Die approbierte Originalversion dieser Diplom-/Masterarbeit ist in der Hauptbibliothek der Technischen Universität Wien aufgestellt und zugänglich.

http://www.ub.tuwien.ac.at

The approved original version of this diploma or master thesis is available at the main library of the Vienna University of Technology.

http://www.ub.tuwien.ac.at/eng

MASTERARBEIT

Central Library Helsinki

ausgeführt zum Zwecke der Erlangung des akademischen Grades einer Diplom-Ingenieurin unter der Leitung von

O.Univ.Prof. Dipl.-Ing. William Alsop
E253/4 Institut für Architektur und Entwerfen
Abteilung Hochbau und Entwerfen

eingereicht an der Technischen Universität Wien
Fakultät für Architektur und Raumplanung

von

Jana Bäumker
0527605
Johann-Strauß-Gasse 41/2
A-1040 Wien

Wien, 07. Jänner 2014

Kurzfassung
Entwurf einer Bibliothek für Helsinki
durch Agenten-basierte Simulationen von Nutzerverhalten

Ziel war es, eine Bibliothek auf Prinzipien der Nutzungsweise eines Parks zu entwerfen, eine Bibliothekslandschaft, die eine Vielfalt an räumlichen Qualitäten bietet, auf deren Basis sich durch den Besucher eine Nutzung entwickelt, die jedoch flexibel ist.

Kern des Entwurfskonzepts ist die Wahrnehmung der Bibliothek als ein Ort, der nicht mehr der Aufbewahrung von Büchern dient, sondern eine essentielle und einzigartige Erweiterung an Aufenthaltsraum für die Bewohner der Stadt sein möchte, ein Ort der von allen Gesellschaftsschichten und Menschen jeden Alters besucht und unterschiedlich genutzt wird. In einem Park existieren keine von außen auferlegten präzisen Bereichszuweisungen, was die Nutzung sehr flexibel und zugleich effizient macht, und dennoch findet in einem Park jeder Nutzer seinen *"perfect spot"*. Durch die technologische Entwicklung wird es möglich, dass strikt zugewiesene Nutzungsbereiche in Bibliotheken überdacht werden können, zum einen da viel Material online verfügbar ist, desweiteren da durch Laptops und Tablets auch die Nutzung der Onlinematerialien räumlich flexibler wird. Die Nutzer selbst definieren die Nutzungsbereiche und dies passiert laufend neu und anders. Nutzer finden ihren Platz aufgrund ihrer Kriterien anstelle von vorab zugewiesenen Bereichen.

Dafür wurde in der Programmiersprache processing ein Analysetool entwickelt, das nicht die Analyse räumlicher (architektonischer) Parameter in das Zentrum stellt, sondern die Bewertung dieser durch die Nutzer, die wiederum auch miteinander interagieren. Die Ergebnisse der Analyse können in der folgenden Entwurfsoptimierung verwendet und interpretiert werden, um die im Konzept festgelegten Ziele der Reduzierung nicht genutzter Bereiche und der Förderung von Bereichen großer Nutzungsvielfalt zu erreichen.

Abstract
Central Library Helsinki
agent-based simulations of user behavior informing the design process

My design is based on the idea of a park. A park does not offer very specific areas nor furniture, yet everyone finds her or his 'perfect spot' for a variety of different tasks without the necessity of any signs or restrictions.

Assuming that a library is not anymore a storage for books but an essential and unique extension of recreation space for city's residents. Technological developments allow to rethink the system of strict space reservations for specific tasks, a lot of material is available online and laptops and tablets make the use of it even more spatially flexible. The users themselves define the usage areas and they define it constantly anew, they find their 'perfect spot' according to their own criteria instead of predefined areas.

To help with the design and analysis of these spaces an analysis tool has been developed in processing. The program does not focus on the analysis of spatial (architectural) parameters, but on their evaluation by the patrons and the patrons' interaction with each other, the results inform the following design optimization towards the predefined design aims, the reduction of spaces that are not being used and the creation of spaces with a high variety of uses.

Acknowledgments

Ich danke Prof. William Alsop für die inspirierende Betreuung meiner Diplomarbeit. Ich danke meiner Mutter für die bedingungslose Unterstützung während meines gesamten Studiums sowie meinem Vater, Oma, Wolfgang und Dominik Mann. Desweiteren möchte ich mich bei Katariina Knuuti, Natalia Dziadus, Alexander Hammerschmied, bedanken und den KollegInnen aus dem Arsenal für die schöne Zeit.

Structure of the book

The first chapter gives an overview on the topic of the library, its significance and function for society as well as its development over the centuries, followed by the description of the Seattle Central Library as a reference project.

This leads to the definition of my design aims in the second chapter and the description of the design method (program) developed to achieve these. This chapter includes the structure of the program as well as the instructions for the application of the program in the design process.

In the third chapter, the design strategy developed in the previous chapter is presented on: The design of the Central Library Helsinki.

The fourth Chapter describes the development of the design for the central library Helsinki.

Chapter five and six finish the book with the conclusion and appendix.

Contents

1. LIBRARIES
   - 1.1. The Significance of the Library 9
   - 1.2. The Library through History 11
   - 1.3. Reference Project: Seattle Public Library, OMA 15
2. DESIGN OBJECTIVES
   - 2.1. A Library like a Park 21
   - 2.2. Design Strategy 23
   - 2.3. Functioning of the Code 25
   - 2.4. Application of the Code 38
3. DESIGN CONTEXT
   - 3.1. Finland and Helsinki 40
   - 3.2. Planning Area 43
   - 3.3. Urban Fabric and Surroundings 47
4. DESIGN DEVELOPMENT
   - 4.1. Design Concept 51
   - 4.2. Cubage | Integration in Urban planning Context 53
   - 4.3. Transport Connection 59
   - 4.4. Spatial Program 60
   - 4.5. Analysis 1 62
   - 4.6. Analysis 2 68
   - 4.7. Analysis 3 74
5. DESIGN DESCRIPTIONS
   - 5.1. Arrangement of the Functions 81
   - 5.3. Structural System 118
   - 5.4. Façade 121
   - 5.5. Sight Fields 124
   - 5.6. Materiality + Color 125
6. CONCLUSION
7. APPENDIX

1. Libraries

1.1. THE SIGNIFICANCE OF THE LIBRARY

Will there be libraries in the future?

Numbers of online borrowing are increasing, as more sources are available online and e-book reader's usage is also on the rise. This development makes the future of the library often being questioned. Why should it be necessary to have a special location for information that is easily accessible from anywhere?

It is obvious that people asking these questions have not understood the true function of a library. A library nowadays is more important than ever. Society is constantly experiencing changes and so does the library.

Library+city

The perception of the city is changing, as new qualities of urban space are being experienced. It is about becoming conscious of the city, as a part of its identity, feeling as an inhabitant of the city, being aware of others. Still, many cities lack one important element: non-commercial public spaces. In summer, city squares and parks are habitually occupied and used by the city inhabitants; the lack of non-commercial indoor public spaces in winter remains a neglected area. Libraries remain as one of the only such spaces.

Library+society

"The Great Good Place" describes the library as "the

heart of a community's social virtuality and the grassroots of democracy" because it is seen as a place where people can gather and put aside their concerns of work and home and gather together simply for the pleasure of good company and lively conversation. But the importance of the library stretches even further because it plays a crucial role in increasing equality in access to information and knowledge. Living in an information age, in order to be able to contribute to society, one must be able to contribute knowledge. City libraries do not function as a storage space for books, their function has always been the collection, processing and provision of information.

Collective+individual

It is certainly true that every day more information is available online, but it would be wrong to assume from this development would mean a future redundancy of libraries. Having a closer look at the library patrons, it becomes obvious that a large amount of them are not using the library for its provision of material, but rather for being in the presence of others. As soon as you enter the building, you become involved with other people and although access to media virtually might be technically sufficient, it does not fulfill all human desires for places of encounter, inspiration, places where one can study or have a good time. Patrons go to libraries in groups and generate conversation or group activities or do not perform any of these things. The presence of others has an undeniable effect, most evidently in the effect of social control in compelling one to study.

"A library is a very specific sort of building. A building where you collectively do something individual." (Arets, et al., 2005, p. 137)

What should be library be like?

Seeing the true function of the library in these cases, it becomes clear, that libraries will not become redundant, instead becoming more important than ever. The library has never had a fixed concept but rather one of constant change. During the last few decades, the function of the library has expanded dramatically, concerning not only the media being offered, but even more importantly the expansion of social functions a library has to cope with. In Scandinavian countries in particular, it has become common since the beginning of the 20th century that libraries act as community centers.

According to Thorauge, the perfect library is a *"hybrid, where virtual and traditional resources replenish each other"; Rem Koolhaas sees its value in "providing assistance" and "completeness"*. Maybe it is all about offering openness and flexibility to the patrons and giving them the opportunity to bring new uses to the space. This way, the library will never be out-dated.

1.2. THE LIBRARY THROUGH HISTORY

Development and changes in library typology

The library's original function is clearly connected to the book. One must acknowledge however, that today the word 'library' describes either the room or building in which a collection of books is kept, as well as the collection itself. Yet there is no true library typology. Instead over the centuries the typology of the library has experienced strong influences and alterations. The importance of the book in the library in relation to the reader or additional functions has changed, but these changes are a reflection of the correspondent Zeitgeist and developments in society. In the following I would like to analyze these typologies and show the variety of libraries and their expressions.

The first library arrangements belonged to monasteries or universities mostly in England and France and go back to the Sorbonne, the college of the University of Paris. Here the books where chained to lecterns situated near a window for sufficient daylight. Later shelves above the lecterns were added to form a kind of alcove; this became known as the stall system and was mainly used in England in the 14th and 15th century. Fundamental to this arrangement is the space devoted to the reader.

During the Renaissance, a new type of library arrangement was developed: the Wall System or Saal-System. While the space itself was left mostly empty, books were stacked against the walls and ornamentation and decoration became important. The library of El Escorial (architect Juan de Herrera, 1567) is one of the first examples of this type. It became popular in the 17th and 18th centuries mostly in southern Germany, Austria, Italy and Spain (e.g. library of Melk Abbey, Jacob Prandtauer, 1730; Hofbibliothek in Vienna, Fischer von Erlach, 1726). In England, a combination of the medieval stall system and the wall system was introduced by Christopher Wren: Longitudinal rooms with wall-shelving and occasionally galleries to use the space efficiently became the standard up to the middle of the 19th century (e.g. Playfair Library Hall in the University of Edinburgh, William Playfair, 1827).

As the number of books increased excessively in 19th century, wall space was not sufficient anymore and a new arrangement system was developed: The three-zone separation separated the reading space from the stacking area and the office. This system was to become the accepted organization of library space for an extensive period of time. Examples include the Bibliothèque Nationale in Paris (Henri Labrouste, 1868) and the

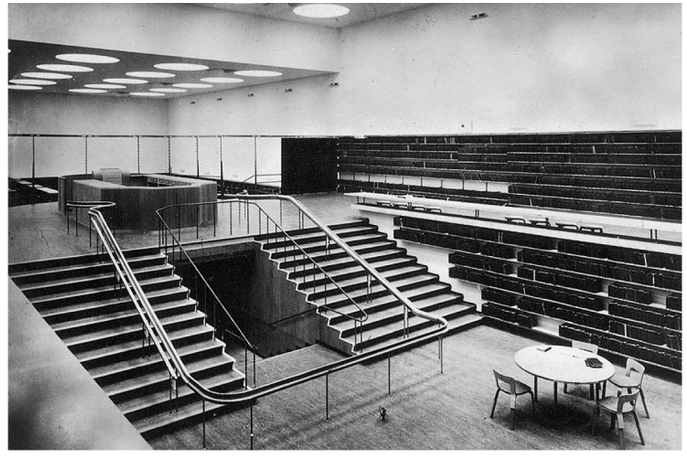


fig. 2.1 Library Melk Abbey, Jacob Prandtauer, 1730
fig. 2.2 Library Viipuri, Alvar Aalto, 1935

British Museum Library (Sydney Smirke, 1857). In this typology the importance was again given to the reading space as it was in medieval times, with the reader now being surrounded by a selection of the library's books.

In the following century, many libraries were built by either on the initiative of the authorities or financed by philanthropic organizations. Libraries always carried an enormous social potential and this is why, as an example in the Netherlands, many libraries were built in the early 20th century as a result of the socialist fight for workers' emancipation. These library buildings which were centrally located and appealingly designed, often acted as community centers. Furthermore, in Scandinavia, libraries became important and everyday places in the community. The Stadsbiblioteket in Stockholm, Sweden (Asplund, 1927) consists of a circular reading room surrounded by a continuous wooden circle of books. The Municipal Library in Viipuri, Finland (Alvar Aalto, 1935) consists of connected spaces structured by differences in the floor level. Both libraries *"express the openness and democracy which would be demanded by modern society in the decades to come"*(Living Library, Wiel Arets, p.212).

A new approach in library building was the Centre Pompidou in Paris (Rogers and Piano, 1976): Designed as *"approachable, flexible and multifunctional", a "cultural department store"*, oriented on mass consumption. Recently built (public) libraries can be seen as continuation of this development, emphasizing their dedication to the information society.

Rem Koolhaas sees a future only for the library that *"transforms itself wholeheartedly to aggressively orchestrate the coexistence of all available technologies to collect, condense, distribute, read and manipulate information". Rather than being a space to read, the library is transformed into „a social centre with multiple responsibilities"*. He claims to express this principle in built form in his Seattle Public Library (2004) (Arets, et al., 2005, p. 212).

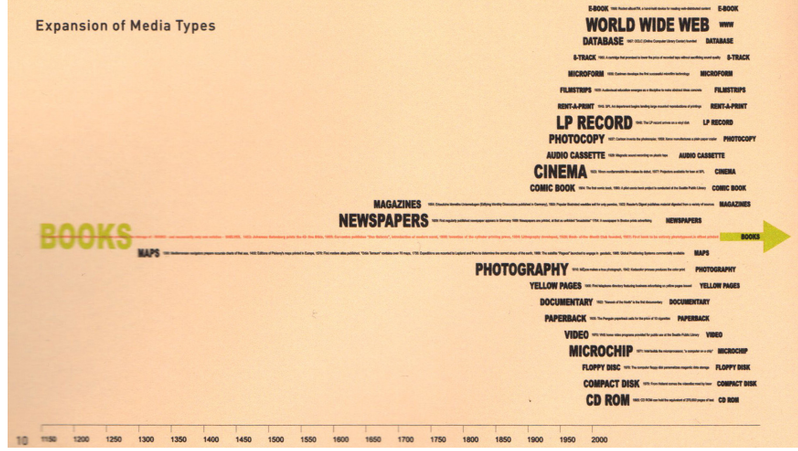


fig. 2.3 Seattle Public Library

fig. 2.4 Expansion of Media Types

1.3. REFERENCE PROJECT: SEATTLE PUBLIC LIBRARY, OMA

| General information:
| Project: Seattle Central Library
| Client: The Seattle Public Library
| Completion: May 23, 2004
| Bid Cost: $111,9 million

Program: 38.300 m² central library, including 33.700 m² of hq, reading room, book spiral, mixing chamber, meeting platform, living room, staff floor, children's collection and auditorium and 4.600 m² of parking

Architect: OMA|LMN
(Kubo & Prat, 2005, p. 160)

"Our ambition is to redefine the Library as an institution no longer exclusively dedicated to the book, but as an information store where all potent forms of media - new and old - are presented equally and legibly. In an age where information can be accessed anywhere, it is the simultaneity of all media and, more importantly, the curatorship of their contents that will make the Library vital (Kubo & Prat, 2005, p. 11).

I selected the Seattle Public Library by OMA as a reference project because in this project, OMA addresses important questions of how and what a public library in our time should be like.

One of the addressed issues is the expanded spectrum of library functions. Koolhaas has been criticized for his idea to *"redefine the library as an institution no longer exclusively dedicated to the book" (Kubo & Prat, 2005, p. 57), but he says "technology is not a threat, but it enables the realization of ancient ambitions - totality, completeness, dissemination, accessibility"* (Kubo & Prat, 2005, p. 57).

In the Seattle Public library, only 32 percent of the space is used for books. Many other functions like support, public service and social spaces as well as spaces for other technologies complete the total function of the library and have to be considered as important as the book itself. This is because *"in an age where information can be accessed anywhere, it is the simultaneity of all media and the professionalism of their presentation and interaction that will make the library new"* (Kubo & Prat, 2005, p. 63).

Concept & Organization

The Seattle Public Library is not only well-known for its outstanding form but also for its interior organization, mainly the book spiral. This idea is based on an experiment Joshua Ramos of OMA and a colleague carried out in several libraries: seeking a book and a federal document and mea-

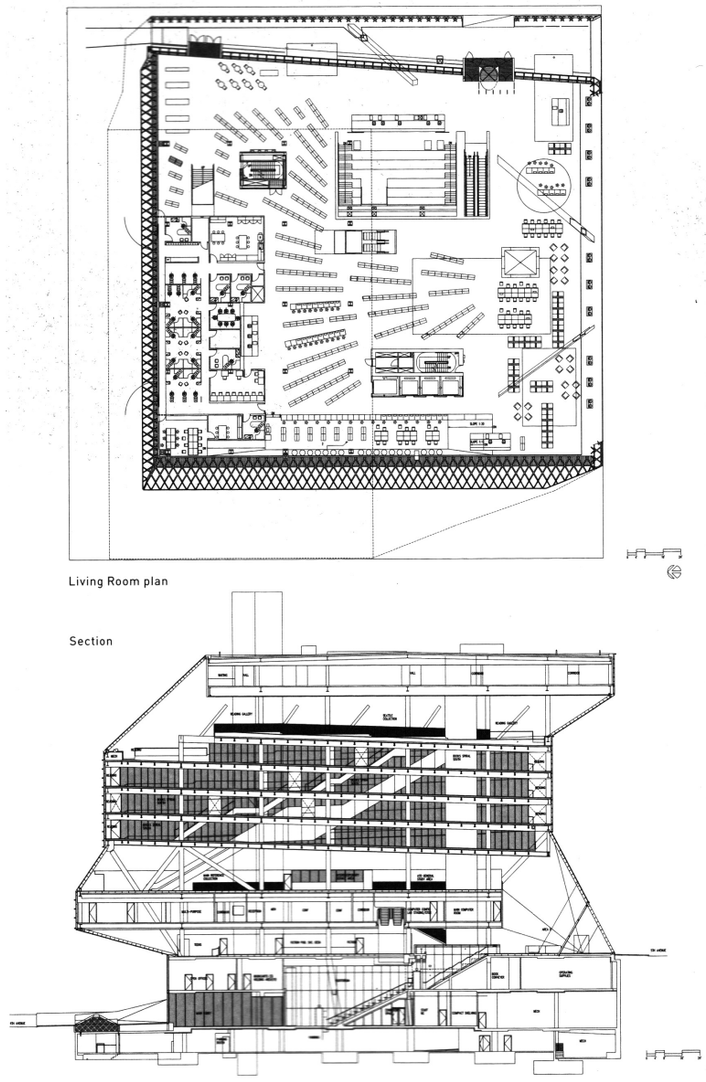


fig. 2.5 Seattle Public Library, Living room plan and section

suring the number of steps it would take them to obtain the book. The results indicated that it took them on average six steps, librarians in one part of the building led them to librarians elsewhere and often books had been hauled away from the main stacks because space had run out. (Kubo & Prat, 2005, p. 59)

OMA's answer to this problem was changing the organization of the library's room schedule: instead of innumerable small functions, the functions were grouped to programmatic clusters, five of *"stability", four of "instability."Stable spaces" are spaces equipped for a specific performance, like parking, staff, meeting, the collection and the headquarters, and "unstable spaces"* as trading floors for information and stimulation as well as contact between the patrons and librarians. (Kubo & Prat, 2005, p. 26)

The book spiral

Most important to this clustering was the merging of the different sections of the book collection which is expressed in space by the continuous book spiral. The usual arrangement of a collection on different floors forces the collection to be divided into sections. But it is impossible to predict how parts of the collection will grow or shrink over the years. As floor plates become overcrowded, materials are dissociated from their categories and move to unconnected floors. For example in the basement or off-site storage which leads to further reduction of legibility and the destruction of the systemic logic. By avoiding flat floors, and arranging the books on the continuous book spiral it gives the different sections of the collection the possibility to expand or contract without destroying the logic of the Dewey Decimal System, thus enhancing the *"totality, legibility, completeness"* (Kubo & Prat, 2005, p. 121). If a section grows too big, it compresses the section above and below it along the ramp, as there is no separation through stairs, escalators or elevators.

At the gateway to the joined collection in the book spiral is the Mixing Chamber, where librarians provide efficient and interdisciplinary assistance instead of having specialized librarians within every section. It is through a combination of services of General Information and Subject Specialties that librarians can consult with colleagues via wireless devices. This requires no travelling from one area to the next and the repetition of inquiries is avoided.

Form + Construction

boxes do not align vertically, thus creating a polygonal form together with the glass-steel facade wrapped around it. The iconic geometry developed from light conditions required for the interior (daylight and shade where it is desirable) and

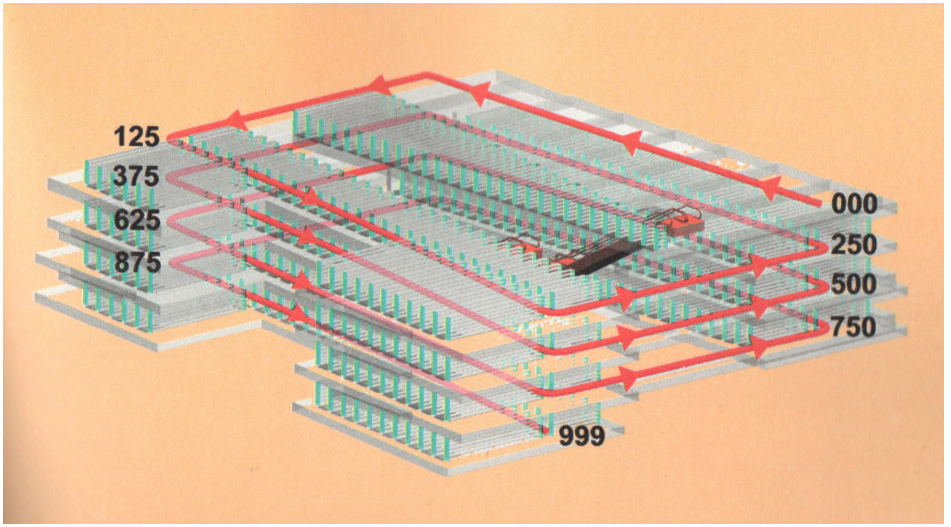
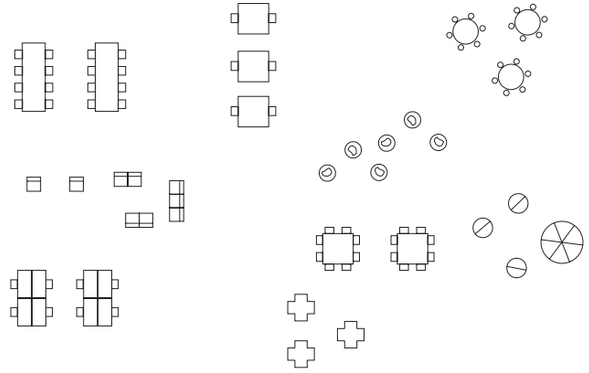


fig. 2.6 bookspiral

the building's context (views) (Kubo & Prat, 2005, p. 31). The twisting motion is being absorbed by the buildings' central core, as the gravity loads will be supported by columns and the lattice-like system of steel tubing of the facade handles 90 percent of lateral loads. As the facade grid does not carry gravity loads, it does not require fireproofing (Kubo & Prat, 2005, p. 63). This grid is clad with diamond-shaped glass panels that are double glazed on the sides that are shielded from much of the weather and triple glazed with an embedded expanded metal mesh on the other sides. The metal mesh reduces glare and heat intake by blocking the sun but maintains transparency when observed from certain angles.

