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# Spatial Building Typology – Function Follows Form

Hielkje Zijlstra

## ABSTRACT

**Buildings today are subject to change. New functions are accommodated in vacant buildings. This is a favorable development from both a sustainability point of view and a cultural-historical perspective. Originally, the volume and form of a building was dictated by its original function: form follows function. We now see that a spatial form is already present. Is it logical to conclude that the new functions adapt to the existing available form and space: function follows form?**

**In order to gain insight into how the existing form and space relate to the possibilities of reuse, research into a spatial building typology is necessary. Existing typological studies of buildings are usually based on functions. An inventory of research that has already been done with regard to spatial characteristics of buildings and the way of translating it into analyzes is part of this research. Also, on the basis of two comparative spatial analyzes of two groups of buildings (Department Stores V&D's and Police Stations in The Netherlands), a methodology is explored that maps the spatial characteristics of the locations. Eight locations per group of buildings were explored through analyzes on four scale levels: city, block, object and envelope and on the basis of twelve spatial aspects. After analysis per location the characteristics have been compared per aspect. Parallel twenty-four students worked on the redesign assignments during two graduation studios at Delft University of Technology (Heritage & Architecture). Their final designs were related to the existing spatial types of the locations in order to arrive at a redesign typology per building group in order to answer the question: can statements be made about the redesign possibilities of these buildings based on a Spatial Building Typology of buildings? Finally, some recommendations are made for further research.**

**Keywords:** Analyses, Buildings, Redesign, Typology.

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## I. INTRODUCTION

Buildings originally constructed for eternity are changing their function. When we redesign buildings to enable new functions and different uses, it is necessary to gain insight into the spatial aspects of these buildings. Based on spatial characteristics, different design solutions can be considered and lead to an optimization between use and space. It could be useful to define a spatial building typology to align this repurposing process with spatial aspects. In the current situation there is first space and then functions are placed in it. When buildings were first constructed, there were initial functions and space was created around them based on the characteristics associated with these functions. Design guidelines have been drawn up on the basis of a functional typology. The oldest examples of this are from Durand and De Quincy around 1800 (Madrazo, 1995; Güney, 2007; Moneo, 1978) and later we see this reflected in the design manuals by Neufert that were used in the architecture schools (Neufert, 1980). The functions determine the space and shape of buildings. In adaptive reuse design assignments, this is reversed, and the function must follow the existing forms and spaces. A Spatial Building Typology (SBT) could be helpful to provide insight into the redesign options. And refurbishment solutions could be related to the spatial characteristics of those buildings.

### A. Research Goal

Traditional research methods into typologies in architecture almost always start from typologies that are based on functions. As the function and use of the original buildings are changing today, a different approach is needed to examine building typologies. Space becomes central and research into similarities and differences in the spatial characteristics of a collection of buildings, originally realized for one specific function (group), yields a series of spatial properties that can give direction to the possibilities for redevelopment. Over the years, various buildings, originally designed for one specific function, have been the subject of education and research in adaptive reuse at the section Heritage & Architecture (HA) of the faculty of Architecture at the Delft University of Technology (TUD). At HA students always start with a thorough analysis of the buildings (Clarke *et al.*, 2019). In the HA graduation studio Vacant Heritage from

Sep 2020 – Jul 2021 and Sep 2021 – Jul 2022, two groups of function related buildings were chosen to investigate the spatial characteristics in relation to the design solutions for repurposing: Department Stores V&D's | Vol. 1 (Zijlstra *et al.*, 2021) and Police Stations | Vol. 2 (Zijlstra *et al.*, 2022) both in The Netherlands. The central research question addressed here is: How and why do specific series of spatial aspects on multi scale levels influence the design possibilities regarding the redesign of a specific group of buildings with the same original function? Further research and the development of a research method that can be applied in education as well as in practice is being carried out.

This article first sketches a contextual framework and my personal fascination for this topic. After that it examines existing research methods and studies that have already been conducted in this area are reviewed. Subsequently, the Spatial Building Typology research method used in the two HA graduation studio's will be elaborated and the research results are discussed in the concluding chapter called: Redesign Types in relation to a Spatial Building Typology.

### B. Contextual Framework

The HA Vacant Heritage graduation studio addresses research and design in the field of vacant heritage. More and more buildings today require a repurposing. We see buildings not only changing in use, but also in function. Are all buildings suitable for all functions? Functions change but buildings remain. Buildings are shells and forms of specific activities. So, functions have turned out to be temporary and space is universal and timeless. The space in its form continues to exist. We are moving from 'form follows function' to an architecture of 'function follows form'. Sullivan claimed in 1896 that form is derived from function, Frank Lloyd Wright argued against this in 1953 by saying '*form and function are one*' (Craven, 2019). But in the present time, where buildings in various forms have proven their timelessness and are enclosed spaces in a certain form, functions will have to adapt to the spaces in forms that become available. Repurposing is the new dogma (Carlson, 2022). Existing buildings that may or may not have heritage value will not be automatically demolished to make way for new buildings. Sustainability starts with the reuse of what is there. Lacaton and Vasal have been using the motto since 2017: '*re-use, never demolish*' (Ruby Press, 2022). Their projects show that existing space has a right to continue to exist (Fig. 3). Changes are usually made with regard to the existing, such as expanding or breaking through. The existing is adapted to new wishes, requirements, use and functions. Lacaton reformulated their slogan in 2018 as follows: '*Transform, add, re-use, never demolish*' (Spoormans *et al.*, 2018). The existing is redesigned and reprogrammed. The reason for changes come from within but can also come from outside. The environment itself and the requirements set there also change. So sometimes increasing the volume is a desirable and realistic option.

The existing spaces form the new canvas for the designer. It is not white but already has a shape, color, and character. From here, the designer will reprogram and adapt the building to new uses and new functions. The way in which this is done, the solutions, are explored in options. These are largely determined by what is already there. Which enclosed spaces are present. The redesign is not determined by the original function that a building had, but by the spatial qualities that the building has. Design possibilities are generated by the spatial characteristics. If we compare different series of buildings (originally realized for a specific function) with each other, can we make an arrangement based on the spatial characteristics that gives direction to the redesign options and is decisive for the final solution? Then a Spatial Building Typology could be formulated from here. Subsequently, redesign options and solutions can be related to the defined spatial types to arrive even at a redesign typology as well.

The curiosity and urgency of researching spatial building typology stems from my PhD research (Zijlstra, 2006 and 2009). It examined seven case studies in order to arrive at a method for analyzing buildings from the 1940-1970 period: Analyzing Buildings from Context till Detail in time. At that time, buildings from that period were designated to become listed monuments. The criteria used to designate buildings as monuments were being developed at the time. During my research I concluded that oversizing of spaces in particular simplified the possibilities for reuse of those buildings. This presented opportunities that would not have been possible in the design of new buildings. Three examples demonstrate this. The Turbine Hall in the Tate Modern offers the option of freeing up the space or setting it up for specific expositions (Fig. 1). The Loc Hall in Tilburg has also produced an atypical (from a functional point of view) library due to the excess of existing spaces (Fig. 2). Lacaton and Vassal also demonstrated at the FRAC Museum in Dunkerque that creating more space takes precedence over costly restoration of the existing space. They doubled the space instead of just turning the existing building into a museum (Fig. 3). The existing space offers unprecedented opportunities for special events. My fascination with this phenomenon forms the basis for further research into spatial characteristics of existing buildings before they are redesigned for a new function or different use.

