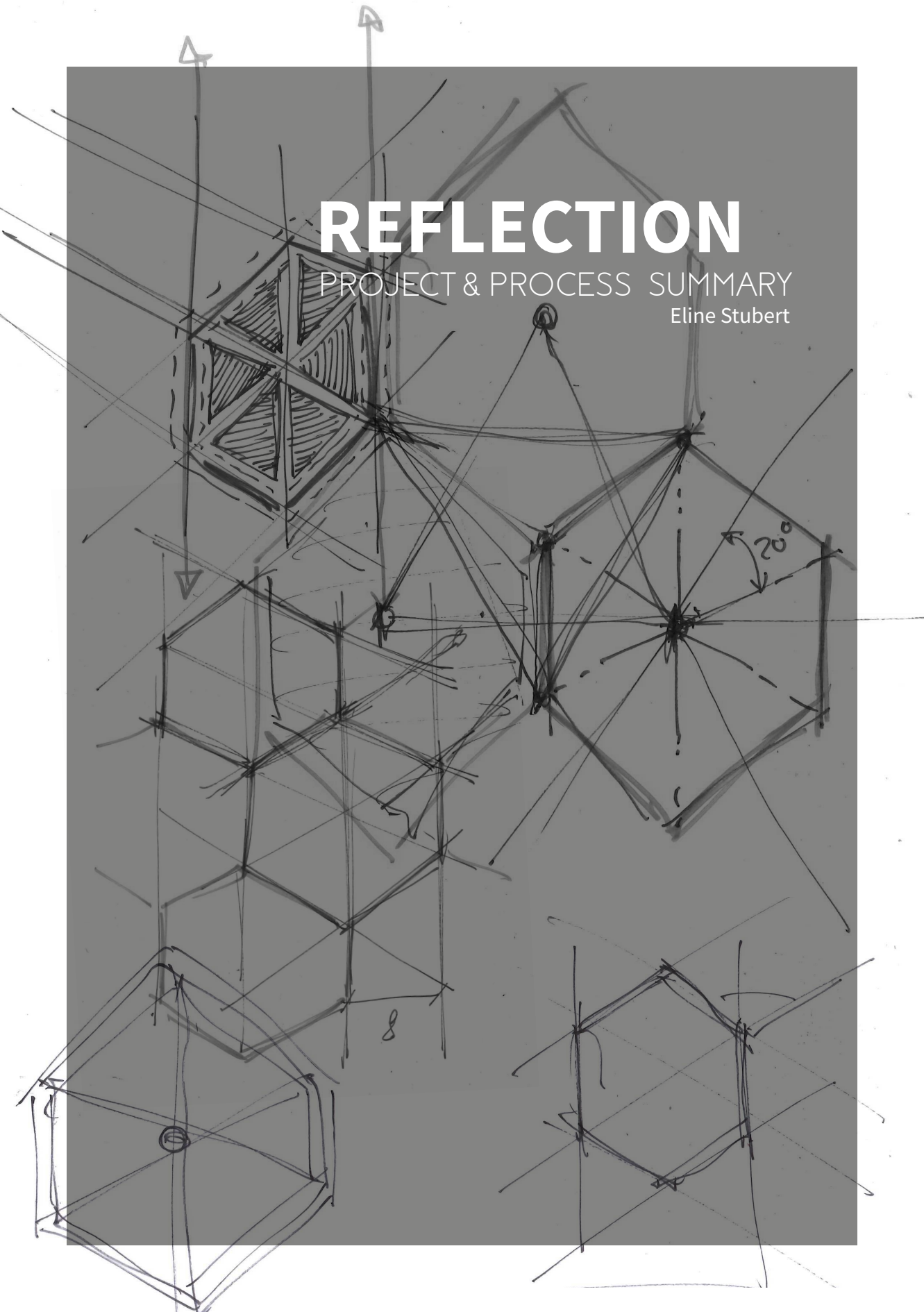

REFLECTION

PROJECT & PROCESS SUMMARY

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SUSTAINABLE ICE RINK:

maximum annual use density

demands of the users

material choices

logical spatial composition

ENERGY NEUTRAL PERSPECTIVE

The ice rink paradox

When I would summarize the main function of an ice rink building, it would be: A building which houses a sheet of ice, which makes it possible to continue the ice skating season in our soft winter. Producing ice means, to extract heat from a surface or area, which leaves the surface being colder than before. In this way, ice rinks are actually huge heat producers, which releases their heat towards the outer air. This process contributes in an elevation of the outer temperature.
We made a solution for ice skating in soft winters, but with this solution we indirectly create winters with even a softer character.

