

The methodology of the optimization of production processes as a
basis for architectural design

AR3A160 Lecture Series Research Methods

Kees Fritschy 4222229

Chair of Architectural Engineering, "Harvest Studio"

Thesis "The future of food production"

10-05-2019

I INTRODUCTION

The knowledge of architecture is embodied in the way that we use space. An architect has the job to shape the built environment into meaningful places. Before the decisions by the architect were mainly based on form reasoning, social or generative methods and visualization. However, last decades a new important question overrules: How do we (my generation of designers) contribute to the reverse of climate change? The sustainability question, among other thing made the profession of the architect more complex. Collaboration and research are becoming more essential than ever before. A conscious methodology is able to improve the research findings in relation to the current challenges in the built environment.

The intention of research is come up with a meaningful result originating of the data gathered (Lucas, 2016). Most often, In architecture this meaningful result is the foundation for a building. In architecture, the research is not the project itself. The research outcomes form an essential foundation on which a project can be developed, through research the designer understand what can be addressed through design. The heuristic character helps me as designer to make conscious choices and justify them to others. My studio, the Architectural Engineering Harvest studio examines the demands in relation to the resources. The cycle of resources influences the architectural landscape and objects. In this process social and economic circumstances should profit from the innovative design solutions. Their design methodology is based on investigating local and scientific knowledge as a foundation for innovations, bringing these epistemes together is leading to new types of space and materialization.

The lecture series made me aware of methods that I never used before, however it especially motivated me to reflect upon the research methods I use most often. The lectures made me more aware of choice of the designer has to select a certain method applicable for the project or even a combination of methods. A conscious methodology will help the designer to be more efficient in tackling issues. Within my studio you get to choose between a flow- or make-analysis approach. My research includes the flow-analysis approach, the most suitable research method to explore my research question is the material flow analysis (MFA). This method is evolved to construct processes and systems for resource management. In this context resources include material, energy, environment and waste (Brunner, 2003). My research investigates how a sustainable (food, energy and material) production system can be integrated with the territory of South Limburg, and lead to (health, social, economic and environmental) benefits for at least 250 people.

In my research, I sort processes and material streams to research the possibility of interrelated connections to be able to create a more efficient whole. This is relevant because most cases of design are leading to an increasing demand for raw materials, energy production and the generation of waste. However, when design is able to adopt these demands as internal part of the planning process. The designer is able to select legitimate sources based on local stocks and processes. Rather, than seeing the use of resources as an external factor happening independently of the process. By talking to my teachers and finding out about this approach, I realized that using this approach as a start of a design project, is not corresponding with the design methodology of most designers in practice at all. In my point of view this is an approach that every designer should start to adapt in relation to environmental issues we are facing.

II RESEARCH-METHODOLOGICAL DISCUSSION

Recently there is a upcoming initiative in design that helps to integrate system thinking and human-centered design. It is called the systemic design approach. This holistic approach allows designers to cope more easily with the complexity in projects. It aims to improve the capability of common design strategies to be able to include multi-stakeholder systems to rearrange social and spatial systems (systemic design.net, 2018). I used this strategy as heuristic technique to map the possibilities of interconnecting systems as a basis for the MFA (material flow analysis). This method starts with mapping the needs of the people that should benefit from the system. Literature research and interviewing people are additional methods that are essential to specify future needs and wishes, these go alongside the main method. During my project, I experienced that the literature research is the foundation to gain knowledge about the processes and outcomes that I am integrating. To proceed first the systems and players need to be identified, and also the technologies that are available. Next, is understanding the relation between context and the participants and all aspects like communication, marketing and services. For all inputs and outputs the quantitative and qualitative aspects need to be investigated. So we can determine which resources we need and what is occurring during the processes (Bistagnino, 2011). The final step within this method is to find all opportunities for beneficial connections and try to join the processes into one interrelated system. Such a system is presented in a flowchart diagram, it shows the relations between the processes. In a flowchart each relation expresses a flow of substance from one process to the next.