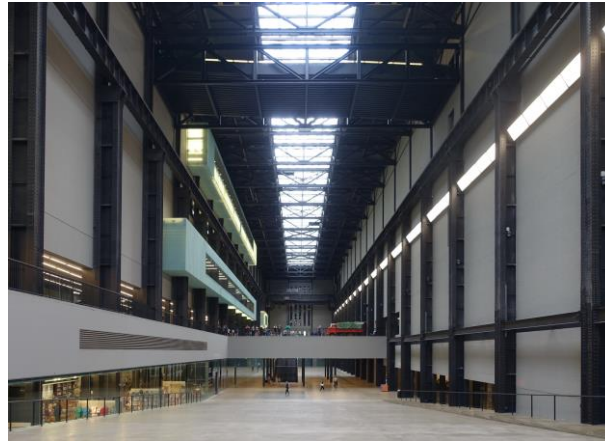


Fig. 1. The former turbine hall of the Tate Modern Museum in London serves as free floor for expositions.

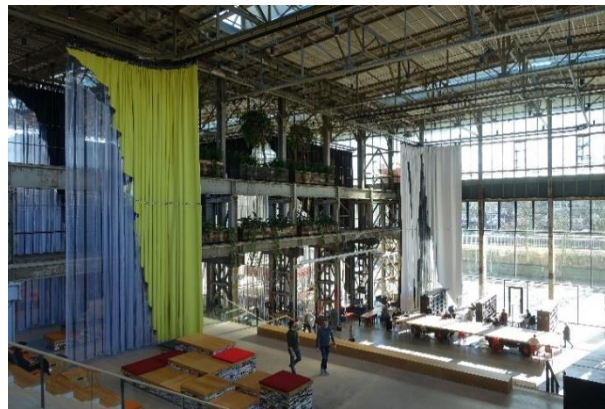


Fig. 2. The Loc Hal in Tilburg houses a library, offices, and facilities in a former industrial railway factory.



Fig. 3. The FRAC museum in Dunkerque was doubled in space by coping the original hall and leaving it open and creating an optimized museum in the extra volume.

## II. METHODOLOGY

### A. Previous Used Methods in Typology Research

Research formulated into building-level typologies appears for the first time around 1800. Architectural types are classified in the large format pages and beautifully illustrated 'Recueil et Parallèle des Edifices de Tout Genre, Anciens et Modernes' by Durand. 1,176 drawings show more than 40 types of buildings classified according to their function. Quatremère de Quincy's 'Encyclopédie' from 1789 also provides an overview of buildings classified according to functions (Luccarelli, 2016). These standard works were intended as guidelines for the design of buildings for a specific function (Madrazo, 1995; Güney, 2007; Moneo, 1978). The overview that Nikolaus Pevsner teaches in his lectures in 1970 is also based on a classification according to functions (Pevsner 1979). We subsequently see studies emerging that classify buildings according to, for example, building shape (Fonatti, 1982) and floor plan shapes (Schneider, 1994). For the Spatial Building Typology research an inventory has been made of research methods in the field of spatial typology of buildings. Twenty-eight methods have been divided into five chapters.

### 1) Documenting Buildings by Re-drawing

In 'Architecture, Form, Space, & Order' Ching (1979) discusses elements of architecture that are useful to understand when designing a building. With spatial analyses (by sketching) he emphasizes various spatial qualities. He reduces the buildings to elements that can be compared with each other by (re)drawing them in the same way. Many principles are depicted in diagrams. In this way he can simplify complex plans and sections to main design principals. Barbieri and Van Duin (1999) provide an overview of One Hundred Years of Dutch Architecture from 1901 to 2000 by selecting twenty buildings from the twentieth century. They are all drawn in the same way. That makes them comparable. The main purpose is to document the buildings, not to analyze or compare them. No common spatial or functional aspects have been identified. A timeline has been added in an appendix to place the buildings in and relate them to history. Komossa and others (2002) document different combinations of buildings in urban blocks in her research 'Atlas van het Nederlandse Blouwblok' (Atlas of the Dutch Building Block). All blocks are drawn in the same way. Original drawings and photos have been added. It provides an overview and could form a basis for comparable research. Although the objects are categorized by type: closed, access to a gallery, radial city, based on form and access, there is no general arrangement or typology. Komossa again researched many buildings in 2011 and published them in: 'Tekboek Stadsgebouwen' (Book with drawings from city buildings). It concerns eighteen large hybrid buildings. Pages 8 to 11 and 12 to 13 are the most interesting because all façades and situations are drawn on the same scale. The buildings have been redrawn. Spatial aspects seem to be important, but they are always linked to functions. The large size, 'BIG' was the first and most important selection criterion of cases. Three (spatial) types were eventually discovered: Fabric Hybrids, Craft Hybrids, and Monolith Hybrids. Lewis 'Manual of Section' from 2016 shows in particular that the cross-section is a very good way to represent the main spatial properties of a building and contribute to an understanding of space of a building. It's like building a model. A section can show a lot: space, use, structure, materials, etc. In general, when analyzing buildings, floor plans are used, but the section is necessary as well. So, Lewis categorized sixty-one buildings into seven spatial 'modes': extrusion, stack, shape, shear, hole, incline, and nest, as well as some combinations of modes he defined as hybrids. But he does not look for similarities, but for as many differences as possible. All drawings have the same style and finally the buildings are only compared in height. Things could be worked out even more extensively and complicated. Like Kiefer and Neubauer published in 2020 in five small booklets combined in a (green) cube. Each part contains different aspects: Building, Landscape, Park, Use, Qualities. They contain questions: (?) and answers: (!). Questions are formulated in text and in very clear diagrams. Answers are indicated by listing case studies and diagrams. The cases themselves are difficult to understand from a reference alone. The diagrams are clear but rather abstract and are used to define overall patterns and to indicate relationships between the five aspects.

### 2) Analyses of the Urban Scale Level by Mapping

Dovey *et al.* (2018) presented an overview of urban-level research methods that are mainly based on mapping. Especially in the first chapter, they explain the methodology behind mapping: '*Mapping as Spatial Knowledge*'. By mapping you can reduce information and compare different locations on one or more aspects. After mapping, you draw conclusions in which the information is summarized in diagrams. Architectural firms like OMA / AMO make extensive use of mapping before starting the design. Mapping is the backbone or reasoning for their design. Bacon's 'Design of Cities' (1974) presents a number of classical methods of understanding the city by redrawing it. His subject is the city itself in all its facets. By emphasizing and reducing things that are important, structures and relationships are made clear. The historical development of cities is clearly shown in black and white drawings. By also using photos, the atmosphere of locations is shown as well. The aim is to teach urban design using analyses of the historical development of cities. Steenbergen and Reh (1996 and 2003) also explore many locations. They conduct research into landscape in relation to buildings, estates, etc. At this scale level, it concerns space and spatial aspects. Twenty-four cases have been thoroughly researched to discover the design concepts from classical European gardens and landscapes. No general analyses or comparisons are included. The cases are divided into three chapters. In 2008, Steenbergen *et al.* presented an overview of many research methods that can be used to investigate landscape and urban configurations. All research methods and drawing techniques are explained. The research also includes a part on typology (pp. 265-325). Some examples of the 1996 and 2003 surveys are included in the research. It is a very complete overview of applicable techniques and methods at this scale level. In contrast to Bacon, Steenbergen and Reh's, Graff explored (only) one city: Nice in France (2000). The current situation is explained by past research. A building is part of a block and is related to the historical urban development. The urban development is explained by superimposing different time layers in different colors. All historical maps (used for the research) are included in the Atlas.