Therefore an ice rink indirectly works against itself, but improves its reason to exist. We need artificial ice, if we want to continue practicing the ice skating sport with warmer annual temperatures.

Most ice rink buildings are created to provide comfort for the sporter and to protect the ice from outdoor circumstances as wind and rain. In general these buildings can be described as shells in which insulation and efficient climate control are non-existent. This, in combination with the high energy demand and the vacancy problem during summer, concludes that the ice rink typology could be improved in the sustainability of its architectural design.

Personal motivation

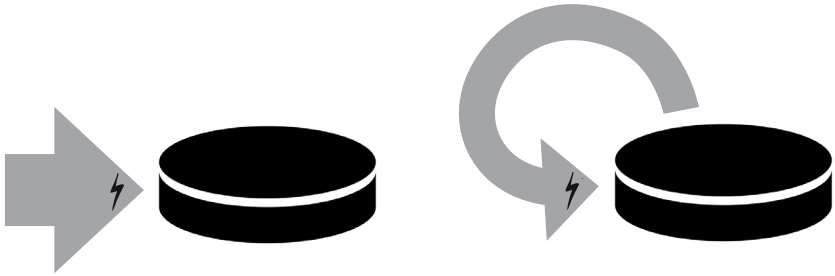
As an ice speed skater I enjoy to make use of an ice rink, but simultaneously have the feeling that I have to defend myself to make use of a building which is so environmentally unfriendly. By practicing my sport I intentionally contribute to humans bad influence towards our environment.

Research directive

Within the research solutions had to be found for the energy inefficiency, vacancy in summer and at the same time take the demands of the sporters into account, all assembled in one building which must generate an attractive appearance. The final goal is to make the ice rink energy neutral.

What is energy neutral building?

My definition derives from Net-Zero-Energy Building (ZEB), which can be explained as:



Current situation Project goal

‘‘A net zero-energy building (ZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies.’’ (1)

Designing an energy neutral building is to minimalize the energy demands, in other words maximize the energy efficiency, and to compensate these demands with the energy producing architectural elements.

What is energy efficiency?
In order to fulfill its purpose, an ice rink acts as an ‘‘active building’’. It needs electric energy to produce a layer of ice. Even in the most ideal scenario, in which the energy consumption of the building is as low as possible, there is still electric energy needed. Energy efficiency can be explained as:

‘‘Percentage of total energy input to a machine or equipment that is consumed in useful work and not wasted as useless heat.’’ (2)

In this research ice rink building design act as the ‘‘machine’’ in the definition above.

The main research purpose was to find architectural means to generate energy efficiency.

But there are **other goals** involved, as explained in the research directive:

- To maximize the use density of the building throughout the year.
- To take into account all demands of all potential users of the ice rink in winter and summer.
- To have a logical spatial set-up of the building, designed for large visiting numbers.
- To generate an appealing appearance, to generate large visiting numbers.

1. Torcellini, P., Pless S., and Deru, M. (2006). Zero Energy Buildings:
A Critical Look at the Definition. Conference Paper AECEEE Summer Study. Retrieved 29-10-2017, from https://www.nrel.gov/docs/fy06osti/39833.pdf
2. http://www.businessdictionary.com/definition/energy-efficiency.html

The design challenge is to combine all goals in a holistic and integrated ice rink design. But all design challenges will be faced from the energy efficiency perspective.

The conclusion of this research will be a program of requirements, a manual which can be used as foundation for the design.

Methodology
For this research multiple methods were used. To gather information about the practical use of an ice rink multiple ***interviews*** have taken place, ice makers, ice rink chairmen and engineers were interviewed within this research.

