LSRM FINAL ASSIGNMENT
Self-Assessment on Research Methods

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Rule-Based Typology

I INTRODUCTION
Why do people design? We design things in order to solve problems we encounter in everyday life. In order to make informed design decisions it is important to acquire knowledge. This knowledge is acquired by research. Therefore, a fundamental part of designing is doing research.

What makes awareness about the different available research methods important for architects is the fact that architecture uses knowledge from vastly different scientific areas; on one hand we apply knowledge from disciplines like civil engineering, physics and computer science, while on the other hand we apply knowledge from sociology, psychology and history. The variety between these disciplines makes it less straightforward for architects to choose a suitable research method for their research question at hand, simply because research questions within the field of architecture have such a wide variation[1].

In all these disciplines there are different opinions on which methods can be considered as being 'scientific' and which cannot. Note that, when questioning the research method, one immediately questions the research outcome. So, by being conscious about committing to a certain research method, one also is able to defend the choice for this method – and, with this, defend the outcome of the research. When the research informs the design, this becomes even more important. By questioning the outcome of a particular research, consequently the validity or quality of the design can be questioned as well. This makes it important for designers to be conscious about the way they perform research.

During this course several research methods have already been presented to us in a series of texts, combined with lectures. A lecture of particular interest to me was the one by Fransje Hooijmeijer, who discussed the subsurface in relationship to architecture. The lecture was very informative for me because around that time the development of my graduation project started to involve the subsoil of my site to a large extent. What was interesting to me is that she pointed out that the complexity of this field of research is visible in the large variety of specialists that are involved in the process, and that an architect cannot – and should not aspire to – know every detail about the subsoil, but should be aware of the constraints that the subsoil brings with respect to buildings. This greatly focused my own design development and kept me from trying to understand every part of this complex, multifaceted discipline.

The topic of my thesis is high-density housing. Current high-density housing constitutes of spaces restricted by their construction method; the bounding box of the orthogonal concrete structure defines the size of the spaces. The only way that higher densities can be acquired is by reducing the size of this bounding box, which reduces the size of **all** spaces. My thesis concerns itself with a more detailed approach to space, where each space has very specific spatial requirements in terms of size, based on its function; in high-density contexts we want to minimize the volume allocated for functional spaces and maximize the volume allocated for the living space. By 'packing' a number of apartments based on this principle we are able to construct high density housing without loss of internal spatial quality. My research question is based on this idea:

> *How to computationally generate a collection of apartments within the smallest possible bounding volume and other spatial constraints?*

II RESEARCH-METHODOLOGICAL DISCUSSION

On one hand, **precedent studies** were used as a research method. Existing generative design methods were researched which could accommodate the generation of an apartment building within a minimal bounding volume. For this, I did literary research into computational generative design strategies like *recursive modeling, packing algorithms, evolutionary optimization* and a*gent-based modeling*. I started with this precedent study because this kept me from 'reinventing the wheel' and places my thesis inside a broader theoretical framework. This research was partly conducted with the use of the TU Delft repository. A pitfall concerning this research method is a reduction of the scientific value of the research because one does not necessarily add onto new knowledge when relying too much on existing knowledge.

Besides this I researched how to integrate design ideas into the generative system using spatial constraints. In order to find this out I isolated the idea to reduce the complexity[2] and researched possible integrations with the creation of **prototypes**. An example of such a new design idea was creating the possibility of having the apartments stack on top of each other without the use of a secondary structure. By experimenting with clay models, I created (proto)types for multiple stacking configurations. I also made schematic diagrams of the stacking configurations which helped me understand the translation of this stacking configuration into rules within an abstract computational model. The apartments were represented as lines and the connections as dots (see Figure 1).