### 3) Analyses of Buildings in Detail

Frampton (2001) analyses many buildings by six internationally renowned architects. He starts with a clear focus: what does Tectonic in Architecture mean? It includes first the definition of terms, a literature review, the historical scope, then some case studies per architect and finally a concluding chapter. The case studies are analyzed in detail, to find out 'how it is made' and to conclude that technology is an important factor in architecture. The cases are not compared. It does become clear, however, that the use of material is essential for the perception and interpretation of buildings and space. Instead of afterwards, Heene tries to interpret the architecture forwards (2004). He explains how the Pantheon in Rome (rebuilt in 125) could possibly have been built by analyzing what he sees in the current situation and what he knows from literature and experience (traces, prototyping, description of techniques from the time). He reconstructs the construction process of this building on the basis of planning, logistics, materials science, geometry and composition. A CD-ROM with animations and drawings is included. Through reinterpretation, the realization of spaces is relived. Foscari (2014) started her research after Rem Koolhaas / OMA's research at the 2014 Venice Biennale: Elements. She chose twelve elements to investigate in Venice. Much of the research has been done on the scale level of the building object using different methods: mapping, case studies, site observations, literature review, interpretive-historical research (see Groat & Wang, 2013). All locations are examined in context and in detail. There are no global conclusions drawn for each element and the research is a collection of studies that are not related to each other, but it does teach people to look closely, note, (re)draw, simplify and conclude from there. This kind of research cannot only be done from paper but being on location is essential. Just like Foscari, Schulz visited her objects often. She studied several buildings by architect Carlo Scarpa (2010) to discover the layers. *'Scarpa's layered architecture makes visible the time-related sedimentation of material and meanings.'* *'Layering describes the physical composition of layers defining space as well as the parallel presence of cultural referrals and formal associations imbedded in the physical layers.'* (Schulz 2010, 2) In a 2D drawing she shows the 3D spatial stratification per case study, where the use of materials and especially the façades of a building are the most important factor in determining the design decisions that the architect made.

### 4) Analyses of Buildings in Context

Buildings seem to be individual objects in various investigations, but they are always part of an environment or determine that environment. Buildings should be examined in relation to the context. Like Graff, Fortier (1989) researched one city: Paris. The subtitle is: *'Un Atlas de Paris'*. It is the result of a project with students. It contains several introductory thematic chapters and fifteen in-depth analyses of buildings in their urban context and historical development. Two photos and two pages of text have always been added to indicate the building's context and atmosphere. There is no comparison between buildings, only fifteen thoroughly elaborated cases. Eisenman limited himself even more in 2003 by examining two buildings by the architect Terragni and published this in 300 pages. The composition of the facade is central. Eisenmann uses many diagrams, but they are rather complicated and difficult to understand. They are not simplifications, but they add a layer of complexity and abstraction to the existing situation. He also uses models to explain in three dimensions what he believes is the underlying design principle of Terragni. The two buildings have been redrawn in many ways to compare them to each other. In 2008 Eisenman again studied ten buildings this time built between 1950 and 2000. He selected a top 10 of buildings (a canon). The buildings are drawn in the same way. They are individually examined for various spatial aspects. The drawings with short captions are the main content. No overarching conclusions have been drawn, but this research shows the results of analyses on many spatial building aspects in a very inspiring way. The color red is added to the black and white drawings to emphasize a specific spatial aspect. Unwin also examined ten buildings in 1997 (1st edition). The research is accompanied by a detailed description of his methodology for analyzing buildings. Many contextual themes are described. The buildings have been redrawn as hand sketches, as Ching and Bacon also showed. In the cases, various aspects have been examined and are illustrated for each theme. Conclusions in the 3<sup>rd</sup> edition (2009) contain a lot of text. In the chapters 'How analysis helps design' and 'Architecture as identification of a place', p.15-34 and in the section 'Themes in spatial organization' pp.171-214, the spatial aspects from different cases are compared with each other. Unwin continued with his building analysis methods in 2010 (up to the 4th edition in 2014). After a short introduction, he now discusses twenty buildings. It is not so easy to compare them. In a case, other buildings (types/context) are mentioned, but not compared. Only on the cover of the 2010 edition are the floor plans of all buildings drawn on the same scale in one overview. Sketching by hand is a method for Unwin to reduce information, select, analyze and conclude. He shows what is important for a particular aspect. Unwin wants us to understand the design of the building afterwards by redrawing it after studying it. It is not done by paper work but by site visits as well.

### 5) Towards a Spatial Building Typology Research

Based on the research methods discussed in the previous four groups of methods, the following aspects are important to include in a research methodology for Spatial Building Typology Research: visit the locations, redraw in an unambiguous way, reduce information and conclude in diagrams, include urban context, use floor plans and sections, include material aspects, make overall comparison by drawing, and add only a little amount of text, and show some photos.

Finally, seven research methodologies, that have been applied by others and that incorporate more of these aspects at the same time into their methods, have been studied in detail. The Spatial Building Typology research method has been derived by combining a lot of aspects from this analysis of these methods. 1<sup>st</sup> method: Christ and Gantenbein, together with students, explored several cities in the world (2012 and 2015). Types in floor plans and volumes are described. The buildings from four cities (in each book) are not compared with each other. No general typology is formulated. Form is leading in this research. It is a collection of floor plans and volumes of buildings that have been placed out of context. An exercise in replacing buildings in other cities is part of this exercise. The drawing style is clear, but the out-of-context approach makes it mainly theoretical research. 2<sup>nd</sup> method: Radford *et al.* (2014) made a major publication of their research into fifty buildings with 2,500 illustrations and six pages each. The same aspects have not been examined for all buildings. What is really useful is that simplifications (reduction drawings by hand) and diagrams form the basis of the conclusions. Text is secondary. Some common themes are described in text only at the end. 3<sup>rd</sup> method: in 1988 Haraguchi made a 'comparative analysis' of twenty houses from the 20th century. It starts with an overview of all cases structured on the basis of five research themes and illustrated with clear diagrams. A timeline is included to position all buildings in history (1400-2000) with sixty-five floor plans and colored lines representing typological aspects such as: open floor plan, Do-mino system, tripartite composition. The main body of the research, 3D axonometric drawings, are fun exercises but difficult to understand and too complicated to read and to serve as analysis. 4<sup>th</sup> method: Clark and Pause (2012) also start with an overview of indicators. 118 buildings have been included and redrawn to analyze the following aspects: light, structure, massing, plan to section, circulation, unit to whole, repetitive to whole, symmetry and balance, geometry, additive and subtractive and hierarchy. They compare these aspects in all cases by reduction drawings and placing them on one page so that configuration patterns (types) can be discovered on: plan to section or elevation, unit or whole, repetitive to unique, additive, and subtractive, symmetry and balance, geometry, configuration patterns, progression and reduction. Clarke and Pause call these spatial elements: formative ideas. The combination of overview, analyses and comparisons makes this research very complete. In the third edition, the selection criteria for the cases were mentioned: *'This section now includes the work of thirty-one architects. Collectively they represent architects of historic importance and those who have produced meaningful work recently. All were selected not only because of the quality and strength of their work, but also because they afford the opportunity to explore buildings, their organizations, and ordering ideas, through comparison. The selection of buildings is based on.'* The goal of the research is: *'... to provide a vocabulary for architectural analysis that helps architects understand the works of others and aids in creating original ideas. Whether a novice or professional, this work enriches the reader's design vocabulary.'* Within the fourth edition (2011) they started to include the overarching equations in twenty-eight pages. 5<sup>th</sup> method: another complete approach is offered by Wims Floet (2014 and 2021). She investigated 185 Hofjes in eight cities in the Netherlands. She discovered several types: three in building block; four in facades; seven in listings and sixteen in maps. In general, she defined four main types: courtyards behind a wall, hidden courtyards, monumental courtyards and city palaces. All case studies have been redrawn precisely and very well documented to understand the objects in their origin, context and development. The relationship with the urban context is part of this spatial typology research. 6<sup>th</sup> method: the 'Dutch Atlas of Vacancy' (Vacant NL, Venice Biennale 2010, only 5 books produced) by Rietveld & Rietveld (2014) included an overview of vacant monumental buildings in the Netherlands. Only very small photos and a few pages are included in the 2014 book. They discovered types of vacant buildings related to: original function, condition of use, creative ecology, and spatial quality. The research was conducted to point out the urgency to reuse existing vacant buildings rather than build new ones. It is therefore not just about documentation and analysis as an end in itself, but about exploring future perspectives and opportunities for reuse. 7<sup>th</sup> method: finally, the study by Jallon & Napolitano from 2017 is mentioned here. They studied Haussmann's interventions in Paris and the current situation. All scale levels are covered, from city to urban block, to building object, use of materials and details. All structured in three parts, with the emphasis on the consistent treatment of a number of spatial aspects. The collection of buildings is the main object, and they zoom in and out. In a comprehensive way, all aspects are examined by redrawing them. After that, diagrams form the basis for the conclusions. Only small text blocks are included. Various topics and aspects are compared and analyzed in overviews and themes such as sustainability, renovation and restructuring of floor plans are part of the research.

