Transformation of Gasværksvejens Skole:

Unfolding the potentials of a Late-Modern Prefabricated Building

> May, 2024 MSc04 Arc19,

MSc04 Architectural Design,

Aalborg University Master Thesis Project

Project period:

01.02.24 - 31-05.24

Project supervisors:

Joel Peter Weber Letkemann

Rasmus Lund Jensen

Group: Msc04 Arc19

Amalie Reventlov Petersen

Clara Skjøth Sennels

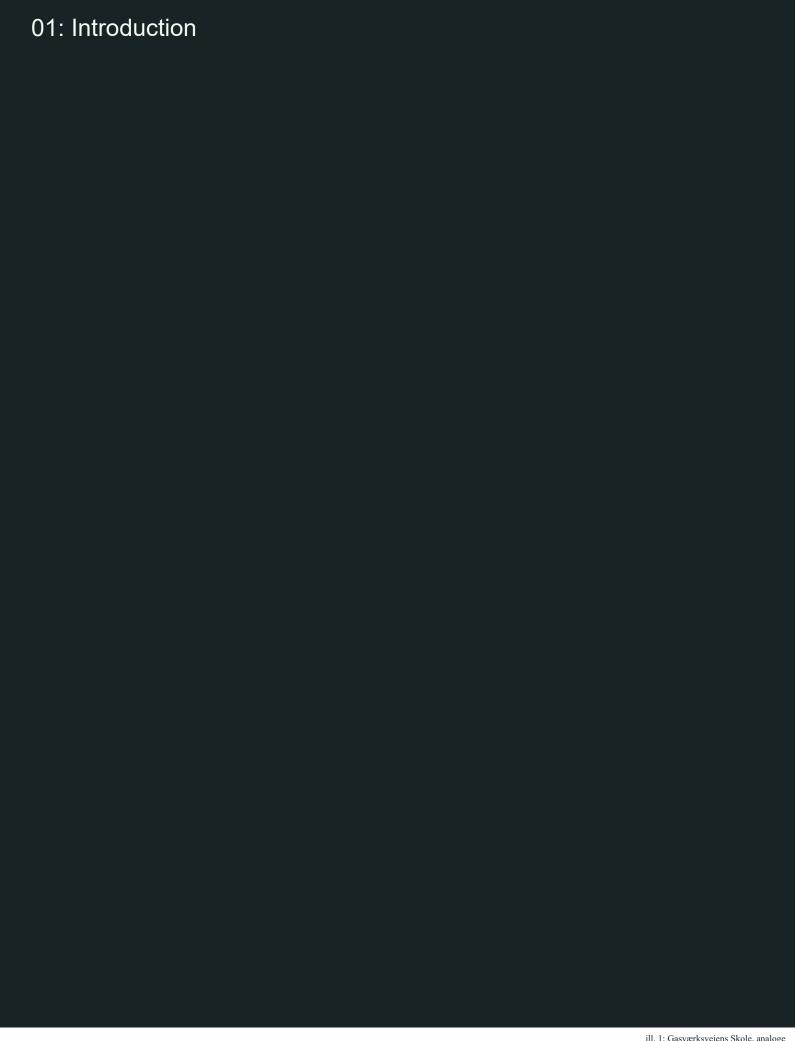
Julie Wienecke Houlberg

Abstract

Late-modern prefabricated buildings have recently become a discussion as many of them have passed the age of 50 years making them potential candidates for preservation. Debates have emerged regarding their architectural, cultural-historical, and resource value within a lifecycle perspective, as well as the health hazards pollutants such as PCB and asbestos contamination. Various stakeholders, including the public, architects, and politicians, hold differing opinions on whether these buildings should be transformed or demolished. This project advocates for the transformation rather than the demolition of such buildings, focusing specifically on the Gasværksvejens Skole addition from 1971 by Hans Christian Hansen. Through an integrated design approach, the project explores the potential of this era's buildings, aiming to preserve their architectural significance while addressing contemporary challenges. Gasværksvejens

Skole addition serves as an example of a building from the period of industrialization. The project highlights the adaptability of modular systems

and the potential for bridging the unique and the universal by transformations within prefabricated structures. a body-scaled system is introduced to humanize the interior space and address PCB contamination. These interventions are designed to remain open for future adaptations as needs evolve, symbolizing a continuous narrative for the building.



Introduction

Late-modern prefabricated buildings* are in recent years being taken up for reconsideration. Many of them have already passed the age of 50 years, and while they can still be considered relatively young buildings, their condition at present generally demands that we take a position on their future. Discussions are raised on their architectural, cultural-historical and resource value in a lifecycle perspective, but also the significance of their health challenges posed by PCB and asbestos contamination. Public, architectural, and political interest and opinions are many and often contradicting, with arguments posed both for and against their transformation or demolition (See Opening reflection).

*Hereafter "Gasværksvejens Skole" will be used to refer to the addition building from 1971 by Hansen.

Transformation of Gasværksvejens Skole addition from 1971*

This project argues for transformation rather than demolition, through exploring the potentials of a building of this era. Specifically dealing with the transformation of Gasværksvejens Skole 1971 addition by Hans Christian Hansen, which will soon be unoccupied. The building is unfolded through analysis as a multifaceted building which negotiates between the universal—the industrially produced pre-fab - and the unique – H. C. Hansen's design.

Welcoming complexity and none definitive design solutions

This project applies an integrated design approach in which complexity is welcomed, in the search for open-ended, sustainable design solutions. The building is analytically 'dissected' into layers, with an aim to understand the multifaceted nature of the building. This is summarised as a value assessment and forms the basis for a palette of transformation strategies suitable for each 'layer' - rather than proposing any singular, definitive transformation concept. In some cases, preserving what is materially there, in some cases preserving a design idea and in other cases introducing new design elements. What establishes a coherence between these various strategies are three main concepts, formed throughout the design process:

Main design focus areas

Open-ended transformation into a valued, human-scale building

Engaging with and revealing the potentials of the prefabricated system

PCB remediation and healthy indoor climate

Engaging with and preserving the architectural principles and ideas articulated by Hans Christian Hansen

Main architectural interventions

The concrete architectural design answering to these concepts, deals with mainly two interventions.

A facade renovation that balances demands of indoor climate, energy efficiency, lifecycle perspectives and architectural expression. The renovation entails an internal post-insulation of the existing prefabricated concrete panels, replacement of the windows and brise-soleil-facade structure. In dealing with reduction of overheating in the summer period, the intervention becomes a significant means of PCB remediation.

The introduction of a 'body-scaled' system, that immerses itself in the logic of the existing modular system and subdivides it into a scale that relates to the human body. It forms light walls, storage, seating and paneling, that mediate between the universal character of the modular spaces and specific and varying programmatic needs. It makes the contaminated walls approachable, by implementing a mounting system, so that users can again hang and mount elements on the wall without breaching the PCB sealant.

The system consists of bio-based elements, that add a natural layer to the interiors, that are otherwise defined by (PCB) sealed prefabricated concrete. The hard and sleek surfaces are thereby supplemented with the organic, soft, nature of the system. This is intended as a means to 'soften' up the spaces on an emotional level and serves to improve the indoor climate of the spaces, by responding to acoustics, daylight and moisture conditions. By protecting PCB sealants and integrating a concept for absorbent materials of PCBs, the body-scaled system supports PCB remediation of the building.

A comma, not a period.

