, Investigations in Collective Form, p 14.
All terms describe either a form or a structure. Their specificities are characterized by three criteria, each answering a specific question.

Programmatic criterion What does it contain?
Aesthetic criterion How does it look?
Contextual criterion How does it relate to its environment?

The criteria are addressing two recurrent themes.

Flexibility Can it transform, and if so: how does it change?
Linkage Can it connect, and if so: what does it link?

Those determining criteria and recurring themes will be considered for all appearances of collective form throughout the research.

Investigations in Collective Form

Maki wrote ‘Investigations in Collective Form’ in 1964. The research was intended to be polemic: ‘...these papers are intended to discuss why, what, and how we should design. These are open-ended discussions, to be polemical rather than definitive. They represent, however, only the beginning of a vast inquiry on the collective form.’ To interpret the concepts of collective form it is essential to analyse its foundations. Only then we will be able to determine its relevance and potential for contemporary applications. The following chapters will consider each appearance of collective form through the criteria and themes listed above.

30 The investigations in Group-Form Maki did in collaboration with Masato Ohtaka, the investigations in Linkage were done with Jerry Goldberg. Maki, Investigations in Collective Form, p V.
THE APPEARANCES OF COLLECTIVE FORM
2. THE APPEARANCES OF COLLECTIVE FORM

2.1 Collective Form and Master Form
With ‘Investigations in Collective Form’ Maki pleads for the addition of a time dimension in planning, changing the masterplan into a master program. This master program provides space for both the requested program as the possible change over time. The architectural solution that embodies both the specificity and future change of the program results in what he calls the masterform. Besides the acknowledgement of a time dimension, the masterform also anticipates on the new scale of highways and the world seen from above through airplanes. Examples of the master form are megaform and group-form. On a large scale, the master form is part of collective form.

Collective form is characterized as an interrelated ensemble of architectural elements. Those elements can be complete buildings, but also smaller units in a larger frame. Maki and Ohtaka categorize three possible collective forms:

1. Compositional form
2. Megaform (megastructure)
3. Group-form

2.2 Compositional form and Nolli’s map of Rome
‘The compositional approach is a commonly accepted and practiced concept in the past and at present. The elements which comprise a collective form are preconceived and predetermined separately. In other words, they are often individually tailored buildings. Then, proper functional, visual, and spatial (sometimes symbolic) relationship would be established on a two-dimensional plane.’

The compositional form is considered a classic approach used throughout history exemplified by Maki through Oscar Niemeyer’s masterplan for Brasilia. Compositional form points to an urbanism based on ground-figure plans, of which Giambattista Nolli’s map of Rome in 1748 is most known. In his plans individual buildings like churches and houses compose a variety of public space.

2.3 Megastructure and the ongoing popularity of megaform
‘The megastructure is a large frame in which all the functions of a city or part of a city are housed. It has been made possible by present day technology. In a sense, it is a man made feature of the landscape.’

Maki refers to an exhibition called ‘Visionary Architecture’ and emphasizes the

difference between technology used as a tool for human solutions and the possibility for ‘structural virtuosity’ which he relates to inhuman applications. With the publication dating from 1964 it is likely that he is blaming the utopians of the sixties. Considered as visionary architects, their structural virtuosity was sometimes infinite. Maki favours a human approach for the exploitation of technology.

‘Technology must not dictate choices to us in our cities. We must learn to select modes of action from among the possibilities technology presents in physical planning.’

Maki praises the works of Kenzo Tange and his plea for megaform giving shape to a so called mass-human scale. Through the acknowledgement of long and short cycles of change a masterform is defined which is able to ‘move into ever new states of equilibrium’. Long cycles concerns the design of large infrastructure like highways and airports, those elements usually last for fifty years or even a whole century. Short cycles concern the design of architectural elements like residences, cultural centres and shops, those elements are subject to frequent change differing from one year to several decades.

The incorporation of a multiplicity of life cycles ends up with an architectural program that could easily transform every year, but still hosts elements that last for a century. The outcome is an open-ended structure, which requires a properly designed control mechanism. This mechanism carefully selects independent functional systems, but designs the interdependency through the points where the systems are meeting. Maki elaborates on those connections in his chapter about linkage. Also in this research those links will be discussed later.

In 1999 Kenneth Frampton elaborates further on the megaform in his lecture ‘Megaform as Urban Landscape’. He takes the notion about megaform from the Metabolists and analyses its fundamentals through the use of historical and

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35 Frampton, Megaform as Urban Landscape
contemporary precedents. In his lecture he distinguishes the megastructure from the megaform. A megaform is by default contextual, a megastructure does not necessarily relate to its environment. One could say that the Metabolists made megaforms and the European utopians megastructures. The death of the megastructure was best described by Reyner Banham in his book ‘Megastructure: Urban Futures of the Recent Past’ who concluded that the concept of megastructure died because ‘recognition and exhaustion arrived together’[36]. The interest in the ‘over-scaled, colossal, multi-unit architectural mass’[37] was maybe gone, its modest alternative of which megaform was its clearest manifestation seems to be an on-going interest of architects. Kenneth Frampton confirms this with his lecture from 1999 in which he exemplifies the concept of megaform with contemporary architecture like L'Illa Diagonal built by Rafael Moneo in 1994[38].

Despite their distinctive popularity, both megastructure and megaform are characterized by their structural approach. It provides a framework, either literally or metaphorically, in which space is ordered.

2.4 Group-form and megastructural predecessors

‘Group-Form...evolves from a system of generative elements in space.’

Other than the megaform, group-form consists of several elements without an all-encompassing roof or container. Its form is generated through a system of elements. Unity exists through uniform spatial characteristics. The repetitive use of materials, construction methods and visual elements is used to create an order responsible for the whole. A small unit generates the greater form. Maki uses the example of Japanese villages in which the house generates the village and the village generates the house. Another celebrated example in the text is the 16th century canal house in Amsterdam. The spatial area outside the house, which the Dutch call *stoep*, is partly pavement and partly the threshold of the house. The repetition of this ambiguous stoep, but also the trees along the canal, the uniform paved roadways, the large glass windows and rear gardens construct a unity labelled as group-form. Maki points out ‘This set of situations has emerged through long experience and the wisdom of the people’[39]. The separate elements that construct the group-form contain what Maki calls a ‘built-in link’, a space generator maintaining the whole. Those elements have the character of a prototype.

‘The element and the growth pattern are reciprocal both in design and in operation. The element suggests a manner of growth, and that, in turn, demands further development of the elements, in a kind of feedback process’[40].

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36 Banham, Megastructure: urban futures of the recent past, p 162.
37 Banham, Megastructure: urban futures of the recent past, p 196.
38 Frampton, Megaform as Urban Landscape, p 20.
40 Maki, Investigations in Collective Form, p 19.
Characteristic is the possibility for transformation without changing the structure of the group-form. When a unit is either added or removed, the group-form remains the same. Nevertheless it is the element of group-form providing its essence, unlike the situation in megaform where it is about the skeleton in which elements are placed afterwards. Maki and Ohtaka use the bazaar as example par excellence, based on the collectivity of function, social coherence and spaces. After all group-form is characterized by its sequential approach. It provides a system generated by units with uniform characteristics forming the whole, without specifically relying on one of them.

As analysed by the Metabolists, collective form existed before it had a name. Medieval cities and Greek islands are brought up as historical precedents. Not incorporated, but at least as relevant, is the medieval habitable bridge as found in cities like London and Paris. It is the petrified version of the bazaar, a highly architectonic example of collective form. The occupied bridge, inhabited by merchants, faced similar transformations of addition and removal as the linear town and bazaar. The amount of units changed over time, while the group-form remained the same.

