Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences
Graduation Plan: Explore Lab

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

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<tr>
<th>Personal information</th>
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<tbody>
<tr>
<td>Name</td>
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<td>Student number</td>
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<td>Telephone number</td>
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<td>Private e-mail address</td>
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<th>Studio</th>
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**Problem statement:**
Within the ice speed skating world a shift has taken place. Instead of skating on frozen lakes/natural ice the sport is nowadays mostly practiced indoors on artificial ice. The climatic requirements of these buildings request a lot of energy, the ice rink is an active building, which, due to this high energy demand, has an energy bill which cannot be compensated with the incomes of the building. The building will in his whole lifetime be unprofitable.
The energy is mostly needed for the production of the ice layer, by production of cold, heat is a waste product. In most rinks this left-over energy is not used in its
fullest potential.
Also, because of its shift indoors, the sport has suffered losses in participation. This loss consists especially of youth, but in general from recreational skaters, whose numbers were higher when the sport was still practiced on natural ice. Ice skating on natural ice is preferred by this target group, the scenery and social gathering is important to them.
Furthermore, a lot of rinks comb with indoor climate problems, mostly related to moist. The choice of materials does, in this case, have a high contribution to a better indoor climate.

Main research question:
How to make an energy neutral ice rink, applicable to a broad public?

Sub questions:
- What are the climatic requirements of an ice rink?
- How can a long span construction be made?
- What climatic equipment does the production of ice require? And how can the quality of an ice floor be guaranteed with this equipment?
- What aspects within an ice rink are requiring a lot of energy?
- How can energy producing elements be integrated in an ice rink design?
- How can the architecture of an ice rink made recognizable to a visitor?
- What climatic problems are ice skating rinks combing with?
- What are the requirements for professional skaters?
  - What is the architecture of topsport?
- What are the requirements for recreational skaters?
  - How can we make ice skating attractive for the common public/children?

Design assignment
The design will cover an 400meter ice speed skating rink. Which in its climatic design/material choices/construction/building physics will result in an energy-neutral ice rink. Energy neutral is defined as the energy needed within the production phase and operational phase, which will be compensated with energy producing elements. The sum of the energy consumption and energy production will be zero at the end of the rinks lifetime.
Furthermore, the rink will house functions which will cover a high daily occupancy of the building in winter and summer. In this way, the highest potential of the building can be guaranteed and will the building produce more income, goal is to prove an ice rink can be profitable.
Due to climatic/light solutions and well-chosen equipment this rink will have “fast ice”, which means the resistance of the ice surface will be as low as possible. Most importantly, the design will improve the energy efficiency of the ice rink and will attract a broad public: professional and recreational skaters.
By doing a smaller orienting research it became clear that scientific literature about the building typology, climatic requirements or financial problems are not highly present. Most information can be found in a small group of experts. Architects of recent new rinks, but also cooling/flow design technology experts, exploitants, but most importantly: ice makers. This profession includes technical management of a building, and these are the people who have experience with climatic, financial and building physical problems within ice rinks.

My method will include interviews with the professionals mentioned above, literature research, and case studies. Goal is to find within these interviews, case studies and literature ways to lower the energy demand within ice rinks, for example types of insulation, programmatic solutions, building physical aspects to improve the inner climate and lower energy loss.

These will be the requirements which will be implemented into a Program of Demands. This program will be an overview of (if possible: measurable) goals which will be the spine of my design proposal. During the design process, I will test my design on requirements of this Program of Demands by means of simulations in several computer programs:
- Airflow measurements
- Heat radiation measurements
- Air temperature measurements
- Material temperature measurements
- Human movements throughout the building
- Optimal dimensions for construction components

Furthermore, there will be an estimation of the costs of the building process and the materials required for the design, as well as the emissions produced by producing these products and the energy needed to build the ice rink. There will be an estimation of the exploitation incomes/costs as well. In this way a total estimate of the financial balance can be made. As well as the total amount of emissions and energy which the building required. So in the end there can be concluded if an ice rink can indeed be made profitable and energy neutral.

**Literature and general practical preference**

**Literature:**


achieve more energy efficiency in ice rinks. GEA Grenco BV.


Interview participants:
- Gerwin van Dam (Ice maker/Technical director IJsbaan Twente, Enschede)
- Frank Bongelaar (Ice maker/Technical director IJsbaan de Westfries, Hoorn)
- Johan van der Kooi (Director Elfstedenhal, Leeuwarden)
- Ernst Berends (Cooling installer/researcher in cooling technologies at GEA Grenco)
- Jelle van Beek (Ice Maker Triavium, Nijmegen)
- Bas Symons (Main architect Nieuw Thialf, at Zwarts & Jansma Architects)
- Christian Potma (Flow Motion, Delft)

Dutch case studies (All semi or fully indoors):
- Alkmaar (De Meent)
- Breda (Optisport Schaatsbaan)
- Den Haag (De Uithof)
- Deventer (De Scheg)
- Dronten (Leisure World Center)
- Eindhoven (IJssportcentrum Eindhoven)
- Enschede (IJsbaan Twente)
- Groningen (Kardinge)
- Haarlem (Kennemerland)
- Heerenveen (Thialf)
- Hoorn (De Westfries)
- Leeuwarden (Elfstedehal)
- Nijmegen (Triavium)
- Rotterdam (Schaatsbaan Rotterdam)
- Tilburg (Ireen Wüst IJsbaan)
- Utrecht (De Vechtse Banen)

International case studies (All semi or fully indoors):
- Astana, Kazakhstan
- Calgary, Canada
- Hamar, Norway
- Kolomna, Russia
- Nagano, Japan
- Salt Lake City, USA
- Sochi, Russia
- Vancouver, Canada
Reflection
Relevance
In a world where sustainability and durability is being integrated into several scientific fields, the architectural field plays a highly contributing role. Almost 40% of the emissions produced by human kind is by the building process/building usage. A durable/sustainable building has a minimal impact on the environment, is financially independent and can last with minimal maintenance. An ice rink is none of these things. During its lifetime it will only cost money and energy. It produces heat, which it doesn't use. And most Dutch rinks still use gas to heat their buildings and inner air. Sometimes rinks create permafrost, especially when they are open throughout the whole year. The materials used are chosen for their fast production produced and cheap price, but high in embodied emissions.
Also, the public interest in high speed ice skating as Olympic Sport is decreasing, as well as the interest of the leisure skater to go to an ice rink. The appearance and indoor perception of these rinks for this big target group is not fitting their demands. Due to its high energy consumption and low interest these buildings will be unprofitable their entire lifetime. Which is why I want to research the possibilities in energy-neutral building with ice rinks, as well as making them profitable.

Time planning

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