Any intervention is designed for the building to remain open for future elaboration as new needs arise. The transformation is intended as a comma, not a period in the circular story of the building.



ill. 2: working with the 1:5 detail model

As newcoming architect-engineers

As architect-engineers motivated to participate in sustainable building practices, dealing with the transformation of a late-modern prefabricated building raises valuable design questions that challenge us on our creative, analytical and technical design competencies. In the process of learning to understand and transform the Gasværksvejens Skole, we also ask what we can learn from the late-modern industrial building culture; both reflecting on its pitfalls, especially the implications of PCBs and asbestos (with the benefit of hindsight). But also in what ways this design thinking was productive, and worthwhile elaborating upon.

As an argument against the demolition of Gasværksvejens Skole

The thesis is also intended as a contribution to the discourse on Gasværksvejens Skole and decision-making regarding its future. With the aspiration that the project through its analysis of its qualities and exploration of its potential to be a healthy, flexible building can speak in favor of its preservation.

As a homage to Hans Christian Hansen

Since there is little written material on H.C. Hansen's work, we mainly have his architectural works to tell the story of his practice. We deem the Gasværksvejens Skole by Hansen a valuable heritage, showcasing his unique way of making architectural gestures with humble materials, by paying great attention to detail and scale. We wish to learn from these qualities and work within his design thinking, by immersing ourselves in the transformation of Gasværksvejens Skole.

As a contribution to a broader discourse on late-modern architecture

Further the aim is to contribute to the broader discourse on sustainable transformation of late-modern prefabricated buildings. Both in the light of its topicality and the vastness of this building mass, which makes it a relevant and important design question. Specifically this project aims to showcase how an integrated design approach that embraces the complexities and dilemmas of these buildings can be productive. And how a sensibility to the building in question; a curiosity to understand it before intervening, and a deliberateness in where and how to intervene, can be a relevant design position for sustainable transformation of modernist industrial buildings.

Definition of terms

Late-modern prefabricated buildings:

This term is used to refer to buildings of the late-modern period that were constructed in prefabricated concrete elements, approximately in the period 1950-1980.

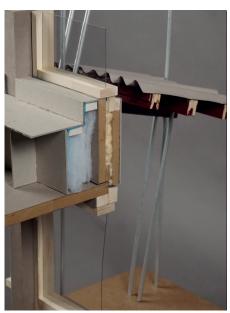
A comma, not a period.:

Describes a design position that speaks in the favor of circularity.

That a transformation shouldn't 'fix a building in time' and limit its future use and flexibility, but instead allow for future elaboration (other transformations), allowing greater flexibility in the long term, and therefore possibly a longer lifespan altogether.

Gasværksvejens Skole:

This term is used in the report to refer to Gasværksvejens Skole's addition building from 1971 by Hans Christian Hansen. That means the project does not address the 1880 building, which is also part of the school.



ill. 3: 1:5 model with internal insulation



ill. 4: 1:20 model of universel / unique



ill. 5: 1:100 model of a modular story

problem statement

How might we uncover the potential of Gasværksvejens Skole through exploration: balancing its heritage with contemporary needs, addressing health challenges of PCB contamination, and fostering an open-ended approach for future adaptability?

Project scope

The framework and question of how to approach Gasværksvejens Skole and late-modern prefabricated buildings is complex and many-faceted, including political, social, cultural, emotional and technical perspectives. We seek to embrace this complexity in our design process and our search for solutions – in other words an integrated design process with a holistic approach to sustainable design, which we believe will contribute to the meaning and relevance of the project.

However, to 'strengthen' the project and allow an in-depth exploration of selected areas, it is crucial to define the scope of the project, by prioritizing the topics dealt with. The four main themes of the project is outlined as:

Open-ended transformation into a valued, human-scale building

Engaging with and revealing the potentials of the prefabricated system

Engaging with and preserving the architectural principles and ideas articulated by Hans Christian Hansen

PCB remediation and healthy indoor climate



Opening reflection:

"Preservation, demolition, transformation: What do we do about the post war building stock?"

As an initiator for the project work, we pose the question; "What do we do about the late-modern prefabricated buildings?", reflecting on the consequence of preservation, demolition or transformation of them.

The (overlooked) preservation value of postwar buildings

The preservation value and potentials of postwar buildings are often overlooked. A tendency that has been highlighted in architectural discourse in recent years (Arkitektforeningen, 2022, Zøllner, 2022).

The tendency shows in the skewed distribution of listed buildings across Denmark, with respect to their year of construction, where only 66 are from the period 1951-2021*. Considering the quantity of buildings constructed between 1945-75 which make up more than a third of the Danish building stock (Asmussen et al., 2022), their underrepresentation is evident.

Typically, a preservation assessment is only done for a building 50 years after its construction (Slots- og Kulturstyrelsen, 2024). This means that buildings constructed up until 1974 are currently possible cases for listing in current practice. As they are still not represented, it underlines the topicality that we now evaluate their value and their role in a future sustainable development.

The representation of postwar buildings is also skewed on a social level, as the listed buildings are mainly located in North Zealand and made up predominantly by villas or row houses (Slots-og Kulturstyrelsen, n.d). This image seems to include only the architectural history of a limited, 'high society' regarding this period.

But how do we judge their value and what is the meaning of aiming at a more representative approach in the selection of listed buildings? Is it simply the case that post war buildings generally aren't worth preserving? What are the arguments for preserving the post war building stock?

A new strategy for listing of 20th century buildings

A strategy published by Det særlige Bygningssyn pushes the agenda of a more comprehensive listing of 20th century buildings and focuses especially on the postwar period (Asmussen et. al, 2022). They describe listed buildings as characteristic symbols that tell the history of the development of Danish society and architecture. With this viewpoint they argue the relevance of a listing that is more representative, supporting the notion that listed buildings include all communities and the buildings that portray their story. Representation is also an objective of The Danish Preservation of Buildings Act:

"[...] The purpose of the Act is to protect the country's older buildings of architectural, cultural-historical or environmental value, including buildings that shed light on living, working and production conditions and other significant features of societal development." (Kulturministeriet, 2018, translation by author)

*Number of listed buildings: Before 1850: 2997 1851-1900: 528 1900-1951: 270 1951-2021: 66 (Asmussen et al., 2022).

Architecture of a welfare state

The strategy by Det Særlige Bygningssyn highlights nine themes that describe central traits in the development of Danish 20th century architecture and society. They are intended to guide the forward selection of listed buildings that can relate to one or more of the themes. The selected themes include amongst others 'Community and Citizenship', 'Building materials, Building culture and Sustainability', and 'Welfare state and Welfare society' (Asmussen et. al, 2022). Themes that illustrate a building culture influenced by new ideas of welfare, community and democratization, and an intention to meet the citizens at eye level. Simultaneously, a building culture that was revolutionized, with prefabricated concrete becoming the main building material (Asmussen et. al, 2022). The large scale of demand for dwellings and welfare buildings, together with the enablement to construct at such scale and tempo, fostered one of the most productive periods of Danish buildings industry, with around 1,5 million buildings constructed between 1950-1980 (Sverrild, 2008).

An impersonal building culture

Beyond how the change in building culture contributed to the construction of this extensive quantity of buildings, what about the individual contribution to it? With the introduction of the prefabricated building materials, the craftsman's role took a back seat to the industrialized practices, and a similar tendency applies for the individual architects of the period (Sverrild, 2008). While there are prominent danish profiles from the period; Jørn Utzon, Arne Jacobsen, Halldor Gunløggson, Friis & Moltke (Sommer, 2014), there has been a tendency to tone down the personal angle of the architect's role, when discussing modern buildings, in line with the tendency for the bigger scale, social perspectives of the period (Sverrild, 2008). Kulturarvsstyrelsen highlights this trend by pointing out that not one architect was mentioned in a 40th anniversary publication by the big Danish social housing company, Lejerbo, that describes no less than 22.000 housing units (Sverrild, 2008).