When looking at the proposal for Tokyo Bay by Kenzo Tange, one clearly recognizes the concept of linear growth in favour of concentric expansion. The Metabolists used diagrams of biological accretion to explain the relevance of linearity. An interesting parallel can be drawn with earlier examples of linear megastructures of similar scale. Already in 1900 Arturo Soria designed a linear city for Madrid. Completely contrary to its contemporary Ebenezer Howard lodging small communities in concentric garden cities, Soria firmly believed in housing the masses in a linear city. His design was based on the possibilities of mass transportation transporting people across vast distances. About 10 years later, in 1910, it was Edgar Chambless proposing a Roadtown. This town would continue where the network of the city stopped. Its inhabitants would experience the advantage of the city through their highly connected residences, but also had the advantage of the countryside in front of their house. Another 23 years later, in 1933, Le Corbusier proposed his Plan Obus for Algiers. The 15 km long apartment block both reminds us of the Roadtown of Chambless, but also relates to Tange’s Tokyo Bay project in retrospect. Both projects offer an enormous structure providing space for habitable in-fills like the apartment block. All those

41 Maki, Investigations in Collective Form, p 19.
precedents can be considered examples of collective form. Soria’s *Linear City* could be considered as group-form due to the generative elements forming the whole, Chambless’ *Roadtown* as megastructure due to the rigidity of the residences in the larger frame and Corbusier’s plan *Obus* as megaform due to the flexibility of its in-fills. It proves that the idea of a large linear form was not new in the 1960s. It
was mainly the thoroughness of the Metabolists that distinguishes their works from predecessors. Providing a multiplicity of projects and a profound theoretical framework their legacy is by far the most notable and above all, applicable form of linear design for architecture and planning.

Group form is characterized by a sequential approach. The architectural elements generate the sequence and the group form simultaneously. The unit and the whole are in that sense reciprocal.

2.5 The fusion of architecture and infrastructure
Collective form has either a compositional, structural or sequential starting point. Maki and Ohtaka stretch that ‘in any final form of design, these three concepts will appear either combined or mixed’. Nevertheless only megaform and group-form are considered examples of masterform and allow transformation over time. And not unimportant, only masterform provides solutions for the superhuman scale. To design a masterform one either starts with a megaform or a group form, resulting in either a structural or sequential starting point. After the fundamentals of such an approach, typologies can be combined, mixed or substituted. The outcome works upon both city and region: ‘The primary regional character in urban landscape will probably be in the grain of the city. Both group-form and megaform affect the urban milieu at precisely that level. In megaform, it is a large form that represents all the power of technique, and that may represent the best aspects of regional selectivity’. This regional selectivity consists of both architectural and infrastructural elements, the prelude for a fusion of two traditionally distinct paradigms.

47 Maki, Investigations in Collective Form, p. 23.
MIXING PARADIGMS
3. **MIXING PARADIGMS**

3.1 **Elevating the borders of independent paradigms**
The extra large scale of the masterform calls for collaborations in both design and implementation. According to Maki and Ohtaka the potential of masterform lies beyond the scale of architecture. Through the collaboration between engineers, architects, urbanists, planners, economists and investors new opportunities arise. Collaborations are characterized by sustainability, hybridization and infrastructure. This idea elevates the borders of traditional paradigms. No longer the architect builds the house and the engineer the road, the megaform calls for their collaboration, making house and road an integral assignment. This offers the possibility that the house is the road or vice versa. Either without the merge of those typologies, a new reality is created through the optimal alignment of two paradigms.

3.2 **Engineering and the tenacity of civic works**
Since the masterform deals with large structures it needs both structural and civil engineers. Maki addresses that in their collaboration lies a potential to develop structural and civic design beyond their scope. The expertise of large spans, space frames, light skin structures, pre-stressed concrete, highway infrastructure, landscape and climate control can all be brought together in architecture through the efforts of structural and civil engineers in collaboration with the architect. Described as an environmental building by Maki, half a century later we would probably call this sustainable architecture. And although today the skills of structural and civil engineers are used for the realization of architecture, true collaborations or fusions are scarce. If structural engineers are used for new forms of architecture, this mostly concerns their deployment for building bigger and stronger. The suggested potential for the development of civic works beyond their paradigm seems even fifty years after too futuristic to be realized. Highways, bridges and dams remain a matter of pouring asphalt and concrete.

3.3 **The multi-functional structure and the painful truth**
Written in a time where architecture was mainly considered as the act of designing single purpose buildings, Maki and Ohtaka stretched the importance of combining functions. Today also known as hybridization, they emphasized the useful possibilities of multi-functionalism. Exemplified by Kurokawa’s agricultural city, it reminds of the later works of Allison and Peter Smithson for the Free University in Berlin. In both schemes a multiplicity of functions is covered under an all-encompassing roof. Nowadays the ambiguity of functions in contemporary architecture is so wide-spread that hybridizations became common good. But considering Maki’s definition of the megastructure as a frame containing the

functions of a city, one can think of very few examples embodying this description. As a conceptual approach the building as a city is milked out, the physical outcome of this intention is often a painful truth. Either the concept is an impossible ambition, or the potential is misunderstood and underexploited. In the case of the latter, rereading Maki’s theory can be a motivation for unexplored mixtures of functions.

3.4 Infrastructure as public investment

The Metabolists theorized and built architecture during a time of economic prosperity with the dedicated involvement of its Japanese governance. Architecture was not longer a private affair, but a public concern. In this light the proposal for infrastructure as public investment can be explained\(^5\). Instead of a single private building on a definite plot, they suggested public skeletons without boundaries. The expansion of such megastructures were not limited in two directions, but introduced a third dimension. Land use became three-dimensional, accessible by horizontal and vertical circulation systems\(^6\). Megastructures, like the incubation process of Arata Isozaki, were never fully built on the scale suggested by the drawings, but still applied on smaller projects like the Yamanashi Press and Broadcasting Centre by Kenzo Tange. In this building Tange used Isozaki’s studies for a ‘City in the air’\(^7\). The metabolistic ideas come to life through the design of a heavy structure serving both horizontal and vertical circulation. In between the circular concrete shafts adaptable spaces are located that leave room for change. Besides the physical expressions, also abstract notions are incorporated. The centre is called Bunka Kaikan, which means cultural meeting place or ‘doing together’

21. Incubation process, Arata Isozaki 1962

22. Bunka Kaikan, Kenzo Tange, 1966

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50 Koolhas, Obrist. Project Japan: Metabolism Talks
52 Michael Ross, Beyond Metabolism (New York: Mc-Graw-Hill, 1978)
house’, embodying the multiplicity of characters in the building[53]. The money sided organization housed in the building makes connections with politics, economics and culture through the materialization of metabolistic ideas in the design. Public and private life are merging in one building, not only combining the interests of both parties, but also their means. Private and public investments are combined for the realization of private buildings serving the masses.

Although rooted in a totally different political system this form of financing comes closest to what we today know as Public Private Partnership. The combined interests of private entrepreneurs and public governance are used to realize architecture that without collaboration would have never been. Nevertheless civic works like dams, bridges and highways remain the responsibility of single public governances and their civil engineers. Unlike the Metabolists neither infrastructure gets architectural, nor architecture gets infrastructural. Like for hybridization and engineering, also infrastructure provides a vast range of unexplored possibilities. A rather unemployed potential lies in finance. Although fostered by economic wealth, the ideas of the Metabolists could also be used for times of financial crisis. The shrinking budgets of public governances and private investors could be used for collaborative investments. When architecture merges with infrastructure, public and private interests come together. The logical outcome will be the bundling of forces. Architecture not only gets better through a broad public support, but also more feasible through the diminution of required budget.

3.5 The architectural potential of infrastructure

The Metabolists were right with their prediction that mass transportation would change urban form for good. The network era as we know it now has even greater proportions than envisioned. The scales of highways, train tracks and harbours are so big, that the development of civic works as autonomous paradigm is not surprising. The complexity of such projects might be so challenging that the consideration of other paradigms like architecture is overlooked or even neglected. This could be the possible explanation for the survival of the traditional masterplans drawn by urbanists and municipalities. The distinction between architecture and infrastructure is in those two dimensional designs unavoidable. The engineer still superimposes streets on the city without consulting the architect who builds along the road. The architect still designs buildings, without having the chance to change the surrounding infrastructure. The urbanist is sandwiched between two paradigms, desperately failing in bringing them together. The suggestion by Maki to merge architecture and infrastructure was a visionary thought, but could still achieve a paradigm shift changing the city for good, on a similar scale that mass transportation changed urban form. The challenge is now to exploit the potential of architecture when applied to the rigour of infrastructure. Besides a radical change in the character of two paradigms, it will change the image of our cities. This not only prescribes the theoretical fusion of two paradigms, but also its physical outcome. Besides new technology, the merge also requires new aesthetics.