B. The Spatial Building Typology Research methodology

The design of the Spatial Building Typology research method is based on the findings and conclusions derived from the literature review described above. The main structure of the parts and chapters is based on 'The Haussmann Method' by Jallon and Napolitano (2017). The scale levels are essentially the same, but the aspects are based on topics that have also been discussed in the other described methods as well. The structure of the Spatial Building Typology research method is placed in a matrix (Fig. 4). In the investigation of the first group of buildings (Department Stores | V&D's), the aspects were reconsidered and adjusted during the investigation of the second group (Police Stations). The four scale levels and aspects are therefore: A. Inner City with: I. Historical Development, and II. Building Age, and III. Road Networks; B. Urban Block with I. Composition, and II. Streets, and III. Accessibility; C. Building Object with I. Spatial Layout, and II. Spatial Relations, and III. Load-bearing Structure; and D. Building Envelope with: I. Configuration, and II. Composition, and III. Materiality. Eight locations per group were investigated on these scale levels and aspects by first documenting them, visiting them and redraw them in exactly the same way. The final product of the research worked out in a graduation studio is a book: Spatial Building Typology. Volume one (2020-2021) on Department Stores | V&D in The Netherlands and Volume two (2021-2022) on Police Stations in the Netherlands (Zijlstra *et al.*, 2021 and 2022).

HA		Research Outline MSc3/4 HA Vacant Heritage (VOL 2 - July 2022)						
Scale level	Aspect	Location Analyses	Compare Aspects	Spatial Topics	Redesign Options	Redesign Types	Conclusions References	Context Index
		PART 1	PART 2	PART 3	PART 4	PART 5	PART 6	FINAL BOOK
		Loc 1	City	Stud 1	Stud 1	Type II		
		Loc 2	Block	Stud 2	Stud 2	Type II		
		Loc 3	Object	Stud 3	Stud 3	Type III		
		Etc.	Envelope	Etc.	Etc.	Etc.		
<b>A</b>	<b>Inner City</b>	<b>I Historical Development</b>						
		<b>II Building Age</b>						
		<b>III Road Networks</b>						
<b>B</b>	<b>Urban Block</b>	<b>I Composition</b>						
		<b>II Streets</b>						
		<b>III Accessibility</b>						
<b>C</b>	<b>Building Object</b>	<b>I Spatial Layout</b>						
		<b>II Spatial Relations</b>						
		<b>III Load-bearing Structure</b>						
<b>D</b>	<b>Building Envelope</b>	<b>I Configuration</b>						
		<b>II Composition</b>						
		<b>III Materiality</b>						

Fig. 4. Overview of twelve spatial aspects that have been researched on four scale levels in the graduation studios by HA Vacant Heritage at the University of Technology in Delft – in the academic years 2020-2021 and 2021-2022.

1) Research Approach

A group of buildings, originally realized for the same function, were examined at eight locations on these four scale levels and twelve aspects. This results in output per location, per scale level and per aspect. Finally, conclusions are drawn from a spatial typological perspective that are ultimately important for the redevelopment options in general and for this group of buildings in particular. Because the research was combined with the HA graduation (design) studios, the main research and data collection was done by students. They worked together in groups of three students. During Volume one (Department Stores | V&D's) they worked at one scale level at all eight locations and at Volume two (Police Stations) they worked out two locations at all scale levels. We experienced pros and cons with both approaches. For a more consistent workflow in the same drawing style, the first option worked best. For the students to better understand the location in preparation for the design assignment, the second option worked better.

2) Research Methods

Information about the locations is collected, selected, organized, and shared through research from archives, literature and other sources. Some of the drawings were provided directly to the students by the owners of the buildings. The twelve aspects are further investigated in the literature on the basis of specific topics and areas of attention. Beside that the students formulated a more specific research question based on their personal motivation or fascination. However, those questions are always related to 'space'. Drawings are used as much as possible at the level of analysis of the information at scale and aspect level. Plans, cross-sections, structural plans, reduction drawings, diagrams and schemes were used for the final output, all drawn in the same layout. The students started by developing one handwriting style and draw up a guideline, which is essentially derived from the 'Haussmann Method' (Jallon & Napolitano, 2017) and based on the review of the other research methods (as described above). For Volume two, the methodology developed for Volume one became leading (Zijlstra *et al.*, 2021).



### III. RESULTS

This paper examines the results of the research elaborated in the previously indicated volumes. The results are briefly discussed per section on the basis of a few examples from Spatial Building Typology Location Volume two, Police Stations. For the more specified content regarding all case studies, reference is made to both publications that are accessible in open access via the internet (Zijlstra *et al.*, 2020 and 2021).

#### A. Location Analyses

So, first of all, all information from the locations is collected and made accessible by the students. Secondly, the locations are elaborated per aspect in a homonymous set of drawings and short text blocks. This results in Part 1. Location Analyses. In both volumes eight locations have been researched on the scale levels of City, Block, Object and Material. A selection of results from this part are discussed on the basis of the example in Eindhoven. Inner City (Fig. 5 & 6): Demography and mobility are supported by some figures. Eindhoven shows an average picture. The historical development positions the relatively modern building (1981) of the police in Eindhoven in time and in relation to the rest of the surrounding buildings in the inner city, which has seen a lot of new construction after the second world war in 1945. The building is located in the city center near the station and shopping area. The road network shows that the object is located directly on the secondary network and the primary ring road is at some distance and it is easily accessible by car and train. A map also shows that there is a relatively large amount of space around the building and that greenery and water are some distance from the object.



Fig. 5 & 6. Eindhoven Inner City: Network of roads and presence of Green, water, and public squares.

Urban Block (Fig. 7 & 8). The composition of the block in relation to the surrounding buildings shows that it is a solitary building, close to the railway line. The street profiles are wide and the façades monotonous. The boundaries between private and public are separated by fences due to the current function.