Challenges and negative stories of late-modern prefabricated buildings Possibly, this lacking personal link between architect and building, plays a role in our inability to relate to these buildings today. For, their value in a cultural heritage viewpoint doesn't entail that they are valued in people's day-to-day experience. They still take part in most people's everyday lives, and many have strong opinions about them. Today, many of the welfare buildings have eventually acquired a bad reputation (Sverrild, 2008). While their rationality solved essential problems of their time, the experimental character of these buildings poses challenges in the possibility of transforming them today (Sverrild, 2008).

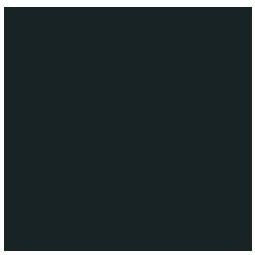
"That significant changes over a short period of time do not happen without problems. All the positive and central parts of the physical welfare project are under attack these years. What made the extensive construction possible and formed the framework for welfare development is up for discussion: Standardization, industrialization, anonymization, division of functions, democratization, rationality, geographical spreading and social integration"

(Sverrild, 2008, p. 63, translated by author).

Beyond negative associations on an experienced, emotional level, large numbers of buildings from the period contain materials with environmental hazardous substances, including asbestos and PCB-toxins (KILDE). A serious issue and one that can only add to their negative story and make their social welfare ideas harder to recognize when looking at them today. These substances make up a core problem, in the design task of their possible transformation in the coming future.

The (problematic) demolition of late-modern architecture

The challenges of the post war buildings also put them at risk of demolition (Sverrild, 2008). The welfare institution buildings from the period are prone to attrition and at risk of becoming unoccupied (Kulturarysstyrelsen, 2008),



ill. 7: Gasværksvejens Skole in the 1970's

which has a negative impact on their preservation value (Asmussen et. al, 2022).

If the value of these buildings is not articulated and assessed, whether that be in debate, listings, or SAVE assessments, it opens to the possibility of their demolition on a wide scale.

"In contrast to protected and preservation-worthy buildings, everyday architecture is not safeguarded, and it is easy for owners, developers, architects, and ambitious city councils to dream big ideas that just require a quick demolition." (Lindberg, 2024, translated)

This tendency is already seen in effect when looking at the transformation plans of Danish late-modern social housing complexes, that entail extensive demolitions with social improvement objectives (Midtiby and Mortensen, 2021). In other cases their demolition is argued on the basis of their health challenges, as is the case of Brøndby Strand*, where five high-rise blocks were recently torn down owing to PCB contamination. A demolition project, that makes up to be the biggest in Danish history, with 30.000 ton of PCB contaminated concrete sent to the Netherlands to be decontaminated (Andersen, 2024).

Brøndby Strand was contsructed 1968 til 1974 (Andersen, 2024)

Demolition provides us with a much simpler tabula rasa design basis. The opportunity to leave the late-modern buildings behind and design only with contemporary building standards and practice in mind. To start anew with healthy buildings that are 'likeable' today. But several of the problems that the modernist buildings tried to answer, we are still faced with today when designing everyday architecture; economic limitations and the challenge to create architectural quality within the building practice of mass-production' (Beim and Hvejsel, 2016). With the need to adapt and mitigate climate change, more are adding to the list. This makes the strategy to demolish questionable.

Have we learned the lessons that the late-modern prefabricated can teach us before we get rid of them? Have we now cracked the code of making relatable and appreciated buildings – in the long term – within an industrialized building practice? Or are we simply engaging in a cycle of hastily constructing on a wide scale to then again demolish? Can the way we handle the late-modern prefabricated buildings set the tone for next time we have a building stock that falls into disfavor - what could likely be the destiny of buildings constructed today?

With 2-3 million m2 of existing building stock demolished and 6 million new constructed in Denmark each year (Pedersen, 2024) accounting to 5 million ton of waste produced by the Danish building industry each year (Realdania, Teknologisk Institut and VCOB, 2021), the scale of it alone gives rise to reconsider if there are other answers to the challenges that serve as motivation for demolitions.

Anti demolition agenda and life cycle perspectives

The problems of demolitions are voiced both in Denmark (Andersen, 2023, Muelas, 2019, Reetz, 2024) and 'neighboring' countries. In both Germany and Switzerland, where demolition also produces big quantities of waste,

'Abriss atlases' have been developed. They map out demolished and 'demolition-threatened' buildings all over Germany and Switzerland, aiming to make the vast extent of demolitions more tangible and call for change toward a higher degree of maintaining, converting, and reusing of the existing (Architects for Future (A4F), n.d., CORRECTIV CrowdNewsroom gGmbH, n.d.).

Others challenge the notion that the preservation value of a building is only regarded beyond a specific age (50 years) and speculate in the reverse scenario: that any building would be considered listed until an age of a 100 (Christensen, 2023) or by default, and its demolition only permitted with strong justification (Lindberg, 2024). Like the 'preserve or explain' position, that suggests a shift in Danish building legislation and district plans, so that preservation potentials are always considered first (Pedersen, 2024). Arguments for preservation that relate closely to the perspective of Life Cycle Assessments, although these consider buildings over a 50-year timespan (Social- og Boligstyrelsen, 2023). In this perspective the integration of late-modern prefabricated buildings in our future development is just as relevant.

"Action occurs when we can concretize the potentials of our existing building stock and envision what it can become to meet new needs. Analyses and calculations show that, both economically and in terms of CO2 emissions, preserving, renovating, and maintaining our buildings is the right solution." (Pedersen, 2024, translation by author)

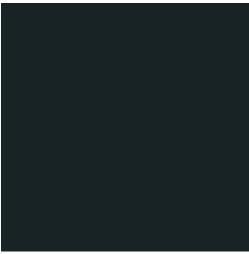
Potentials for recycling and adaptive reuse

How can post war buildings be integrated in future development? Today, a bit over a third of building waste is reused or recycled in some way, however a big part of it is only utilized as a low-quality product; e.g. by crushing building materials to be used for road construction (Realdania, Teknologisk Insitut and VCOB, 2021).

A report published by Miljøstyrelsen presents an analysis and proposal for implementation of selective demolition* in the Danish building industry. The motivation behind the report is to recycle building waste on a higher level in the waste hierarchy** and to ensure correct disposal of building waste, that contain environmental pollutants. With regards to the economic incentive to reuse building waste in favor of using new materials, the report concludes that the potential is bigger for buildings constructed in brick than concrete. That means late-modern prefabricated buildings have a smaller potential for (high level) reuse, both due to their high level of concrete and their potential of containing environmental poison (Miljøstyrelsen, 2022).

Regarding the utilization of their material resources, this lacking potential for reuse, points toward the need of more direct reuse strategies; adaptive reuse.