2. Design objectives

"Space between things turns out not to look simply empty" (Arnheim, 1977)



2.1. A LIBRARY LIKE A PARK

Conventional Library Design

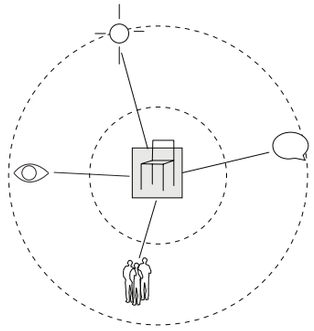
Typical library floor plans consist of spaces that have always a very specific function assigned to them. According to this specific function, the space is also equipped with specific furniture that is considered appropriate for this function.

But this specification of spaces also increases the restriction of alternative uses for the spaces. The use of media in libraries is becoming more flexible. This is because more material and resources are available for access online and that portable laptops and tablets are making the localized desktop computer obsolete in public spaces. Due to this development, it is necessary to think of flexibility in the way we use space and the importance to the patrons of other factors like the space's description and furniture. Furthermore, producing spaces optimized for one function would be excluding other (new) functions. It is worth noting that although pursuing the same task, different patrons might stipulate different spatial requirements.

The perfect Spot

A park is an open space that can be used by a variety of people for different uses. It is not empty of qualities or specifications, but rather it can be interpreted in multiple ways. In a park, everyone locates their own perfect spot. We find our spot by not only considering lighting and the 'furniture' of the park, but rather importantly, by taking into account other people in the park and what takes

fig. 3.1 Park



influence factors defined by architecture
visibility, light, view

influence factors defined by users
loudness,
distance to cirulation areas,
distance to others,
movement of others

finding | defining the perfect spot

Every spot is influenced by its surroundings and their distance.
people define their perfect spot differently, even for the same task.

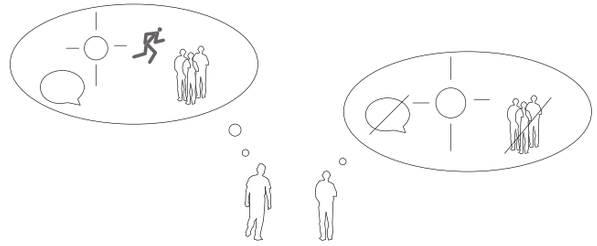


fig. 3.2 influence factors

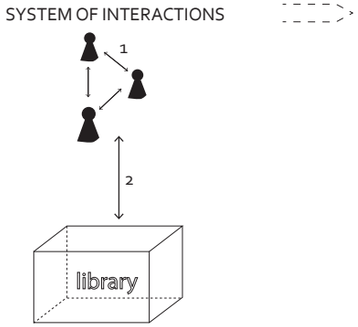
place nearby. Do we want a group of people making music next to us? Do we prefer people reading books around us? What is the perfect distance in between? In the end people will be spread more or less evenly throughout the area without any labeling.
People go to libraries because of the importance of interaction with other people, so why not apply the same mechanisms in open library spaces?

Specification <> flexibility
The aim is to design a library space which upholds the principles of a park, offering a variety of spatial qualities instead of spaces with qualities that are considered best and take only a few specific functions into account. The idea is that by offering the user a greater variety of qualities, they will be given the possibility to find a spot which meets their own personal and unique requirements to a larger extend than in a generalized space, thus producing more contentment and happiness with the space.
If not explicitly needed, spaces will not be separated by walls in order to create a continuous library landscape that offers more open spaces than normal. This will make the library spaces far more flexible and through this flexibility, it will provide efficiency. The patrons define through interaction together how the areas are used and define it every day anew. Because the spaces are not separated from each other, a mixing of uses takes place, but at the same time the space is designed in a way that the patrons do not disturb each other if not intended. No area is completely visually separated, nor completely integrated.

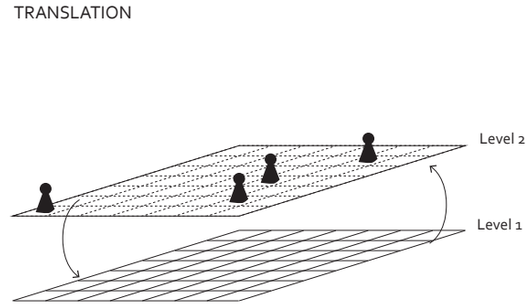
2.2. DESIGN STRATEGY

"Space between things turns out not to look simply empty" (Arnheim, 1977)
The perception of space is not as delimited as it appears in graphic plans. How can the intrinsic qualities be leveraged to design with?

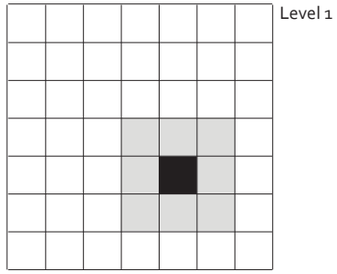
Simulation of self-organization processes
The occupation of open spaces in a library (park) by patrons can be described as a self-organization process. Every user finds their 'perfect spot' by evaluating the criteria of different areas and in 'der folge' also influences their surroundings depending on their own characteristics. Hence the usage of a library can be described as a complexity system par excellence. For the analysis of complex systems, bottom-up models are well suited.



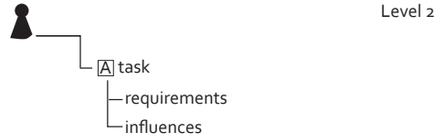
Function of a library consists of
1. interaction of the patrons
2. interaction with the building



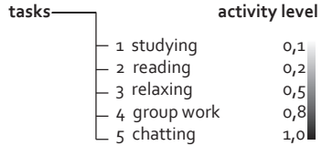
Level 1 | mobile agents | multi-agents system
Level 2 | environment | cellular automata



cell with Moore-neighborhood



Every agent gets an assigned task.



Due to their nature tasks have been assigned an activity level symbolizing their impact on their surrounding in movement and soundscape.

fig. 3.3 functioning of the code - levels of interaction

Bottom-up models aim to explain macro-level phenomena through the rules of interaction of single elements on a micro-level (König, 2010). Models based on bottom-up processes allow the evaluation of the consequences of different designs by means of scenario-models of varying perspectives and timeframes and can thus be employed as a tool to help in decision making and testing several alternatives against each other.
Similar to this idea is the concept of Synergetics (concept by Hermann Haken) as an approach within the theory of complex systems. Synergetics assumes that behaviors cannot be influenced directly but only through alteration of certain framework conditions. These framework conditions can be called control parameters (A Wunderlin 1996 in König 2010). The aim of this methodology is to look for qualitative changes at a macro-level (H.Haken 1996).
For the simulation of dynamics of spatial processes cellular automata and multi-agent systems are employed. They represent two essential components of the system. Cellular automata are being used to represent the environment as a regular grid and are location-bound but can change their status. On a second level we find the individual and collective actors, called 'agents'. Agents can communicate with the cells, evaluate the parameters and choose their location. A system that consists of cellular automata and a multi-agent system is called FACS, (Free Agents in a Cellular Space). (Portugali 2000 in König 2010).

2.3. FUNCTIONING OF THE CODE

Configuration and structure of *"The perfect Spot"*
Based on the previously described concepts, the application *"the perfect spot"* has been developed for the analysis of the usage of open plan areas in libraries and in the evaluation of different design alternatives.
In the first design step, a design concept has to be developed. According to this concept and to the site specific conditions, a cubage providing the necessary areas for the design task has to be developed. This geometry will be loaded into the application representing the environment for the interaction of and with the agents representing the patrons. Each grid cell is of the size 1.2m by 1.2m and has its own properties. These properties are evaluated subsequently and influenced by agents representing the patrons.

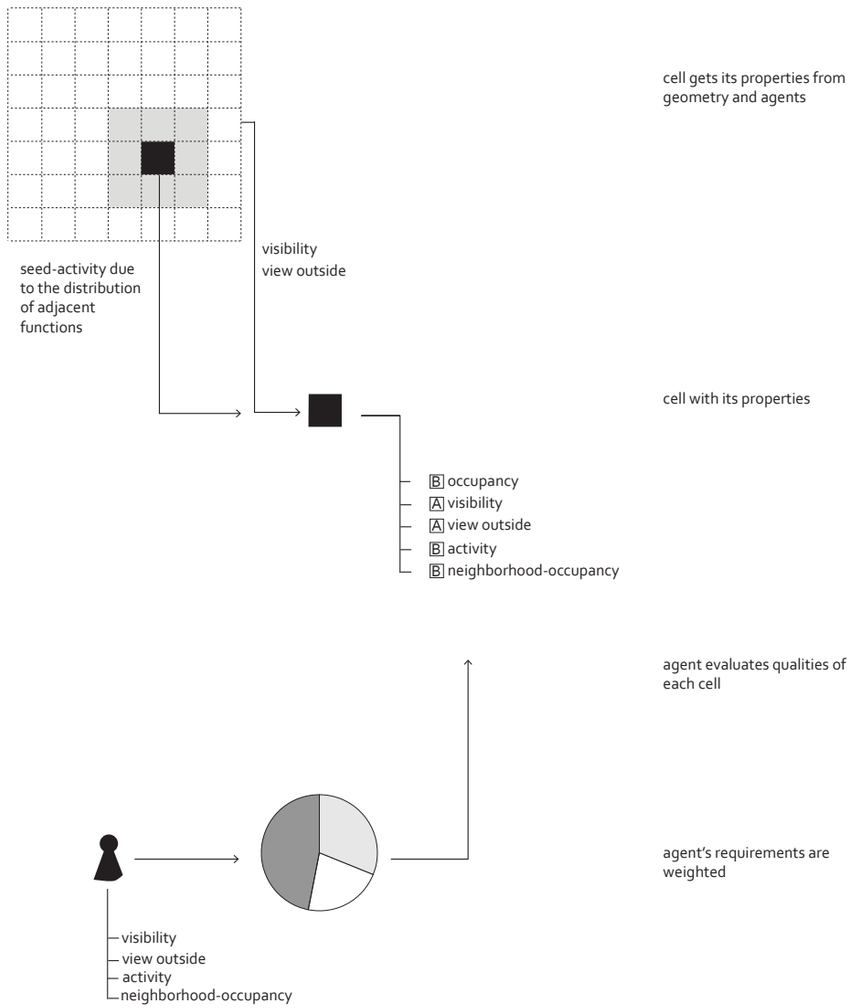


fig. 3.4 functioning of the code - agents evaluating cell properties

Choice of Evaluation Criteria

Without any doubt, there are an infinite number of factors that influence our perception of space. One can identify two groups of different nature, but in order to come to simulations that give us a specific result, we need to keep the model limited to the essential influence factors. The chosen factors belong to two groups: *"primary factors" are defined by the building itself, its layout and geometry, and "secondary factors"* that occur when the building is actually being used, through location-bound functions and the flexible users themselves. Four factors have been chosen: Visibility, view outside and activity and the neighborhood.

As the tasks being executed at a library mostly differ in how much concentration is needed, the concentration needed depends often on how intimate a space feels. A main factor influencing the intimacy of a space is the level of visibility. The view outside also has a strong influence on the perception of space, which can, depending on the executed task, either be positive or negative in the sense that it might divert attention.

Activity symbolizes the influence of others in creating different levels of noise and distraction. Functions that are presumed to act as attractors within the library landscape thus constantly create a certain noisiness which will create an initial 'activity level' (which can also be considered a 'seed value' having an impact on the following simulation). This initial state has to be evaluated by the agents and will subsequently be influenced according to their choice of location and task.

Crowdedness in the area is considered based on the assumption that people go to libraries because of others and usually do not prefer the completely deserted areas, but also areas if they consider them to be overcrowded.

User Preferences

Agents symbolizing the 'perfect' patrons of the library evaluate the given parameters of each grid cells and choose the one that fits their preferences best. Every agent gets randomly assigned one of 5 tasks that are considered typical to be executed at a library: 1_studying, 2_leisure reading, 3_relaxing, 4_group work, 5_chatting. The task defines the agent's preferences, but not explicitly, as it only defines a range that the agent selects its preferred value from, thus maintaining its individuality. What the task defines explicitly is the agents influence value, increasing from task 1 to 5, describing the extent of activity with which the agent is influencing its neighborhood.

Creation of the Agents

The analysis is based on the course of a day at the library, which is displayed by a timer in the upper right corner of the user interface counting from 08.00 to 22.00, which are exactly the opening

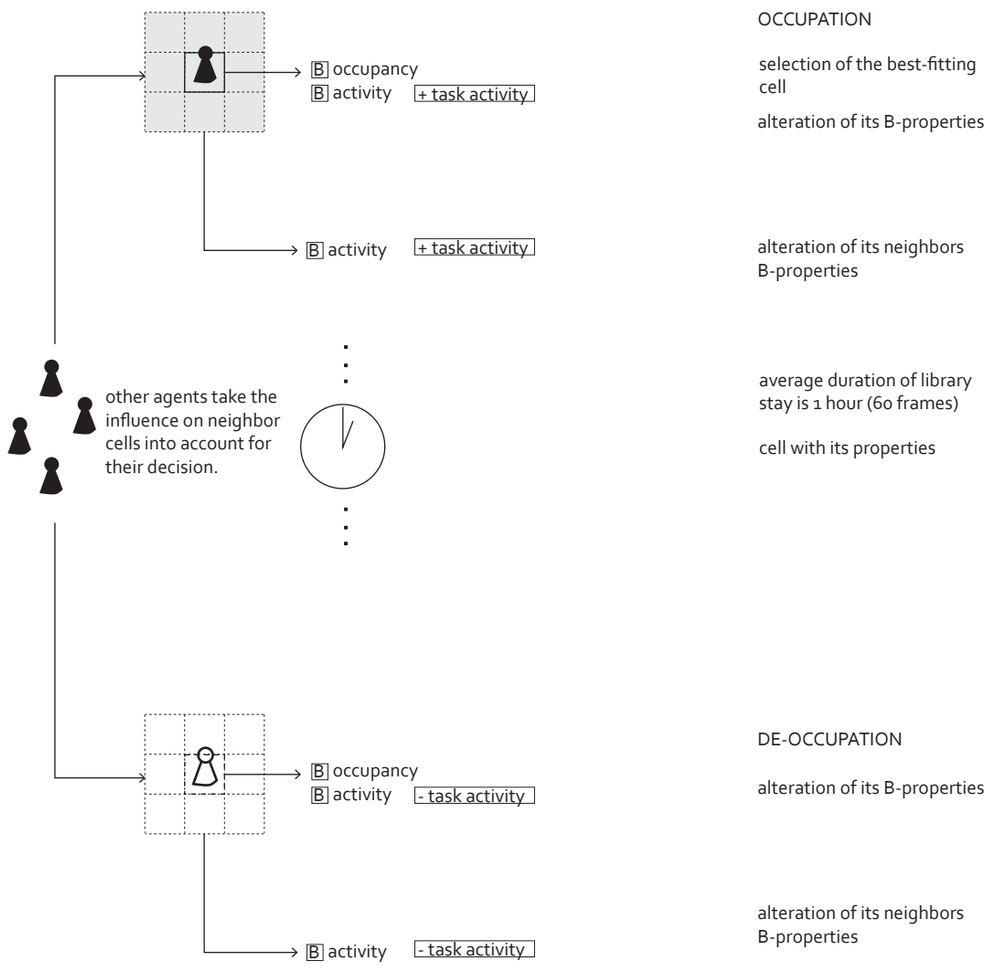


fig. 3.5 functioning of the code - process of occupation and de-occupation

hours of the library in Helsinki according to the design brief. It also states that about 5000 patrons are expected at the library each day. According to analyses of library usage (http://www.b-i-t-online.de/archiv/2006-01/fach2.htm), users stay at an average time of 60 minutes and the peak usage time in the number library users is around 3pm. Based on these factors and a normal distribution curve which approaches the curve in the given analysis, the number of agents that are to be created at each time step is calculated. Each agent remains in the system for 60 time steps (minutes) and maintains its influence on the system during this time, which is then again being considered by other agents created during this time in their evaluation, thus simulating the system of interaction between the agents. Afterwards its influences are reset.

Neighborhood

The influence of an agent is applied on the so-called Moore-neighborhood, which includes a cell's neighbor that shares an edge with it in addition to the cells on the corner. A Moore-neighborhood can therefore consist of 8, 24 or more cells, in this case only the direct 8 surrounding neighbors are being influenced.

Placement of the Agents

Each agent compares his values for every requirement to the values of each grid point that is not occupied. The maximum points for matching values points to the larger the difference between the required value and offered value is, as each parameter is weighted by a predefined factor that resulted from different program tests that can be influenced by the user.

The agent always selects the grid point that matches his requirements best and changes its occupation parameter to 'true' which influences the activity parameters of the surrounding grid points according to the agents' assigned influence factors.

Manipulation and Verification

To confront the accusation of manipulation and exclude the possibility that one factor might be overruling of the others, a weighting system is introduced and adjusted until the most suited combination of values is found.

The current weighting factors have been selected because the simulations show distribution behaviors that seem realistic: Agents tend to occupy the smaller space rather in groups instead of alone. This also leaves spaces free to prevent spaces from becoming overcrowded. We find agents tend to choose spots close to other agents of the same or a task similar to their own in activity levels. Activities pulsate around seed-activity attractors and spread from there. New activity groups

tasks

fig. 3.6 functioning of the code - tasks and preferences

appear and disappear. The result also produced by applying the same input factors never show the exact same result but always prove the same statement. Naturally this is only a model and needs to be verified in a real built environment and adjusted according to the results.
It is import to mention that the design task is not handed over to the program. Instead, the program is being used as an analytical tool informing the design by indicating strengths and weaknesses and leaving decisions in the hands of the designer.

As I declared, my aim was to create a landscape of varying qualities and a space that can be used for different activities. The areas with no occupation at all represent a weakness as well as the areas being used for the repetitive same task: showing the areas where the design needs to be improved.

Further explanation on the methods applied in the code

visibility analysis
Every grid point gets translated in the z-direction to reach *"eye-height"*, and builds a connection to every other grid point. If the connection does not intersect with any of the loaded geometry meshes (slabs, walls). The visibility from that point and to that point is being assumed at the end of the analysis as a visibility factor between 0 (least visible) and 10 (most visible) which will be added to every grid point.

view outside
Around every grid point, a circle of a certain radius is being divided into a certain number of segments defining a number of circle points around the grid point if a connection between the grid point and the circle point intersects a part of the loaded 'wall outside' geometry. If the grid point is situated within the defined distance of the 'wall outside', at the end of the analysis a value between 0 (no view outside) and 10 (every connection hits the 'wall outside' geometry) is assigned to the grid point's view outside the property.

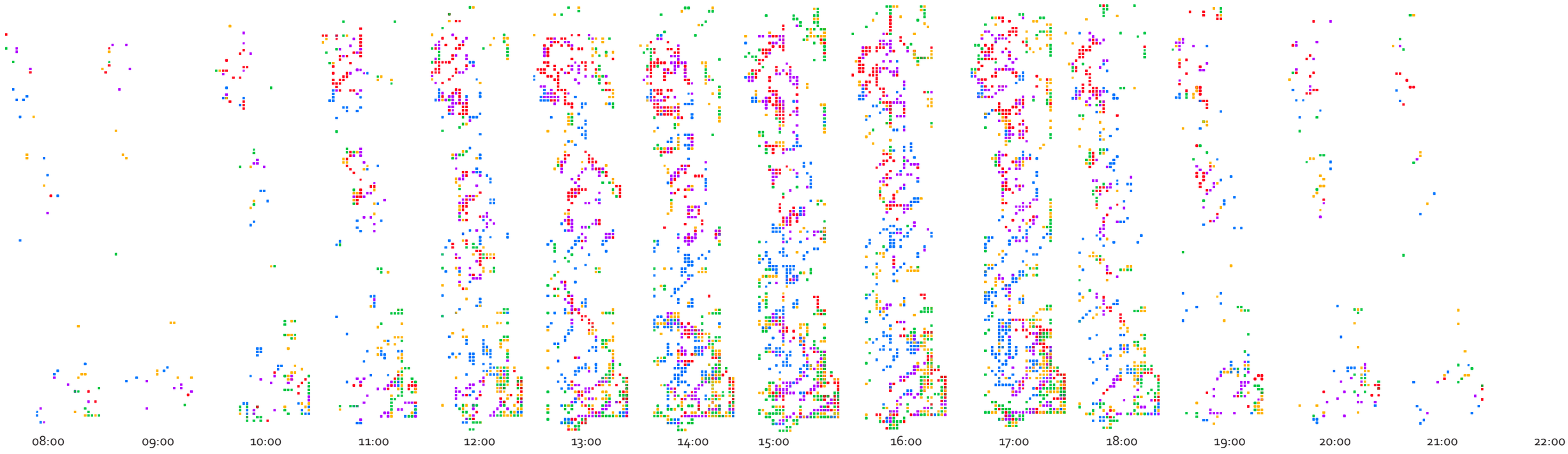


fig. 3.7 distribution of users over the course of a day a the library

Distribution of 5000 users (expected according to design brief) during the course of a day at the library, based on normal distribution curve approaching analyses of library usage with an assumed average stay duration of 1 hour. The colors symbolize the agents' different tasks.

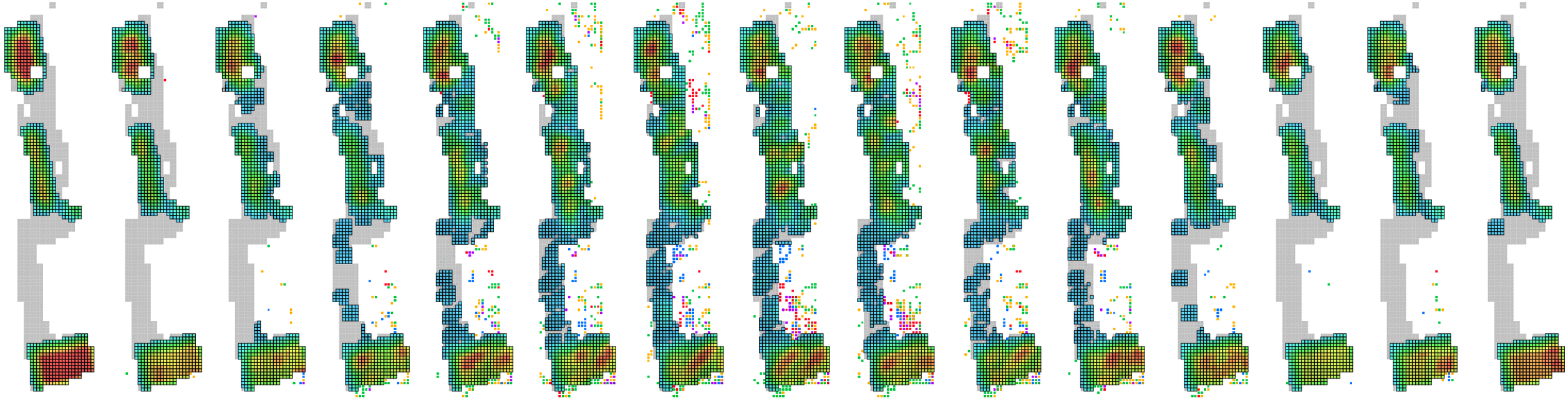


fig. 3.8 emerging activity fields over the course of a day at the library | level 0

Agents first occupy areas where a seed activity is positioned, pulsating activity fields emerge over the course of the day.