4. THE PRESENCE AND ABSENCE OF ARCHITECTURE

4.1 The flexibility and open aesthetics of the masterform

The Metabolists were both encouraged and alarmed by the technological innovations of their era. The increasing amount of short-lived items inspired them to distinguish them from long cycle elements concerning topographical interventions like dams, highways and harbours. In their theory of the Master form Maki and Ohtaka are looking for an architectural container providing space for elements of both life cycles. Through the elimination of a rigid hierarchy, they are striving for a new efficiency providing space for transformation. The masterform is a large-framework maintaining visual consistency. This means that the masterform not only prescribes an organizational logic, but also a formal outcome. Like the organization of the program, the aesthetics are open. Maki and Ohtaka are explaining this through a quote of John Voelker: ‘In open aesthetics, form is a master key not of any aesthetic significance in itself, though capable of reciprocating the constant change of life’. The open form that results from this a recognizable entity. An architectural container encompassing visual coherence and programmatic flexibility.

4.2 Engineering the unpredictable in Bigness

When reading Rem Koolhaas’ theory about Bigness we find characteristics that are similar to the masterform as described by Maki. Both bigness and masterform are engineering the unpredictable. Like the masterform, also bigness anticipates on the relations between the systems that it is hosting. ‘It develops strategies to organize... their independence and interdependence within a larger entity in a symbiosis that exacerbates rather than compromises specificity.’ The multiplicity of possible functions within the masterform is comparable with the ‘programmatic alchemy’ of bigness. The concepts of bigness and masterform both result in a symbiotic architecture, a term worshipped by the Metabolists. But bigness is not at all another appearance of the masterform. Its difference lies in contextuality. At the very end of his text Koolhaas attributes bigness the representation of the city, without longer needing this very city. At this point bigness is the antagonist of the masterform which heavily relies on the city, aspiring profound connections with its environment. In a further comparison we find nevertheless more similarities between the two phenomena. When Koolhaas describes bigness, he emphasizes the inability to ‘animate the entire mass’. Its result is programmatic openness, ‘zones... free from architecture’. In the masterform this are exactly the flexible zones subject to open aesthetics. And although their shared ability to accommodate change, visual consistency is in both bigness and masterform maintained. Koolhaas justly addresses the possibility of disconnection between interior and exterior, a result of programmatic flexibility and visual consistency.

56 Rem Koolhaas, Bigness, pp 495-516.
longer what you get58.' This disconnection highlights both a potential and danger for the design of the masterform. Its required specificity will be constantly weighed against the visual consistency pleading for genericity.

4.3 Indeterminate provision in Lacaton and Vassal’s Plus
The French office Lacaton and Vassal is famous for their generous architecture. Their working method is clearly expressed in their theory of the Plus. Architecture is considered as the act of creating capacity, no matter the context. This capacity allows room for change, transformation, adaptation, and not to be underestimated, appropriation. The creation of capacity is not so much the enlargement of the mass, but especially the design of usable surface without determining its future function59. Like bigness and masterform, the plus is engineering the unpredictable. In their generous designs Lacaton and Vassal use a limited amount of materials. Through the smart embedding of simple materials, often coming from industry, they realize architecture with limited resources. They consider this aspect essential to create a lightness providing possibilities for reversibility and flexibility. Materials and aesthetics are as such directly related to programmatic flexibility.

4.4 Dutch liberalisation and Van Klingeren’s openness
During the heydays of the sixties also Dutch architecture evidenced interest for an open architecture providing space for change. It was Frank van Klingeren and his design for a cultural centre in Dronten envisioning a flexible architecture capable of change over time. Its interior was kept empty to foster a multiplicity of functions and activities60. Remarkable was his idea that besides accuracy and interchange, architecture also consists of designing obstacles. He stated that architecture is ‘60%

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58 Rem Koolhaas, Bigness, pp 495-516.
59 Audrey Contesse, Ruimte als Duurzame luxe – Interview with Anne Lacaton (A-plus 214, no. 214 okt./nov.) pp 70-76.
60 Frank van Klingeren, De Drontener Agora (Bouwkundig Weekblad 1968, no.3)
perfection, 20% meeting and 20% hindrance. This concept was not only based on pragmatism, but also inspired by the political process of liberalisation during the sixties in the Netherlands. It was the end of an era in which society was divided in so called pillars. Van Klingeren was convinced that the abolition of this social segregation could be embodied by architecture. The new openness of society was translated into an architecture that allowed a similar freedom. Most notably in his design for the Meerpaal Van Klingeren envisioned a certain absence of architecture in his buildings. Not only the generous creation of space capable of transformation and appropriation, also the aesthetics left room for interpretation.

4.5 The neutrality and specificity of aesthetics

The concepts of the Metabolists, Koolhaas, Lacaton and Vassal and Van Klingeren all share a notion of flexibility in architecture. In all cases this concerns the transformation of program. They present buildings as adaptable containers for a variety of activities. Besides the common interest for programmatic change, there are outspoken ideas about its aesthetics. Remarkable is a shared interest for a certain absence of architecture, and the local design of specificity. The balance between those two interests, the balance between neutrality and specificity, characterizes each concept. One can conclude that the flexibility favoured by all, forces to make decisions on neutrality. Part of the building will be ‘free from architecture’. The notion of specificity distinguishes the different approaches. Like the Metabolists derive specificity from context, bigness only is specific inside its envelope. The equilibrium of neutrality an specificity will play an ongoing role in the challenges of a flexible architecture.

24. Frank van Klingeren, De Meerpaal, Dronten, 1964

61 Frank van Klingeren, De Drontener Agora
ARCHITECTURAL INFRASTRUCTURE OF MEANING
5.1 Contextual megastructures

No matter if one considers the European utopians of the sixties or the concept of bigness by Koolhaas, those notions are characterized by their lack of context. It is exactly this point where the Metabolists distinguish their-selves. Collective form is by definition contextual, no matter its appearance. Local characteristics are used to make connections on a multiplicity of scales including history, urbanism, sociology and program. The building is therewith considered as a mechanism that selects the independent functional systems working upon the architecture. The establishment of interdependency, crucial at the points where systems are meeting, is considered as the design of *Linkage*. Within collective form linkage plays a significant role, turning large-scale architecture into sensitive megastructures. A special chapter of ‘Investigations in Collective Form’ is dedicated to the design of links in architecture, providing linkage its own stage.

5.2 Complexity and ambiguity in comprehensive architecture

The new rate of change that Maki describes in his text coincides with a new level of complexity. The unpredictability of the future is translated into the design of programmatic flexibility. In search for an ordering force, this is the architectural answer for a new complexity. But moreover Maki and Goldberg were looking for a comprehensible solution that provided human significance in what they called ‘a disjointed world’\(^{63}\). ‘But when a plethora of stimuli begins to divert us from receptive consciousness, the city renders us insensible. Then, in our inability to order experience, we suffer the city, and long for some adequate means to comprehend it as a product of men like ourselves-as the product of a more intelligent, ordering force’\(^{64}\). They envisioned a leading role for urbanism to give meaning to places beyond the organisation of mechanical forces working upon city form. The recognition of order and its meaning could make unity from diversity. The outcome is not only spatial, but provides several layers of meaning through its profound connections with non-architectural tools like association. This approach allows ambiguity in the design of architecture. Intermediate spaces can have dual or multiple meanings\(^{65}\).

5.3 Multiple layers of significance

To provide human significance, Maki and Goldberg analyse urban design and its underlying principles. They state that comprehensible links in urbanism are fundamental for the presence or absence of significance in collective form. Their theory looks for tools to create a ‘humanly evocative environment’. In their vision such an environment is more than the primary linking of discrete things. Through examples they emphasize that all established links have ‘a complicated secondary

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\(^{63}\) Maki, Investigations in Collective Form, p 28.
\(^{64}\) Maki, Investigations in Collective Form, p 29.
\(^{65}\) Kurokawa, Kisho Kurokawa: The Architecture of Symbiosis, p 12.
system of meanings and uses. As an example they take the medieval bridges of Perugia. Primarily linking two buildings at both sides of the river, the bridges also take secondary roles like the structural support for river walls, overhead for pedestrians and spatial reinforcement of the pathways in the city. A single link can have multiple layers of significance.