"If we develop strategies for how we can let buildings and plans convey the history of the period, then we also get an idea of how much or how little it is desirable or necessary to preserve to make it possible to tell the story. Recycling of defunct buildings, also from this period, is already a theme, and it can be a way forward if we want to preserve the essential values in the welfare society's buildings." (Sverrild, 2008, p. 70, translated by author)

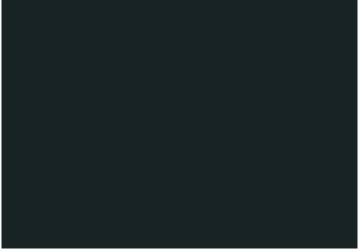


ill. 8: demolition in Brøndby Strand

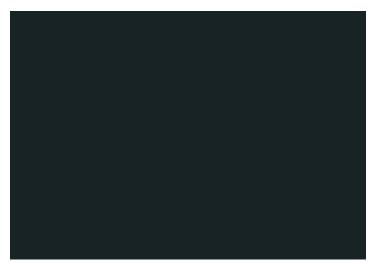
*Demolition of a building in a manner that ensures that its materials can be sorted correctly and reused or recycled in the best possible way and that materials containing environmental hazards are disposed correctly.

(Miljøstyrelsen, 2022)

**The closer to its original function a material is reused or recycled, the higher in the 'waste hierachy' (Miljøstyrelsen, 2022)







ill. 10: Gasværksvejens Skole anno 1880

Gasværksvejens Skole: A unique building exemplifies a general picture

The Annex of Gasværksvejens Skole from 1971 stands in many ways as a unique building that exemplifies the practice of architect Hans Christian Hansen (Hansteen, 2023). But it also stands as a prime example of the outlined tendencies and challenges.

The school consists of architecture from various periods, mainly a building from 1880 and the addition from 1971. The school is not listed but has some SAVE-assessments. The building from 1880 is assessed with a preservation value of 3 (high)* Part of the addition, facing Eskildsgade, has a preservation value of 5 (medium), while the sports hall is not assessed (Slots- og Kulturstyrelsen, n.d.).

As it is designed for a public school it is a representative of the welfare-state architecture that was widely built in its period. The school was built as part of the montage plan 'Fynsplanens skoler', that accounts for 90 schools constructed in Denmark (Andersen, 2013). So, the 1971 addition also exemplifies the prefabricated building practice that is characteristic of the period.

Since the school is moving out in the coming year (2025) (Københavns Kommune, 2024), it exemplifies the trend that buildings of its kind are at risk of being unoccupied, and the problems that this poses for their preservation. This underlines that the need to reevaluate its value and potential is pressing. The building also exemplifies the extensive problem with environmental pollutants in buildings of its period, as it is contaminated with PCBs and has fiber-cement roofing containing asbestos.

Hans Christian Hansen being an unknown name outside some 'architect-circles' (Hansteen, 2023) exemplifies the tendency that the individual architect's role took a backseat in the vastness of buildings that they contributed to. The relevance to open our eyes to his works is further justified given that his practice has recently been studied in the PHD 'The works of an architect' (2023) by Aida Espanol Vilanova.

Hansen's project Ringbo was recently demolished (Buus, 2022), despite appeal from Arkitektforeningen (Arkitektforeningen, 2022) highlighting its architectural value and proposing transformation rather than demolition. How can we image a different fate for Hansen's Gasværksvejens Skole Addition, that preserves its unique architectural, and cultural value and thus also prevents its material resources wasted?

SAVE preservation value scale:

1-3: High

4-6: Medium

7-9: Low

Methodology of an integrated-design process

The Integrated Design Process

To create a sustainable intervention in the intersection between architecture and engineering, the Integrated Design Process (IDP) by Professor, Mary-Ann Knudstrup, has formed the framework as the overarching descriptive methodology for structuring the thesis. This holistic and cyclical approach, alternating between the method's five phases* in an integrated, iterative process, ensures that the disciplines and phases are combined and inform each other throughout the thesis (Hansen and Knudstrup, 2005).

*problem, analysis, outline, synthesis, and presentation

A quantitative / qualitative approach

The Integrated Design Process is combined with a dualistic approach to all phases of the thesis, including both quantitative and qualitative analyses and arguments. This includes e.g. desktop analyses of the context, mappings, and altering between LCA* calculations, BSim simulations of indoor climate, daylight simulations and Be18 calculation of the energy-frame as quantitative aspects. The qualitative aspects include interviews, case studies, on-site experiences, valuation methods*, light studies, and workshops. These complementary approaches are used in all phases of the thesis, as neither the measured nor the immeasurable can be dispensed within a comprehensive architectural intervention.

*Life Cycle Assessment

*SAVE-metode og Strategi 2022

Be18 calculation and BSim simulations

Design tests for the facade renovation are simultaneously tested in Bsim and BE18 (Appendix B-J), with the purpose of providing an understanding of the total energy frame of the building (BE18) while also considering the impact of interventions on indoor climate on room basis (Bsim). First the building is modelled in its existing state and simulated for its existing program and ventilation (Appendix A). A new test-program is chosen, a multi-room for Reden, as it is occupied for many hours during the day, and thereby represents a suitable 'stress-test' for the building. With the introduction of the new test program a new ventilation setting is also defined, with variable air supply and night cooling (Appendix B). This case represents the benchmark for all design tests. The Bsim model defines a 'normal classroom' of four modules and 60 m2 on the 1st floor.

Critical analysis, reflection and positioning

Every project is created from a standpoint or position. Therefore, it is important for the thesis' relevance to address and reflect on its position and acknowledge the biases and perspectives associated with it. To prevent this from creating limitations or a 'tunnel vision', it has been essential for the thesis, through a critically reflective and analytical approach, to consider that our perception and perspectives as architecture students may vary from other potential viewpoints. In relation to this, it is crucial to both identify and engage with other stakeholders in the thesis to ensure a comprehensive understanding - including a consultant from the Copenhagen Municipality, an employee from BUILD, an expert in harmful substances in construction, an expert in the remediation of PCB, as well as representatives from Reden,

Vesterbro Local Committee, and Gehør.

Valuation as a method

As the project concerns the transformation of an existing building, it is essential to utilize and deploy methods to understand and assess the potentials within the existing building. The project relies on the foundation of evaluation and valuation on the SAVE method, utilized by the Danish Agency for Culture and Palaces to identify the architectural, cultural-historical, and environmental value, originality and condition, and thus whether the building has preservation potential (Kulturministeriet, 2024).

However, the SAVE method is elaborated and rephrased, and technical aspects, such as environmental pollutants, indoor environment and energy, are added to make the evaluation a comprehensive tool for unfolding potentials and strategies for possible interventions. The SAVE method views the building as an architectural outer 'shell', but in this thesis the building is dissected to analyze and valuate different building layers. In this way, strategies for intervention on various building layers can be varied.

Based on each dissected building component, a sub-conclusion is attached consisting of an evaluation diagram that visually indicates the assessed potentials of the building layer based on the categories*, a design strategy based on architect and professor Nicolai Bo Andersen's method subtract - reconstruct - repair - transform - add, and design questions that together form the basis for the focus areas of the design phase and thereby a direction for our interventions - transformation strategies.

Unfolding transformation potentials through methods

Subtraction removes material, reconstruction reinstates something, repair fixes the existing, transformation changes the existing, and addition constructs new structure (Andersen, 2015, pages 82-83). This division of transformation strategies in the analysis phase has provided a clear and distinct direction for the design process.

Additionally, his method landscape - still life - portrait is used to investigate architectural characteristics and subsequent interventions on a large, medium, and small scale, both in the analysis and design phases, ensuring comprehensive registration, analysis, valuation, and architectural interventions. Landscape* addresses the building's relationship with its context. Still life* focuses on the building's scale, while portrait* examines detail and material qualities (Andersen, 2015, pages 77-78).