As well as a ***questionnaire*** to acquire the requirements of the potential building users. For spatial composition and material choices precedents were examined: ***case studies.*** The answers from the leftover unanswered research-questions were derived from ***literature studies***.

Design conflicts
During the research conflicts between the project goals became clear.
Conflicts deriving from the research:

- The demands of the sporter (high ice quality, high light intensities, strict climate control) are contradictory to a low energy demand.
- The building needs to have different functions in summer and winter, which may not be easy to combine in the spatial composition.
- To achieve an attractive and inviting appearance natural daylight is appreciated, though this is in conflict with achieving an ice sheet for high-performance ice skating. And a requirement of the broadcasting users, the sport area should be able to be darkened.
- A low ceiling in the event area can stimulate airflows which divide the sport and spectating area, but could result in a low
- To make use of waste heat, a heat pump should be attached, which consumes energy. So waste heat requires an investment of more electric energy if one was to use it.
- The building should be detailed as airtight as possible, but it needs a lot of fresh air during events with large visiting numbers.
- The users require a columnless event area, which means a large span should be achieved within the construction. Large spanned construction are known to have large dimensions, which means a large investment of material and thus energy to produce these materials is needed.
- To provide a controllable, and thus as energy efficient as possible, climate in the ice sport area, the event hall should be detailed as airtight as possible. At the same time it should be able to open up to large numbers of spectators.

General remarks on the process

This research is connected to the graduation Explore Lab of the Architecture department of the University of Technology in Delft. Goal of this graduation studio is for students to dive into a subject of fascination.

To have a fascination in a certain field, in my case the technology and architecture of ice skating rinks, can help in stimulating oneself in a project. But it can also mean that keeping a clear overview on the research process may be a challenge, since every sub study seems important and seems to support your initiated purposes.

Looking back to my process, there is one general recommendation I have to give myself, which considers the focus of the project. At the beginning of the project I was keeping my project goals vague, to make sure they could be altered when necessary. But by doing this, the project never got a clear structure from the beginning. This reflected on the interview and questionnaire structures I did, which was set up in a broad way. The amount of data retrieved resulted in a lack of overview and an even broader focus.

Looking back, my questions during the interview could have been more specific. And when an answer wasn't helpful, I could have asked for other sources, this was done a couple of times, but I could have been more specific in my intentions. The interviews were extensive, but still more in width than in depth.

Lack of specific data

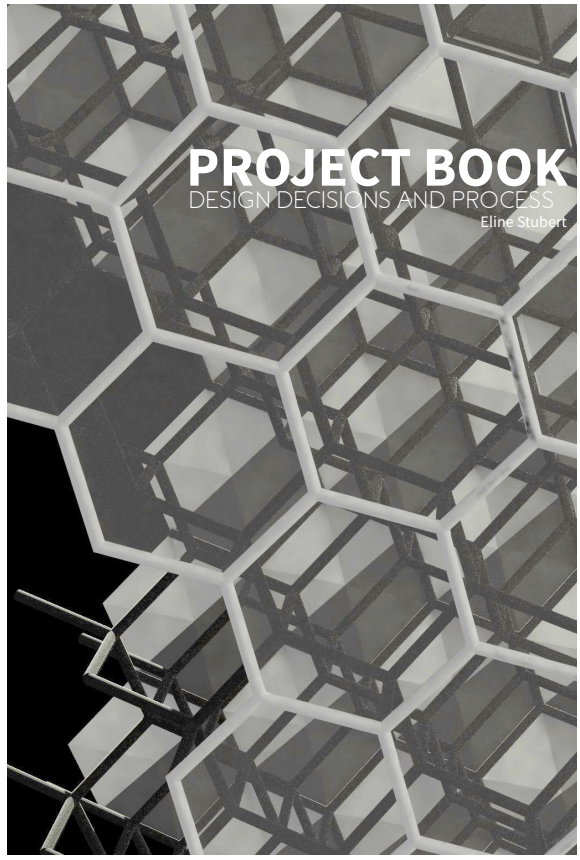
''Energy efficiency in the ice rinks buildings, is a relatively young research field, with no academic background.''