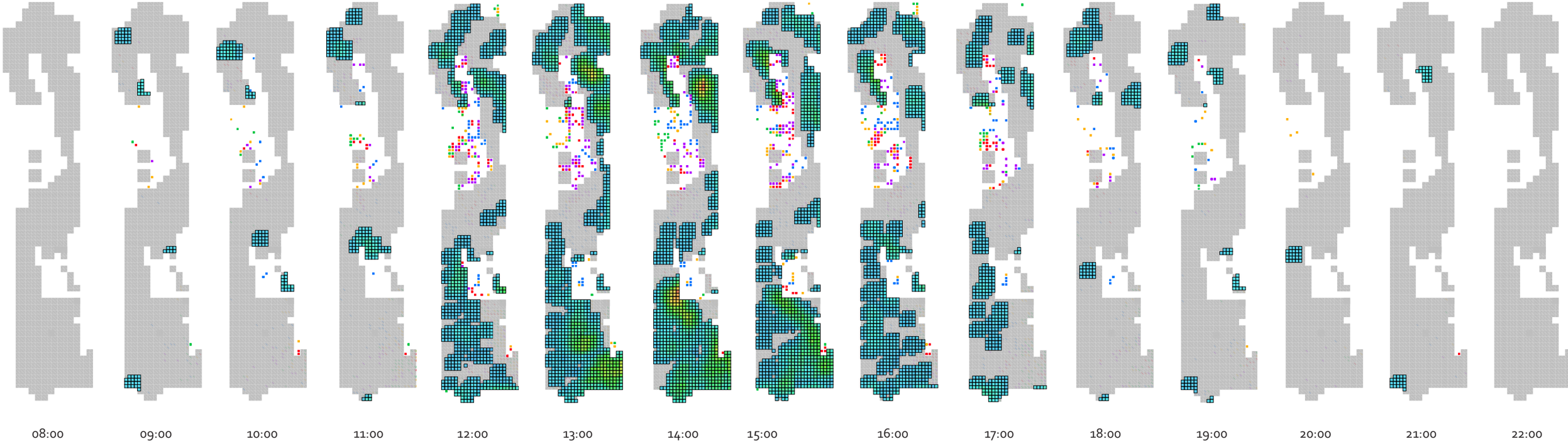


fig. 3.9 emerging activity fields over the course of a day at the library | level 3

In this example, level 3 does not possess any seed activity. Areas where there is no activity at all, are less likely to be occupied. It can be seen, that agents attract other agents and new fields of activity emerge.

2.4. APPLICATION OF THE CODE

Design development strategy

1. concept / site analysis

development of concept and building massing

2. spatial program - division into groups

type 0: non-public
type 1: public, localized by external restrictions
type 2: public, not bound by external restrictions
type 3: flexible spaces

Definition of spaces that act as activity influencing

3. placement of spaces

3.1 placement of space reservations spaces type 0
3.2 placement of spaces type 1
analysis 1
3.3 placement of spaces type 2, placement of freely arrangeable spaces according to the results of the previous analysis.
analysis 2
3.4. optimization of arrangement of spaces type 2,
analysis 3.x
repetition of analysis and optimization until result is satisfactory.

3. Design Context

"The library of the future is a living haven of culture, a hub of knowledge and inspiration. It is a multi-media node that people can access at life's turning points or come to just have a good time, anytime. The library is a fascinating place, wether you are visiting physically or virtually. The library of the furure is all about content. [...] Books are at the very heart of the library and will remain so in the future. The library will be among the first to implement technological innovations. The library of the future is where people come together [...]"
(Mikko Leisti, p.5)

The design strategy developed in the previous chapter is hereinafter being applied for the design of the Central Library for Helsinki.

The design is based on the architectural competition started in 2012, finished in 2013.

3.1. FINLAND AND HELSINKI

Culture + Population

Finland has a population of 5.4 million and is forecast to grow up to 5.7 million (Statistikcentralen, 2013). The proportion of foreigners is about 1% and the lowest in Europe, with Russians, Swedes and Germans dominating this group. Minorities with Finnish nationality are the Finland-Swedes as well as the Sámi (laplanders) and Roma (Iwanowski, 2008, p. 82).

Outstanding factors in comparison to other states in the European Union are its strong economy (Ranked 2nd, World Economic Forum: Global Competitiveness Report 2006-2007) and its education system which ranks as one of the best in the world (IMD World Competitiveness Yearbook 2006, OECD PISA assessment 2000, 2003, 2006) and can also be seen as foundation of Finland's economic success. The school-system features full-time day schools, obligatory free lunch, a good student-teacher relation and valued social workers. 62% of the population have a general qualification for university entrance (Germany: less than 30%), 25% have a university degree (Iwanowski, 2008, p. 85). Especially Helsinki is highlighted as a knowledge hub by the State of European Cities Report (2007) (Leisti, 2013, p. 15). Finland is also leading concerning emancipation and equality.

Helsinki

At the core of Finland's success is in every way Helsinki and its surrounding area, an innovation center built on scientific and artistic excellence, already now producing more than a third of Finland's GDP (Leisti, 2013, p. 16), and with a population 1.3 million that is expected to grow to 2 million within the next 50 years (Leisti, 2013, p. 18).

Many important development projects are taking place at the moment as part of Finnish Government's effort to establish Helsinki as a globally competitive city. Therefore the whole Gulf of Finland region is meant to be developed as an area of high quality working and living, hence investments in information and cultural services play an important role.

But as in other European countries also Finland's population is aging, on the one hand giving more power and influence to senior citizens and on the other resulting in an expected decrease of the Finnish working population of 265,000 from 2010 to 2025 (Leisti, 2013, p. 18). The Finnish Government is seeking to answer this trend with positive net immigration (Leisti, 2013, p. 17) in the future by attracting people from other countries, altogether leading to an increasingly diverse and multicultural society, *"open and tolerant atmosphere and good living and working conditions combined with high-quality educational provision will be key to attracting both home-grown and international talent"* (Leisti, 2013, p. 18).

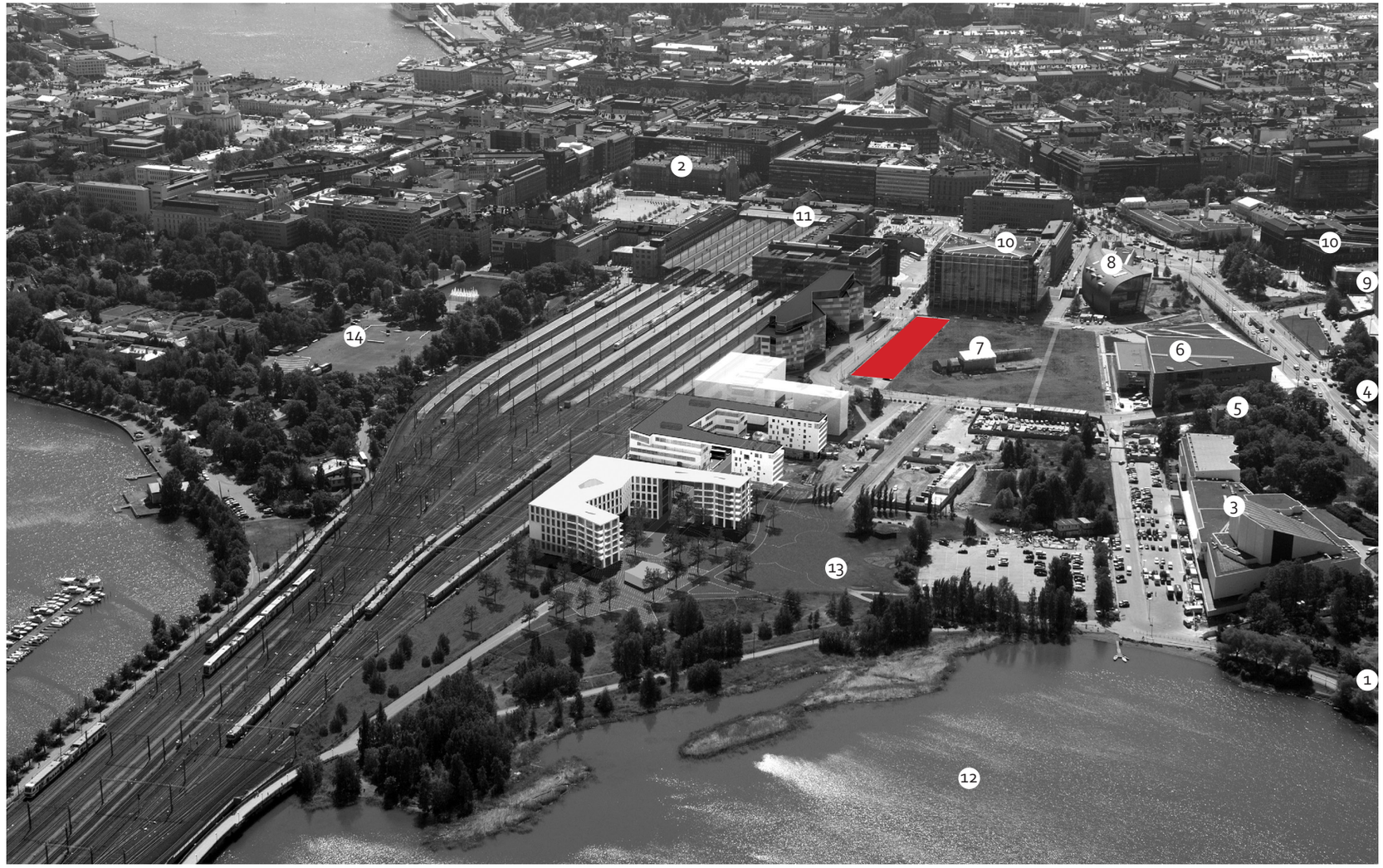
Helsinki - Climate + Light Conditions

Helsinki has a relatively mild climate. compared to other areas in these latitudes the temperatures are as much as 10°C higher in winter. Because of its geographical position, characteristics of both maritime as well as continental climate can be experienced in Helsinki. Depending on the direction of air flow, the temperature is raised by the Baltic Sea, inland waters and airflows from the Atlantic which are warmed by the Gulf Stream. In Helsinki the daily mean temperatures stay below zero during four months of the year, with the lowest daily mean temperatures in February (-4,7°C). Snow covers the city and in sufficiently cold winters Aurora Borealis can also been seen in Helsinki. The lowest temperature ever recorded in Helsinki was -34,3°C in 1987. Spring starts in April with the days growing longer till the second half of June, the highest daily mean temperatures are experienced in July (17,8°C). Evenings grow cold again towards the end of September when autumn starts coloring the Finnish nature in beautiful colors until winter starts in November/ December.

The longest day in Helsinki is June, 21st with 18h 56min daylight time (sunrise: 03:54, sunset: 22:50). The shortest day is December, 22nd with 5h 49min daylight time. (sunrise: 09:25, sunset: 15:14) (http://uk.weather.com/climate/sunRise-SunSet-Helsinki-FIXX0002?month=6 , 2013/04/17)

History + Development of the Competition Area

Helsinki became capital in 1812. Although Turku was bigger and more important at that time, tsar Alexander opted for Helsinki because Turku was too Swedish-oriented and the new Finnish elite should rather be oriented to St. Petersburg than to Stockholm. Hence the university of Turku also had to move to Helsinki and Alexander commissioned Johan Albrecht Ehrenström and Carl Ludvig to develop a St. Petersburg oriented neoclassicist city planning for the new capital. This might have also been the time when Finns first felt as a people with their own culture, history, language and patriotism. The Russian epoch lasted till 1917 when reign of the tsar had collapsed over the October Revolution.
(Iwanowski, 2008)



3.2. PLANNING AREA

Culture

1. Finnish National Opera
2. Helsinki City Theater
3. Finlandia Hall (Congresses & Events)
4. National Museum
5. Hakasalmi Villa (City Museum)
6. Helsinki Music Center
7. Railway Warehouse Ruin
8. Kiasma Museum

Government

9. Parliament House
10. Parliamentary Ombudsman

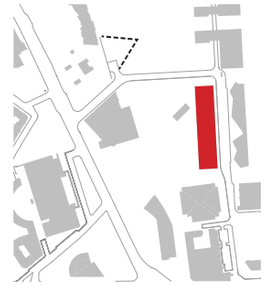
Traffic

11. Central Railway Station / Metro

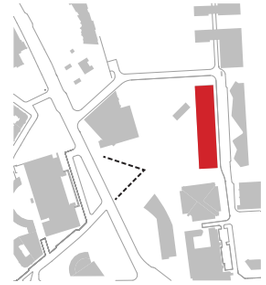
Leisure

12. Töölönlahti Bay
13. Hesperian Park
14. Kaisaniemen Park

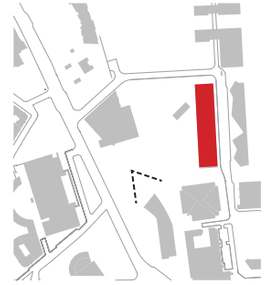
fig. 4.1 aerial view of planning area



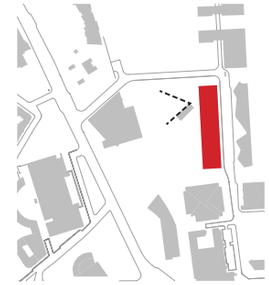
Hakasalmi Villa | City Museum



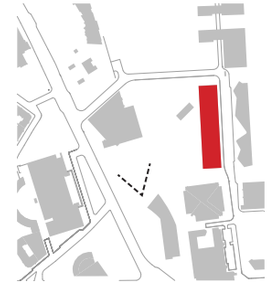
Finnish Parliament



Kiasma Museum of Contemporary Art



Musiikkitalo | Helsinki Music Center



Musiikkitalo | Helsinki Music Center

Sanoma | Office Building

fig. 4.2 neighboring buildings

fig. 4.3 map Helsinki

3.3. URBAN FABRIC AND SURROUNDINGS

The Töölönlahti area is one of the most valuable ones in Helsinki currently being developed, situated at the heart of the city and with provided with an excellent infrastructure and important public functions like the Finnish Parliament, the central railway station, Finlandia Hall and the Kiasma Museum. Despite its closeness to the hectic city center it could maintain a recreational character through being coined by the park and Töölönlahti bay. In the past the area has been used as railway yard. Restructuring of the area started with the completion of the Kluuvi area situated south of the Tölöönlahti area, the buildings were subject to architectural competitions. In 1993 Steven Holl won the competition for the Kiasma Museum, materials used for its facade are aluminium, zinc and glass. Next to it is the Sanoma building, which is owned by Finland's most important newspaper. The building is with its nine levels the highest in the area and is completely covered in glass. Further functions situated south of the library are the Hotel Holiday Inn, Elielinaukio piazza bus terminal and Eliel car-parking garage. In May 2011 the Helsinki Music Center was completed as the first building of the Tölöönlahti area, it is facing the main facade of the central library, its facades are made of glass and copper. The city blocks adjacent to the railways lines are currently under construction. City block no. 2015, direct neighbor to the library along its east facade, is owned by an insurance company and contains office spaces. The design is based on an invited architectural competition from 2011. Towards the north along the railway tracks to similar city block are also under construction, block no. 2016 will contain offices, no. 2017 north of it offices and apartments, block no. 2018 offices and apartments. Apartments will be facing the park side of the blocks as well as cafés and restaurants on ground level.

The design for the public street and park spaces is based on the international landscape architecture competition winning entry "*Secret Gardens*" by Artto-Palo-Kaijansinkko-Rossi-Tikka.

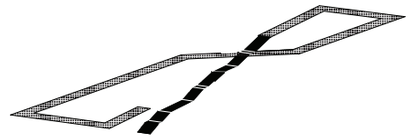
Traffic

Mannerheimintie is one of the most important traffic routes crossing Helsinki in north-south-direction and passes by the Töölönlahti area in the west, the planning area is connected to Mannerheimintie via Töölönlahdenkatu, which forms the planning area's north and east boundaries. Along the east boundaries Töölönlahdenkatu currently forms part of a ramp leading to a car-parking garage and service spaces. This ramp is planned to be replaced by a ramp extending further towards the north and leading to the City Center Tunnel.

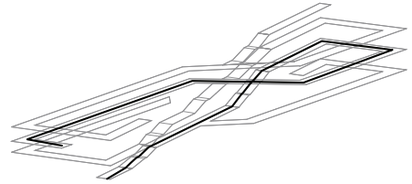
The City Center Tunnel is planned to be crossing Tölöönlahti area in east-west direction, also passing through the planning area. Therefore underground spaces in the south of the city block are to be reserved.

According to the master plan the area is part of the pedestrian center where walking is the main mode of circulation. Bicycling is another important mode of circulation in Helsinki and especially in this area. The main bicycle routes are situated next to the railway lines and along Mannerheimintie road. Further bicycle routes run through the west part of the park connecting Helsinki Central Park to the city center. An important transversal bicycle route using an old railway corridor, called Baana, Helsinki's *"Low Line"*, has been opened in 2012 and connects the Western Harbor area to Kamppi and Töölö bay. The possibility of a bicycle tunnel underneath the railway tracks is currently being examined. Furthermore the central railway station is also a terminus of the Helsinki subway and an important stop in the tramway system.

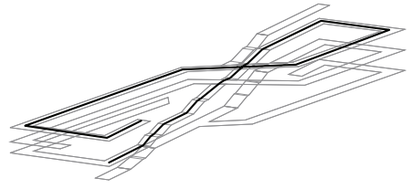
4. Design Development



2 elements: axis + s-shaped floor



circulation paths



circulation paths

fig. 5.1 circulation structure

4.1. DESIGN CONCEPT

The core of the concept is the idea of a library as an important indoor public space for gaining experience of one-self and society. Therefore a circulation system was developed, that encourages the patrons to wander around and experience the landscape, offering a variety of continuous paths through all floors, aiming to make the whole library conceivable.
This is being achieved by a circulation structure based on a lemniscate-like loop composed of two key elements: On the one hand an axis of vertical circulation containing generously proportioned stairs that also function as stepped sitting areas and elevators, and on the other hand s-shaped floors that intersect the axis and connect at their ends to the circulation axis thus completing the loop.

The direction of the axis of vertical circulation is diagonal to the building site's boundaries and runs from south-east to north-west. This corresponds to the unique location of the building in the cross field between the city in the south-east and park to the north-west. Main element of the axis are the stairs and stepped planes all inclining towards the bay and thus emphasizing the long view which is usually rare in cities. The direction of the axis is also founded by the intrinsic dichotomy of the stepped planes: While the ascending steps emphasize the view on the other patrons and library space in direction of the city and hectic central station, the descending steps let the stair area itself in the field of view shrink and put the view to the park and nature in the center of the field of view thus offering relaxation.
Having the vertical circulation elements organized in one strict axis for easy orientation allows to have the floors areas meandering around this axis thus creating varying experiences in both spaces. The s-shaped floors intersect the vertical axis in the middle zone of the building creating an intercommunion area of mixing and high activity. Function spaces are distributed throughout all floors, encouraging to new discoveries along the paths.

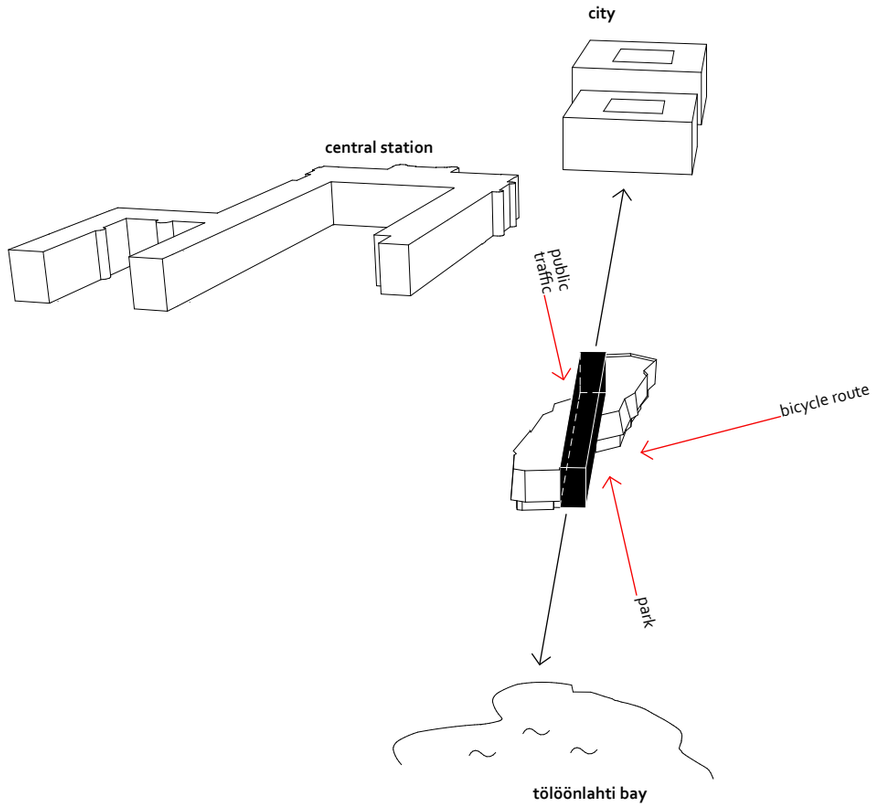


fig. 5.2 design concept

4.2. CUBAGE | INTEGRATION IN URBAN PLANNING CONTEXT

As the buildings' axis is diagonal to the building site, it forms part of the northern part of the west facade as well as the southern part of the east facade. This does not only make the concept's key element and direction of internal organization perceivable from the outside, but as the direction of the axis is also the direction of connection between the city and the park, it also leads people approaching from the park or the central station along its facades directly to the two main entrances opening up to one common entrance area in the middle of the cubage. Furthermore the axis facade part of the west facade is parallel to the facade of the Helsinki Music Hall which faces the facade on the other side of the park.

The other facades make reference to the lines of the masterplan and neighboring buildings but play about this orientation with soft creases of the facade in order to contrast the severity of the axis and achieve an easing to the surroundings. The directions of the segments of the folds refer to important visual connections in the surroundings framing these views for the patron inside the building and creating a dialogue with the neighboring buildings.

The building height adapts the masterplan and the surrounding buildings except for the southern end of the axis which surpasses the height of the adjacent office and residential building. This seems justified given the important public function of the library. Furthermore the surpassing leads to making the axis as the connecting element between park and city become readable from the outside as a descending element which finds its continuation on the northern part of the axis. Additionally the rooftop offers descending sitting areas which offers through the surpassing a impressive view over the library itself in combination with the Töölöönlahti bay and park.

The combination of the two conceptual elements, the axis and the s-shaped intertwining slabs, results in a waisting in the buildings' cubage as the vertical circulation axis is diagonal to the site and the building contours are align partly to it. This waisting structures the extreme length of 150 meters of the building massing and enunciates the main entrance areas, the withdrawal from the streetline Töölönlahdenkatu (street) creates a small entrance piazza and in the west the kink is giving space to the open plaza in front of the library by extending it in direction of the extension of the main arrival directions, the cycling route by the parliament as well as the approaching direction from the park.

URBAN PLANNING CONTEXT

The buildings' axis is diagonal to the building site emphasizing the direction of connection between the city and the park and leading people approaching from the park or the central station along its facades directly to the two main entrances opening up to one common entrance area in the middle of the cubage. Furthermore the axis facade is on the west facade is parallel to the facade of the Helsinki Music Hall which faces the facade on the other side of the park.
The other facades make reference to the lines of the masterplan and neighboring buildings but play about this orientation with soft creases of the facade in order to contrast the severity of the axis and achieve an easing to the surroundings.