I think it is fair to say that before the final step in the research process you already realize how discordant it is to simply focus on separate parts, and neglect all links in and around the processes. The natural world is an example of all single parts working together in a dynamic and resilient interconnecting whole. In a forest many processes happen alongside without generating any waste in the end. I see this as an inspiration for all designers in the transition from linear to circular economy. The Netherlands has the ambition to be a circular economy in the year 2050 (Nederland Circular, 2016). Circularity is a solution to cope with the growing world population and increasing consumption in the next years. Nevertheless, this transition is rather complex, consumerist culture forms the basis of decision making in the political and economic choices of a country and influences the value system civil society is referring to (Bistagnino, 2011). As designers, I believe we are able to set an example of how to integrate circular thinking in society. Thomas Rau states that waste has no identity (Rau, 2018). However to give waste an identity as material we need data. According to Jaap Dijkgraaf data is the key factor in ultimately implementing circularity. He states that artificial intelligence and blockchain are seen as "disruptive development", nonetheless they play a part in managing data and improving circularity. These algorithmic technologies manage data of stocks and flows, in which I see the next step to optimize what the MFA method enforces as well. Nevertheless, Carlo Petrini makes a very sharp comment in which he states, that modern society is blind in the search for replacing technology to innovate. This is a vicious circle in which the new technology becomes old the moment it is introduced (e-consumption), the previous object will lose its purpose and is not always recyclable (Bistagnino, 2011). So introducing new technologies might be useful to improve the method, but is also a potential pitfall in what the MFA try to achieve in the first place.

III RESEARCH-METHODOLOGICAL REFLECTION

In essence material flow analyses are based on the principle of mass conservation that derives from natural science. To determine unknown flows one can make use of the natural balance before and after a process in which you compare inputs, stocks and outputs (Brunner, 2003). Until a few decades ago this method was not used by architects yet, but by all kind of other scientists. One of the most early attempts of researching flow were done by Santorio Santorio in the seventeenth century. He investigated the material flow in- and outputs of a body, to understand human metabolism (Major, 1938). The study of the metabolism process inside a body is only a small fraction of all the processes that happening around food consumption outside the human body (Brunner, 2003). Abel Wolman was the first researcher who looked into the metabolism of cities in 1965 (Wolman, 1965). He started to see the connection between inputs and the generation of waste outputs. Ten years later, Duvigneaud and Denayeyer-De Smet concluded that an interdisciplinary approach is needed to investigate the cities metabolism flows in order to ensure its continual welfare. This statement demonstrates similarity to my own research. To clarify, I include not just the welfare and social issues of the particular place I work on, but also the overall strategy to not deplete the world from its natural resources to also not negatively affect other areas or people. However the necessity to do so was already pointed out in the early 1970s, when Newcombe researched the metabolism of Hong Kong. He concluded that the huge demand for material and energy in the big cities would lead to negative impact on the environment and the worlds natural material stock (Brunner, 2003). Newcombe's use of the method explains the contemporary reason of a growing interest to use the MFA method. Nowadays the necessity and so the interest for circular systems increases due to the problems we are facing.

Brunner and his fellow researchers were looking into additional methods to improve resource utilization on a regional scale in addition to the MFA (Baccini, 1991). They started to research on anthroposphere activity, these are metabolic processes in human-made systems. I will use this approach within my own research as well. I started looking for traditional human-made processes that are home to the region, such as beer brewing. Traditional processes usually count on local material inputs. Reintroducing (forgotten) processes is key to cut down emission of material transportation. My findings of industrial and ecological processes can be combined into one system to allow processes to benefit from one another. This approach is closely related to industrial ecology, defined by Jelinski as an approach to optimize the material cycle from raw to end product by using industrial systems in harmony with its natural surrounding systems (Jelinski, 1992). Like a natural ecosystem, processes can be combined to strive for a closed sustainable system. However one should consider the economic aspects to make the system work properly (Brunner, 2003). The role of MFA is to expose the processes cycle of materials, discover suitable stocks, detect loss and waste to form new loops. The researcher can use MFA to compare options and find the optimal solutions on process level. I experienced that within this method, the drawing process is important when you search for the optimal solution. The production of diagrams allows the maker to reflect upon the represented processes. While working on a diagram the maker can digest and consider every step. In the end this results in a better understanding of the produced work. The visual methodology of drawing includes many aspect such as: the notational or pictorial aspect, autographic qualities and aleatory processes (Lucas, 2016). These different qualities are influencing one another and allow you to make conscious choices about what and how you draw. Nonetheless, drawing the diagram involved constant thinking when checking for potential dangers that might occur in connecting streams. There might be danger in the optimization of closed loops of using waste streams. The loops might end up polluted and cause wide spread contamination in other processes.