5.4 Horizontal linkage and symbolic value
In their theory of linkage Maki and Goldberg stretch that links ‘at a particular scale of urban activity, ...have more to do with movement through space, than with a standard vision of the shape of a place’. The analysis of new kinds of spaces caused by increased mobility and new commercial realm require in their vision a specific approach not conceived before. Taking the train station as an example, they consider such space not as a stop, but as the link between two worlds: the one of the train and pedestrian movement. The understanding of such horizontal linkage can provide symbolic value beyond its literal manifestation.

5.5 Vertical linkage and the skyscraper
In addition to linkage on the ground level, Maki and Goldberg plea for the introduction of three dimensional linkage through the use of high rise towers. They aim for an integrated experience of the multiple levels of the building, making connections with the city. They propose: ‘each deck of a tower or slab must be transparent to us, and each level of activity must be unique. Then, and only then, will we sense three-dimensional linkage.’

5.6 Historical linkage and the cycle of decay
In his architectural approach Maki already addressed the issue of life cycles and decay through the plea for programmatic flexibility. In their ideas about linkage Maki and Goldberg approach the city with a similar notion, but now anticipating on the decay of the city. ‘The cycle of decay can become a linking force in our cities. If recognized, it provides an opportunity to replace old structures in an old environment with new structures’. The mixture of old an new structures is favoured above large areas of what they consider ‘formless agglomerates’. According to Maki and Goldberg this is the only way to be truly urban. ‘There is nothing less urbane, nothing less productive of cosmopolitan mixture, than raw renewal, which displaces, destroys, and replaces, in that mechanistic order.’

5.7 Designing connections and actions
The theory of linkage demonstrates a strong belief in the potential of architecture. ‘Linkage is simply the glue of the city. It is the act by which we unite all the layers of activity and resulting physical form in the city’. According to Maki the different links will shape the city, providing an extensive infrastructure of

67 Maki, Investigations in Collective Form, p 32.
68 Maki, Investigations in Collective Form, p 34.
69 Maki, Investigations in Collective Form, p 35.
architecture and meaning. Buildings are no longer autonomous objects in the urban fabric, but mediators of the city. They draw relations, crystallize activities, foster transformations and interact with its users. Architecture as collective form works like an Active form as formulated by Keller Easterling. In her text ‘The Action is the Form’ Easterling considers the character of infrastructure in our cities. She stretches that infrastructure is made out of action, as much as it is made out of matter like asphalt. She celebrates strikingly similar notions as Maki does with linkage. An event within an infrastructure, whether a digital network or a cityscape of streets, ‘is not reliant on movement but rather on unfolding relationships inherent in its arrangement’. Architecture here is not considered as a static object, but as active form. This potential, already envisioned by Maki, is according to Easterling underexploited in architecture and urbanism today. The contemplation of the active form would according to Easterling open a new field of possibilities for architects and urbanists. Architecture and infrastructure are no longer considered as static objects of urban form, but spatial agents or actors in the city. These actors condition the city through establishing links. The architect of active forms designs an infrastructure of meaning which not only determines what changes, but also what survives. The resulting urban infrastructure is a powerful network of architecture permeated with scripts that govern use and growth. Not the physical form matters here, but the resulting events. ‘Designing infrastructure is designing action’. Implicitly stated by Maki, the design of architecture and linkage concerns the assignment of creating an infrastructure of meaning. The complexity of parameters working upon its outcome turns the design of architecture into a highly contextual act. Chosen links will not only determine the design of the building but also the activities that will take place in and around it. Architecture and infrastructure undo their-selves from their rigour and become devices for the orchestration of the city.

25. Fumihiko Maki’s linkage diagrams: to mediate, to define, to repeat and the sequential path, 1964

70 Keller Easterling, The Action is the Form (Moscow, Strelka Press, 2012)
71 Easterling, The Action is the Form
72 Easterling, The Action is the Form
5.8 Linkage and the curse of segregation

In his investigations Maki follows a structure in which he starts with the theorization of a concept and considers the architectural application afterwards. The analysis of urban phenomena in linkage is followed up by a tool box to establish the theorized connections. Maki summarizes the design of linkage in five operational categories: to mediate, to define, to repeat, to make a sequential path and to select.

To mediate

‘Connect with intermediate elements or imply connection by spaces that demonstrate the cohesion of masses around them.’ Maki and Goldberg use the example of the Dutch stoep. The stoep is the pavement in front of the house, working as a mediator between the public and the private. But it also mediates between the house and the street, between inhabitant and city. The ambiguity of the stoep provides a duality from which two worlds are benefiting. The contemporary version of the stoep might be the plinth with its semi-public foyers and vast retail areas. Celebrated by urbanists the plinth provides both space for the private and the public, for building and street. The acknowledgement of its ambiguous quality made some urban plans prescribe the public character of the plinth to widen the public space of the street.

To define

‘To surround a site with a wall, or any physical barrier, and thus set it off from its environs.’ Maki and Goldberg illustrate this with the medieval city wall, but also bring up the modern ring road as a tool for definition. These elements inform the growth of a city and its architecture. The city wall was such a determining element that growing cities mostly densified within the perimeter. The outcome was a centralized urban fabric. Whether we consider the removal of city walls or the construction of ring roads, a completely new urbanism arose with the elevation of former borders. Centralized cities fractionated into an urbanized landscape with multiple centres. In the poly-centric development of urban form, the modern highway played a double role as tool for definition. Although it broke down the borders of the centralized city, it also constructed new barriers. Like the medieval city wall defined a centralized city, the network of highways and streets informs the sub centres of the poly-centric city.

To repeat

‘To link by introducing one common factor in each of the dispersed parts of a design, or of an existing situation. That common factor may be formal, or material, or even functional-historical.’ Maki uses the example of the Italian town where each house has a private defensive tower. The repetition of this architectural element unified the town. Also in their analysis of the Dutch canal house we notice an

73 Maki, Investigations in Collective Form, p 37.
interest for repetitive elements: the repetition of windows, trees and pavement construct the whole.

**To make a sequential path**

‘To arrange buildings, or parts of multi-use buildings in a sequence of useful activity. Further, to reinforce such a path by any means necessary to propel persons along a general designated path. Finally, to design a path, or reinforce a path in the natural landscape which will catalyse and give direction to new development along its course.’ Maki emphasizes that this concerns a path both between and inside buildings, and for that reason is three-dimensional. The multiplicity of buildings along the path give both meaning to each other and the path. Such a path is the result of an ‘activity sequence’ like a pilgrimage along multiple temples. A more contemporary example we can find in our shopping districts. Sequential paths lead shoppers along store fronts, public atria and food courts. The sequence works like a script evoking, what Easterling calls, actions. The sequence not only defines the popularity of its elements, but also informs future expansions. Although described as a sequence of useful activities by Maki, this strategy can be used for anything. The architectural means do not change whether one designs a sequence of contemplative spaces, commercial malls, cultural centres or public parks. This offers the possibility to exploit the sequential path as tool for the design of meaningful cities, or the exploitation for mono functional interests like shopping. Jon Jerde, designer of a vast retail areas around the world including Rotterdam, seems to be a master in the sequential path. In his projects clearly defined sequences determine the movements of shoppers. Although Maki’s pilgrimage along temples contrasts with Jerde’s opportunistic consumerism, the formal outcome is strikingly similar.

26. Repetitive defense towers, Mestia, Italy, 1980
27. Sequential path, Jerde Partnership, 1989

75 Maki, Investigations in Collective Form, p 40.
To select

‘To establish unity in advance of the design process by choice of site.’ Maki and Goldberg hint the possibility of the designer selecting his own site for the establishment of a link. According to them a careful selection can both affect the design itself and its environs. They emphasize the unifying potential of such projects, exemplified by Russian hill in San Francisco. Such a design exploits the potential of the landscape. According to Maki and Goldberg such natural advantages are too little acknowledged and used for the establishment of powerful links. In the network era such links are partly embodied by the nodes in the network. Stations, malls, business districts, bridges, squares, parks and campuses are either making links in the urban fabric, or exploit existing connections. The mobility of citizens make neighbourhoods, districts, cities and even regions compete. Where some nodes evaporate caused by indigent linkage, optimal connected places flourish in a network of opportunistic users. The selection of strategic nodes and potential links will play a significant role in the development of our cities in transit.

76 Maki, Investigations in Collective Form, p 42.
6. ROTTERDAM, A HISTORY OF INFRASTRUCTURE

6.1 No Infrastructure, no Rotterdam
Rotterdam has a rich history of infrastructural works. Its architecture came almost always after, or ideally at the same time. Rotterdam emerged from a port, which in the centuries thereafter developed and shaped the city. Without infrastructure no port, without port no Rotterdam. One who wants to understand the urban form of Rotterdam as found today, will find its answers in the development of the infrastructure throughout the ages.