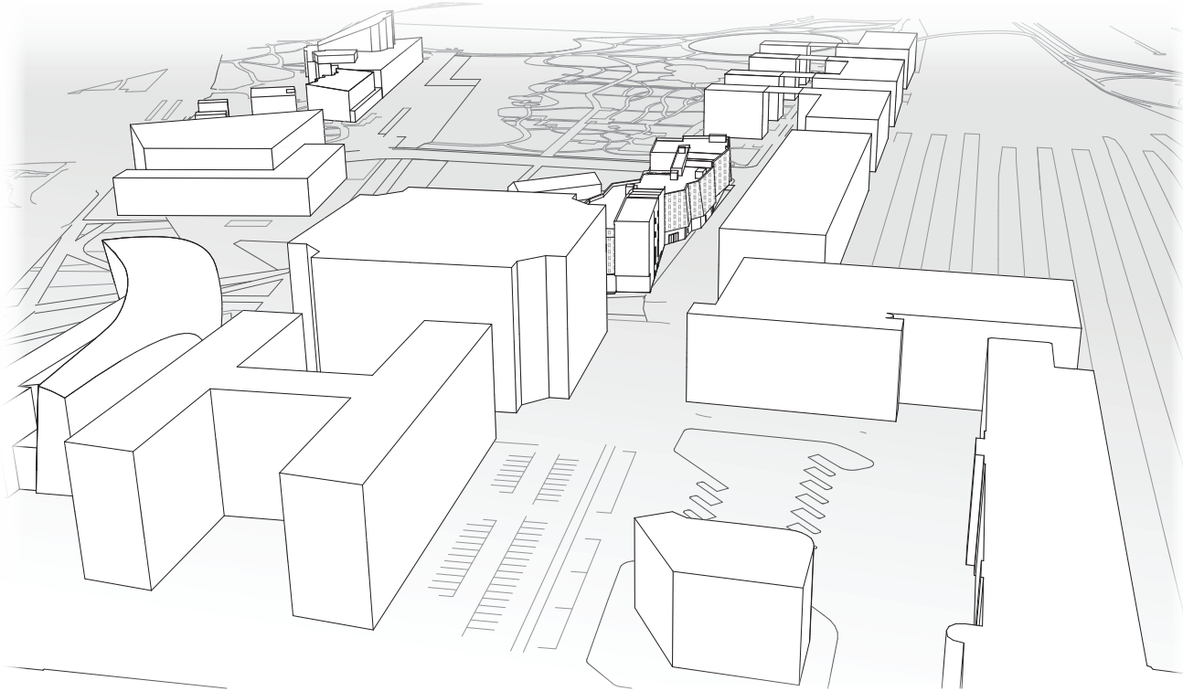


fig. 5.3 building context - view south-east to north-west

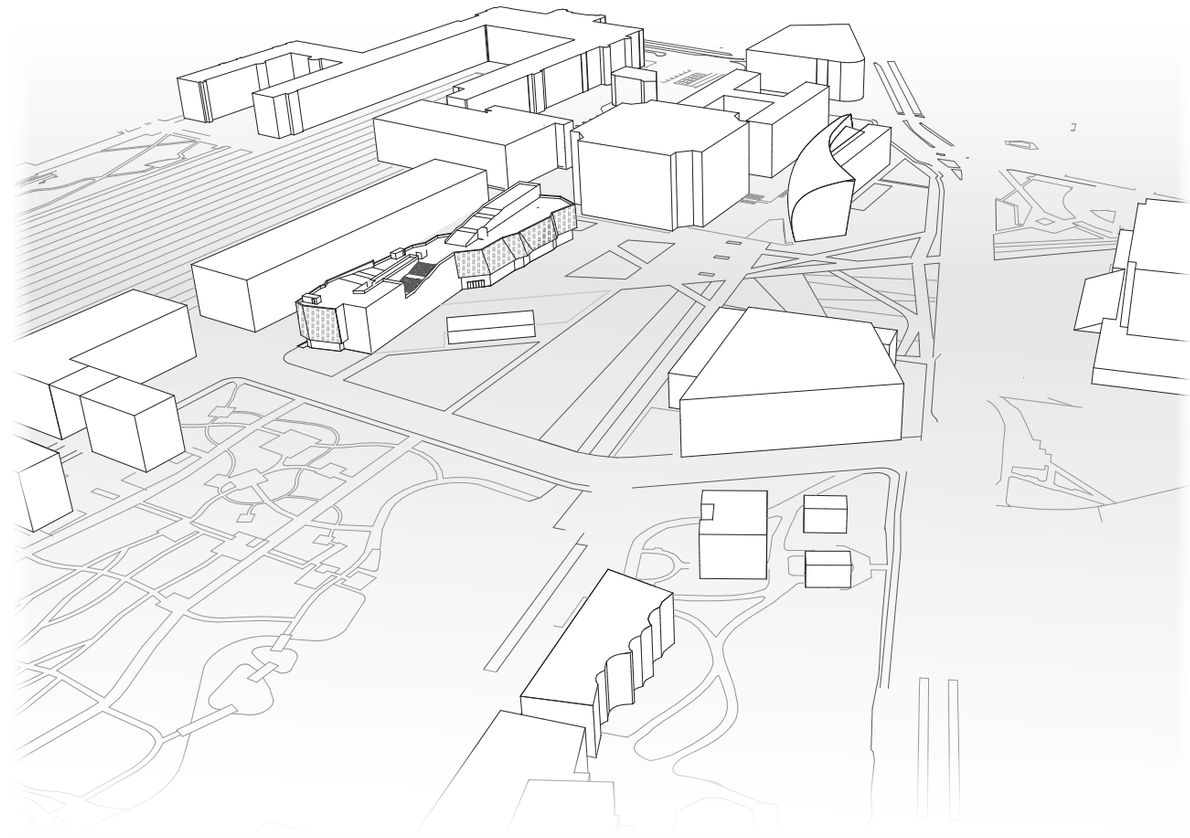
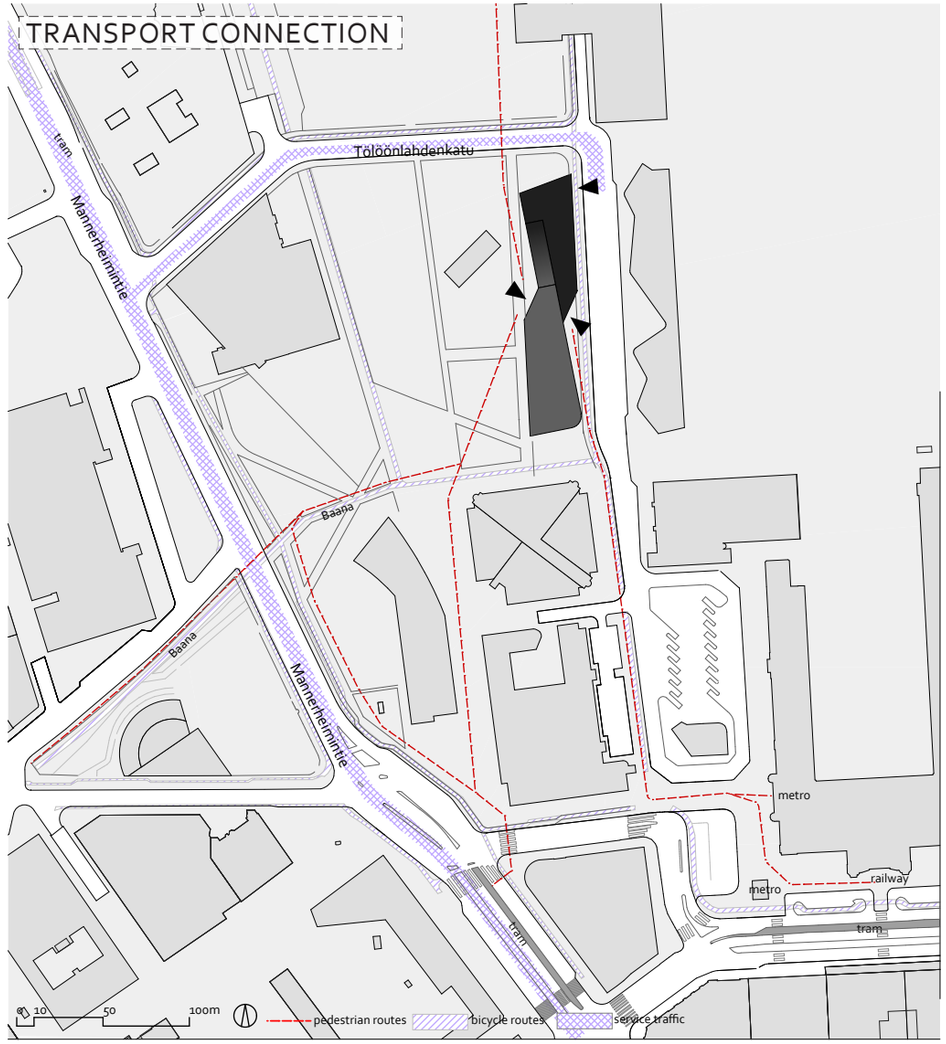


fig. 5.4 building context - view north-west to south-east

fig. 5.5 visual connections

The directions of the segments of the folds refer to important visual connections in the surroundings, framing these views for the patron inside the building and creating a dialogue with the neighboring buildings.



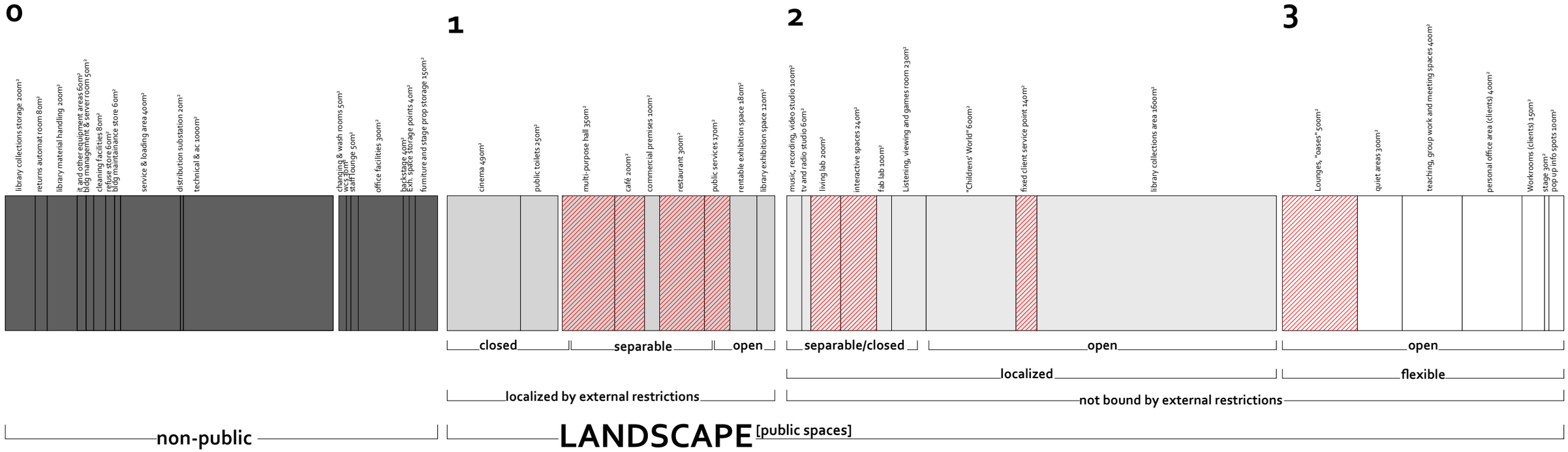
4.3. TRANSPORT CONNECTION

The library is situated in a pedestrian area with a very good connection to the public transport system. Therefore there are three main arrival directions: 1. Patrons arriving from the south-east coming from the city center, railway, tramway or metro station situated there, the withdrawal from the streetline in Töölönlahdenkatu will guide them directly to the entrance on the east facade facing the direction of the railway station. 2. Patrons arriving by tramway or by foot via Mannerheimintie or by bike via the Baana, Helsinkis most important bicycle route, will use the entrance on the west facade, situated at a kink in the continuation of the Baana. 3. Patrons arriving via the park will also use the entrance on the west facade which faces the park.

Service traffic accesses the library via Mannerheimintie and Töölönlahdenkatu using the service traffic ramp starting at the north-east corner of the building giving access to the service and material handling spaces in the basement.

4.4. SPATIAL PROGRAM

The spatial program is divided into groups according to the function's restrictions and flexibility. The assigned group defines the order in which the functions are going placed in the design concept, e.g. analysis 1 will include only functions of groups 0 and 1.



type 1: space reservation for non-public spaces | type 2: spaces localized by external restrictions | type 3: localized spaces | type 4: flexible spaces

fig. 5.6 spatial program

4.5. ANALYSIS 1

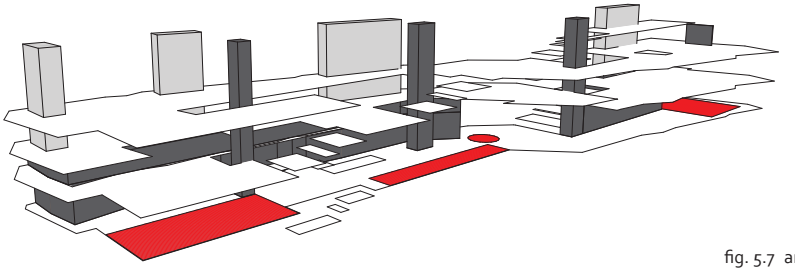
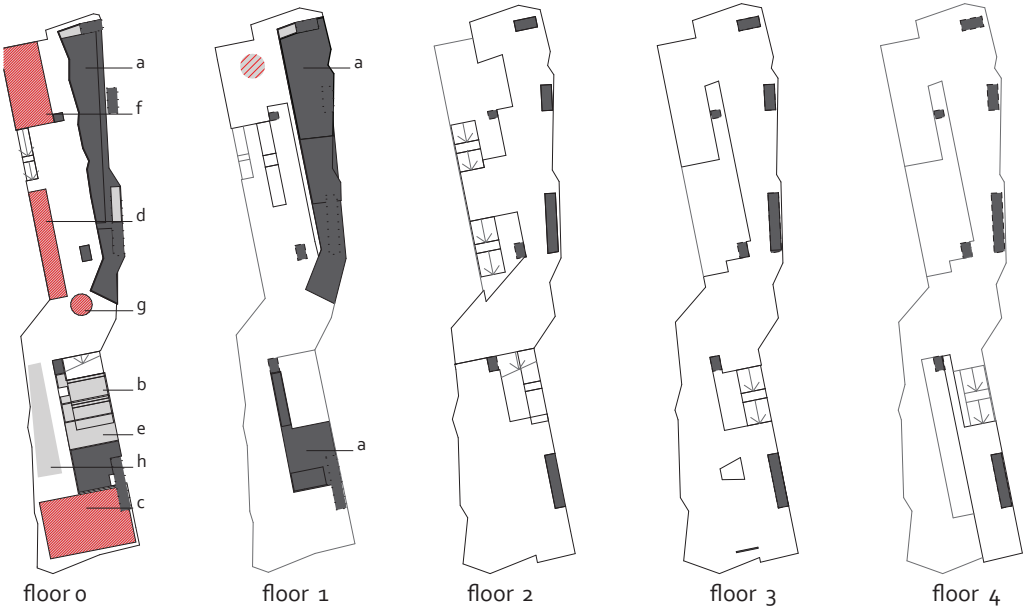


fig. 5.7 analysis 1 perspective input



a *non-public spaces*
b *public toilets*
c *multi-purpose hall*
d *café*
e *commercial premises*
f *restaurant*
g *public services*
h *exhibition space*

not visible: cinema located in the basement

fig. 5.8 analysis 1 floor plans input

Interpretation of analysis 1 (spaces type 0+1)

visibility analysis: On ground level we find rather low visibility values, higher values on levels 1 and 2. An interesting difference is that comparing level 2 and level 3, the values on level 3 show less variation than on level 2. the lowest visibility levels can be found on level 4.
activity: spaces of type 1 (spaces localized by external restrictions) had to be situated at ground level, to have access to the plaza and park or be close to the entrance (reception). activity seed at ground level.

usage evaluation: At first surprising are the results of the usage evaluation. Level 2 and level 3 possess almost the same values in the view outside analysis and they both do not have any activity values. But while level 2 offers more variation in visibility values, level 3 is by far being more used. As the area being most used possesses rather low visibility values, we can assume that the agents prefer lower visibility values and take that into account in the next design step. Basically, the whole area on ground level is being well used, this seems to proof our point on level 3, because we find similar visibility values on this level and additionally this is the only area with seed-activity so far. On level 4 there can also no difficulties in occupation be found, it is well used, having also rather low visibility values and most of it also excellent view outside values.

usage variety evaluation: In contrast to the usage evaluation, the usage variety evaluation shows a completely different image. While in the usage evaluation most of the spaces are being used, the variety evaluation shows that there are actually only a few spaces that are being used for more than one task. These spaces are situated mostly on ground level and the at the core in the south on level 3, and level 4 offers good variation values.

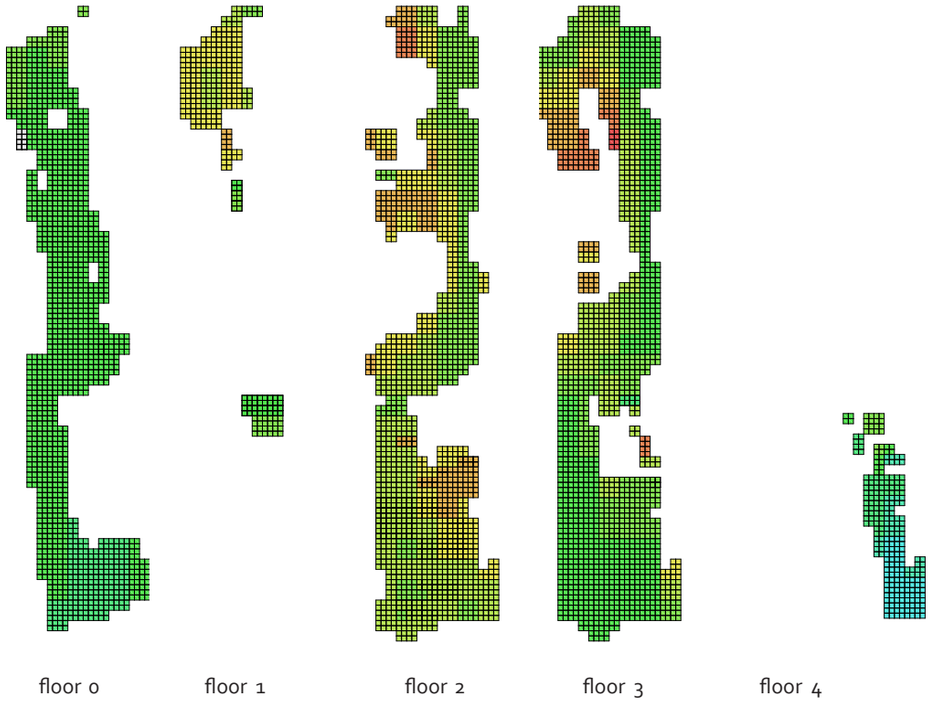


fig. 6.1 analysis 1 (spaces type 0+1) | visibility

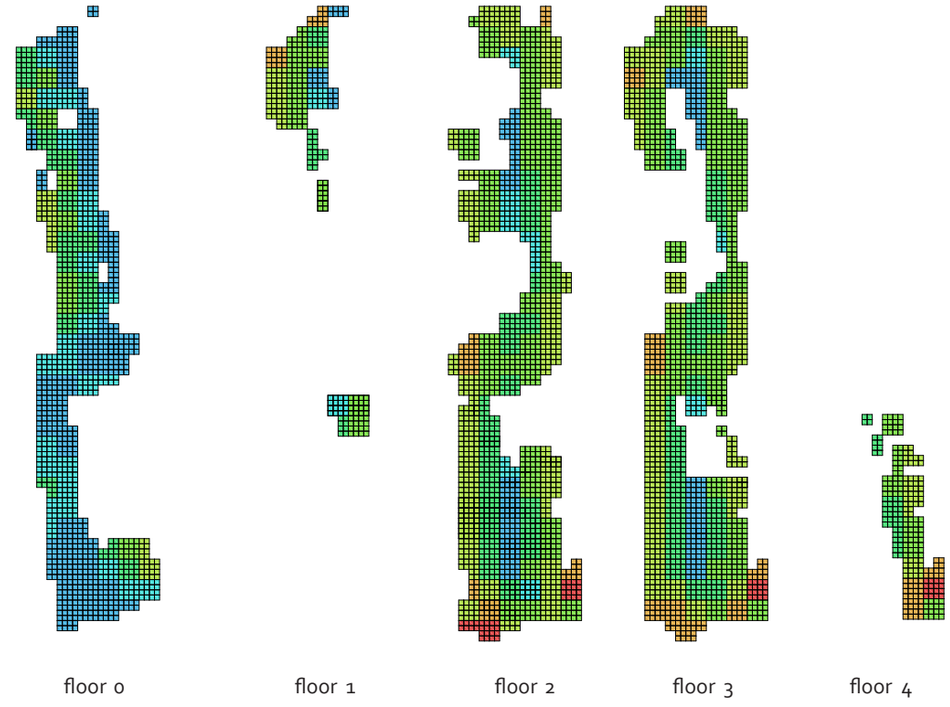


fig. 6.2 analysis 1 (spaces type 0+1) | view outside

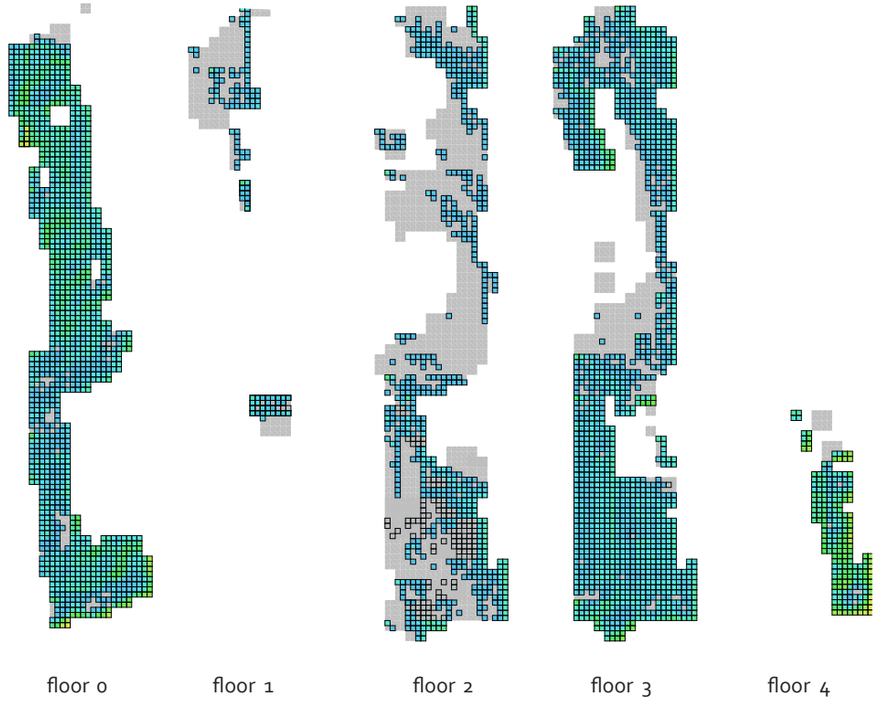


fig. 6.3 analysis 1 (spaces type 0+1) | usage evaluation

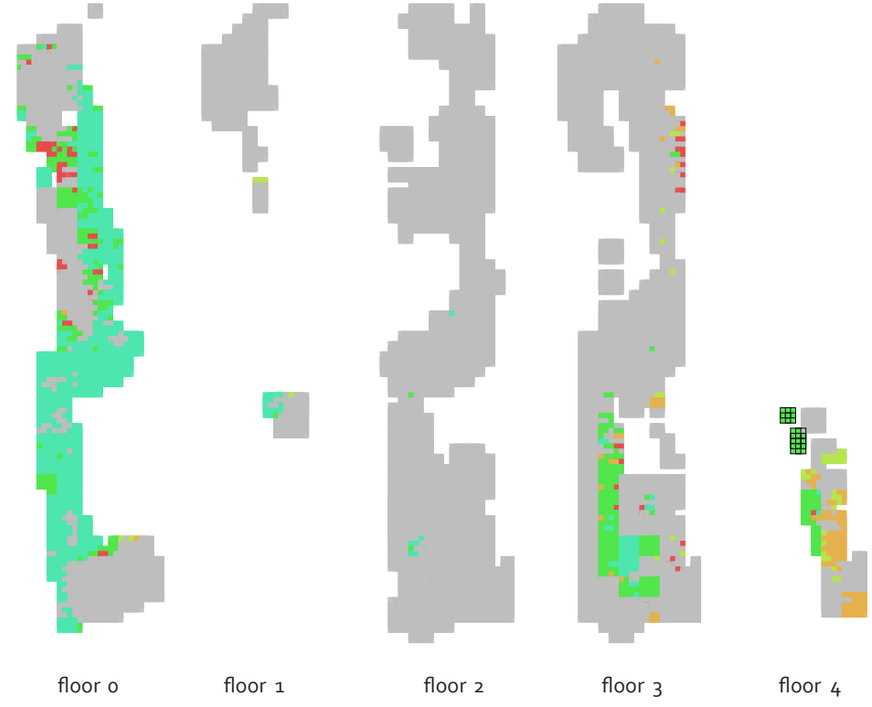


fig. 6.4 analysis 1 (spaces type 0+1) | usage variety evaluation

4.6. ANALYSIS 2

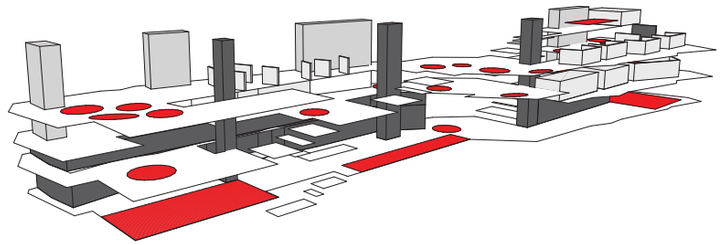
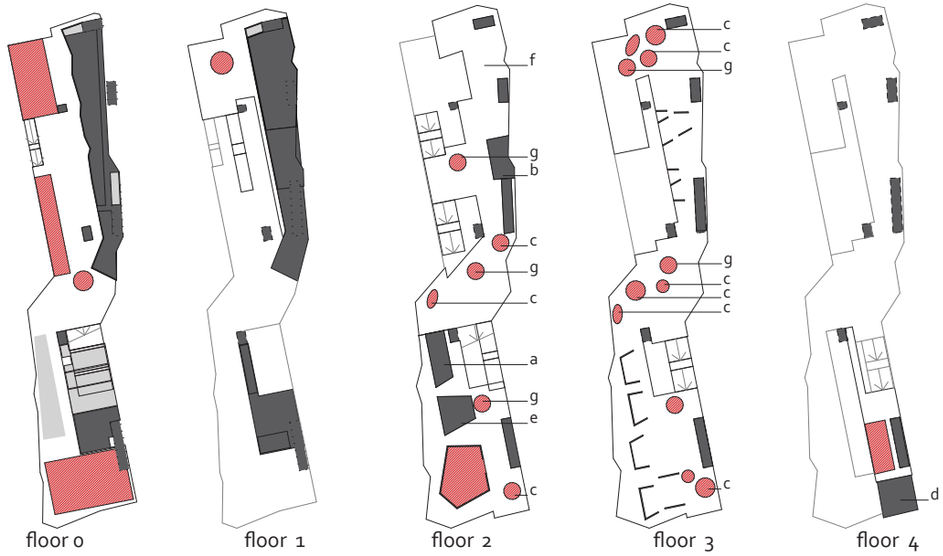


fig. 6.5 analysis 2 perspective input



a *music/video studios*
b *tv+radio studio*
c *interactive spaces*
d *fab lab*
e *viewing+games room*
f *childrens' world*
g *fixed client service point*
h *library collections area*

fig. 6.6 analysis 2 floor plans input

Interpretation of analysis 2 (spaces type 0+1+2)

visibility: more variation of values on level 0, 1, 2, visibility in southern part of level 3 still not much variation in values.
usage: Even on the previously already well performing level 3 a further increase of usage can be observed. The same is true on level 2, while here especially an alteration from many small areas of usage towards fewer compact usage areas can be observed, some smaller areas on level 2 need to be improved. Level 1 is now also showing good values of occupation. In contrast to this, level 0 shows especially in the southern part less occupation. This is not surprising taking into account, that the number of agents testing the space is still the same and otherwise the increase in occupation on the other levels would not be explicable. Furthermore no changes in geometry or placement of activity since the last analysis step have been affecting the area which shows the significant decrease in usage, thus we can conclude that the values in this area have not deteriorated, the values of the other areas have only improved and hence are being preferred.

usage variety: On level 0 the spaces of variation have decreased, additionally no more spaces of high variation can be found. On each of the other level we find a small increment in variety spaces, although there are still not many of them. The introverted spaces on level 3 have a higher variety of uses, the rare combination of low visibility, little view outside and little activity seems to be suitable for many tasks. In general a tendency contrary to the tendency in usage is observable: Single cells of variation are emerging instead of fields of variation.