These levels of scale are translated in the project to the work of understanding assemblies and transitions between elements. Both in an analytical model of a facade element in 1:5 and by keeping the detail in mind in the design process, understanding the building's modularity and introducing a 'body scale' system experienced in 1:20, while the relationship between the building and the city is examined in 1:100.

*architectural, cultural-historical, environmental, originality, condition, harmful substances, indoor environment and energy

*typically scale 1:500, 1:50 and 1:5



A theoretical frame: Positions and strategies in transformation

This theoretical chapter uncovers and explores renovation and transformation from a historical perspective, contemporary positions, and approaches, as well as references of transformation approaches applied to buildings from the post-war period.

A Historical Perspective: Early Thoughts and Theories on Transformation and Restoration

Adapting existing buildings for new purposes is not a new phenomenon. Historically, buildings have been adapted and utilized for new purposes, needs, and functions over time. However, these transformations were often carried out based on economic or functional requirements and to a lesser extent concerning the preservation of cultural heritage (Cleempoel and Plevoets, 2019, page 7).

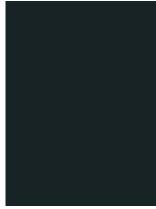
This changed in the mid-1800s when attitudes towards restoration and transformation garnered theoretical attention. Two distinct positions, considered to constitute the poles of classical transformation theory in terms of the degree of intervention - maximal and minimal respectively - emerged during this period (Andersen, 2015, page 34).

The French architect and theorist, Eugène Viollet-le-Duc, considered the architect's task as understanding the language of the existing building in detail and the original architect's vision before the restoration began (Andersen, 2015, page 34). With this understanding of the building's intention and spirit, he believed that it was not only about preservation but also about completing and/or enhancing the building through creative reconstruction. According to Viollet-le-Duc, this could be achieved through the addition of new elements or alterations to the existing structure using new technologies and materials. Thus, one should create a strengthened integrity and aesthetics with the opportunities that development provided to fulfill the original architectural intention (Renauld, 2021).

Viollet-le-Duc put his theory into practice in the mid-19th century both in the renovation of Notre-Dame in Paris, where he added a new spire that was not part of the original building, and also in the renovation of the Chateau de Pierrefonds, where he expanded the castle's structures and added towers, spires and decorations that were inspired by the castle's original era, but also marked by his own aesthetic vision (Moore, 2022).

In contrast to Viollet-le-Duc's restoration movement, was the English art historian, John Ruskin, who emphasized the original material and the traces of time as primary in his anti-restoration or conservation movement. He introduced the idea of time as a player in the development of architecture and emphasized the importance of preserving the original substance and character of the building, including decay and patina, as an integral part of the building's history (Andersen, 2015, page 34). According to this movement, the building should be allowed to exist on its own terms and Ruskin saw any attempt to 'optimize' an existing building as a form of cultural arrogance (Cleempoel and Plevoets, 2019, page 11).

Viollet-le-Duc and Ruskin acted as opposites in their fundamentally different attitudes towards transformation and renovation, which can be reflected upon as a deeper philosophical division regarding how architecture and history are valued and preserved.



ill. 11: the spire of Notre Dame

Rethinking Architectural Preservation: Embracing Palimpsests in Contemporary Contexts

Nevertheless, the early positions were focusing on historical buildings (Cleempoel and Plevoets, 2019, page 28). But the question is whether, in a contemporary context, there is a need for a more nuanced understanding of the relationship between historical and new architectural interventions and means of action (Harlang, 2020).

In contrast to Ruskins conservation-oriented monumentalization as a strategy, the building can be understood as a palimpsest*. This metaphor implies that the new entity acknowledges and engages with the structure as a layered narrative, where contemporary architectural layers/interventions can overwrite, reveal, or hide previous architectural layers (Cleempoel and Plevoets, 2019, page 30).

With this idea of architecture as a continuous movement, contemporary perspectives also move further away from a view of architecture as unchanging, where one must not add or remove without weakening the work. By acknowledging the architecture as something more uncomplete - the existing building will co-exist and interact with the added elements with mutual respect and complexity (Harlang, 2020).

Contemporary Perspectives and Positions on Transformation

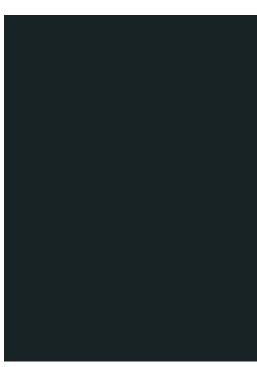
Where transformation was previously a dogmatic discussion - between the old and the new - today it is less about the building as an object delimited by a specific period, but more about how, through transformation intervention, one connects the past and the future (Andersen, 2015, page 32).

One of the Danish architects who has since positioned himself within the field of transformation is Johannes Exner, who, in his work with transformational architecture, aligned with and built upon the classical approach within the field. He used the contrast between the existing and new architectural elements as a consistent architectural motif in his work. The approach is based on a 'status quo' principle, where the added elements must not in any way compromise the integrity of the existing and leave it intact (Andersen, 2015, page 34). Methodologically, he worked with four 'keys' - originality, authenticity, identity and narrativity (Andersen, 2015, page 34). An example of this position is the renovation of the castle, Koldinghus, by himself and his wife, Inger Exner, where all phases of the castle's history are preserved visibly. This is achieved through a division in e.g. materials, where only modern materials such as steel and laminated wood are used, distinguishing from the original materials (Danish Architecture Center, 2024).

This approach can be characterized by respect towards the existing; however, the simultaneous desire to create a contrasting effect between old and new can lead to a forced attempt, and in the attempt to express this temporal difference, there is a risk of ending up with a monument or museum that lacks a connection between the old and the new, rather than achieving a living architectural work (Andersen, 2015, page 34).

Architectural researcher, Fred Scott, argues that the transformation must aim to be part of the development, but at the same time, architectural interventions must refer to the building's intended and 'ideal' form. The building is, therefore, dynamic, and the architect must aim for the work to hover between completion and incompleteness. Scott states that transformation is about creating 'incomplete perfection' (Andersen, 2015, page 34).

*a manuscript or a parchment roll, where parts have been scraped away to make room for new additions with new meanings



ill. 12: Koldinghus

ill. 13: Facade towards Istedgade



ill. 14: Gasværksvejens Skole canteen

How are late-modern prefabricated buildings approached in transformation?

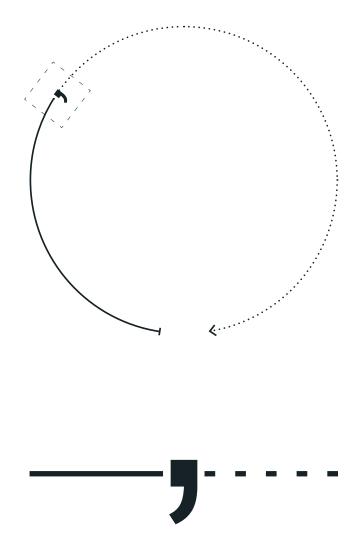
An overview of the waves of renovations and the associated strategies A large proportion of the vast building stock that emerged in the post-war period has undergone several renovations since their construction. Already in the late 1980s, many of the post-war buildings underwent renovations. This was often due to problems with construction, but because of the advent of postmodernism, there was a greater desire to change the architectural expression in the renovation (Bech-Danielsen, 2015, page 20). The post-modern criticism of late-modern buildings focused on the often repetitive expression and the industrialized, gray concrete, which was frequently concealed under a more colorful facade cladding, as well as the addition of ornamentation (Bech-Danielsen, 2015, page 21).