IV POSITIONING

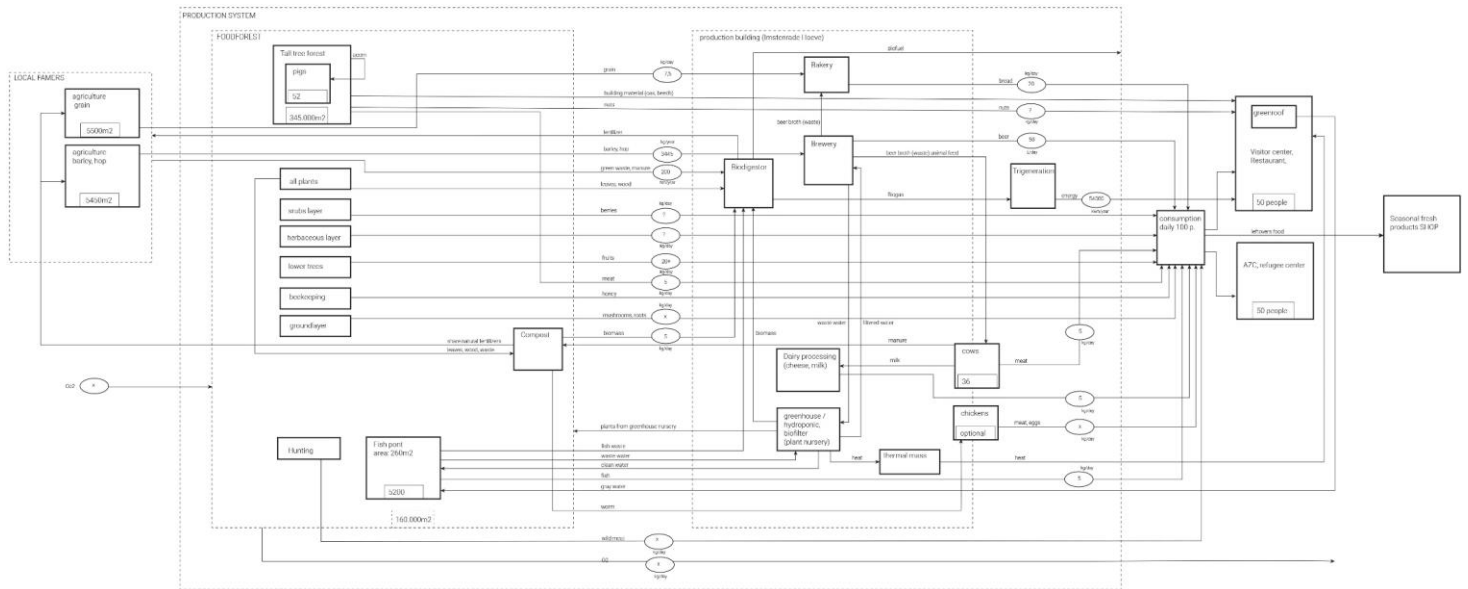
The lecture series helped me foster my awareness about the importance of various research methods an architect has access to. I started reflecting on my own design process and the development of these processes over the years. Usually I have a strong vision based on my personal fascinations, which can be good and bad in a sense. When the fascination holds me back to explore, it is limiting the project. However, over the years strong fascinations proved to be useful guidelines. I realized that as a designer I envision qualities for the final result on an early stage in the project. Having these qualities set out, allows me shape my own design methodology to explore how to achieve these qualities. I see the subjects of the lecture series as a toolbox of different methods for me to choose from in the future. Once more, I learned how research forms a solid foundation for a designer to build upon.

Within my own research the understanding of processes is coming before the actual building. Therefore, I identify with the position of Fransje Hooimeijer's lecture on investigating territorial scales and drawing the subsurface. The underlying structures and systems form the foundation on which the building is designed. However, as much I believe investigating the underlying processes is fundamental for a sustainable world, as I describe in this paper. In my opinion an architect should never focus too much on one aspect or approach. Very often, also within my studio, I see technical processes as excuse to forget aspects like creating comfort and pleasant spaces to be at. A pleasant or a beautiful space probably has a long life, which is also sustainable in a sense. I can argue that the architectural engineering studio has not enough of an integral approach in their research methodology, and focusses too much on the technical processes. Nevertheless, The profession of the architect became more complex over the years, which makes it in most cases simply too hard for one designer to switch between all conditions and therefore different research methods. The greatest architects are masterminds, nevertheless collaboration is key within the current state of architecture. A team of experts is needed to answer the rising complexity we encounter in the contemporary built environment.