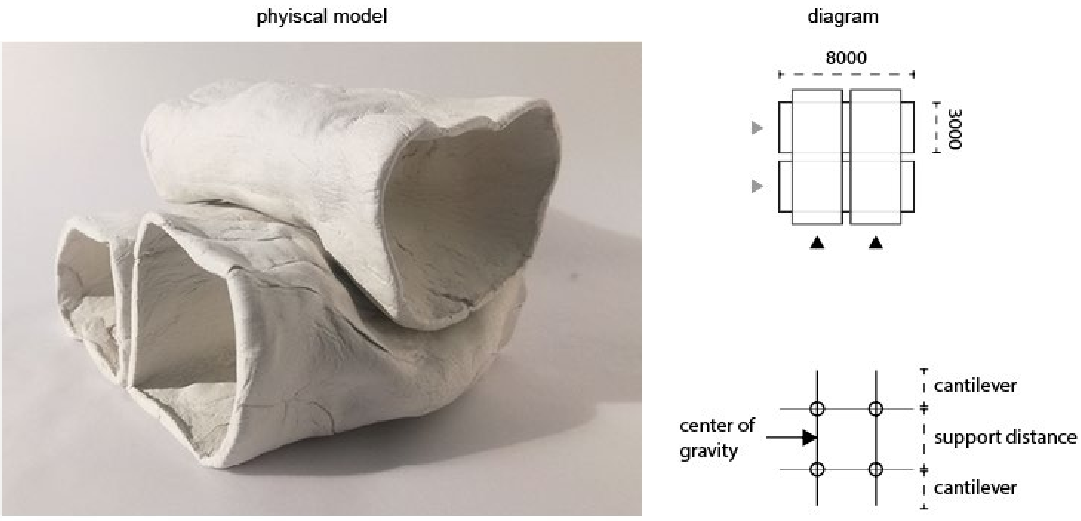

Figure 1: example of clay model with diagram of stacking configuration

Within this process I did not think of a solution in advance which was then represented in a model; in contrast, the act of clay modeling helped me to think about the problem itself and possible solutions **while** modeling. I chose this research method because it helped me understand a complex problem more clearly. Because during the process of prototyping multiple 'types' of stacking configurations were designed and analyzed, my process can be defined as a **typology in a research through design approach**. Instead of studying existing types, I created types by myself. The connection between the production of prototypes and typology becomes clear when looking at the definitions of the word 'type' and 'prototype':

Type *"idea or symbolic meaning that is embodied in an element, an object or a thing*"[3]
Proto "*first formed/primary*"[4]
Proto**type** "*a standard or typical example*"[5], or, based on the earlier two definitions: the first of a series of types with similar ideas.

My paper will be about the use of this analogue method with respect to the development of computational generative design rules.

My research method can be considered as research through design because the **act of designing** (making prototypes) was applied in order to **generate more knowledge**[6] (how to impose constraints within a generative design strategy based on this specific design idea). Research through design is part of a series of three categories describing the relationship between research and design[7]:

1. research **for** design,
2. research **through** design,
3. research **about** design)

Other terms which describe this concept are: '*design research through practice*'[8], '*research by design*'[9] or '*action research*'[10, 11].

Interestingly, using the act of designing as a research method has only in the last couple of decades been accepted as a legitimate way of doing research[12]. The urge to define design as research came from the fact that a lot of funding towards educational institutions depend on the distinction between design and research[13]; should design education be taught on a university level when it cannot be considered as scientific? More importantly, however: is 'research through design' output credible if it does not follow scientific norms? Or: how can we convince others of the quality of our designs if the methods which we use to gain knowledge are not appropriate?

To scientize the act of designing, many writers have defined requirements for this research methodology in order to be considered as scientific. A frequently heard requirement for research through design is that it is "*methodically transparent, as well as systematic in the way insights are gathered and subsequently communicated*."[14] This opinion is also heard in research-methodological literature in the field of landscape architecture.[15] Some describe that the research through design approach has been "*hindered by the lack of any fundamental documentation of the design process which produced them*."[16]. This is problematic, since in order for the creation of prototypes to be a generator of knowledge, the insights have to be "*fed back into the disciplinary and cross-disciplinary platforms that can fit these insights in the growth of theory*"[17]. Some writers question the need to simply adopt these methodological requirements from other disciplines, and stress the "*distinctive quality of discovery in art and design*"[18]. Lucas points out that that some parts of the research approach have some freedom concerning process, saying: "*Experimentation is a responsive form of research, as each experiment suggests the next step in your work*"[19].

These considerations are of course important in typology as well; when typology is applied as a research method and the types are designed by the researcher instead of studying existing types, it is important that the production of these types is according to some kind of method or structure.

III RESEARCH-METHODOLOGICAL REFLECTION

Explicit thinking about typology in the field of architecture started at the end of the 18th century when Quatremère De Quincy provided the first formulation of the idea of 'type'. He stated that the use of type in architecture is connected with a certain "*logic of form connected with reason and use*" [20]. So, De Quincy states, the type is connected to a certain function instead of a mere formal representation. The type also has a strong link with history: "*Type expressed the permanence, in the single and unique object, of features which connected it with the past, acting as a perpetual recognition of a primitive but renewed identification of the condition of the object.*"[21] Here, De Quincy made an important distinction between the type and the simply reproducible 'model'; the type can change as time progresses, whose evolution gives it a historical significance. Henry Wotton describes the importance of underlying 'rules' in typology, and states that rules can be isolated from the historical context in order to "form them into a (design) method"[22].