In the 2000s, many late-modern prefabricated buildings had to be renovated again, as the material quality of the original structures and their first renovations often were low. These renovations were often characterized by both stylistic and tectonic changes, as a radical response to the post-war industrial expression (Bech-Danielsen, 2015, page 22). Introducing completely new design principles and tectonic expressions to these buildings often weakened their architectural strength (Bech-Danielsen, 2015, page 24).

At the same time, a strategy was formulated in the mid-1990s, without the intention to reject the industrialized tectonics and expressions of the post-war period. The existing was considered as an integral part of the cultural heritage of the welfare society, while also directing focus towards contemporary building requirements. This required a change and adaptation that did not involve erasing architectural narratives and traces, but rather preserving them and added new qualities. The approach insisted on exploring the potential and qualities of the existing, while supplementing with new elements. The challenge was not to create a new architectural expression on the facade, but rather to generate architectural qualities that provided users of the building with improved spatial relationships and experiences, optimized daylight conditions, views, etc. (Bech-Danielsen, 2015, page 27)

In the transformation of late-modern prefabricated buildings, it is therefore crucial to consider the previous renovations the buildings have undergone (if any) and understand the layers of these changing renovation strategies and their significance. If new elements are introduced based on a new architectural idea or intervention, there is a risk that the existing structure may not interact and harmonize with it. This can lead to different elements working against each other and create challenges in developing a convincing architectural intervention (Bech-Danielsen, 2015, page 30)

This represents an approach that avoids a complete reset and instead implements strategies that add new layers of meaning to a mindset characterized by layer-on-layer complexity, and the transformed building will thereby reveal its layers of time (Bech-Danielsen, 2015, page 31). In this way, our transformation **becomes a comma, not a period.**



A comma,



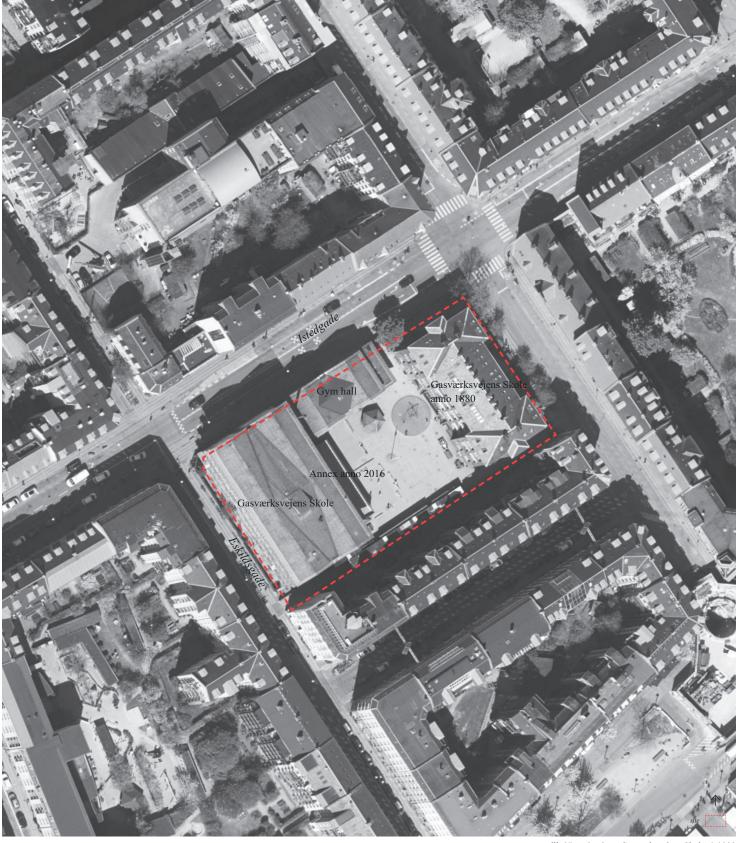
not a period.



1 out of 90: a modular school building

ill. 16: orthophoto of Denmark

Gasværksvejens School, anno 1971, is used to exemplify the potentials and challenges relevant to the school as a specific building example, but which can also, to a large extent, be translated to a larger context – namely the remaining 89 schools that are also part of Fynsplanen. Common to them are the challenges with environmental pollutants (Andersen, 2013), the potentials in the modularity, and the 'honest' and circular building system from which they are all constructed.



Gasværksvejens Skole

ill. 17: orthophoto Gasværksvejens Skole, 1:1000

The school consists of two building volumes, namely the 'red building' with high conservation value, constructed in 1880, and Hans Christian Hansen's addition from 1971 with medium conservation value, except the sports hall, which holds no conservation value. In total, the buildings have a gross floor area of 6300 m2, resulting in a building density of 162 percent on the site, which has a site area of 3881 m2. The site is not subject to a district plan, but the site is designated for public use* (Vesterbro Lokaludvalg, 2024).



Opinions and interests

When Gasværksvejen Skole relocates in fall 2024, the old school buildings will lose their welfare-generating purpose and will be left 'functionally empty' (Vesterbro Lokaludvalg, 2024). Consequently, they are also at risk of demolition if the future functional program does not align with the existing structure. The municipality has formed a team that has conducted an investigation into whether the building can serve as the framework for a retirement home as a future function – and if not, whether the building should be demolished. This function is justified by the need for more retirement home spaces in Copenhagen, but one might question whether this is the right function in the middle of the bustling Istedgade. In an interview with a consultant from Copenhagen Municipality, we learned that the PCB challenge plays a crucial role in the decision on whether to preserve or demolish the building.

Apart from the municipality's interest in creating retirement homes – regardless of whether it requires demolition – the public has divided opinions about the building's aesthetic and future life.

When encountering the building, one might also be uncertain about what to think due to its neglect and wear. Both teachers and students at the school asked us during our site visit why their school was interesting for this thesis.

While the general public opinion is largely marked by a negative discourse towards Gasværksvejens Skole, which is also evident in the comments on Facebook, architects are writing articles stating that 'Proper programs save old buildings' and that 'Gasværksvejens Skole is threatened by demolition.'



Navigating PCB

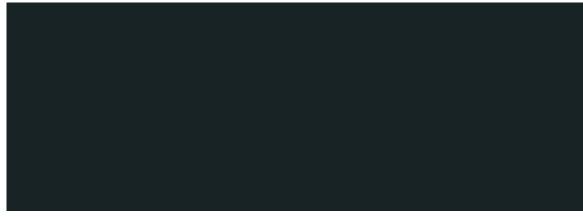
A technical perspective /

Polychlorinated Biphenyls (PCBs) are hazardous and persistent environmental pollutants. PCBs were legally used as plasticizers in building materials such as sealant, adhesives, paint, and thermal sealants in double-glazed windows from 1950 to 1977, which is called the 'PCB period' as the widespread of prefabricated concrete elements also led to the prevalence of PCB-containing sealant (Andersen, 2015).

In 1977, PCBs were included in the global Stockholm Convention on Persistent Organic Pollutants (POPs) ('PCB er et giftigt stof', n.d.), and their use in building materials was consequently prohibited. PCBs are considered the 12th most dangerous environmental pollutant globally. It does not cause acute illness, but if a person is frequently exposed to the substance over an extended period, it can act as an endocrine disruptor and carcinogen.