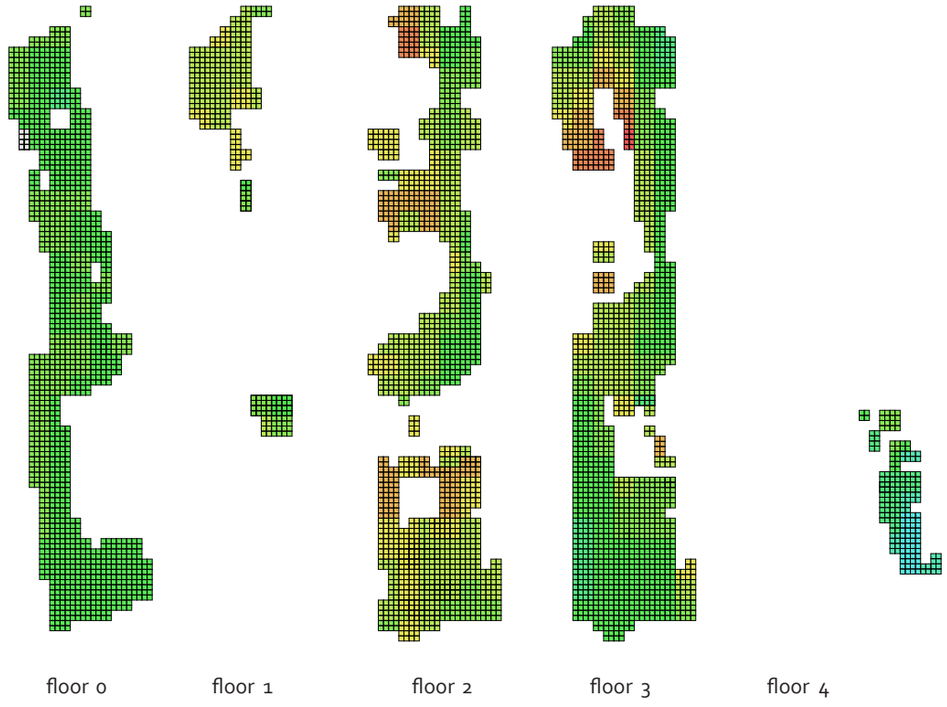


fig. 6.7 analysis 2 (spaces type 0+1+2) | visibility

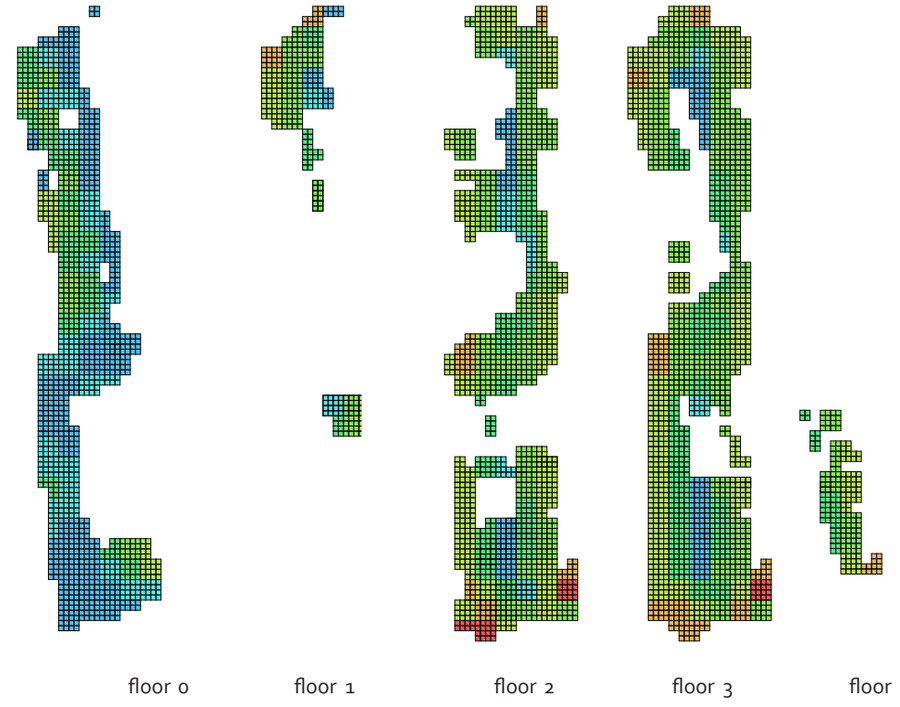


fig. 6.8 analysis 2 (spaces type 0+1+2) | view outside

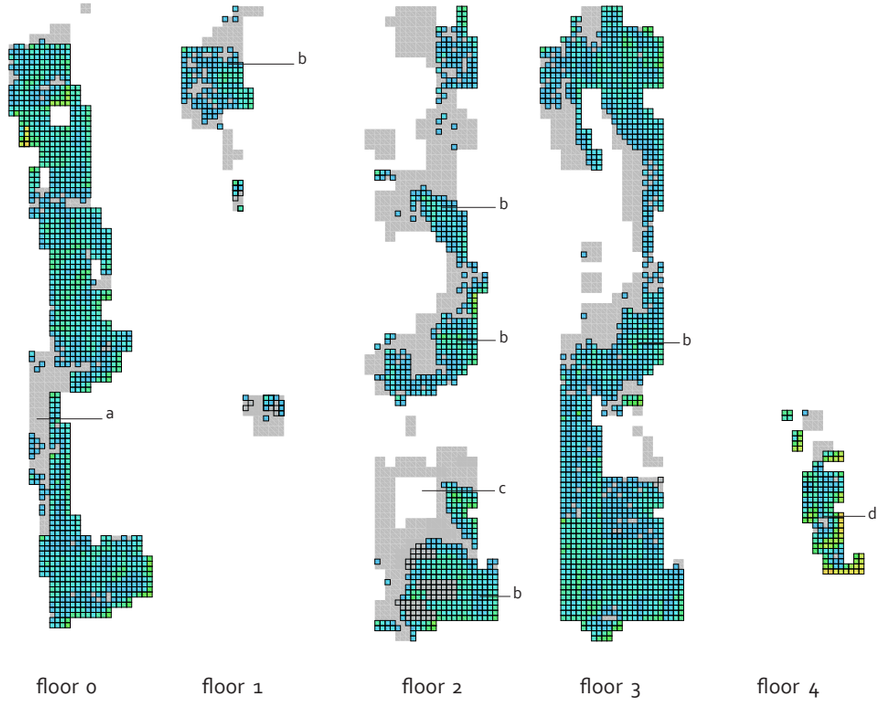


fig. 6.9 analysis 2 (spaces type 0+1+2) | usage evaluation

a *less usage than in previous analysis*
b *improvement of usage*
c *space occupation by functions*
d *level with best occupation values*

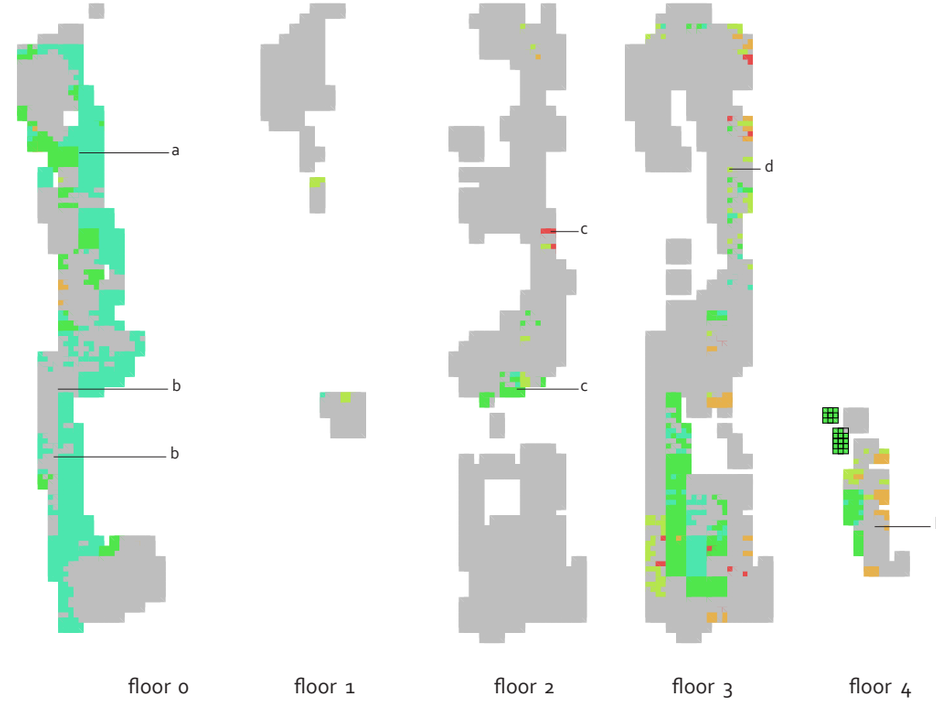


fig. 6.10 analysis 2 (spaces type 0+1+2) | usage variety evaluation

a *no more high variation spaces*
b *area of less variation compared with previous step*
3 *new variety area*
4 *emergence of new single variation cells instead of variation fields*

4.7. ANALYSIS 3

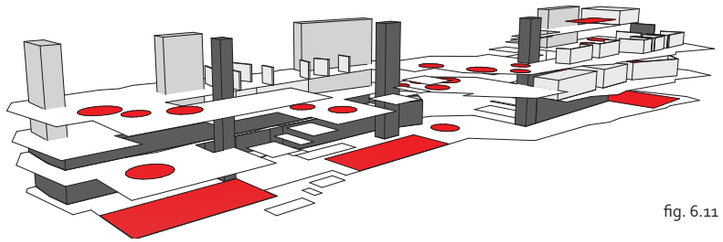
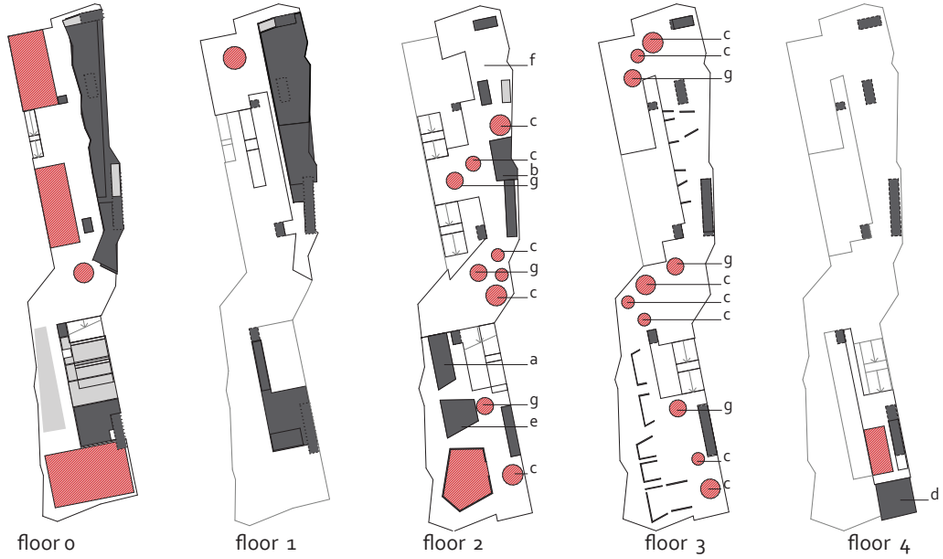


fig. 6.11 analysis 3 per-



a *music/video studios*
b *tv+radio studio*
c *interactive spaces*
d *fab lab*
e *viewing+games room*
f *childrens' world*
g *fixed client service point*
h *library collections area*

fig. 6.12 analysis 3 floor plans input

Interpretation of analysis 3 (spaces type 0+1+2)

usage: On level 0 and 1 an increase in usage can be observed, a decrease of usage on level 2, level 3 and 4 show no significant changes, although in general scattering is increasing and more single un-used cells are observable.
usage variety: The values of level 0 in usage variety are coherent with its values of usage as we can observe here also an increase of usage variety in the southern part. Opposite to this are the results of level 3, in the south we find a decrease of usage variation, without the usage values having changed, while in the northern part of level 3 an area of high usage emerges. In this area the core has been moved away from the façade which have led to changes in visibility and view outside.

Design decision

Other design variations have also been tested but I decided to develop this design further because spaces are being well used on all levels and the design shows a new emergence of one high variation area but apart from this not so many different variation areas.
This may be contrary to the original design aims, in which big areas of variation were said to be desirable, but during the analyses I realized that the present analysis result actually shows something better:
Offering lots of space to a certain number of agents (patrons), the amount of variation usage in some areas could only be increased by not using other areas. This is to be avoided in any case. Furthermore the analysis shows that the analyzed spaces seems to have quite specific qualities fitting to specific usages, agents occupy them because of their preferences not because of a predefined space allocation. A result which was not expected like this, but actually proofs a good point.

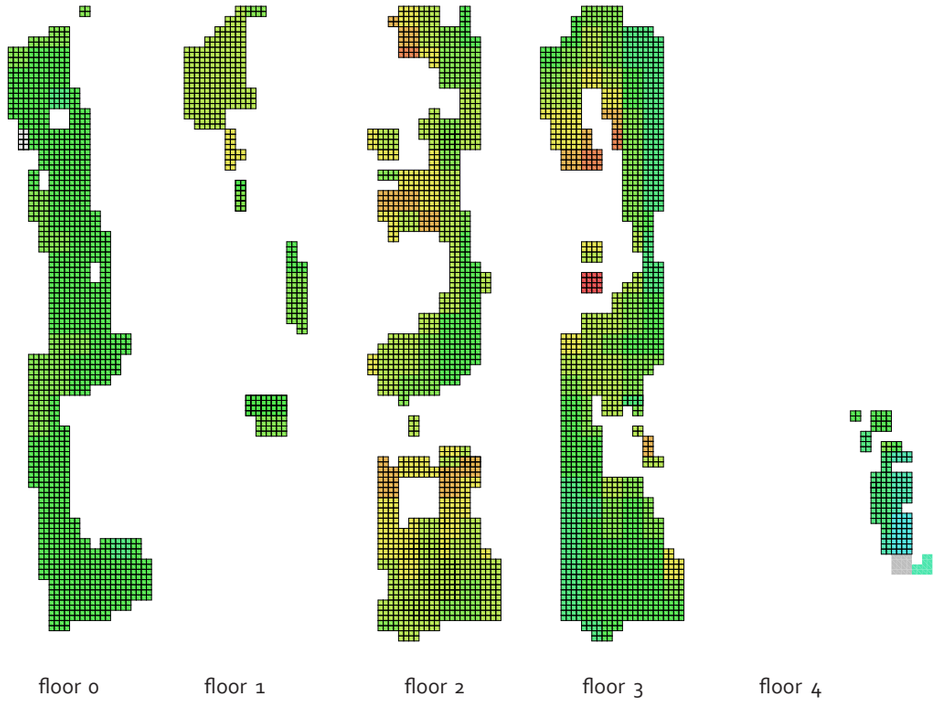


fig. 6.13 analysis 3 (spaces type 0+1+2) | visibility

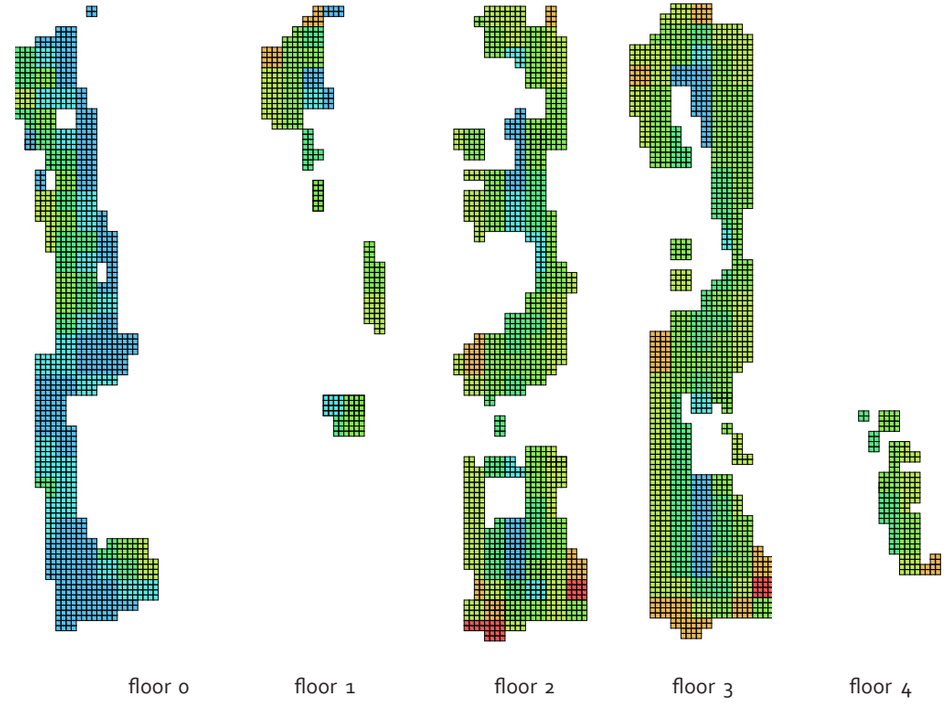


fig. 6.14 analysis 3 (spaces type 0+1+2) | view outside

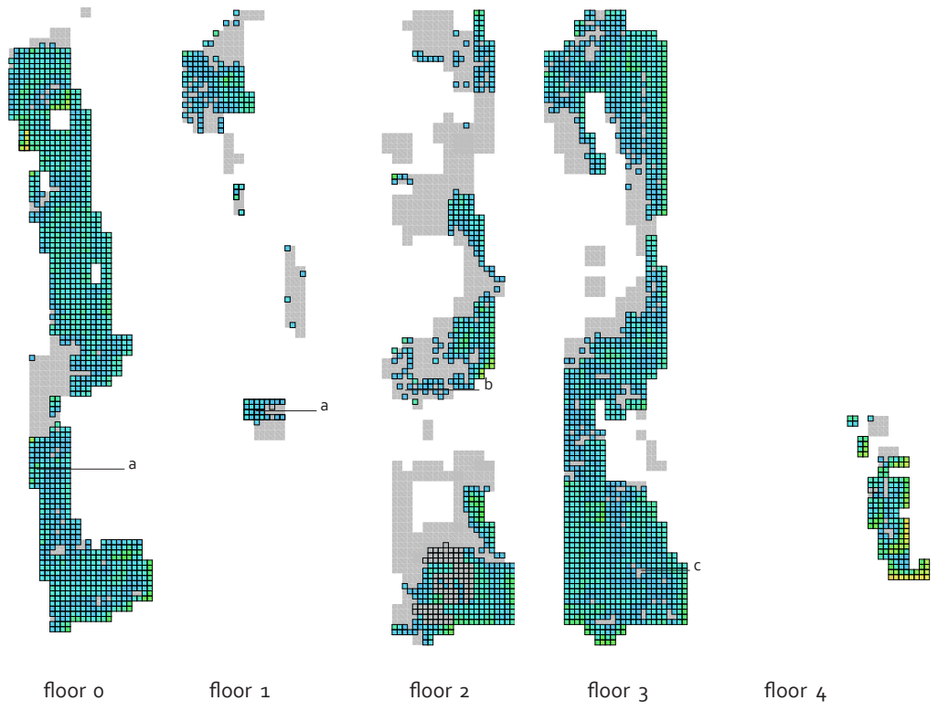


fig. 6.15 analysis 3 (spaces type 0+1+2) | usage evaluation

a improvement of usage
b *less usage, scattering*
c *new left out cells in usage pattern*

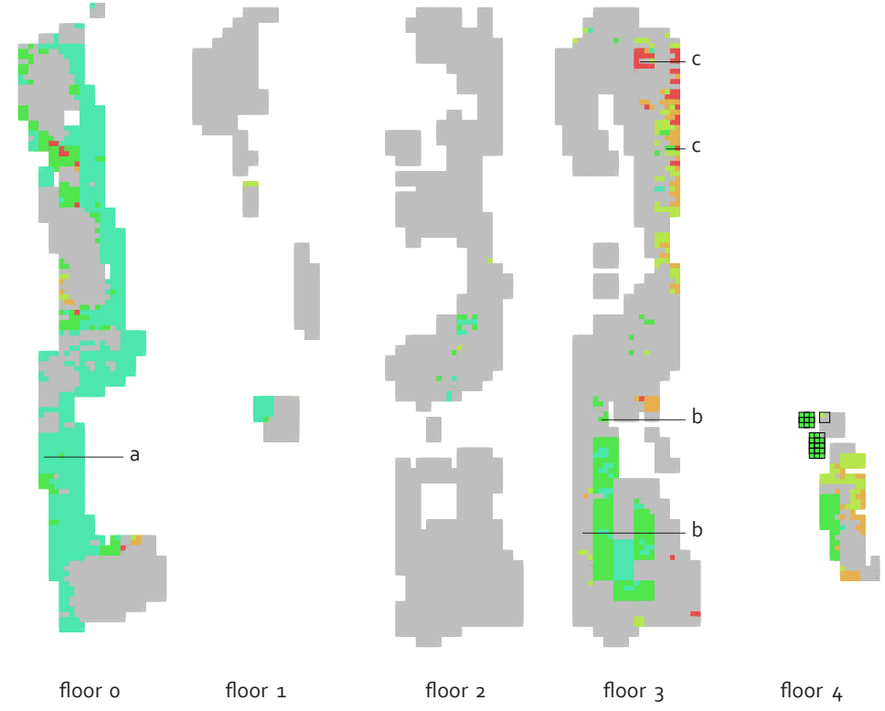


fig. 6.16 analysis 3 (spaces type 0+1+2) | usage variety evaluation

a *increase in variation*
b *decrease in variation*
c strong increment in variation and emergence of high variation area

5. Design Descriptions

5.1. ARRANGEMENT OF THE FUNCTIONS

The spatial program of the library is spread over five floors plus two underground floors. Fire escapes and technical shafts are as well as most of the sanitary spaces are situated along the east façade. Five elevators for the patrons are situated along the axis at the center of the building. An elevator for library staff situated on the east façade but in the middle of the buildings length to keep distances short, connects the book returns automat room on ground floor to the material handling space and service transport area in the basement and the other library collection levels. A service elevator for external providers connects the café kitchen and restaurant kitchen directly to the service and loading area and their storage spaces in the basement.