From 800 till 1250 the area of Rotterdam faced subsidence caused by the extraction of peat\(^{77}\). The threat of sea became so dangerous that the city required dikes. The dike built in 1270 in the river Rotte became the marking place of Rotterdam, right at the place where the Rotte flowed into the Maas. Behind the dyke of the delta and enclosed by two canals, the city derived its typical triangular shape. Strategically connected with the hinterland, Rotterdam developed an important agricultural market after it achieved city rights in 1340. Despite its flourishing market, the city barely grew until the 16\(^{th}\) century. This changed with the fall of the port in Antwerp, increasing the importance of the harbour in Rotterdam. The port experienced its geographical advantage lying in between Antwerp and Amsterdam, but also connecting Germany with the North Sea\(^{78}\).

6.2 The representative waterfront
Rotterdam started as a city behind the dike, but connected itself to the river at the end of the 16\(^{th}\) century. Numerous harbours in between the old village and the Maas changed the centre of gravity towards the river. Around the Wijnhaven and Scheepmakerhaven a mix of warehouses, shipyards, sail makers and rope houses represented the new economical and political heart of Rotterdam, also called Waterstad. The decreasing threat of war made it possible to construct a waterfront serving both industry and public. The new quay was called Boompjes. A generous waterfront enclosed by lime trees, ‘boom’ is Dutch for tree, turned the Boompjes into storage location and pedestrian esplanade. The scenic quality of river and city was enhanced at the end of the 18\(^{th}\) century with Rotterdams first public park, the Oude plantage. The park exploited a wonderful panorama of the river\(^{79}\).

The displacement of the shipyards that turned landward transformed the Boompjes throughout the 17\(^{th}\) century into a beloved place to live. The prestige of the waterfront increased with the settlement of influential families and companies in the 18\(^{th}\) century\(^{80}\). The Boompjes was ‘the pride and joy of Rotterdam’\(^{81}\), and even

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77 De Greef, Rotterdam Waterstad 2035
78 De Greef, Rotterdam Waterstad 2035
80 Meyer, City and Port
81 Meyer, City and Port, p 293.
28. Rotterdam: Dam in the Rotte, 13th century

29. Rotterdam 1560

30. Rotterdam and its Waterstad, 1664

31. Panorama of the Boompjes, the river-front of Waterstad, 1665
32. A view from south to north onto the Boompjes, 1780

33. Lyrical painting of the Boompjes, lime trees and vessels, 1823
described as the Venice of the North\textsuperscript{82}. The political and economical face of the city was represented at the river, the real harbour activities happened behind its urban facade. In the same period, representative waterfronts could also be found in Genoa with the Piazza Caricamento, Amsterdam with its Damrak and ultimately Venice with its Riva Degli Schiavioni\textsuperscript{83}. In the 19\textsuperscript{th} century the Boompjes further developed itself as the central meeting place of Rotterdam. This was partly caused by the decision of the municipality to use the Boompjes as marketing device. The route from Antwerp to Amsterdam and therefore from Katendrecht to city centre turned the Boompjes into a panoramic view promoting Rotterdam. This was evidenced by enthusiastic travel stories and expressive paintings\textsuperscript{84}. Waterstad became a popular place for both locals and tourists, fostering the construction of hotels and cafés near the water. With its destinations to the unknown parts of the world and the international trade, the Boompjes not only introduced visitors to the city, but also provided an introduction to the world\textsuperscript{85}.

\textbf{6.3 Industrialisation crosses the river}

The industrialisation in the 19\textsuperscript{th} century leaded to the construction of the Nieuwe Waterweg in 1872. This connection strengthened the economical position of Rotterdam and accelerated its growth. New harbours arose at the south side of the river, hosting a new scale of port activities. Technology made wood turn into iron, sail boats into steamships and handicraft into machinery\textsuperscript{86}. To connect city and harbour with the hinterland a train was introduced. Its chosen track was constructed through muting the Rotte and crossing the river by a railway bridge constructed in 1877. In addition to the railway crossing, a bridge for cars, pedestrians and bikers was added: the Willembrug was finished in 1878. The public work stimulated the private developments around the bridge. The most remarkable initiative was the White House constructed during the early 1900s. The first skyscraper of Europe contained a roof terrace providing a new panorama of Rotterdam. This tower was ‘the culmination, both literally and figuratively, of the fusion of port and city, of public works and private enterprise’ as described by Han Meyer in his book about

\begin{itemize}
\item \textsuperscript{82} Kees Nieuwenhuijzen, Rotterdam gefotografeerd in de 19e eeuw (Amsterdam, Van Gennep, 1974)
\item \textsuperscript{83} Meyer, City and Port
\item \textsuperscript{84} Meyer, City and Port, p 290.
\item \textsuperscript{85} Meyer, City and Port, p 31.
\item \textsuperscript{86} De Greef, Rotterdam Waterstad 2035
\end{itemize}
the history of Rotterdam and its port. The increasing size of ships during the beginning of the 19th century required for both Willemsbrug and railway bridge adjustments. The height of the Willemsbrug was increased in 1925 and resulted in a 360 meter long slope at the Boompjes making the bridge accessible for cars and pedestrians. The railway bridge at the south side of the Noordereiland was replaced by ‘De Hef’ in 1927 to facilitate a new scale of vessels.

6.4 The bombardment of a dissatisfied city
Shortly after the start of the Second World War Rotterdam was bombed. On 14 May 1940 the German air force performed an aerial bombardment on Rotterdam. The triangular shaped city centre disappeared from the map. Except a few mayor buildings, the city was left in emptiness. Although for most citizens dramatic, some people considered the bombardment a relief: ‘valuable memories of the things we lost are attached to shortcomings of our old city... it cleaned up all things that we, people from Rotterdam, did not lay aside despite its inconsistency with the material requirements of contemporaneity’. The quotation taken from the first urban renewal proposal after the war in 1946 clearly exposes the dissatisfaction about Rotterdam before the bombardment. This dissatisfaction was already part of the prestigious urban renewal projects that started before the war. The refurbishment of Hofplein, the construction of the Maastunnel and the Beurs were significant projects to change the urban fabric for good. Although discomposed form their context, the execution of these projects continued after the bombardment. The reconstruction after the devastating war was in line with a new scale already started before the bombardment.

Besides the accelerated growth of industry, industrialisation also mobilized the people. After the introduction of the automobile at the beginning of the century, cars became affordable in the decades that followed after. The resulting new scale

36. Parking, Feyenoord football match, 1937
37. Start construction Maastunnel, 1937

87 Meyer, City and Port, p. 309.
88 Martin Aarts, Michelle Provoost, Wouter Vanstiphout, Hans van Dijk, Harm Tilman, Jan van Teeffelen, Vijftig jaar wederopbouw: een geschiedenis van toekomstvisies (Rotterdam: 010 publishers, 1995) p. 66.
89 Vijftig jaar wederopbouw, p. 92.
of mobility called for new forms of urban planning. The combination of infrastructural needs for the harbour and the emergence of an automobile society can be considered the main reasons for the construction of the Maastunnel in 1937\footnote{Vijftig jaar wederopbouw, p 90}. The innovative intervention caused so much attention that the Maastunnel became a tourist attraction in the fities\footnote{Hans Webbers, De brug: geschiedenis en bouw (Rotterdam: Nai Publishers, 1996) p 12.}. One could consider the Railway bridges and the Willemsbrug marking the first wave of industrialisation represented by the train in 1877, the Maastunnel marked a second wave of technological revolutions represented by the car in 1937. The presence of the car heavily influenced the urban renewal of the post-war period. Left with a tabula-rasa after the war, urban planners were able to redesign the city including its former infrastructure.