During the 19th century we see a change in the use of types contradictory to De Quincy's definition. Types were now used as a form of examples of how different elements in architecture should be designed[23]. In effect, the distinction between type and model was not made anymore. Durand, for example, made collections of multiple types of architectural elements which then could be combined by applying them onto a grid[24]. The type is no longer something that can change, but has evolved into (a set of) examples which can be arbitrarily combined. Interestingly, Durand made use of a rather systematic approach[25] (see Figure 2). However, he was quite inconsistent; while the first column in his scheme represents a systematic transformation of the square, this systematic transformation is not reproduced in the other columns[26].

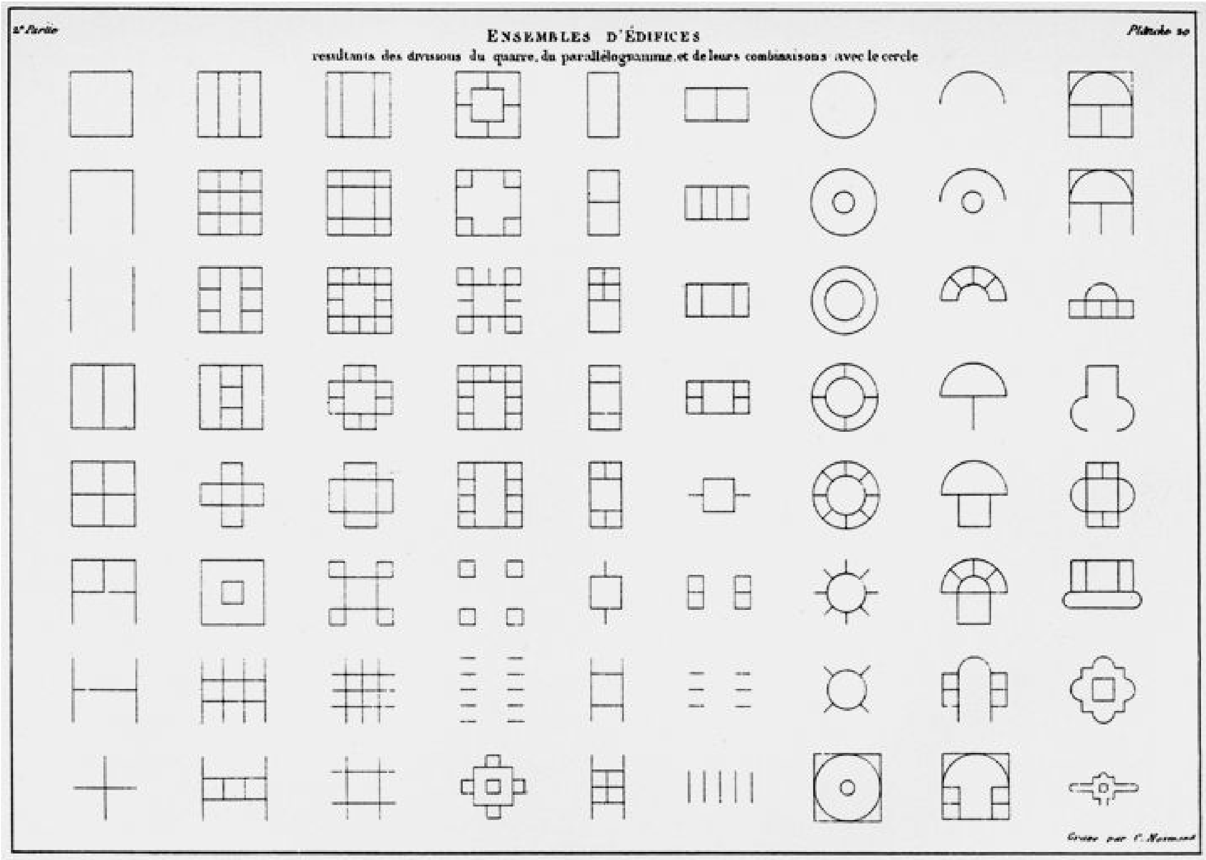

Figure 2: Durand, Building Forms, 1809.[27]

The 'exemplary' function of types is the very notion that the 20th century modernists tried to reject. This notion mainly restricted the designer in developing any change in these types, a development which they thought was necessary because of the large variety of changes that society underwent[28]; why should we build according to the models that were formulated in the previous century, when we have so many new architectural possibilities? With this they also rejected the historical character of De Quincy's definition of types and thought that this use of precedents had no use in the new architecture. In the modern movement, the type was given a new meaning. This meaning was based on the desired mass-production of building elements. Every constructed type could be infinitely reproduced, regardless of context[29]. We can see this in the work of Le Corbusier, who designed his buildings with an assembly of mass-produced elements; as in the assembly of architectural elements onto a grid in the design method of Durand, Le Corbusier combined industrially manufactured building components.