The ground floor is mint by transparency. Both main entrances open up one common entrance area with a reception desk, reservations pick up

area and returns automats situated within sight of the entrances. Additionally, being a key element of the building, a wide stair also connects to the entrance area, functioning here as shortcut to the second level, waiting and meeting area as well as tribune for flexible events aiming to attract a broad public. Further functions situated in the basement are the multi-purpose space, the café and the restaurant. These functions are situated along the façade, with the possibility of opening and extending the function area towards the park. The multi-purpose hall is situated at the southern end of the building to act as an attractor that draws people down the path and make experiences, also, it gives the possibility to hold events without separating the space off the common lounge space thus enabling passers-by to perceive the taking place of the event and to sneak in if they are interesting in it. Still, the possibility to separate the space off the lounge area is given by a sliding door, the space can also be darkened with a curtain. If no event takes place the area merges into the common area or can be used an extension to the adjacent exhibition space. Close to the entrance area is also the stair to the cinema situated in the basement. The café and the restaurant are situated in immediate proximity to the old Makasiini railway warehouse with a separate entrance for the restaurant for opening outside library hours, contributing to restaurant situated in the building and forming a common piazza.

Via a free-standing staircase the patron arrives at the first floor with the main customer service and information desk as well as magazine and reading area and presentation area of new publications.
The eye-catching element on this level is the wide staircase opening up the view through the building and onto the next levels. But even more impressive is the view sitting on this staircase looking down over the park and to the Töölöönlahti Bay. Flexible furniture elements fitted to the stairs give the possibility to influence the path patrons will take on the staircase and use is as a sitting area, tribune or presentation area.
Adjacent to the customer service desk is the office area with a common working space area for the librarians as well as meeting rooms. The staff lounge open to all staff is situated between the office area and the changing and wash rooms for other employees.

Level 2 and level 3 continue the distribution started on level 1: Spaces along the axis act as spaces of exchange and communication, impulse and input. On the one hand because the stairs in these areas create special kind of mutual perception and a multitude of different visual connections among the patrons. On the other hand, this is also an area of mixing, where the axis intersects with the meandering function spaces. People that are just using the stairs to get to another level, people that are using the library for relax purposes, people that are working in the collection spaces or people who came to the library for certain function, seeking information or input, all of them come together in these areas and create a perception of the diversity of society. To achieve this, attractor-functions like service desks and interactive spaces are situated in these areas (of these attractor-functions it is assumed that they have a relatively high probability of being constantly used by some-one, creating a constant *"activity-level"* through the presence of some-one, that other patrons can decide if they like it or not). Service desks provide information, laptop lending services and coffee, interactive spaces are spaces where people can learn about changing topics and new technologies. This is rounded out by thematic issues presented attractively on shelves in this input and mixing area.

The complimentary part to these areas is the landscape that meanders around this axis containing further spaces for reading, working, relaxing or whatever patrons decide to use it for. The landscape is offering different combinations of qualities (visibility, view, distance to activity functions) giving the patron himself the possibility to decide which space he wants to use.

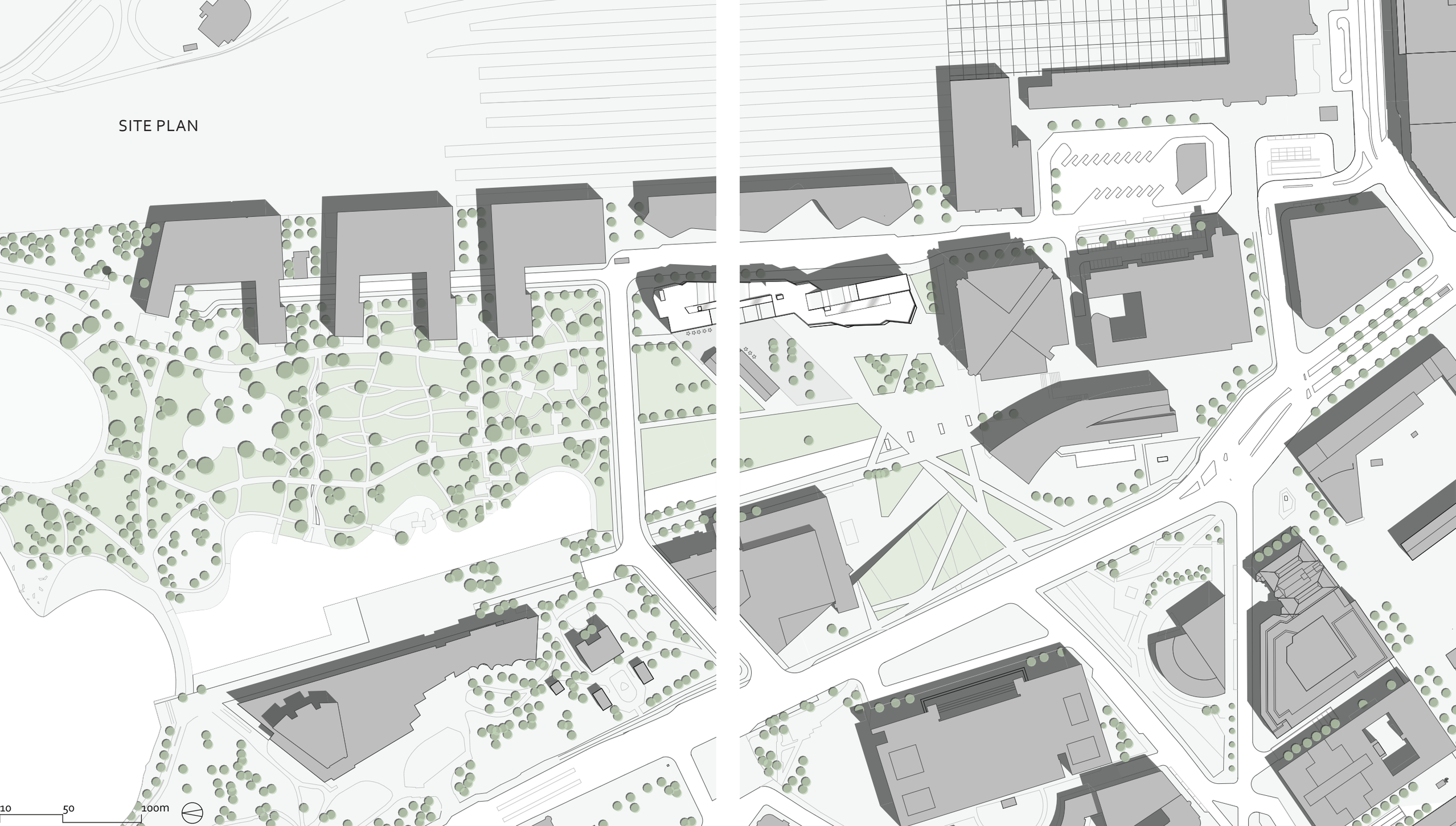
The landscape is structured and activated by the implementation of functions that are circling different thematic issues. On level 2 functions with no need for natural lighting are situated that offer new experiences techniques to try out. Level 3 offers functions that aim on self-development, concentration to one's self, focus and activities of small groups or of the individual. The perception of space also changes towards spaces of smaller units with a skylight providing good natural lighting. This space contains smaller spatial separations for the patrons to use for varying functions. Level 3 also offers the possibility of extension of the reading area to the outside. The open air reading area is situated in continuation of the axis with sitting steps and connecting to a reading garden enabling to enjoy the mild temperatures and overview over the city.
On level 4 relaxation and leisure inputs are situated like the fab lab and community kitchen, also with the possibility of extension onto the rooftop.

fig. 7.1 illustration entrance area, floor 0

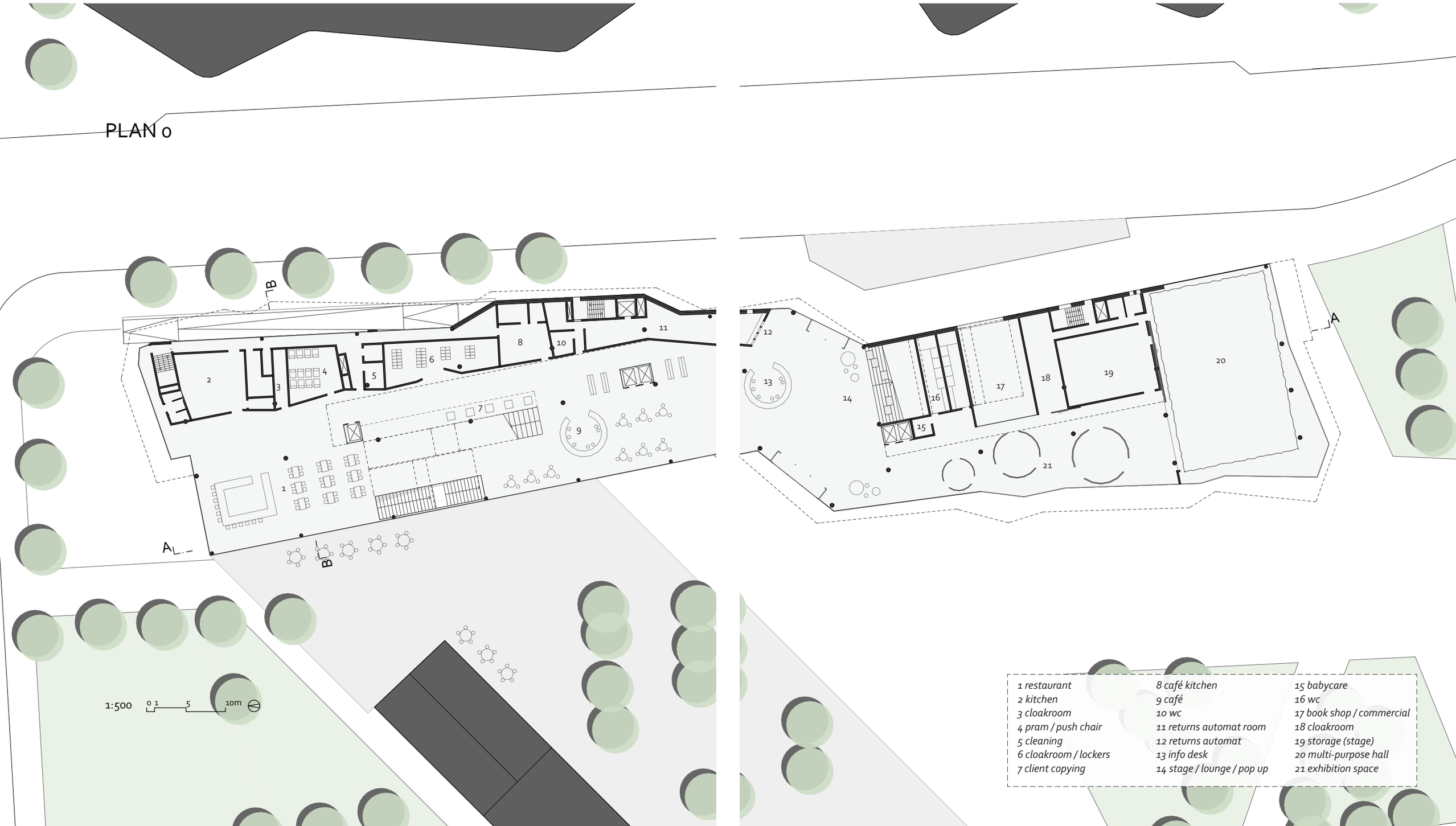
fig. 7.2 illustration bay view, floor 2

fig. 7.3 illustration mixing area, floor 3

SITE PLAN

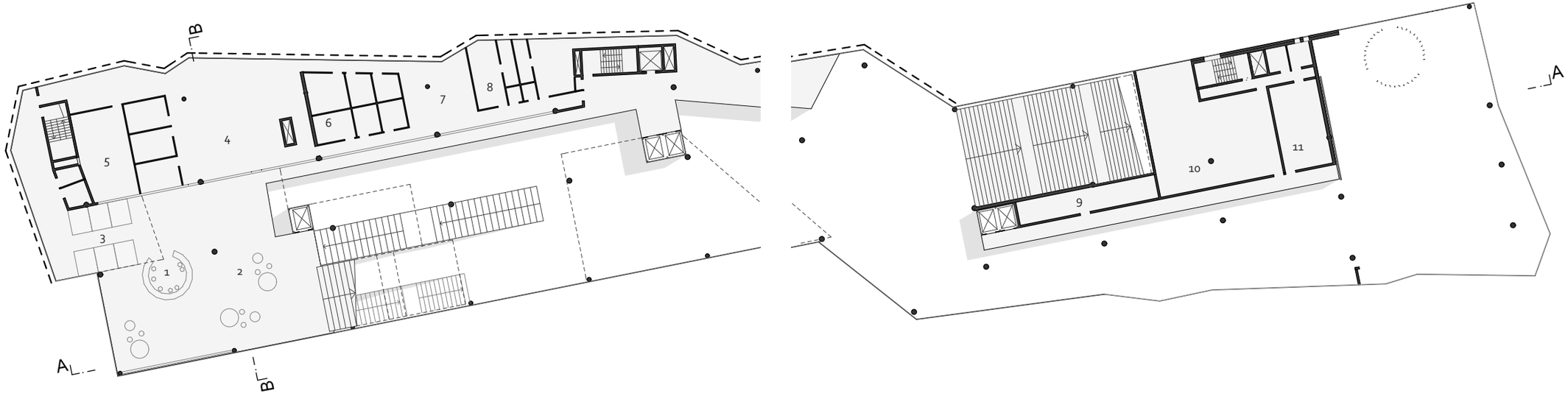


PLAN 0



1 restaurant
2 kitchen
3 cloakroom
4 pram / push chair
5 cleaning
6 cloakroom / lockers
7 client copying
8 café kitchen
9 café
10 wc
11 returns automat room
12 returns automat
13 info desk
14 stage / lounge / pop up
15 babycare
16 wc
17 book shop / commercial
18 cloakroom
19 storage (stage)
20 multi-purpose hall
21 exhibition space

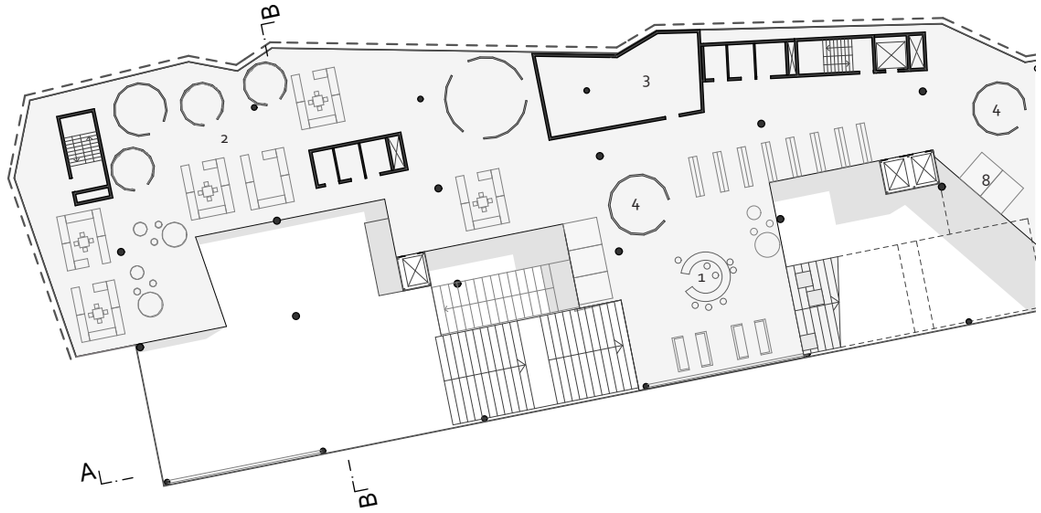
PLAN 1

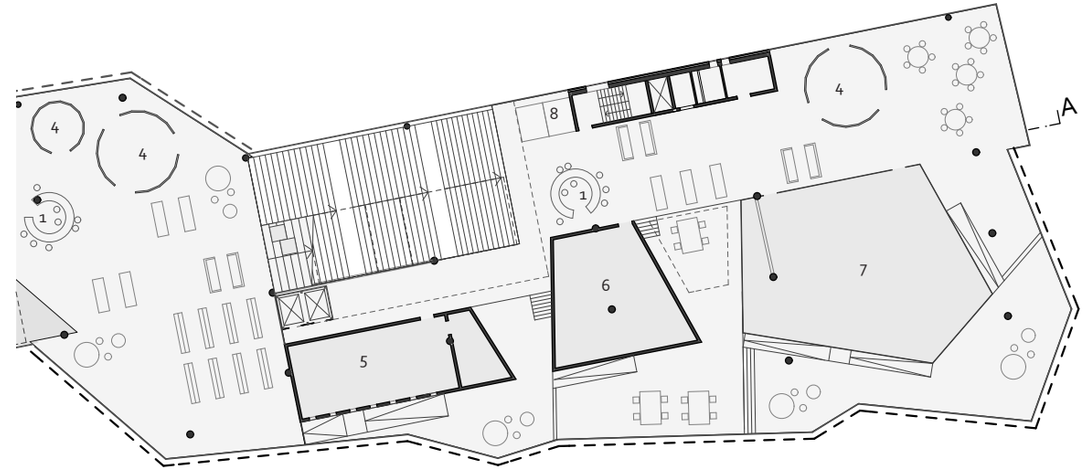


1:500 0 1 5 10m

1 service point
2 magazine + book pick up
3 self service area
4 staff office
5 meeting rooms
6 separate working rooms
7 staff lounge
8 staff changing+wash
9 cleaning facilities
10 server room
11 backstage area

PLAN 2

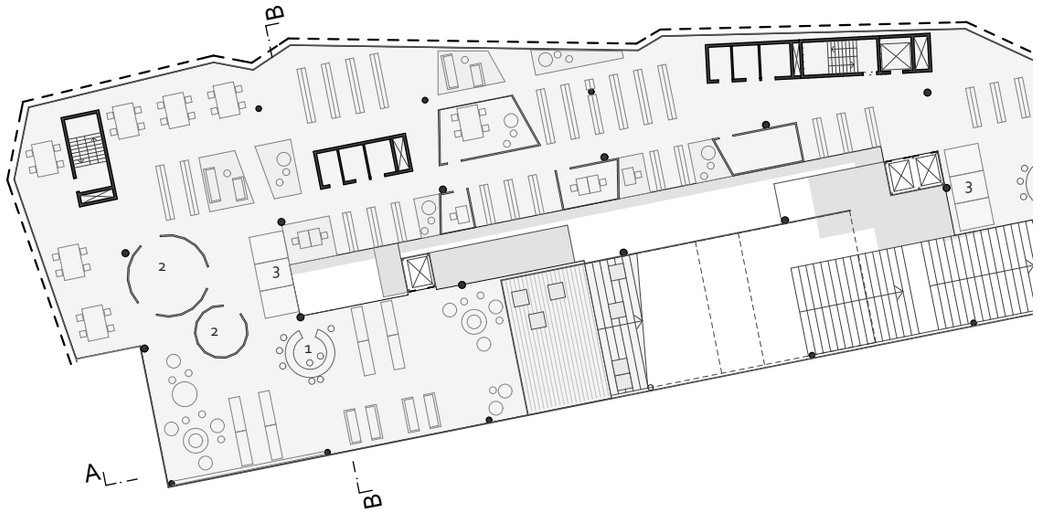


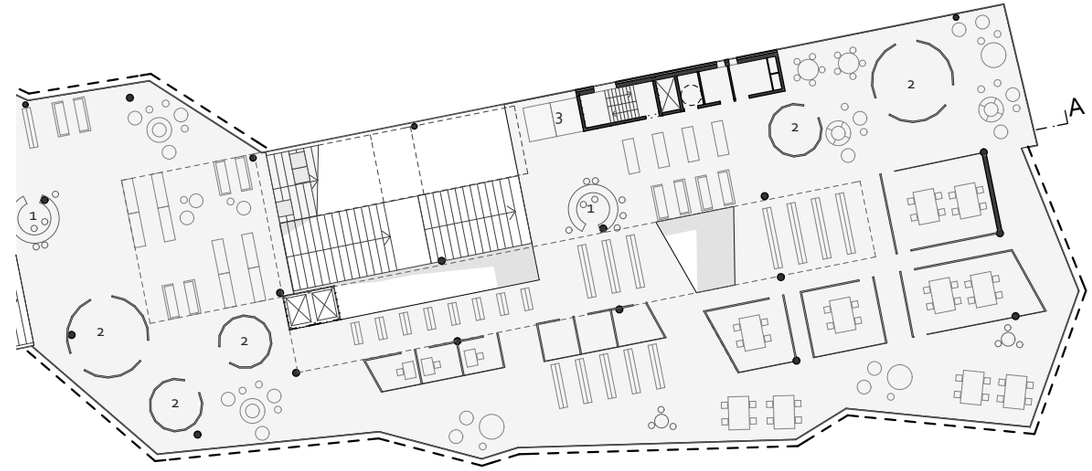


1:500 0 1 5 10m

1 service point
2 childrens' world
3 tv+radio studio
4 interactive space
5 music+recording studio
6 listening+games room
7 living lab
8 self-service point