The interpretation of infrastructure caused many discussions. In the period after the war Van Traa was an urbanist of the municipality and member of the OpRo, a commission for the reconstruction of Rotterdam. Urban assignments like Hofplein were in his eyes infrastructural challenges to be solved as organisational problems\footnote{Vijftig jaar wederopbouw, translated by author}. Van den Broek however stated that the form was more important than its function, advocating the urban qualities of infrastructure and its architecture\footnote{Vanstiphout, Vijftig jaar wederopbouw, p 129. (32)}. He addressed the formal outcome of civic works like the roundabout and the crossroad, looking for an urban solution rather than solving an infrastructural problem. In his traffic studies of 1945 called ‘traffic and square shape’ he questions if a logistically perfect crossroad can be the base of an urban square. With his studies Van den Broek tries to create qualitative urbanism out of infrastructural rigour\footnote{Vijftig jaar wederopbouw}. Vanstiphout emphasizes in his text ‘Leegte 1945-1965’ that Van den Broek was not looking for traffic solutions, but sought for architectural answers. ‘The shape of the traffic knot was not derived from its sculptural qualities, but from the urban qualities of its built surroundings\footnote{Vijftig jaar wederopbouw, p 131. (35)}. Vanstiphout calls this the search for a synthetic solution for infrastructure, architecture, public space and image. With this architectural point of view we should consider the studies for the Oude Haven. Vanstiphout calls the
investigations ‘exercises for congestion’\textsuperscript{96}. Van den Broek considers several options for the area including a multi layered bridge hosting both trains and traffic. This bridge was inspired by the Viaduc du Passy in Paris\textsuperscript{97}. In his later studies the scale of intervention increased to a more urban level. First with the consideration of the urban sequence from Oude Haven until Stieltjesplein\textsuperscript{98} and later even until regional dimensions with the consideration of a metro-line connecting the outskirts of Rotterdam. Those studies nevertheless had a limited influence on the reconstruction of Rotterdam since it was Van Traa deciding on the final urban renewal plans for the city. Although Van Traa used the studies of Van den Broek, he did not share the ideas about traffic. Van Traa approached the traffic as an autonomous paradigm with far-reaching consequences for the city. Vanstiphout states that Van Traa did exactly what Van den Broek considered impossible; ‘the superposition of big autonomous infrastructure on the urban landscape, imposing its image and sculpturality onto the remaining elements\textsuperscript{99}’.

On the zoning map of 1955 one can see the enormous infrastructural apparatus connecting Rotterdam with the surrounding highway network of the Randstad. Vanstiphout concludes that the masterplan of Van Traa has nothing to do with

\textsuperscript{96} Vijftig jaar wederopbouw, p 131.  
\textsuperscript{97} Vijftig jaar wederopbouw, p 131.  
\textsuperscript{98} Vijftig jaar wederopbouw, p 132.  
\textsuperscript{99} Vijftig jaar wederopbouw, p 133.
Rotterdam itself. ‘Rotterdam is not about Rotterdam, but about something different. Probably about world trade, about Europe, about the future, about every family a car, about democracy, about wealth, about technology’. The most notable example of Van Traa’s interpretation of traffic issues was the double-layered roundabout envisioned at the Oude Haven. The multi-layered traffic knot would have served city centre and Willemsbrug with a diameter of 200 meters. This proposal was not realized, although its site was kept empty for decades. In the masterplan of 1955 it formed one of the mono functional clusters of the city. With the same rigour as its infrastructure, each zone of the city had its own function. Shopping, culture, offices and residences were segregated into comprehensible urban clusters. The result is still tangible in Rotterdam where functions barely mingle.

An exception in the segregation of the 1955 masterplan were the plans for the Groothandelsgebouw. The devastating war left many entrepreneurs without office. The Groothandelsgebouw had to become a large multifunctional building bringing wholesalers, business men and companies together. The building was one of the first architectural outcomes from the new scale of post-war urbanism. The Groothandelsgebouw represented a new Rotterdam, becoming a symbol of the reconstruction era. The collective efforts of state, municipality, post-war financing and companies made it possible to focus energies and realize the ambitious project. Huig Aart Maaskant was appointed as architect and played a significant role in the location, design and organisation of the building. It was Maaskant who picked the location right next to the central station, amid the most important traffic.

100 Vijftig jaar wederopbouw, p 133.
101 Vijftig jaar wederopbouw, p 134.
103 Provoost, Groothandelsgebouw, pp 6-13.
104 Provoost, Groothandelsgebouw, pp 6-13.
routes of the city. The obviousness of the location was explained by Maaskant as a site with the most infrastructural potential in the city\textsuperscript{104}. The considerations about infrastructure continued with the design of the building. With a fascination for Albert Kahn and the industrial architecture of the United States, Maaskant incorporated traffic in the Groothandelsgebouw as if it was an assembly line\textsuperscript{105}. Maaskant designed an underground parking garage and a network of streets on three levels of the building. Those streets were part of the shared facilities designed for a multitude of users. The collective facilities concerned restaurants, cafés, a bowling alley, theatre, bank, post office, tourist agency, barber and shops. Those functions were for both users of the buildings and citizens of Rotterdam. It laid the foundations for a building that was not only embedded in the urban fabric, but also in public life: the dynamics of the city flowed into the building. This was reflected on several scales in the building. The design of flexibility to accommodate future change was one of the other challenges executed by Maaskant. In combination with a remarkable sensitivity for aesthetics, Maaskant managed to deploy bureaucracy for flexibility while maintaining a monumental gesture in its urban context. The collaboration with specialists externalized his intentions for efficiency, modernity and flexibility. The collaborations between engineer and architect, and the combination of architecture and infrastructure made the design of the Groothandelsgebouw in 1953 a revolutionary building. The mix of paradigms and involved parties was highly remarkable in the urban plans of the fifties dominated by mono functional clusters. Due to its flexibility the building is still appreciated. The Groothandelsgebouw is now one of Rotterdam’s most remarkable buildings, a monument in many senses.

Other proposals from Van Traa were executed with the rigour as presented in the proposals for the Oude Haven. One of them was the relocation of the primary dyke. Formerly positioned at the Hoogstraat the new dyke was located right at the riverside. Envisioned by the Basisplan of 1946 the Boompjes transformed into the primary embankment of the city in 1958\textsuperscript{106}. The new infrastructure was placed on

\textsuperscript{105} Provoost, Groothandelsgebouw, pp 6-13.
\textsuperscript{106} De Greef, Rotterdam Waterstad 2035, p 16.
top to provide access to the city. Considering the enormous surfaces of asphalt, it becomes clear that the traffic map of 1955 is better embedded on the scale of the region, than the grain of the city. This can be partly addressed to the developments and growth of the harbour. With a growing port that moved seawards, the ring road was at least as important for the harbour as it was for the city. With the construction of large infrastructural nodes like the Beneluxtunnel in 1960\textsuperscript{107} and the Van Brienoordbrug in 1965\textsuperscript{108} the harbour remained optimally connected with its hinterland to foster prosperity. Due to its continuous growth Rotterdam became the biggest harbour of the World in 1962\textsuperscript{109} relying on its infrastructure of waterways, railroads and highways.

\textsuperscript{107} http://www.rotterdam.nl (accessed 23 December 2012)
\textsuperscript{108} http://www.rotterdam.nl (accessed 23 December 2012)
\textsuperscript{109} De Greef, Rotterdam Waterstad 2035, p 17.
6.5 The birth of big buildings

The displacement of the port from south to west, called for new planning strategies in Rotterdam during the seventies and eighties. With the urban renewal proposal of 1976 former harbour areas were designated to become residential areas\textsuperscript{110}. In the seventies Waterstad developed itself into a habitable zone through residential complexes like Leuvehaven realized in 1974\textsuperscript{111}. The waterfront was incorporated in those developments through the facilities for temporary events. The tribunes at the Boompjes are the most tangible heritage of that concept, better known as the festivalisation of the city\textsuperscript{112}. The planned events nevertheless did not return the attractiveness to Rotterdams waterfront.

The port of Rotterdam kept expanding, being so distant from the city that its growth was hardly visible in the centre. But although far away from daily life in Rotterdam, the port kept changing the city: both economical and physical. The latter was most tangible with the new requirements for bridges due to the increasing scale of shipping traffic. In 1981 the old Willemsbrug was replaced by a modern version located several meters further down the stream\textsuperscript{113}. The infrastructural adjustments changed the eastside of the Boompjes into a complicated traffic knot, and transformed the Jan Eleveld park at the Noordereiland into a brutal slope dominated by asphalt and steel. It is important to highlight that at this time the centre and Feijenoord were only connected through this bridge.