For centuries the use of paper and pen were the go-to tools for the production and evaluation of different architectural prototypes. Recent technological developments, however, have brought new tools to replicate reality more realistically besides these 2D tools[30]. Currently, an important emergent strategy is the augmentation of experimental research with simulation modeling[31]. For typology, this allows designers to produce and evaluate different types in a larger variety of ways. We can think of, for example, rapid evaluation of structural capacity of several design options.

IV POSITIONING

Based on this methodology on typology, we can draw an important line between typology and generative design (see my initial research question). In the lecture on typology (the study of types)

Gorny stressed that the types which are being analyzed should be characterized based on their ‘idea’ instead of their appearance[32]. It is not necessarily important what the prototype looks like, but which ‘rules it follows’, as Henry Wotton also puts it. Here he also builds on the earlier described definition of ‘type’ by Quatremère De Quincy. We can see this in an example given by Gorny of hospital floorplans, where by making connectivity diagrams the functioning of different floorplans could be compared based on their ease of evacuation (see Figure 3). Abstraction allows analysis.

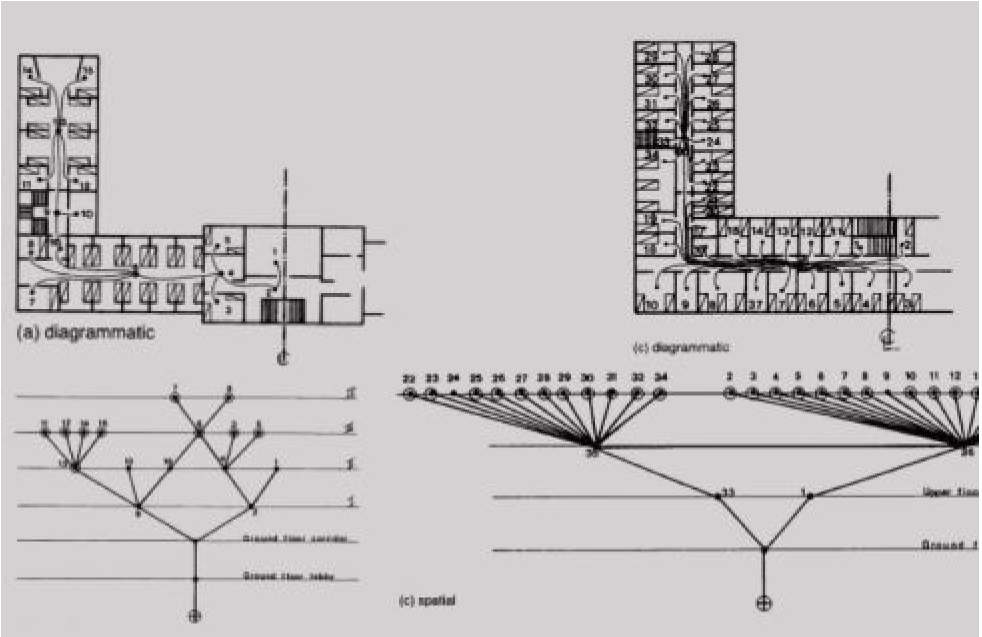

Figure 3: R. Gorny, lecture on Typology, slide 24

We can see a similar process of abstraction in my own research: the most important output of my research were not the clay models themselves, but the diagrams which explained the computational rules for each type (see Figure 1).

This focus on the ‘underlying idea’ in typology suggests the value of typology when developing generative design algorithms. A common problem when applying these algorithms is that it is difficult to define the translation from a physical requirement (stacking, in my case) into a rule that the computer understands. I found out that typology can play an important role in this development. During the production of several (proto)types of a certain requirement, a thinking process can take place where the designer ‘thinks while doing’ about the requirement at hand and the possible translation of this requirement into a set of (digital) rules. **It becomes apparent that this rule-thinking, as offered by typology, has an added value in the production of generative design algorithms where the formulation of underlying rules and principles is important**.

In turn, rule-thinking (combined with generative design tools) can be important for the field of architecture in general since these rules can result in a variation of design properties of architectural elements, contrary to the modernist notion of ‘type’ where each architectural element was assumed as fixed and unchangeable (regardless of, say, changing context). This relates to the transition from mass-production to mass-customization; instead of defining each architectural element as a ‘type’, we define the rules that govern the placement, size and morphology of these elements (according to several criteria) as types. This way of designing could help us to move away from the generic, non-specific character of the modernist notion of ‘type’[33] to types that can vary according to changing conditions, similar to the evolution of animals in different climates.