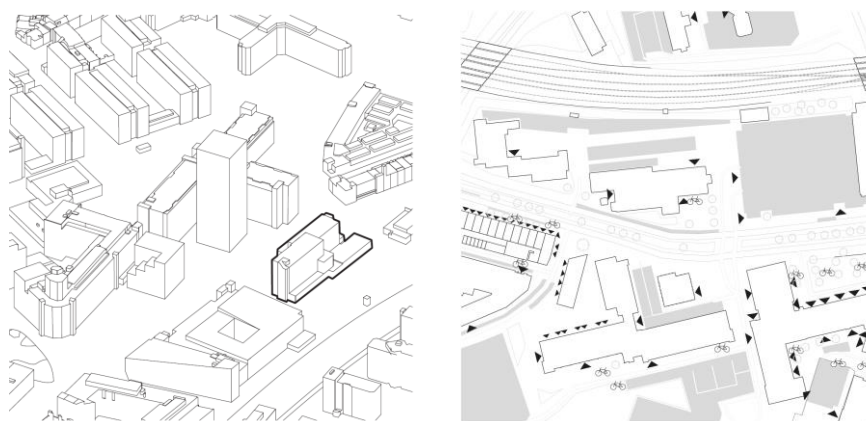


Fig. 7 & 8. Eindhoven Urban Block: Isometric drawing of the Urban block and Accessibility.

Building Object (Fig. 9 & 10). The floor plans, cross-sections, supporting structure and position of shafts, lifts and staircases show that it has a regular layout based on concrete floors and columns in a grid of 6×7 meters. It is characterized by an inner corridor with attached rooms. The story height of 3 meters is sufficient for various uses. The building is made up of two high volumes with lower volumes on the ground floor.

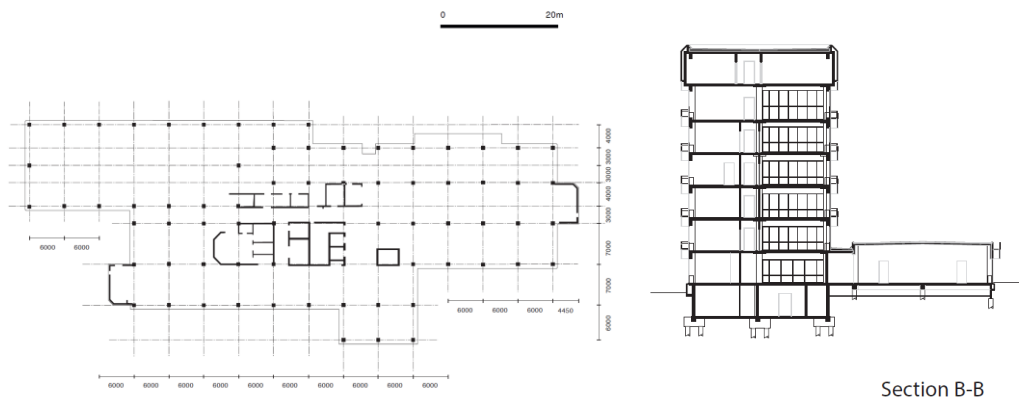


Fig. 9 & 10. Eindhoven Building Object: Structural Floorplan and Cross Section.

Building Envelope (Fig. 11-12). The roof view and the surrounding façades are drawn all around. In detail, a fragment of the facade has been drawn and provided with a picture of the same spot. In Eindhoven the use of materials is robust with a lot of prefab concrete, wood, metal, and glass. Extra measures are needed to make the building more sustainable in the future.



Fig. 11 & 12. Eindhoven Envelope: Composition of South Façade and Textures.

### A. Aspect Comparisons

Subsequently the locations at aspect level per group of buildings were compared with each other. This is elaborated in Part 2. Aspect Comparison. This makes it possible to compare data from all locations and draw conclusions per aspect level. The following components have been compared for each scale level: Inner City: road network, city density (Fig. 13) and green, water and public squares; on Urban Block level: block information, façades, and isometrics (Fig. 14); and on Building Object level: floor plans (Fig. 15), sections, spatial relations (Fig. 16), and structural plans. These do not entirely correspond to the aforementioned aspects. The selection was made to compare twelve sub-aspects with each other that clearly have spatial implications. For example, the next conclusions were drawn for the Police Stations.

#### 1) City and Building Block

The locations of the eight Police Stations are within the urban fabric of 1900 and are connected to the primary network or are close to it. The buildings of the Rotterdam Haven (Port Police) are located on the main waterway in Rotterdam. The 'recycled' buildings for police stations such as Haarlem and Warnsveld are also connected to the water but is not used for the police themselves in either case. The building complexes and spaces of Groningen, Haarlem, Rotterdam Haven and Eindhoven form a building block themselves and are visible in the context from all sides.

#### 2) Building Block and Building

The main forms of Middelburg and Rotterdam Witte de Withstraat are relatively simple. However, they are part of a building block and are connected on two sides to other buildings in the block. The hollowed-out volumes of Haarlem and Groningen form building blocks but are part of the urban fabric. The Haarlem building was expanded in 1971 to replace another volume. The building in The Hague is part of a building block whose buildings around the main volumes are used by the police. Over time, the main volume doubled. The Rotterdam Port Police forms an island in the urban context. It developed in three stages. Warnsveld, which was an estate, is located like an enclave in the rural area and expanded over time.

2.1.2. CITY DENSITY



Fig. 12. Eight locations compared, Inner City: City Density.

2.3.1. FLOOR PLANS

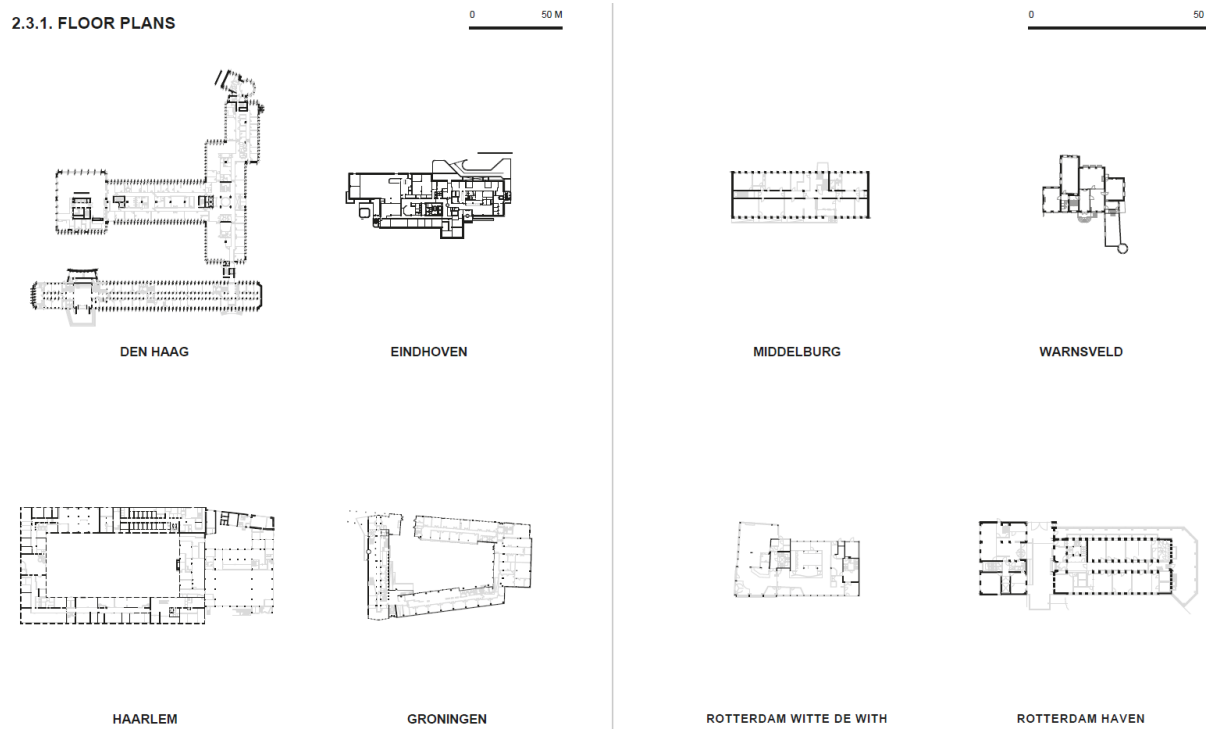


Fig. 13. Eight locations compared, Building Object: Floorplans.