With Rem Koolhaas' celebrated Delirious New York from 1978 the municipality decided to invite OMA for a design in Rotterdam. Dissatisfied with the small scale of densification projects, Rotterdam looked for an architecture of the ‘big building’\textsuperscript{114}. Koolhaas was asked to choose his own site and picked the Willemswerf, right next to the place where the old Willemsbrug was located. At the narrow plot, offering a splendid view on the river, OMA designed a block of high-rise towers. The location was picked for its potential to ‘undo Rotterdam’s age-old frustration’\textsuperscript{115}. This frustration pointed to the lacking relation between city and river. The project was never realized, but the site to which it referred seemed to be an eye-opener for the municipality.

Only several years after the plans of Koolhaas, Wim Quist was appointed to build the Willemswerf. The site of the Willemswerf explored by Koolhaas was actually meant for residences. But after the threat of Nedloyd leaving the city, a strong economic power, the municipality decided to change the bestemmingsplan into offices to realize the building as we know it today\textsuperscript{116}. The design started in 1983 and was finished 1989. With its enormous facade of hundred by ninety meters it set the
tone for new Rotterdam\textsuperscript{117}. Other big buildings like the three apartment towers of Henk Klunder in 1989 were built simultaneously\textsuperscript{118}. Also the realization of the office tower De Maas built in 1989 can be added to the list of extra large architecture that changed the face of the city for good.

The single connection between north and south, the Willemsbrug, changed with the plans for ‘Kop van Zuid’. During the end of the eighties plans were made to develop the former port area in the south into an attractive district. The area was intended to refer to Rotterdam as a harbour city with attractive quays, squares, residences, entertainment, shops and offices\textsuperscript{119}. Those plans were considered as the last round of reconstruction after the devastating war\textsuperscript{120}. Although several attempts were already done to return Rotterdam to the river, the masterplan for Kop van Zuid was considered as the official reintroduction of the river as public space\textsuperscript{121}. The clearest manifestation of this return was the iconic Erasmusbrug, adding an extra connection to the other side of the river. The envisioned international business area at the Wilhelminapier was appointed as ‘Manhattan at the Maas’ and first presented in 1987 by Riek Bakker\textsuperscript{122}. Despite several complications, the masterplan is almost completely realized.

\textsuperscript{117} Willemswerf, http://www.rotterdam.nl/tekst:kantoorgebouw_willemswerf (accessed 23 December)
\textsuperscript{118} Vijftig jaar wederopbouw, p 191.
\textsuperscript{119} De Greef, Rotterdam Waterstad 2035, p 18.
\textsuperscript{120} Vijftig jaar wederopbouw, p 216.
\textsuperscript{121} Vijftig jaar wederopbouw, p 33.
\textsuperscript{122} Vijftig jaar wederopbouw, p 213.
6.6 The domination of civic works

The Erasmusbrug was finished in 1995 and became an icon for the city, described by the municipality as the symbol of the ‘undivided city’. Like the Maastunnel was a tourist attraction in the fifties, the Erasmusbrug now is another civic work attracting tourists. The adjustments to the railway runned parallel to the developments of the Kop van Zuid. With the construction of the spoortunnel in 1993 the Binnenrotte got a new face with the removal of the railway viaducts. Although the disappearance offered new possibilities for the city, it partly resulted in a gash. Meyer describes in his book ‘City and Port’ the urban problems of the removal. ‘With the construction of a tunnel to replace the aerial railway track – the structuring element in the quarter – the architectural coherence of the neighbourhood vanished completely.’

The new public space of the Binnenrotte might have benefited from the removal of the rail tracks, Feijenoord in the south did not manage to take advantage of its new urban form. This was not only due to the disappearance of the train track, but probably more caused by the popularity of the Erasmusbrug. The construction of the Kop van Zuid changed the flows of the city, turning the Willemsbrug into a underutilized connection. Instead of benefiting from a decrease in traffic, Feijenoord suffered from the lack of congestion that it once had when the Willemsbrug was the only possibility to pass the river. With the displacement of the harbour, the demolition of the train tracks and the construction of the Erasmusbrug, Feijenoord has lost its forming elements and former congestion.

After finishing the Erasmusbrug Rotterdam looked for a way to connect the two main shopping districts of its centre. The new connection, right next to the World Trade Centre, also had to provide an answer for the problematic traffic congestion at the Coolsingel. The Jerde Partnership designed in collaboration with Architecten CIE a deepened pedestrian passage to link two districts including

52. Erasmusbrug, 1996

123 http://www.rotterdam.nl (accessed 23 December 2012)
125 Meyer, City and Port, p 64.
126 Conversation with Maurice Bouman, urbanist at the municipality of Rotterdam (Europoint Rotterdam, October 2012)
127 http://www.rotterdam.nl (accessed 23 December 2012)
new shops and a metro entrance. The project known as ‘Koopgoot’, mocks with the urban space as nothing more than a gutter where people shop. The project was launched as ‘Beurstraverse’ and provided besides new retail the requested traffic solution. Surprisingly enough the design was never questioned for its proposal to facilitate the cars at the Coolsingel in favour of the pedestrians on the surrounding streets, shamelessly referring them to the basement. Collectively celebrated by both planners and users it now forms the focal point of urbanity in Rotterdam. The image of Rotterdam is now characterised by the shopping gutter and the extraordinary dominance of infrastructure and cars.

54. Rotterdam ‘City Racing’, 2012

7. **CONCLUSION**

THE FUSION OF ARCHITECTURE AND INFRASTRUCTURE

A historical look on the fusion of architecture and infrastructure shows us that most striking examples are built during times of extraordinary growth and optimism. The Golden Age in the Netherlands turned the waterfront of Rotterdam into a versatile public space serving trade and public. During this progressive era distinct paradigms like architecture and infrastructure exploited their mutual benefits. To be placed in a completely different context, but with similar hopefulness and the contaminating intoxication of infinite progress we should place the ideas of the 1960s. During this rare moment in history the aspirations of society, the possibilities of technology and the ambitions of architects got opportunistically caught up by the Metabolists in Japan. They were the first to combine architecture with infrastructure acknowledging the required flexibility for future growth. Fumihiko Maki’s theory on collective form can be considered as the first architectural approach providing solutions for the network era of which we experience the heydays right now. The Metabolists provided a paradigm shift where traditional borders between architecture and infrastructure evaporated. Collaborations were the logical outcome of a new complexity and the region reached ultimate relevance through the availability of mass transportation. Those intensified parameters only gained relevance in our society obsessed with connectivity and regional mobility. For this reason we can distil applicable concepts for the development of architecture and infrastructure in the city of tomorrow.

The Metabolists were not the first to combine architecture with infrastructure. Contemporaries like Superstudio and Yona Friedman, but also predecessors like Le Corbusier and Edgar Chambless tried to merge two paradigms into a new kind of architecture. What distinguishes the Metabolists is the acknowledgement of continuous change of urban form and architecture. Inspired by biology and Buddhist philosophy architecture was considered as a living organism. The result
is a symbiotic architecture, not only combining architecture with infrastructure, but also past with present, the physical with the abstract, the existing with the contingent. The architectural approach is called linkage, providing connections between a multiplicity of elements and events, whether built or suggestive. This makes the resulting architecture highly contextual, and despite its extra large scale, profoundly human. It is exactly this point where the Metabolists differentiate themselves from notions like bigness thriving on the absence of context. It nevertheless faces similar challenges on scale and identity. Those issues are characterized by a search for specificity. Characteristics of the program, the surrounding city or region, are taken to design specific meaning for each project. Comparable with the architecture of Lacaton and Vassal, Van Klinger and Koolhaas, the architecture of the Metabolists is characterized by a specific balance between neutrality and specificity. This involves all elements of the building, including its aesthetics. The outspoken decisions on the equilibrium of the generic and the specific, a decision on the absence and presence of architecture characterizes the architecture. The success depends on the context of each project. What flourishes in a culture driven by the collective, can be a disaster in a society based on the individual. It might explain the success of Tange in Japan and the fiasco of Van Klinger in the Netherlands. The excess of flexibility in an all encompassing architectural box can end up in a painful hollowness.