PLAN 3

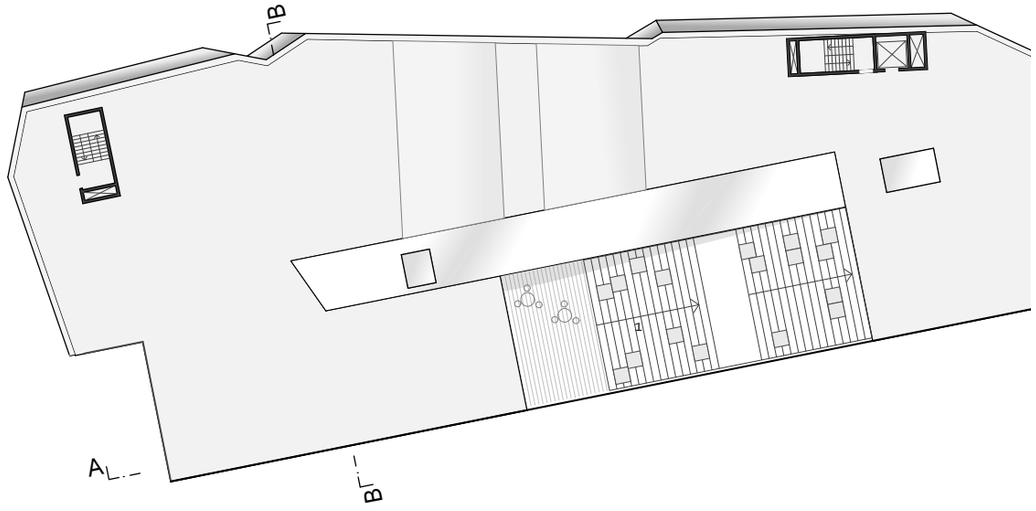


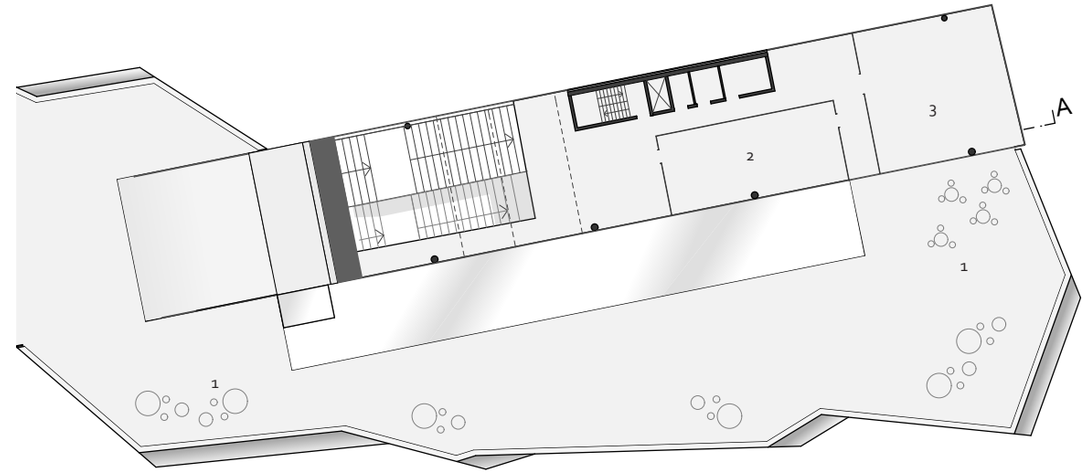


1:500 0 1 5 10m

1 service point *2 interactive space* *3 self-service point*

PLAN 4

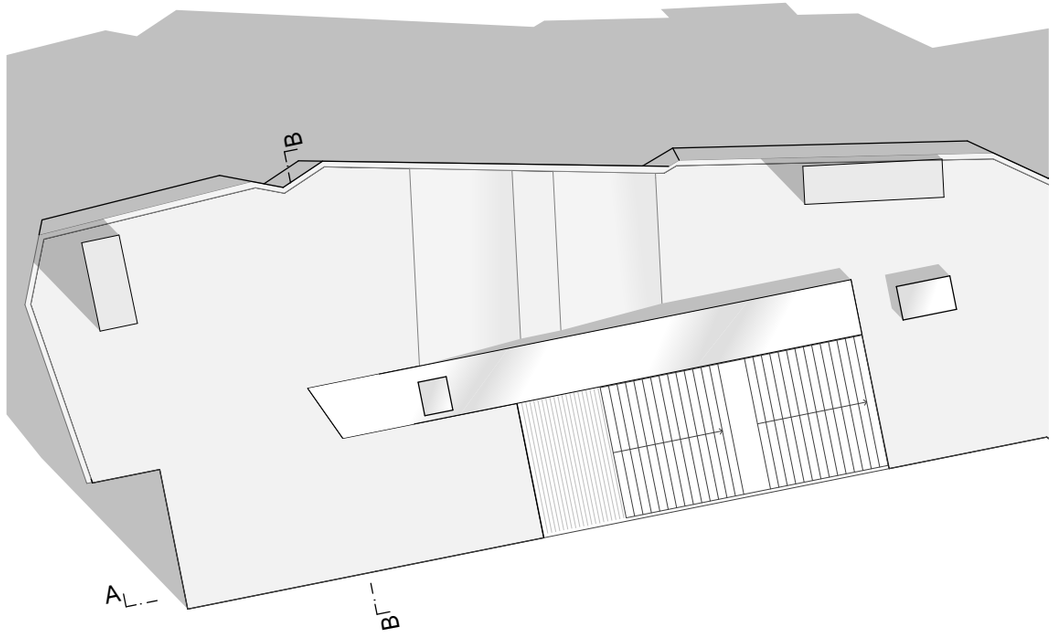


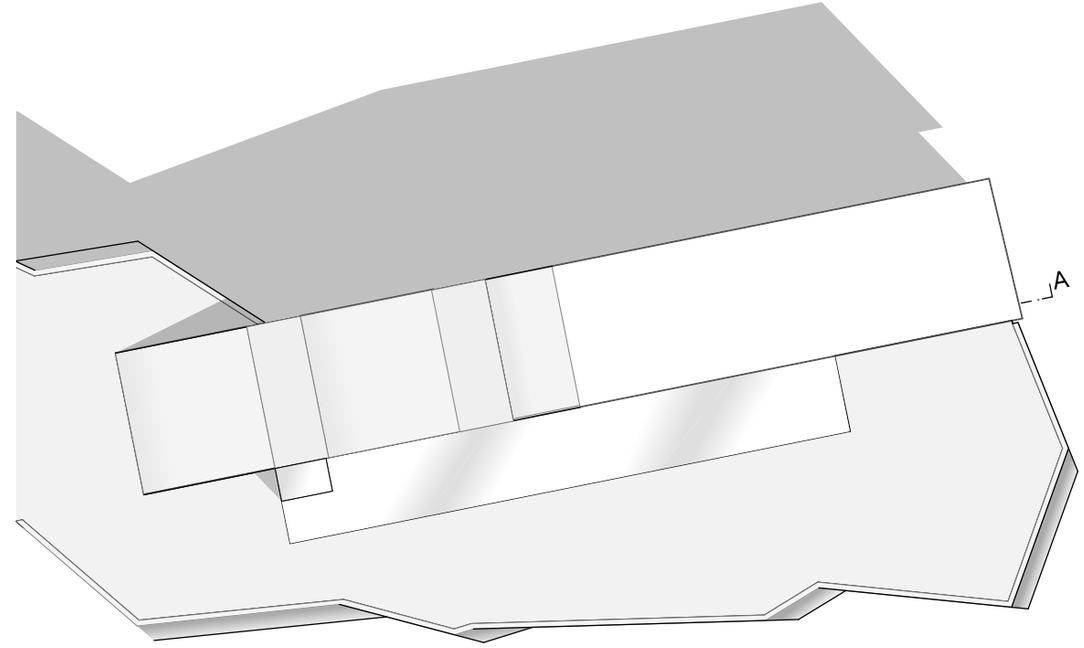


1:500 0 1 5 10m

1 reading terrace *2 project space+communal kitchen* *3 fab lab*

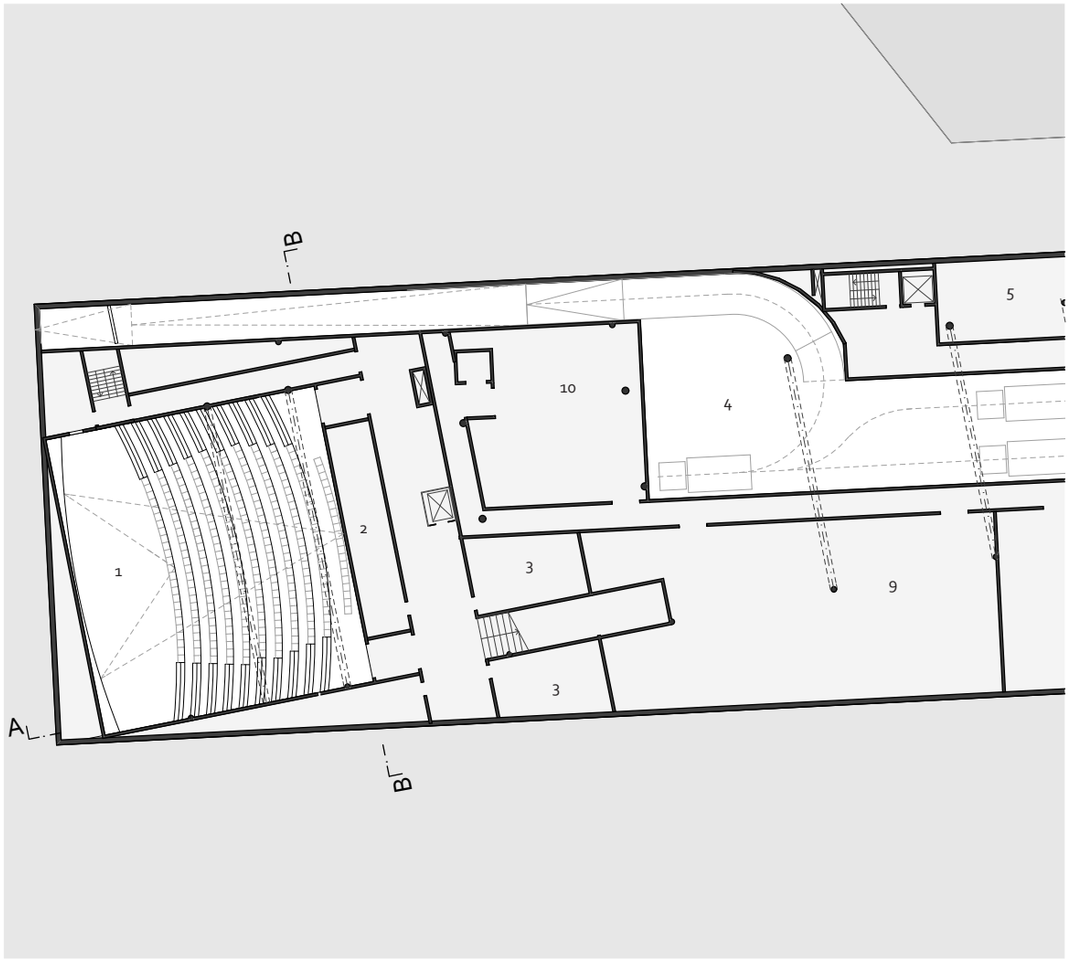
PLAN 5





1:500 0 1 5 10m

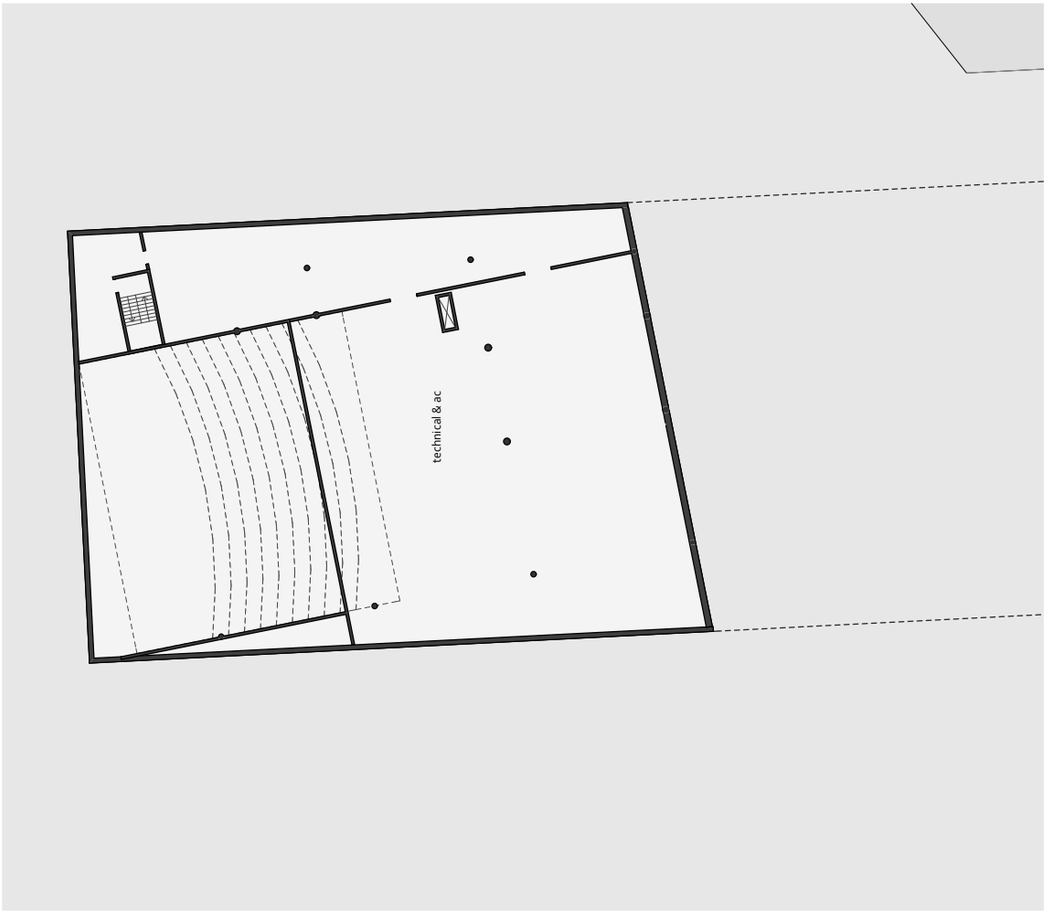
PLAN -1

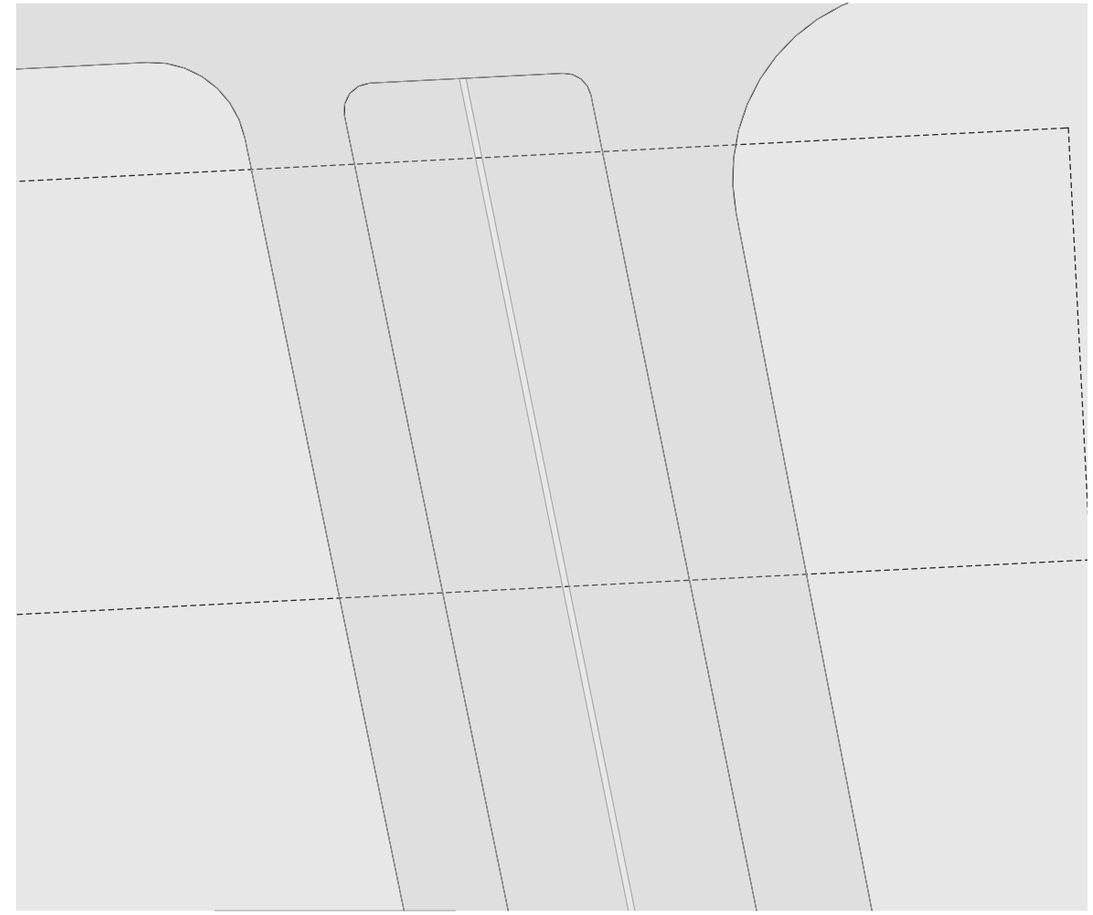


1 cinema
2 projector room
3 wc
4 service+loading
5 library material handling
6 collection storage
7 refuse store
8 building maintainance
9 technical spaces
10 storage external providers