2.3.3. SPATIAL RELATIONS

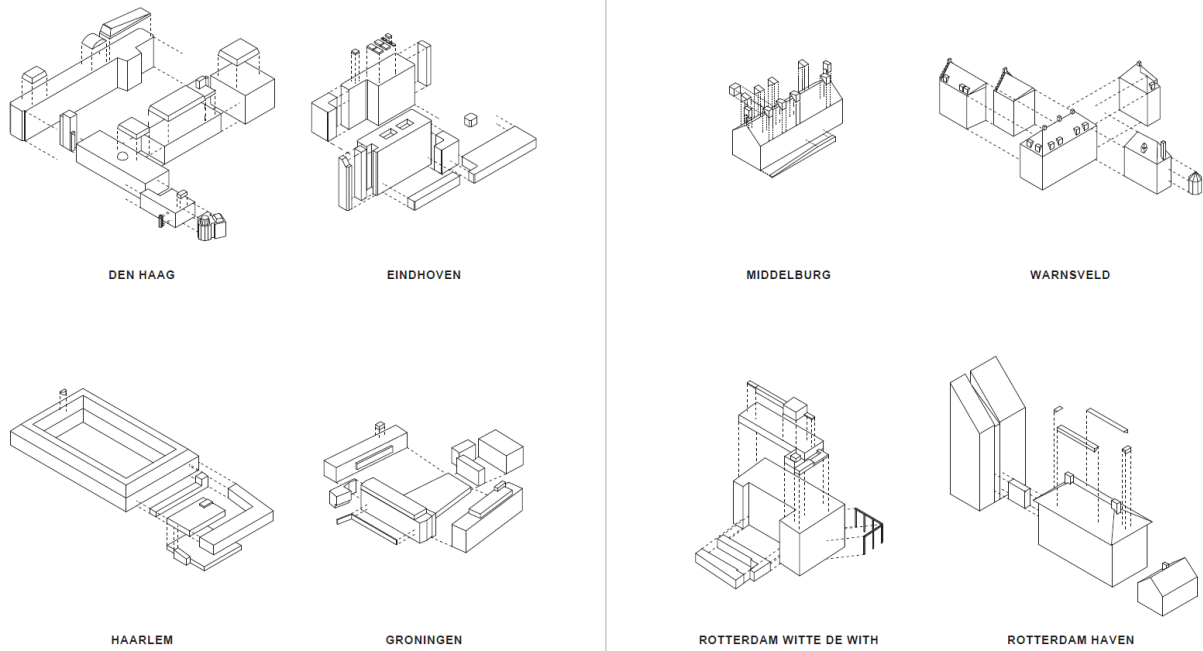


Fig. 14. Eight locations compared, Building Object: Spatial Relations.

2.4.2. TEXTURES

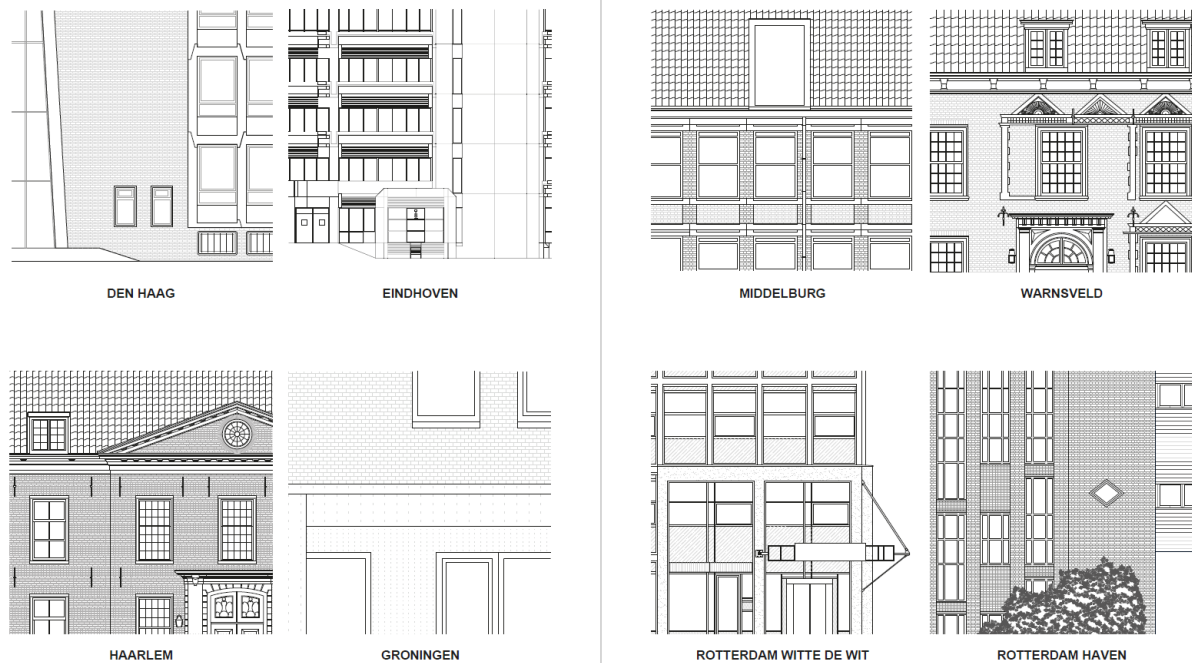


Fig. 15. Eight locations compared, Envelope: Textures.

3) Time and Function

Development over time also plays a role in the typological classification. The buildings that have been expanded over time have a higher degree of complexity but are not the most complex. Three buildings: Rotterdam Witte de With, Haarlem and Warnsveld have been adapted to the different functions over time, but this has not led to a high degree of complexity. If that is the case, the users will look for another location. The buildings with the highest degree of complexity are those with more functions such as offices and cell blocks: Eindhoven, Groningen, and The Hague. The Rotterdam Haven building has been expanded twice with a separate volume, resulting in three recognizable volumes. After the Second World War, most of the buildings were realized or expanded due to the reorganization of the Dutch police.