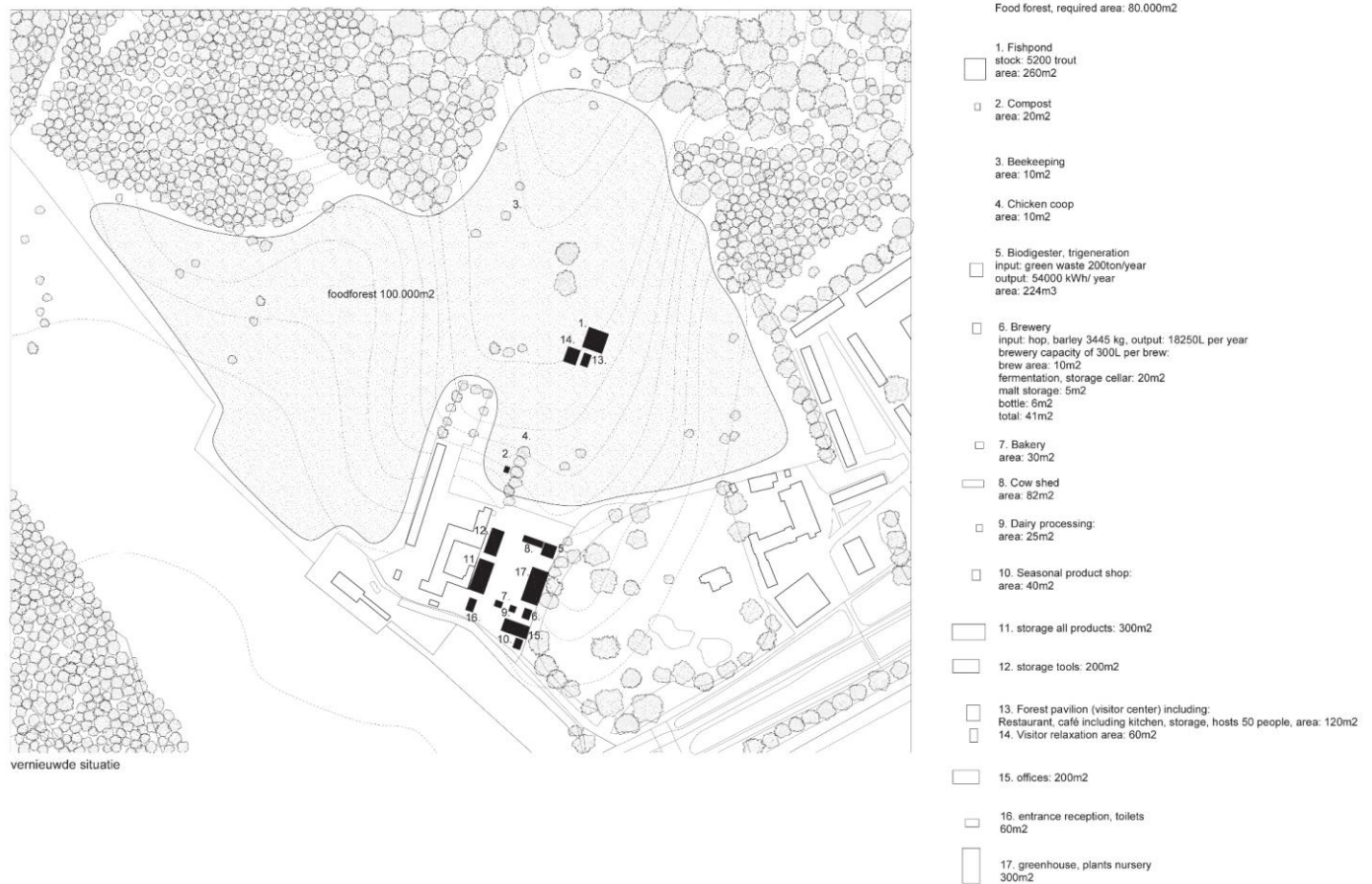
Normally, in a production system the raw material inputs are on one side and the product outputs are on the other side. Within a system new streams can emerge to make the system more efficient. Different production systems are able to provide input for another process. The processes are different, but together spare raw material input. To work towards these interrelated processes to form systems, a multidisciplinary vision is essential. However, I believe the hardest part of this approach is to alongside the research process keep translating it to its spatial appearance. At the end of the research the designer has to translate the process schemes into a conventional architectural language. I experienced that when spatial thinking is included at an early stage of the research the outcome will be much more efficient. This points out the importance of the designer's ability to understand the scope of the selected method to be able to consciously involve other epistemes early enough.

The material flow analyses method forms the foundation to explore my research question. Nonetheless, the research goals do not imply one research method. To collect the right information for this method, other methods and knowledge is required. Different epistemes, such as systemic thinking and also praxeology have value in guiding methodological research. To be able to integrate my envisioned production system into a wider social context. Other epistemes are essential to be able to look at a context from various points of view. I believe that a designer needs a combination of research methods in order to carefully balance the ideologies in an architectural project.

THE METHODOLOGY OF THE OPTIMIZATION OF PRODUCTION PROCESSES AS A BASIS FOR ARCHITECTURAL DESIGN



Flow diagram of the material flow analysis, including all processes inputs and outputs (own image).



Spatial projection of the flow analysis outcomes on the existing situation (own image).

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