1:500 0 1 5 10m

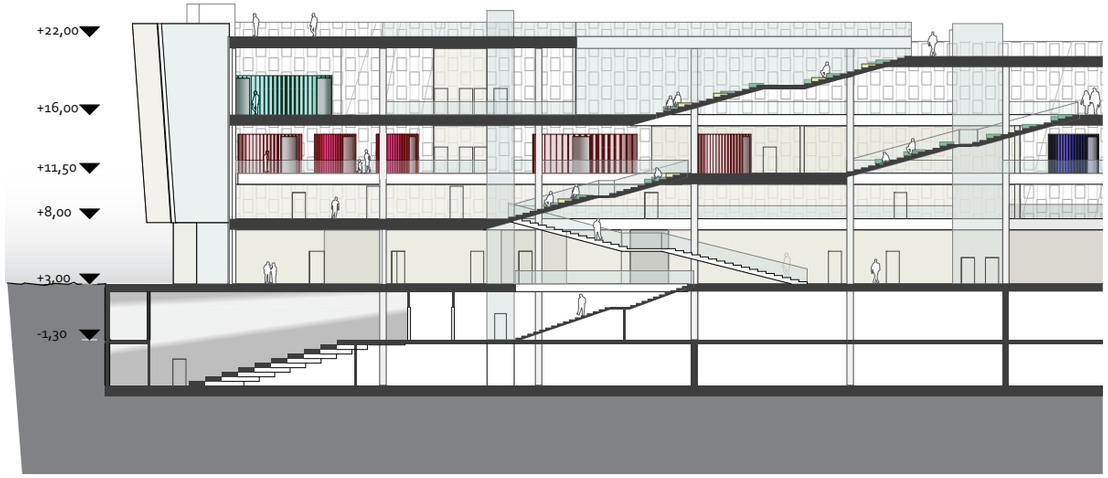
PLAN -2





1:500 0 1 5 10m

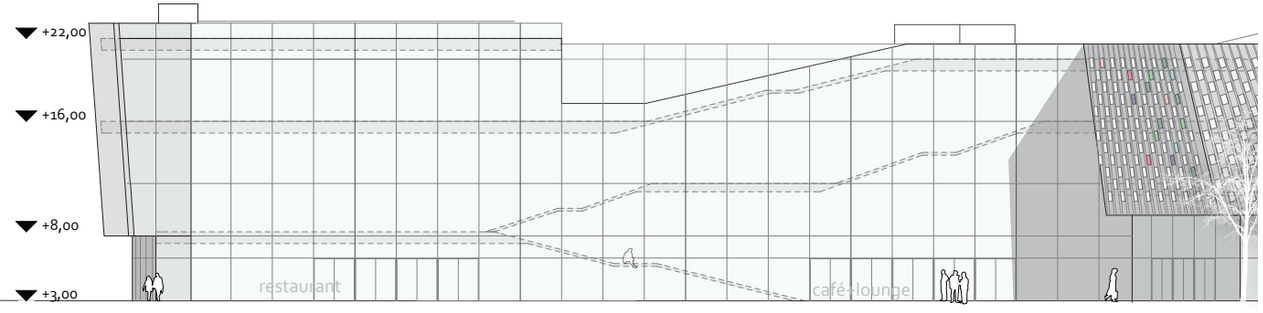
SECTION AA

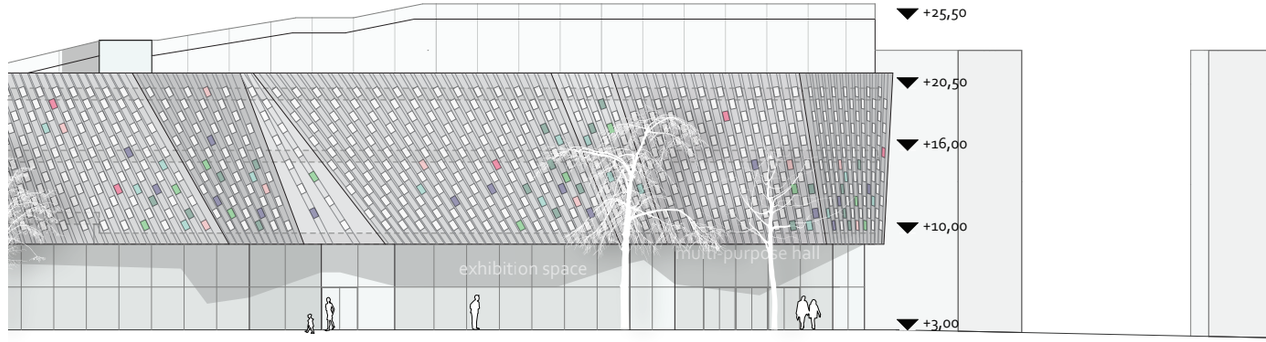


1:500 0 1 5 10m

SECTION BB

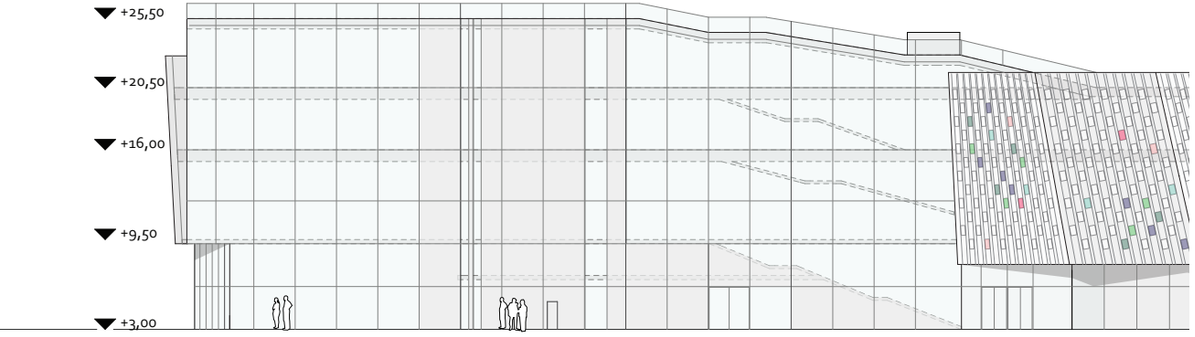
ELEVATION WEST

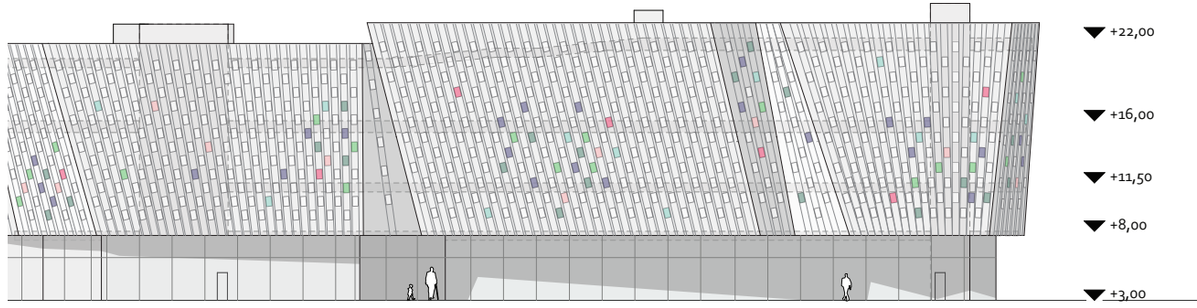




1:500 0 1 5 10m

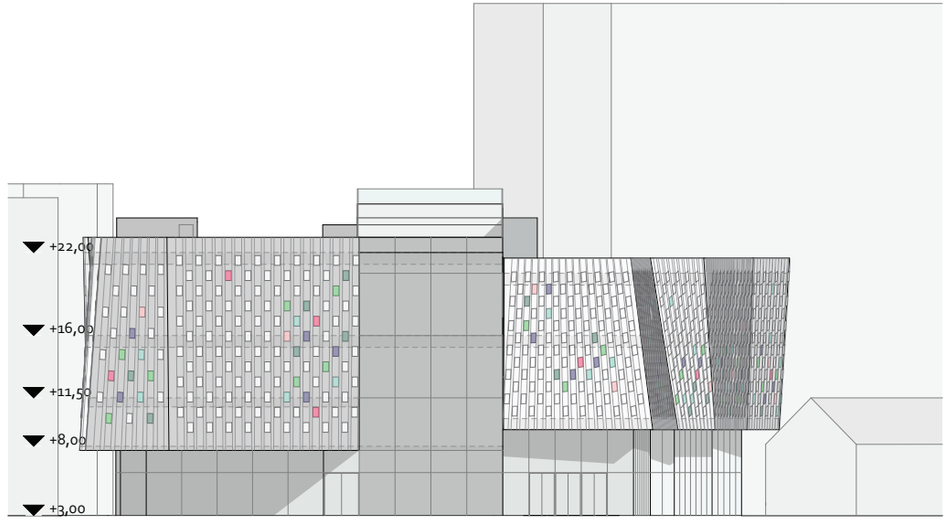
ELEVATION EAST





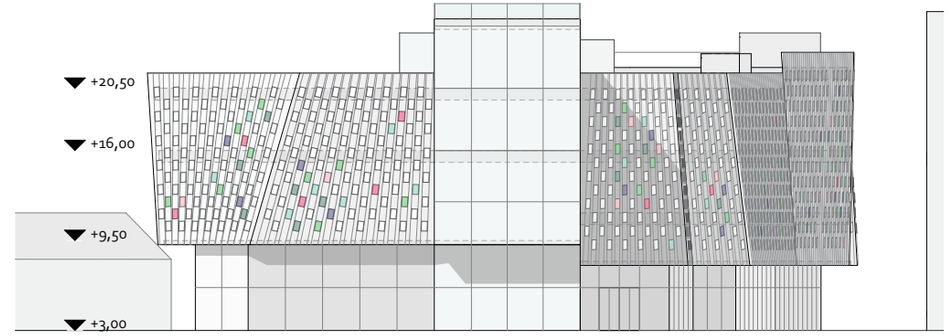
1:500 0 1 5 10m

ELEVATION NORTH



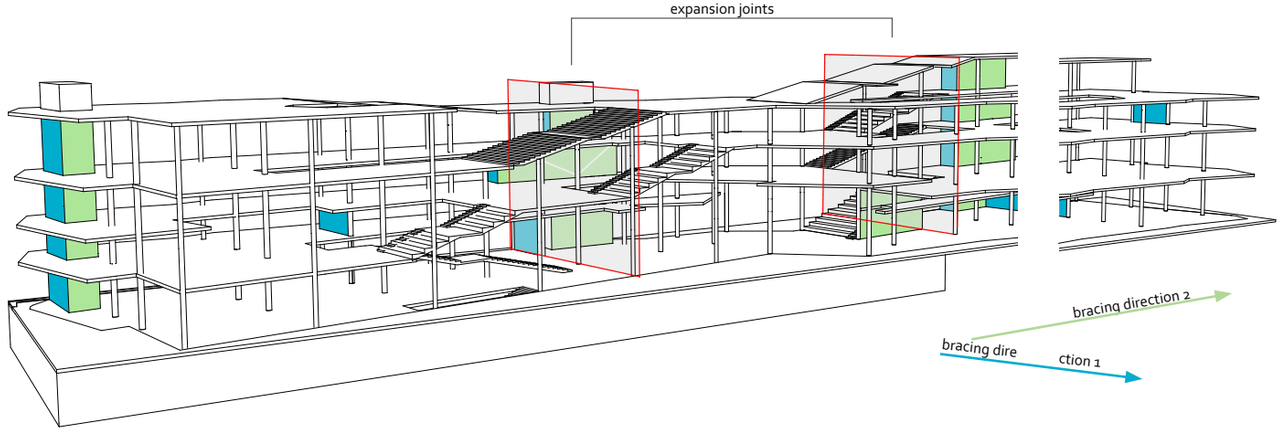
1:500 0 1 5 10m

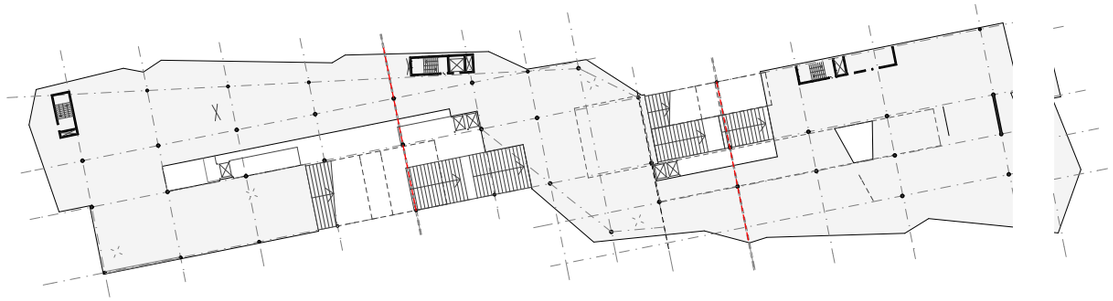
ELEVATION SOUTH



1:500 0 1 5 10m

5.3. STRUCTURAL SYSTEM





The building's slabs, columns, stairs and supply cores are built using reinforced concrete. The supporting structure is based on a column grid spanning 12 meters in one and 6 or 10 meters in the other direction. Due to the extreme length of the building site of 150 meters the building had to be divided into three structural parts connected via expansion joints. Each of the building parts is independently braced by the supply cores of reinforced concrete, diagonal steel connections at the facade of the axis or additional interior reinforcement by interior walls of reinforced concrete.

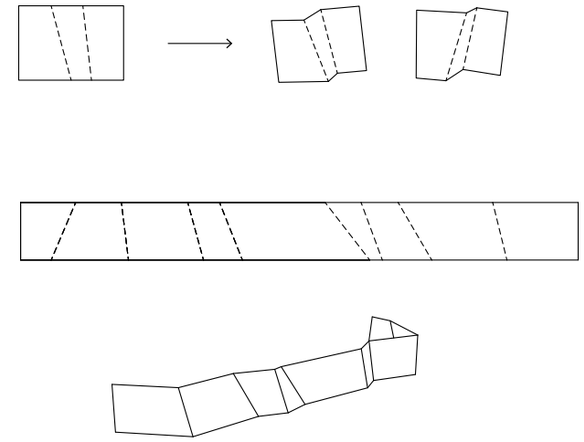


fig. 7.5 folding paper strips

design principle: inclined crease lines produce surface segments tilting towards front- or backside

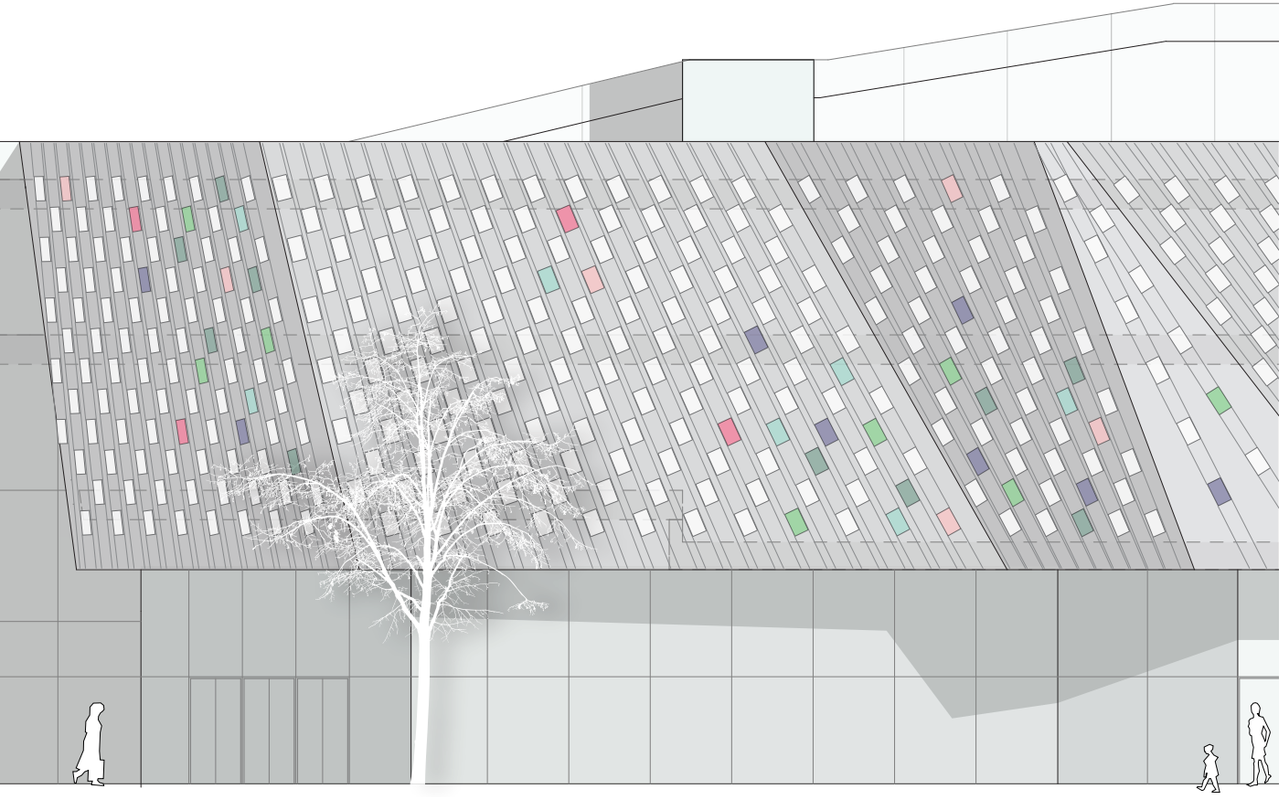
5.4. FAÇADE

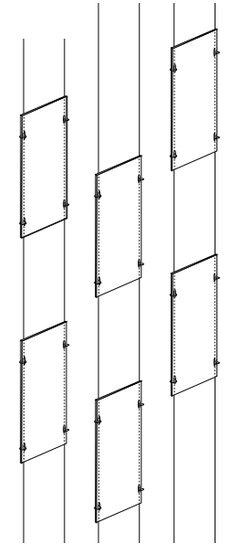
The axis of vertical circulation is mint by the long unobstructed lines of sight and views to the park and bay outside . To emphasize this the facade surfaces of the axis are clad with glass panels, allowing the view to float from the city and hectic central station in the south to the park and Tölöönlahti bay. At nighttime and during the darker winter months the movement of library patrons circulating on the stairs will draw a vivid impression of the library to the passers-by on both main façades.

fig. 7.4 sun shining through leaves, Turku, Finland

The façade raster of the glass panels is orientated on the column raster and takes up in size and proportion the ceiling heights as well as the façade tiling of the Helsinki Music Hall which is parallely facing the Library's axis facade opposite of the Makasiini park. The glass surfaces have integrated sunscreen to reduce solar gains.

On ground level the building façade is glass wherever there are public functions situated behind it to provide openness and lightness. Public func-





translucent panels in book format proportion, suspended from steel-wires

tions like multi-purpose hall, restaurant and café situated at the façade with possibilities to open up to the exterior.

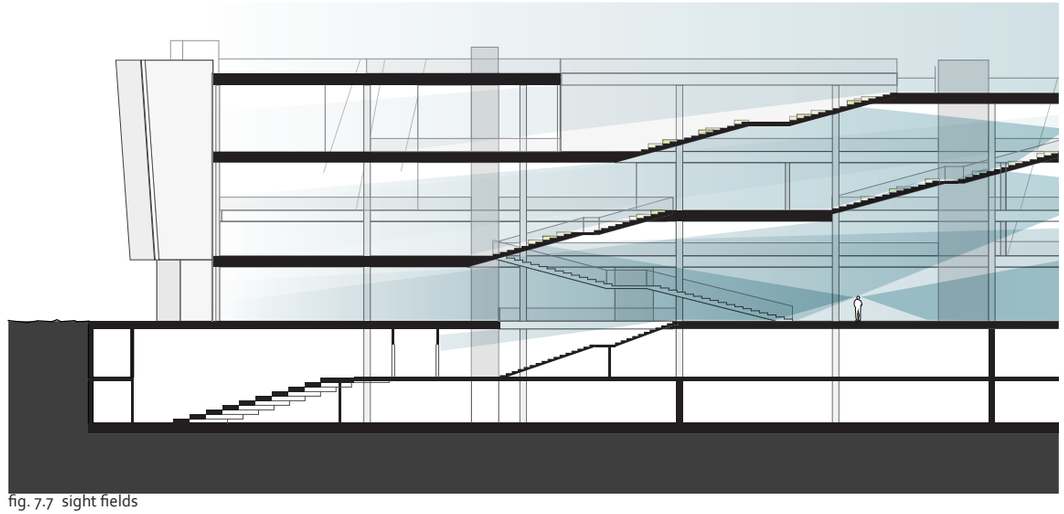
Based on the idea of folding a piece of paper and to contrast the strictly linear layout of the axis and its façades, the façades of the working and activity areas are folded to emphasize certain view directions. Due to the non-parallel crease lines, the facade segments tilt towards the front or back.
These façades are made of glass with a layer of glossy coated translucent GRP (glass fiber reinforced plastic) panels mounted at a distance of 45cm. Being a reminiscence of the library's original core function, the panels take up the proportion of a typical book format. Apart from reducing solar gains, the façade is intended to give the patron more intimate feeling than in the axis areas while evoking the atmosphere of a low setting sun shining through leaves in summertime. Each panel is fixed with 4 wire clips onto two steel wires spanning top to bottom of this façade part with additional fixing on height of each slab.

Opaque facades (sanitary cores, fire escape staircases) are clad with panels of acidified architectural concrete continuing the façade raster of the glass panels.

fig. 7.6 west façade, 1:200

5.5. SIGHT FIELDS

The figure below illustrates the long views on the axis. This helps for orientation and makes the length of the building as well as the presence of other patrons perceivable.



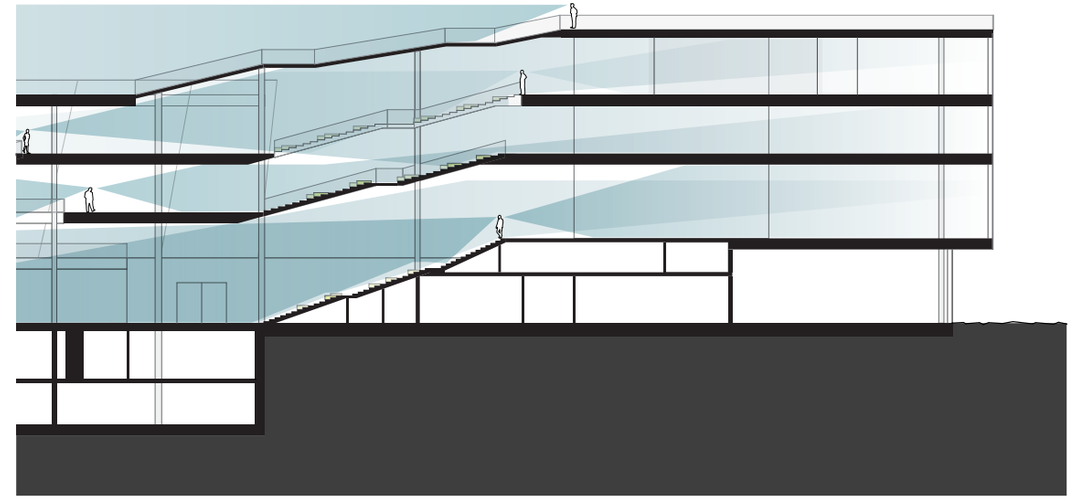


fig. 7.7 sight fields

5.6. MATERIALITY + COLOR

Finish birch wood as been selected as flooring material. This material is used as surface material for both the floor as well as the staircases to express the perception of continuation. The material was chosen because it is a local material, provides a comfortable atmosphere and has pleasant tactile properties so that staircases can also be used as sitting areas without additional furniture. The birch flooring is a very light color in the space and is replenished by white colored walls, columns and book shelves. Very light and reduced colors are being used in order to offer a calm surrounding and for the colorful sitting furniture, the books and magazines coloring the space, the interactive spaces made of colorful materials and the patrons themselves bringing color and liveliness to the space.

fig. 7.8 rendering outside

fig. 7.9 rendering inside

6. Conclusion

My diploma thesis can be seen as an experiment on testing the limits of computational design in the architectural design process. Many analysis methods have been written to analyze existing designs but implementing it in the design process is difficult and often leads to purely formalistic projects. The interesting point is to decide to which extend to rely on these analyses. A parametric analysis can be a justification for design decisions but scepticism is an important part of the work. The result will always be continuous but interesting weighing and questioning.

The question to be answered is: Which value did programming the analysis application *"Finding the perfect spot"* have in this case?
In retrospect I can say that it did not support me in design decisions and the optimization process as much as expected. Still, it had its influence and relevance in several ways:

First of all, having to program the application, forced me to define the spatial qualities that are decisive to me and how they interact precisely. Having these already in mind and running tests on simple scenarios, it is of course already influencing the design process from the beginning on.

Secondly, despite having defined quite simple rules of occupation and interaction, patterns and behaviors emerged, that seemed surprisingly close to reality (groups of similar tasks form themselves; agents do not like to be on their own but also avoid spaces that are too crowded or have to high activity...).

Finally, although I had to modify my initially declared design aims, I can say I succeeded in what I wanted the final analysis to be for my project:
The analysis proofs that the spaces in the library are being well used and no unattractive areas meeting no need exist. Furthermore, the analysis shows that without any descriptions of which space is to be used for which task, areas of certain use can emerge based on spatial qualities and interaction, agents find a spot suiting their task just making the decisions based on spatial qualities.

7. Appendix

LIST OF FIGURES

Except where otherwise stated, figures, graphics and plans are the author's own representations.

fig. 2.1 Library Melk Abbey, Jacob Prandtauer, 1730, http://www.proholz.at/zuschnitt/35/bretter-weise-wissen/ (30.12.2013) 12
fig. 2.2 Library Viipuri, Alvar Aalto, 1935, http://www.studyblue.com/notes/note/n/lecture-20a/deck/6560684 (30.12.2013) 12
fig. 2.3 Seattle Public Library, http://en.wikipedia.org/wiki/File:2009-0604-19-SeattleCentralLibrary.jpg (30.12.2013) 14
fig. 2.4 Expansion of Media Types, Kubo, M., & Prat, R. (2005). Seattle Central Library. Barcelona: Actar, p. 11 14
fig. 2.5 Seattle Public Library, Living room plan and section, Kubo, M., & Prat, R. (2005). Seattle Central Library. Barcelona: Actar, p. 78 16
fig. 2.6 bookspiral, Kubo, M., & Prat, R. (2005). Seattle Central Library. Barcelona: Actar, p. 35 18
fig. 3.1 Park, AUGENKLICK/KUNZ/BERNHARD KUNZ 21
fig. 3.2 influence factors 22
fig. 3.3 functioning of the code - levels of interaction 24
fig. 3.4 functioning of the code - agents evaluating cell properties 26
fig. 3.5 functioning of the code - process of occupation and de-occupation 28
fig. 3.6 functioning of the code - tasks and preferences 30
fig. 3.7 distribution of users over the course of a day a the library 33
fig. 3.8 emerging activity fields over the course of a day at the library | level 0 35
fig. 3.9 emerging activity fields over the course of a day at the library | level 3 37
fig. 4.1 aerial view of planning area 43
fig. 4.2 neighboring buildings, http://competition.keskutakirjasto.fi/extras/docs_en/competition_program_2012_web_16032012.pdf (03.03.2013) 45
fig. 4.3 map Helsinki 46

fig. 5.1 circulation structure 50
fig. 5.2 design concept 52
fig. 5.3 building context - view south-east to north-west 54
fig. 5.4 building context - view north-west to south-east 55
fig. 5.5 visual connections 57
fig. 5.6 spatial program 61
fig. 5.7 analysis 1 perspective input 62
fig. 5.8 analysis 1 floor plans input 62
fig. 6.1 analysis 1 (spaces type 0+1) | visibility 64
fig. 6.2 analysis 1 (spaces type 0+1) | view outside 65
fig. 6.3 analysis 1 (spaces type 0+1) | usage evaluation 66
fig. 6.4 analysis 1 (spaces type 0+1) | usage variety evaluation 67
fig. 6.5 analysis 2 perspective input 68
fig. 6.6 analysis 2 floor plans input 68
fig. 6.7 analysis 2 (spaces type 0+1+2) | visibility 70
fig. 6.8 analysis 2 (spaces type 0+1+2) | view outside 71
fig. 6.9 analysis 2 (spaces type 0+1+2) | usage evaluation 72
fig. 6.10 analysis 2 (spaces type 0+1+2) | usage variety evaluation 73
fig. 6.11 analysis 3 perspective input 74
fig. 6.12 analysis 3 floor plans input 74
fig. 6.13 analysis 3 (spaces type 0+1+2) | visibility 76
fig. 6.14 analysis 3 (spaces type 0+1+2) | view outside 77
fig. 6.15 analysis 3 (spaces type 0+1+2) | usage evaluation 78
fig. 6.16 analysis 3 (spaces type 0+1+2) | usage variety evaluation 79
fig. 7.1 illustration entrance area, floor 0 85
fig. 7.2 illustration bay view, floor 2 87
fig. 7.3 illustration mixing area, floor 3 89
fig. 7.4 sun shining through leaves, Turku, Finland 121
fig. 7.5 folding paper strips 121
fig. 7.6 west façade, 1:200 123

fig. 7.7 sight fields 124
fig. 7.8 rendering outside 127
fig. 7.9 rendering inside 129

7.1. LIST OF REFERENCES

Helsinki Central Library Competition, http://competition.keskutakirjasto.fi/extras/docs_en/competition_program_2012_web_16032012.pdf (03.03.2013)

Arets, W., Beek, M., Boom, I., DeCarlo, E., van Eyck, J., & Savenije, B. (2005). Living Library. München: Prestel.

Hackett, R. (May 20, 2004). The Architecture. Seattle Post-Intelligencer.

Henning, W. (n.d.). Orte der Veränderung - Bibliotheksbauten für das 21. Jahrhundert.

Iwanowski, M. (2008). Finnland. Dormagen: Reisebuchverlag Iwanowski GmbH.

Kubo, M., & Prat, R. (2005). Seattle Central Library. Barcelona: Actar.

König, Reinhard, Simulation und Visualisierung der Dynamik räumlicher Prozesse, Wiesbaden : VS Verl. für Sozialwiss. (2010)

Hauke, Petra [Hrsg.] , Bibliotheken heute!, Bad Honnef : Bock + Herchen (2011)

Edwards, Brian, Libraries and learning resource centres, Amsterdam [u.a.] : Elsevier, Architectural Press (2009)

Leisti, M. (2013, 04 15). Central Library Review Report - The Heart of the Metropolis. Retrieved from http://www.lib.hel.fi/File/2aa4a475-3b90-43b3-ba86-266b7aeeb133/Centrallibrary_reviewreport.pdf

Jürgen Seefeldt, Zukunftsvisionen: Die Bibliothek von morgen, in: B.I.T.online Heft 1/2005: Zukunftsvisionen: Die Bibliothek von morgen, http://www.b-i-t-online.de/archiv/2005-01/fach1.htm, 03.02.2013

Jens Thorauge, Die Bibliothek der Zukunft, in: Büchereiperspektiven 01/04

Statistikcentralen. (2013, 04 15). Statistikcentralen. Retrieved from http://www.stat.fi/tup/suoluk/suoluk_vaesto_en.html

http://en.ilmatieteenlaitos.fi/climate?doAsUserLanguageId=en_US accessed 2013/04/16

http://www.visithelsinki.fi/en/come/welcome-helsinki/climate-and-weather-in-helsinki

Finnish Meteorological Institute. Retrieved 2009-07-08. in http://en.wikipedia.org/wiki/Helsinki, 2013/04/17

http://europaconcorsi.com/projects/225916-Xinjin-Zhi-Museum, accessed 2013/12/30

http://www1.stuttgart.de/stadtbibliothek/druck/b21/b21_rp.htm, accessed 2013/12/30

http://www.duesseldorf.de/stadtbuechereien/information/kundenbefragung2012.pdf, accessed 2013/12/30

Nutzungsanalyse der Hybriden Bibliothek, http://www.b-i-t-online.de/archiv/2006-01/fach2.htm, accessed 2013/12/30