### B. Spatial Related Research Topics

The students also worked on an individual research theme that relates to spatial characteristics of their chosen location. Summaries of those topics have been added in Part 3. Individual Research. The students in the HA graduation studio are expected to make a design that is substantiated from, or inspired by, their research: research-driven design. In addition to the Spatial Building Typology research, they propose a topic that they further develop during the first half of their nine-month graduation process. There is always a link with spatial characteristics of the location. After that each student elaborates an architectural and constructional design for one of the eight locations studied on an individual basis. For the Eindhoven case, Lucca Fischer's research was included under the title 'Architectural Young Classics': *'The police building at the Mathildelaan in Eindhoven built in the 1980's is not listed, but it has characteristics that are valued to take into account in a redesign. In a more sustainable world, carbon emissions can be limited through a long-life cycle of buildings while 1970-80s buildings make up almost 30 % of the Dutch office stock'* (Zijlstra et al., 2022, 421-422). Fischer examines characteristics of this building period that provide opportunities for sustainable redesign. She outlines a strategy on the example of the Eindhoven police, which has so far been considered critical for further development by the police.

### C. Redesign Options

The designs the students made are also included in Part 4. Re-design Options. The accompanying images show the building before and after the intervention proposed by the student in order to be able to compare the changes per location (Fig. 17). For the former police station in Eindhoven Fisher decided to reprogram the site in housing and facilities for families and single persons. She added new volumes on the plot and incorporated solutions to make the building more sustainable (Fig. 18).

She concludes: *'The New Design of the Eindhoven Police aims to turn the police building into a sustainable residential block based on the idea of the city in the city, which opens up to the urban context and at the same time interweaves the historical characteristics of the 1970s and 1980s architecture with the new requirements.'* *'In order to achieve a more inviting character, the building envelope is changed, especially at the openings, by replacing the glass and metal curtain wall through a wooden. This increases an inviting appearance but also requirements to insulation. The new openness of the building is further reinforced by a number of purposefully placed break throughs.'* (Zijlstra et al., 2022, 459-460).



Fig. 17. Re-design by Lucca Fischer for the Eindhoven Police Station at the Mathildelaan, showing the section before and after the design intervention. She added a new building at the site.

## IV. REDESIGN TYPES IN RELATION TO A SPATIAL BUILDING TYPOLOGY

After all the data has been collected by the students, the teachers and researchers set to work to define a spatial typology of the existing buildings on the basis of an inventory of spatial characteristics. Because eight locations per building group have been studied, a spatial typology of the existing locations is required first. Next, the students' redesign options are analysed and finally, both typological studies are superimposed to arrive at more generic conclusions. Between the investigation of the first group of buildings, Department Stores | V&D's and the second group of buildings, Police Stations, remarkable differences emerged in this part of the study.



Fig. 18. An image from the Re-design by Lucca Fischer for the Eindhoven Police Station at the Mathildelaan. The plan of Lucca Fischer is part of the Archiprix preselection 2023 at the Faculty of Architecture TU Delft (Fischer, 2022).

### A. Department Stores | V&Ds

In the Department Stores | V&D's, we were able to determine one basic spatial type for the original eight department stores: Atrium (fig. 19). In all cases, the atrium, which was originally present in all eight situations, had been built up densely over time. The basic type is therefore based on the originally realized design of the buildings. The changes over time were not included in the data collection in the study. This has led to a return to the original situation in a number of cases when designating the spatial types. In the second step of combining both typologies of the Department Stores | V&D's, the students' twelve designs were classified according to the proposed interventions in relation to the spatial typology of the existing buildings. At the Department Stores | V&D's this resulted in five remodelling types: Courtyard, Atrium, Atriums, Passage and Street. Because the buildings are all relatively large and have also been expanded over time with adjacent buildings, no one has opted for expansion of the volume. The excess of the building in an inner-city location led everyone to propose to restore, double or otherwise enlarge the atrium. Finally, for the Department Stores | V&D's it could be concluded that the original spatial type Atrium was restored or expanded and that the court was used to (re)connect the building to the pedestrian network in the inner city. In principle, the redesign type of hollowing out is involved in all cases: creating more open space within the existing volume. A range of new functions (housing, museum, shops, library, offices, education, start-ups, etc.) could be integrated into the existing volume: function follows form.

### B. Police Stations (Vol. 2)

In the case of the second group of buildings the Police Stations, the conclusions could not be drawn so unequivocally. The eight locations differed enormously in size and position in the urban fabric. Four buildings are really part of the city centre, while others are more solitary on the edge of the urban development. There are also three buildings that were originally constructed for different functions: Warnsveld as Estate, Haarlem as Deacon's house and Rotterdam Witte de Withstraat as a newspaper publishing house. The division into types was therefore more complicated here than with Department Stores | V&D's and led to a grouping of types in a matrix (Fig. 21). For the Haarlem location, both the original Haarlem (-) and the current Haarlem (+) configuration are included in this matrix. Finally, three basic types were distinguished for the Police Stations: Solid, Court and Group. Next, a degree of complexity is indicated in the matrix distribution.

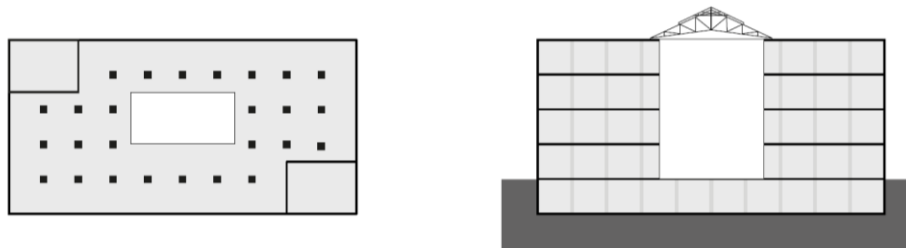


Fig. 19. Spatial typology of the existing buildings of the Department Stores | V&D's.

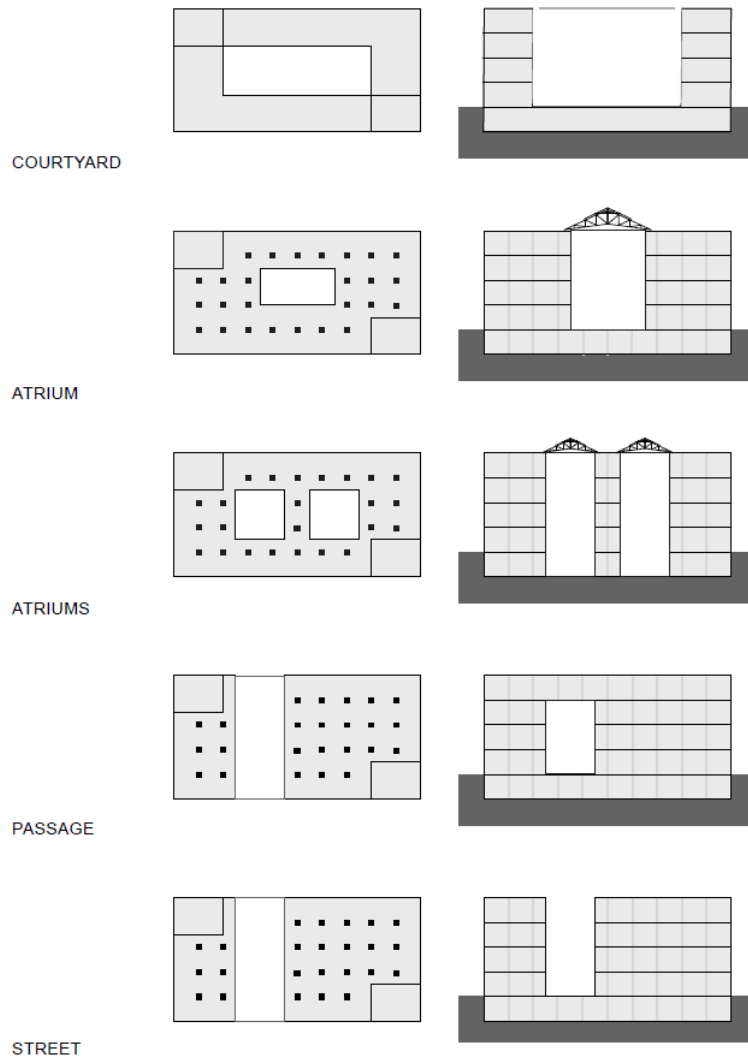


Fig. 20. Spatial typology for the existing buildings from the Department Stores | V&D's.