To avoid the vacuum of endless possibilities Maki provides solutions for a world that he considers disjointed. Through mediation, definition, repetition, sequence and selection he pleads for multiple layers of significance by designing linkage. A bridge not only connects two buildings at each side of the river, but fulfils multiple roles in the urban form. This approach leaves room for ambiguity in architecture where elements can fulfil multiple roles. In this notion a road can become a corridor, a building can take the role of a public square. Here architecture can emerge from infrastructure and infrastructural networks can be approached as architectural challenge. This activates both building and street as spatial agents within the city. The design governs use and growth no matter if it concerns architecture or infrastructure. Roads and buildings are no longer static objects in the urban form but active mediators in the city. Through the establishment of interdependency and the decisions on independency, sequences come to existence that foster architectural possibilities and tutor urban growth. Those sequences link the horizontality of the plinth with the verticality of the atrium, the richness of the...
past with the dreams of the future, the complexity of cultures with the specificity of society. The result is an infrastructure of meaning, where architecture and infrastructure interplay to orchestrate the city.

Considering the port of Rotterdam as infrastructure, one can conclude that the history of Rotterdam is highly infrastructural. The former fisher village changed its urban form throughout the ages constantly anticipating on the growth of the harbour. For a long time port and city were the same entity. If you were in the harbour, you were in the city and vice versa. This leaded to an interesting ambiguity where private trade merged with public life. The most remarkable manifestation of this ambiguity was the Boompjes during the 16th and 17th century. The Boompjes represented the city, merging infrastructure with architecture. The Boompjes as found in the Golden Age can be considered the predecessor of what the Metabolists called group-form. Individual elements constructed the whole through the repetition of recognizable elements and linkage on multiples scales. With the sequence of houses and trees combined with the links between the flows of the water and those of the city, the Boompjes represented a collective form a strong as the linear Japanese village.

The displacement of the harbour and the construction of the railway drastically changed the city during the end of the 19th century. The Rotte got muted to connect the old city centre in the north with the new harbour developments in the south through railway bridges crossing city and river. The new prosperity caused by industrialisation fostered the development of the first skyscraper of Europe, next to the Willemsbrug, providing a splendid panorama over Rotterdam. Like the Boompjes represented city and harbour in the 17th century, this role was now fulfilled by the Maasbridges and the skyscraper at the beginning of the 20th century. Infrastructural prosperity was exploited by architectural entrepreneurship. Fostered by a wave of technological revolutions in the decades after, the infrastructure of the city rapidly expanded through the expansion of the harbour and popularity of automobiles. The first major intervention for the facilitation of cars and trucks was the construction of the Maastunnel in 1937. In the middle of the construction characterized by progress urge, concrete and asphalt, the Second World War started.

The devastating bombing of 1940 swept away the heart of Rotterdam, changing the port city for good. The dissatisfaction about the city centre before the bombing, in combination with the large scale interventions serving cars rather than public space should be considered as turning point for the urban form of Rotterdam. The strong belief in technology, mobility and traffic took hold of the reconstruction plans. The interplay of infrastructure and architecture formerly developed as integral assignment, stepped back from their historical fusion and continued as autonomous paradigms. With the reconstruction plans Van Traa superimposed the traffic network on the urban landscape. The result is still tangible in the city of today where architectural plots seem nothing more than the left overs of a city dominated by infrastructure. The only exception in the harsh distinction between architecture
and infrastructure was made by the Groothandelsgebouw designed by Maaskant in 1953. As a true visionary he combined building with street, private program with public life, the large-scale with the small detail, bureaucratic intelligence with artistic genius. The Groothandelsgebouw seems to be the only building of the reconstruction that acknowledged the tradition of the port city to merge infrastructural necessity with architectural potential.

During the eighties urbanism globally experienced a revaluation of the waterfront. Described as the ‘urban Renaissance’ waterfronts and harbour areas around the world got successfully revitalized. But despite the tribune for temporary events designed at the Boompjes, Rotterdam did not manage to exploit its waterfront. The infrastructural dominance of the multi lane boulevard and the lack of public program seems to be a millstone around the neck of Rotterdam. The development of the Kop van Zuid executed in the nineties slightly changed this, but barely congests a critical mass of people near the water to make the river a valuable place. Except the popularity of the iconic Erasmusbrug, the Kop van Zuid mainly revitalized itself, rather than the public space along the river. The new panorama provided by the skyscrapers on the pier are retained for private parties like the Port Authority and other economical players at the Wilhelminapier. The construction of the Erasmusbrug in 1995 created a new tourist attraction, but like the Maastunnel celebrated in the fifties, it remains a civic work. With the absence of substantial public program the bridge is only a place for photos, rather than a place to be. Tourists pass the bridge to take their snapshots and return before they even touched the quay at the other side of the river. The real congestion of people happens in the Koopgoot, built during the same period as the Erasmusbrug in the nineties. In the underground shopping street, architecture and infrastructure seem to merge. The fact that this happens in a public gutter in favour of its car traffic passing above, is nevertheless striking. One can wonder who or what drives the urbanists of Rotterdam to keep on designing ultimate circumstances for cars at the expense of pedestrians and bikers. It seems that the strong belief in the accessibility of the city, and the regional connectivity to the ring road, is more important than a walkable city with qualitative public space. Where architecture once imposed its interests on the infrastructure of the city, it now subordinates itself on the rigour of the infrastructure. The lyrical descriptions of Manhattan have been misunderstood through the abstraction of its physical form. Instead of creating a wide variety of public program in plinths and courtyards, Rotterdam only imitated a metropolitan skyline. Manhattan at the Maas is now a hollow picture that represents the grandiosity of the metropole without providing the necessary splendour of urban congestion. In addition the lack of diversity caused by the mono functional urban clusters of the fifties seems hard to undo or compensate. Rotterdam still can only dream of a truly urban environment instead of creating it.

Maki showed with collective form what architecture and infrastructure can mean for our cities. With the acknowledgement of the region he provided a theory for

129 Meyer, City and Port
architectural phenomena in the megalopolis as we know it today. The mobility of the masses was used to design architecture and infrastructure of fluid and mobile cities. He provided a theory for the design of congestion as a paradigm itself, rather than the consideration of architecture and infrastructure as autonomous elements. Like the Ponte Vecchio in Florence and the Ponte Rialto in Venice, Maki shows us a powerful tool for the fusion of architecture and infrastructure providing an image for the city, while creating links on multiple scales in the urban form. This is an architecture as much concerned about activities, flows and movements, as the physical form of the elements where it is made of. It is not about either the road or the house, but the mutual benefits of both. At the intersection of those advantages new urban forms can emerge that generate unexpected architecture. Like the Boompjes produced a rich urban ambiguity in the 17th century and the Groothandelsgebouw fostered an explosive mix of public activities, the fusion of architecture and infrastructure is still full of undiscovered potential for cities like Rotterdam and beyond.

Not to be underestimated are the external forces that brought phenomena like the megastructure and the versatile quay of the Boompjes to an end. The oil crisis in the seventies made the megastructure infeasible and unpopular. The bombardment of Rotterdam during the Second World War made the continuation of an existing urban form impossible. Most probably it was not the lack of ideas, but a lack of means that brought the fusion of architecture and infrastructure to an end in both cases. This shows that the fusion of architecture and infrastructure thrives under an abundance of means: intellectual, economical and technological. The analysis shows that new forms of architecture came to existence at points where the aspirations of society, the possibilities of technology and the ambitions of designers caught up opportunistically. The Golden Age produced a vibrant waterfront in Rotterdam and the prosperity of Japan in the sixties produced extraordinary architecture from the Metabolists. It is now time that the enthusiasm and energy about the potential of architecture in the future megalopolis should be exploited for an infrastructure of meaning during the heydays of the network era in which we live now. The obsession for connectivity and orchestration provides a unique opportunity for architecture to achieve a paradigm shift where architecture merges with infrastructure inspired by former eras of optimism. Threatened by an economical crisis it will be crucial to exploit the possibilities of collaboration to diminish costs and improve feasibility.
Whether part of the Randstad or any other megalopolis, the increasing need for customized connectivity in the public sphere will demand architectural solutions beyond the scope of architecture and infrastructure as we know it today. Like mass transportation propelled the possibilities of urban form, the fusion of architecture and infrastructure into a new paradigm can redouble the possibilities of architecture through sincere collaborations on multiple scales. The consideration to fuse architecture and infrastructure can provoke discussion, stimulate collaboration and raise imagination. Roads and buildings are no longer autonomous elements in the landscape, but integral urban devices ready to be used for the orchestration and image of our future cities.
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