In 2009, the Danish Health Authority announced action levels, related to institutional buildings:

If PCB levels in indoor air are 300 ng PCB/m3 or below, it is not considered harmful to health. If PCB levels in indoor air are between 300-3,000 ng PCB/m3, prolonged occupancy is harmful to health, and temporary measures should be taken, such as increased ventilation and cleaning, until an appropriate solution is found. If PCB levels in indoor air exceed 3,000 ng PCB/m3, immediate action should be taken as it poses a significant health risk (Sundhedsstyrelsen, 2013).



PCB in joint (primary source)

PCB spreads to nearby material (secondary source of contamination)

PCB evaporates to indoor air

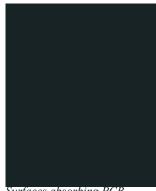
PCB from indoor air spreads to surfaces (tertiary source of contamination)

ill. 21-24: PCB sources

PCB characteristics

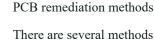
PCB helps the sealant maintain its elasticity, making it ideal for absorbing the temperature variations that occur in prefabricated concrete constructions. The sealant has proven to perform as intended, as the joints containing PCB found today still exhibit elastic characteristics. A specific type of PCB sealant commonly used is the thiokol sealant (Gontmil og Cowi, 2013). which is also found in Gasværksvejens Skole addition.

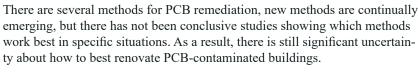
PCB is an oil that migrates towards areas of lower concentration. It evaporates into nearby materials as well as indoor air and dust (Andersen, 2017).



Surfaces absorbing PCB

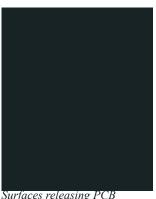
The PCB concentration in indoor air depends on indoor and outdoor temperature and ventilation. It also depends on the composition of PCB congeners in the primary source, the most common PCB congenes are PCB 28, 52,101,118,138,153 and 180. PCB concentrations in indoor air increase with rising temperatures, as the vapor pressure of congeners increases. It has been observed that PCB concentrations in indoor air double with a temperature increase from 18 degrees to 24 degrees Celsius, making PCB concentrations in indoor air seasonal and dependent on both indoor and outdoor temperatures. the congeners react differently on temperature variations, PCB28 and PCB52 react significantly with temperature increase(Andersen, 2017)





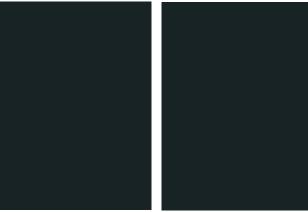
PCB-containing materials removed from a building in relation to PCB remidation or demolishing must be sorted separately and disposed. If the concentration of PCB is above 50 mg PCB/kg, it is categorized as hazardous waste and must be either destroyed or deposited. (Andersen, 2015).

The responsibility for uncovering, removing, and/or disposing of PCB lies with the building owner, whether private or municipal, who has both a duty to inspect and a duty to act (Andersen, 2015). The process of remediation can be difficult which can lead to choosing demolition instead of renovating a PCB-contaminated buildings.



ill. 25-26: PCB receive / release

PCB solidaring methods



Remove and Replace

ill. 27-28: PCB remove / replace

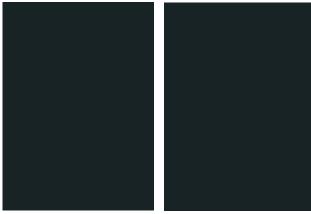
By removing PCB-containing primary, secondary, and tertiary sources, there is a permanent reduction in PCB emissions. Primary sources such as PCB-containing joints are cut out. Secondarily contaminated material such as concrete elements are removed by cutting away the contaminated parts and replacing them with uncontaminated material. Surface-contaminated tertiary sources can be removed by sandblasting, removing approximately 0.5 cm of material.

Advantages:

- -Completely removes the source and reduces health risks.
- -Preserves the value of the building as it can be renovated and refurbished in the future.
- -Provides an opportunity to renovate and maintain a building.

Disadvantages:

- -If not all PCB is removed from the secondary sources, it may penetrate into the uncontaminated materials.
- -Impact on the building's aesthetics and structure.
- -Risk of PCB spread through dust from blasting and milling.
- -Risk of spread when PCB material is exposed.
- -Use of tools increases the temperature in PCB, causing it to off-gass
- -Large amount of waste categorized as hazardous waste that needs to be destroyed or deposited.



Sealing

ill. 29-32: PCB sealing

The PCB-containing sources, primary, secondary, and tertiary, are encapsulated with a membrane or by applying a surface treatment, thereby preventing or reducing the emission of PCB into indoor air.

Advantages:

- -A solution that can be quickly initiated and completed.
- -Less intervention in the building structure.
- -No waste for disposal or destruction.
- -No risk of releasing PCB during remediation.

Disadvantages:

- -Does not remove the PCB and the real problem.
- -Can be complicated to seal all surfaces.
- -Requires regular supervision and control measurements.
- -There may be breaks in the sealing.
- -May be less effective in areas with high PCB concentration.
- -Potential degradation of aesthetic appearance.



Temperature reduction

ill. 33-34: Temperature reduction

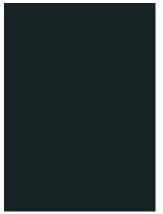
The PCB concentration depends on the room temperature. Rooms with a temperature above 22 degrees Celsius may reduce the PCB concentration if the room temperature is changed to 20-22 degrees Celsius. This can be achieved through passive strategies or cooling.

Advantages:

- -Establishment of passive strategies such as sun shading can be easily implemented.
- -The heat in the building can easily be turned down (reduced energy consumption).

Disadvantages:

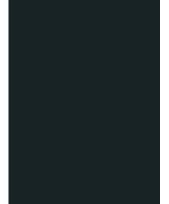
- -Does not remove the PCB
- -Cooling is not common in Danish buildings and will result in higher energy consumption.

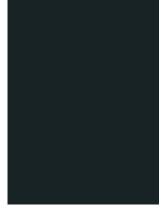




Thermal stripping

ill. 35-36: thermal stripping





Sacrificial materials

ill. 37-38: sacrificial materials

Thermal stripping is a method that exploits the fact that PCB off-gassing increases with temperature, as there is a correlation between the vapor pressure of PCB congeners and temperature. With thermal stripping, secondary and tertiary sources of contamination can be significantly reduced, while the primary source must be removed prior to the heating process. In thermal stripping, the building is sealed off and heated to 50-70 degrees Celsius, the contaminated air is captured by a recirculating air purifier with activated carbon filters.

Advantages:

- -Significant reduction in source strength.
- -No risk of contamination through dust.
- -Less waste associated with the stripping process.
- -Less intervention in the building structure.
- -Can be used in areas where other methods cannot be used due to inaccessibility.

Disadvantages:

- -PCB off-gasses faster with heating, but it also migrates more quickly deeper into materials such as concrete, making it more difficult to demolish the building as the PCB-contaminated materials/parts of materials must be removed separately.
- -Lengthy process due to the building needing to be sealed off.

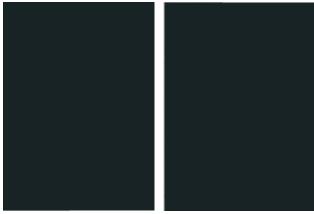
PCB diffuses towards materials with lower concentrations, hence one can introduce a material whose purpose is to absorb a quantity of PCB, after which the material is removed and disposed of. This can take the form of a sealant that is applied to the secondary sources and extracts or neutralizes the PCB, or activated carbon tape that collects PCB and does not release it again, or a material like linoleum that can absorb PCB but only emits a small amount in contrast to more porous materials.