The original research plan was to have a long list of energy saving means and renewable energy means to achieve energy neutrality in the ice rink design proposal. Eventually, this became a challenge. Since most news or literature items were explaining innovations in making the refrigeration process more energy efficient. Most literature ánd people who were interviewed, were more informed about the refrigeration possibilities, than in actual architectural solutions to reducing the energy consumption. Also ''reducing energy consumption in ice rinks'' specifically was not a subject which was well presented in the global academic literature. Most solutions had to be found by asking questions to people in specific ice rink related professions, or were integrated in unofficial reports of manufacturers. It shows that this particular subject, energy efficiency in ice rinks, is a relatively young research field, with no academic background.

A clear overview in energy consumption is, due to confidentiality in many fields, impossible to come by. I tried to compensate for this data by gathering or making this data myself, by making questionnaires and interviews. The required data is, for energy consumption, quite specific to the building design. Since no operators were willing to share this information, the data was found by putting bits from different building projects together. Which leads to the image of the calculations being of a general character. But since this is a general manual before going in depth in a design assignment, the outcome is still useful.

Focus of energy efficiency could have been broader
If I would give myself a recommendation, it would have been to not only stick to ice rinks in the energy-performance research. Case studies could have been done from other sport buildings, or even multifunctional venues, to generate sufficient comparable information.

Research versus Design
The structure of this research was, to express it informally, sometimes lost. The translation from research to design is a challenge for the simple fact that both are intertwined in each other.
To constantly switch between the two brought no structure to the research or to the general planning.
Eventually the decision has been made to literally split both process stages, into two books.
One, the **Research Book**, describes the general problem statement, background information, and answering main research questions, the conclusion of this report is generally a Program of Requirements. It can be treated as the ‘‘package’’ needed to make the design. The second book, the **Project Book**, will analyse the design assignment, location analysis and design decisions.
A tip to myself is to start documenting all decisions at an early stage, in chronological order.



Conclusion of the research process
The research questions suggests a literal outcome, in form of a manual. Already at the start of this research the main goal was to get a list, a program of requirements on ‘‘How to make an ice rink energy neutral’’. This had been proven that there was a need to change course. Already, when looking at the research question, the more simple question arises: ‘‘How to make an ice rink?’’.

This already was a challenging subject. Before one could dig into energy efficiency / production / overview of energy consumption of ice rinks, the basics of defining boundaries on architectural level had to be taken into account. Finding out who the users are, including their requirements, what spaces are needed and the their dimensions were subjects which had to be investigated first.

Also, a literal answer on ‘‘how to make an energy neutral ice rink’’ doesn’t exist.
The goal of this research to have a dry list of requirements where the whole design can depend on, is simply not possible. To design a building which deals with energy efficiency, energy saving measures and renewable energy, constant calculations have to be made, on which the design process needs to be steered. Eventually the Research Book shows an overview of measures which can be done to improve the energy performance of an ice rink.

Remarks on the communication with tutors
As explained before, the process structure can be described as chaotic. There were moments where, to express it informally, I was stuck in the project. During these moments my communication with the tutors was non existent. The idea to solve it myself and to not accept any tutoring or accompaniment resulted in a long static period. No decisions were made and this lead to a lot of useless side projects and avoidance to finalize the research. During this time I could have benefited from conversations with my tutors and be honest about this, instead of being in a state of denial.

For me the solution was to organize in-between presentation, to have a deadline to lead up to. In this way the stimulus to start finalizing some products was present again and resulted in acceleration of my research and design efforts.

During tutoring sessions my products were in various states of completeness. Which made it difficult to actually retrieve useful feedback from. Sometimes the product were present, but were hard to find in large amounts of documentation. In the future I could benefit from ordering these products before a tutoring sessions. The best advice I’ve received was to set boundaries for myself, in my research, but also in my design. To make drawings of certain design inputs, without actually already designing them, eventually made my design intentions more clear.

Personal recommendation
The need to solve everything in a new field, with tools and methods which were new to me, was ambitious. For further research initiations I would recommend to narrow the research angle, and to compare the research plan to others. So to summarize, keep it small and know when you did enough.