Besides this, my research allows us to say something about the of tools when conducting typology. I argue that, instead of using the ‘newest’ (digital) or ‘commonly used’ (2D drawing) tools, the tools for research should be based on the goal of the study. In my case: how to create generally applicable **stackable** apartment configurations. ‘Stacking’ suggests that the tools should be 3-dimensional, since the problem is about the relationship of different objects which are placed under, next to and on top of each other. Besides this, 'stacking' means that the influence of gravity has to be taken into account. This suggests that a physical material is favorable, since this enables us to directly evaluate the prototypes of different stacking configurations. This brought me to apply **3D, non-digital materials** as my tools my typology since the properties of these materials align with the goal of my research. The described advantages of these tools might also be relevant for other typologies, where the added value of a certain type has to be evaluated according to criteria that are inherently represented in physical and 3D objects. Typologies concerning structural stability or spatial experience come to mind as typologies that benefit from 3D approaches.

Adding to this, I found that a 3D approach makes it possible to study a larger variety of types and variations that are difficult to comprehend by using just drawings. By using clay models, I was able to define a rule for a stacking configuration that does not depend on 2D layered geometry. We can see the general applicability in the final computational rule I formulated:

> *"Each apartment has to identify the closest two neighboring apartments that are lower (smaller z value in x, y, z space) and has to be vertically aligned to both of them (have the same x & y values in x, y, z space)."*

This rule could have many different outcomes in the eventual design since it does not assume layers (or any kind of orientation, for that matter). When we compare this to a very simple (2D) stacking configuration, like a brick pattern, we see that this would be much more restrictive. If we want to apply other rules to the apartments (relating to solar orientation, for example) within a brick pattern, this becomes nearly impossible within the limited freedom provided by such a simple rule. Rafael Moneo also stresses the importance of general applicability within architectural discipline:

> "*When a new type emerges - when an architect is able describe a new set of formal relations which generates a new group of buildings or elements - then that architect's contribution has reached the level of generality and anonymity that characterizes architecture as a discipline*."[34]

Another issue posed in the lectures (as well as earlier described literature) has to do with the requirement of a systematic way of working when conducting research[35]. A very systematic approach means that the research process follows a fixed plan or system where the steps of the research process are predefined. An earlier described example of a (partly) systematic approach in typology is conducted by Durand. We can ask ourselves: should the whole research process be considered as predefined when conducting a typology? I argue that this is not entirely desired. As Kaplan puts it: "*To ask for a systematic procedure that guarantees the making of discoveries… is surely asking too much*."[36] Connecting to this opinion, Gaver suggests that "*attempts to establish disciplinary norms of process or outcome are political acts to be approached with care*."[37]. An important reason for this is that the very act of creating prototypes and evaluating them can develop new ideas along the way[38], which may influence the process itself. Hence, instead we can think of a more bottom-up approach, where each prototype guides the next step in the process, which may deviate from the initially expected plan.

Within my own research I also did not rely on a (fully) systematic approach, and let the findings along the way steer the process itself. While a similar process is not completely systematic, thorough documentation of the decisions made during the process could make the outcome scientific: the outcome is falsifiable as each individual step in the argumentation can be traced and, thus, questioned. Besides this, the documentation makes it possible for the research to contribute to a greater body of knowledge[39] because the process as well as the outcomes can be easily communicated. In the work of Durand this argumentation of the deviation from the system is missing. As earlier described, in my own research I increased complexity of the rules throughout the process in order to increase the general applicability of my results; I started with simple layered stacking rules. While this was not part of an initial systematic setup, this argumentation will make the steps I conducted in my research understandable.

Conclusively, I have found that the application of typology has a value in the development of computational generative design models because of its inherent focus on rule-thinking. When applying this research method, the designer/researcher has to align the tools of the research with the goals. Some prototypes might best be developed or evaluated with digital tools, while for others analogue tools are necessary. After this initial setup, the research is developed based on findings during the process. As long as the researcher/designer ensures a thorough log of the process and the successive steps taken, the scientific value of the research approach is not threatened since the decisions made along the way are traceable and falsifiable and the research output can generate generally applicable knowledge. To be able to make the produced knowledge generally applicable it is important that the defined design rules are as flexible and least constraining as possible, since this allows for the integration of these design rules within a large variation of designs.

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