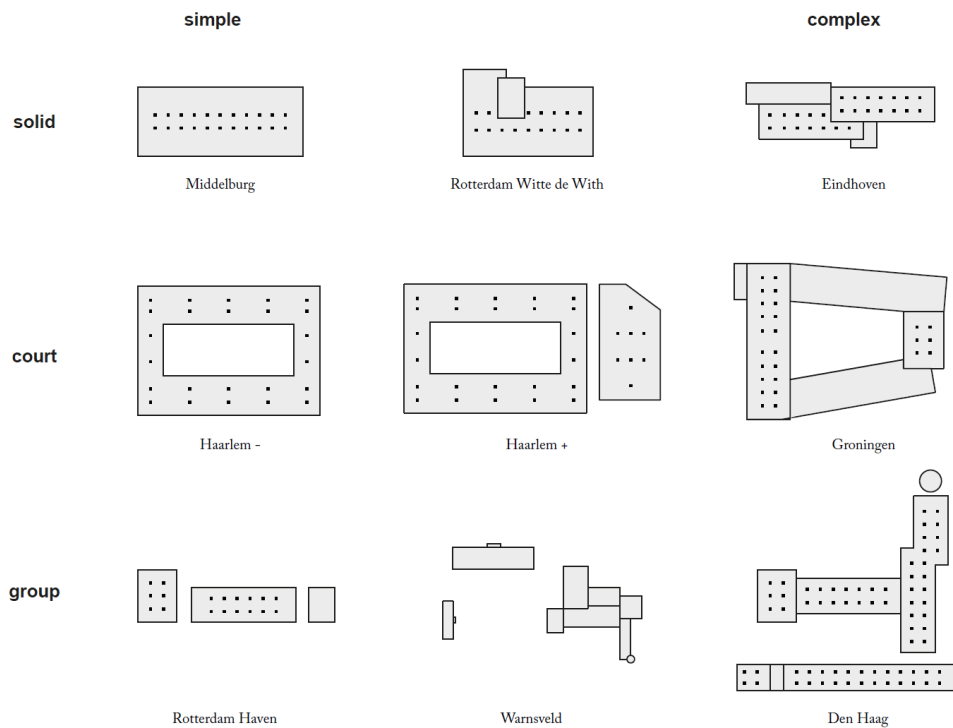


Fig. 21. Spatial typology of the existing buildings from the Police Stations (Vol. 2).

Based on this basic typology, the redesign options were analyzed and classified. It was striking that less complex basic types also entailed a less complex form of redesign / interventions: A. Fill in, B. Add, and C. Shrink. These redesign types are thus defined after the analyses of the twelve designs of the students. In addition to these three types, there was also type D: Redistribute. Type B. Add has three variants: 1 Supplement, 2 Expand, and 3 Top up. So, four types of redesign options could be distinguished in response to the twelve designs. In combination with the three basic spatial types of the original eight buildings, this leads to many combinations and thus options. We can conclude that due to the great diversity in types of the existing buildings, it is not possible to derive an unambiguous redesign typology based on spatial characteristics for the Police Stations (Fig. 22). New functions were also devised for the police stations. Most students opted for housing for various target groups combined with a library, education and work. We see here that the new function follows the form, but that there is also a tendency to add something to the existing form for a particular function or even demolish a part. The statement that the function follows the form is therefore less applicable here.

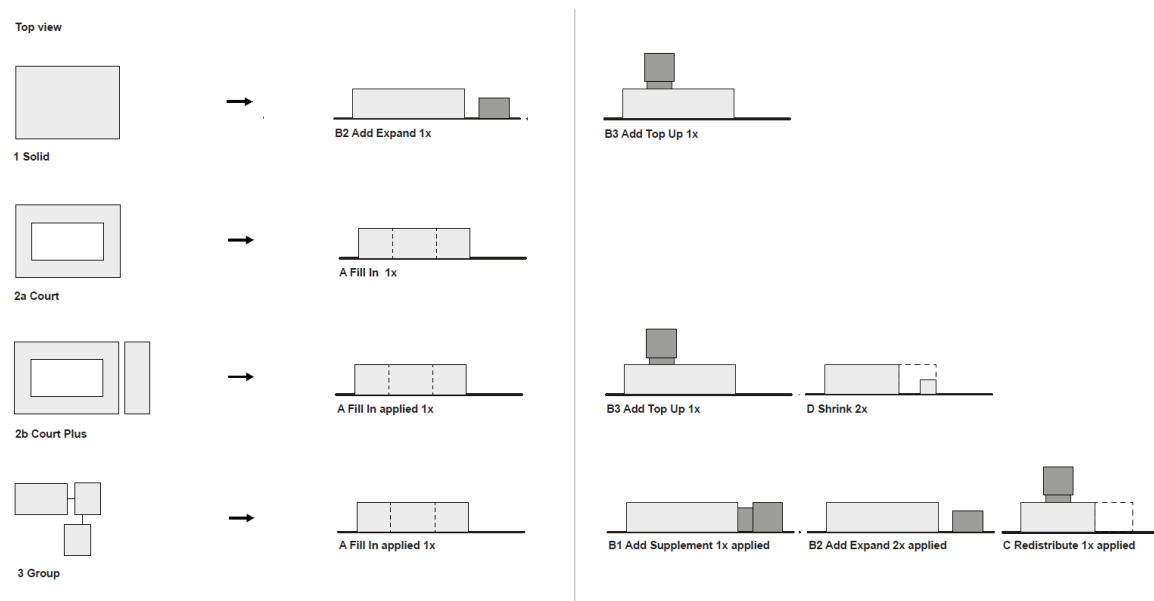


Fig. 22. Spatial typology of design solutions for the Police Stations (Vol. 2).

### C. Possible Follow-up Research

The difference in conclusions that could be drawn from both groups of buildings makes it interesting to include several groups of buildings in this research in the future. It would be useful maybe to analyse more design solutions per spatial building type instead of opting for buildings that originally had the same function. Think of spatial types such as: a hall, an atrium, a composition of different volumes, a linear object, etc. On the other hand, a group of buildings can also be a more specific collection of buildings that were originally designed for one function, such as churches for example. This last group is interesting because, especially in the Netherlands, many churches are vacant or will be in the (near) future. They are more or less suitable for reuse. We already have many examples of this in the Netherlands, those have been documented as solutions in themselves in 2021, but a spatial typological study is lacking. An analysis of redesign options based on spatial characteristics is also missing (Reinstra & Strolenberg, 2021). An initial impetus for this can be found in the TU Delft study 'Kansenkaart voor Kerken' (Mapping opportunities for Churches), which was carried out on behalf of the Province of Gelderland as part of the KaDer research project (Remøy *et al.*, 2021).

Since 2009, ten design studios with students (under graduates and graduates) at thirty locations within the department of Heritage & Architecture (HA) have been held about churches. Based on these designs and on the analyses of realized projects in practice, a profound follow-up (Churches in The Netherlands | Vol. 3) could be added to the Spatial Building Typology research to discover the extent to which form, and function mutually influence each other in the redesign of buildings.

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