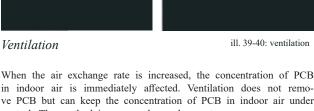
Advantages:

- -Does not remove the PCB, but reduces the source strength.
- -Does not damage the building's structure.

Disadvantages:

- -Waste associated with the sacrificial material that needs to be disposed.
- -The extraction of PCB itself takes a long time.







ill. 41-42: cleaning Cleaning

When the air exchange rate is increased, the concentration of PCB in indoor air is immediately affected. Ventilation does not remove PCB but can keep the concentration of PCB in indoor air under control. The method is commonly used as a temporary measure until more long-term solutions are chosen. Ventilation must be properly adjusted and balanced to avoid negative pressure in the building, as this can cause PCB to be drawn in through the building envelope.

Advantages:

- -Positive effects of low PCB concentrations
- -result in an immediate reduction of PCB levels.

Disadvantages:

- Ineffective at high PCB concentrations
- Does not remove the PCB and the real problem
- Increased energy consumption for the building
- May cause discomfort for the building user

PCB binds to dust; by removing the dust, the concentration of PCB in indoor air decreases. This method is commonly used as a temporary measure until more long-term solutions are chosen.

Advantages:

- -Can be easily implemented
- **Disadvantages:**
- -Does not remove the PCB

PCB Timeline

Points of impact

The first structured PCB remediation in Denmark. All Interior wall joints are removed (primary source)



ill. 43: concrete column

2016 88% of painted surfaces in the building are sealed. (tertiary source)

2008

November

BBP Architects and KEJD (Copenhagen Properties, municipality) are planning a renovation of Gasværksvejens Skole. During the demolition for the renovation high concentrations of PCB was discovered. MT Højgaard and Golder detected PCB values in the material up to 22,000 PPM.

2009

February

Findings:

Golder conducts indoor air quality analysis for mapping of PCB. A total PCB content of up to 1,920 ng/m3 was detected. The primary source is considered the interior and exterior Thiokol seals. The PCB had also spread to surrounding materials, furnishing and in the form of dust in the ventilation system. Measures:

It is estimated that PCB levels will decrease if the seals are removed. Increased ventilation to reduce PCB levels in indoor air is initiated.

March

The first structured PCB remediation in Denmark is carried out. All interior seals are removed, not the exterior. Due to the prolonged off-gassing of PCB, the ventilation systems, electrical installations, plumbing, all furnishings, as well as doors, floors, and ceilings were removed and replaced, resulting in 56 tons of PCB-contaminated waste (MTHøjgaard)

The remediation is completed.

2015

June

A demolition of the existing cafeteria extension from 1994 and construction of a new cafeteria extension is planned. Findings:

Primary sources of PCB are still present on the exterior side of the building, in seals around windows and between concrete elements, as well as interior secondary sources in painted surfaces. Measures:

It is assessed that the affected areas should be remediated before renovation and construction of the extension. (66.8 tons of waste are removed from the existing extension, of which 5,1 tons are hazardous waste containing PCB).

November

Findings:

Elevated concentrations of PCB were detected in the indoor air.

Measures:

Increased cleaning was initiated and ventilation was maximized on the existing systems. This reduced the values by

17% of PCB concentration in the indoor air, but the levels were still above the recommended action values of 300 PCB/ cubic meter of air.

2016

February

Elevated concentrations of PCB were detected in the indoor air. The average concentration was measured at 538 ng PCB/cubic meter of air. The temporary measures were implemented: increased cleaning and enhanced ventilation. Various measures to reduce the PCB concentration were being considered:

- -Sealing: could reduce the values, but there would be more waste if the building were to be demolished, as the sealing would need to be removed before demolition. Additionally, there would be a different appearance as the sealing is high gloss.
- Removing linoleum flooring is not deemed effective as there is not enough PCB in the floor to significantly reduce PCB levels.
- Thermal stripping is costly, and PCB spreads further into the concrete, complicating potential demolition as more material would need to be removed from walls and decks before demolition.

June

Findings:

In a classroom, a PCB concentration in the indoor air of 1058 ng PCB/cubic meter of air was measured at a temperature of 30 with the ventilation turned off, while the same room had a PCB concentration at 220 measured at 21 degrees Celsius with active ventilation. Sampling showed that wall paint was responsible for the high levels of PCB in the indoor air. The congenes mostly found was PCB28 and PCB52 reacting strongly on temperatures (ill. xx) There are still high concentrations of PCB in the exterior seals, but due to balanced ventilation, a low pressure is ensured in the building, reducing the risk of replacement air being drawn past PCB-containing seals.

The concentration of PCB in wall paint was 64 ppm in all types of paint, but up to 118 ppm in some classrooms and corridors. PCB in the paint originates from PCB evaporating from the original primary source, namely the seals, which were removed in 2009. The paint then evaporates into the indoor air.

The windows in the building are original, and glue and seals around the windows have a concentration of 4000 ppm PCB. The surface area is small, but a pilot study showed that evaporation is significant in situations with direct sunlight on the area, as evaporation increases at higher temperatures.





ill. 44-45: damages in the building

2018 Breakage of the sealing in corridors and classrooms. **Operation instructions:** Prevent new breakage. (ill. xx from 2023)



ill. 46: damages in the building

2023 The PCB concentration in indoor air is highly dependent on indoor temperatures, rising above action levels during the summer period. (ill. xx and ill. xx)

July

Measures:

Sealing is chosen as the right method for reducing PCB in the indoor air. All interior wall surfaces as well as concrete beams in the ceiling and window frames was sealed. However, sealing was not conducted behind kitchen areas in classrooms, A/V equipment, and fixed cabinets. It was estimated that there are approximately 11,225 square meters of painted surfaces in the building, and it was possible sealing 9,965 square meters, i.e., 88%.

August

Findings:

The sealing resulted in concentrations below the recommended action levels.

Cleaning can now be returned to normal. Recommend changing the ventilation system from systems with rotating heat exchangers to systems with liquid-coupled heat exchange, which cannot transfer PCB from air on its way out to air on its way into the building. This is to further reduce PCB concentrations.

2017

Measures:

Air measurements were conducted on all floors the PCB concentration is slightly increased.

2018

March

Breakage of the sealing in corridors and classrooms.

June

Suspicion:

That the rotating heat exchanger contributes to the slightly elevated PCB concentrations is being investigated. Testing for ventilation with positive and negative pressure is conducted. With negative pressure, there is a risk of drawing more PCB into the building from exterior PCB joints

-No transfer of PCB in the rotary heat exchanger has been detected. Air exchange and room temperature have a much greater influence on PCB concentration than the pressure difference between indoor and outdoor. Indicates that tertiary sources are the problem rather than the exterior seals.

Measures:

- -Setpoint for supply air at 17 degrees Celsius
- -Air exchange rate of 2.5 h-1 in class-
- -Ventilation starts 2 hours before the user arrive.
- -During periods of high temperatures (above 24 degrees Celsius), set air exchange rate to 4 h-1.

July

The sealing is restored and painted over with regular paint to protect the sealing. Operating instructions for the school:

- -Prevent new breakage.
- -Ensure proper operation of ventilation, maintenance twice a year.
- -Maintain an indoor temperature of 20-21 degrees Celsius.
- -It is not recommended to move fixed fixtures as they are not sealed behind them.

2019

January

Eight control measurements were conducted, where only one measurement recorded a value above 300 on 1 st floor.

2022

february

Measurements were taken at the same locations as in 2019, but now the values are slightly elevated despite the similar temperatures.

2023

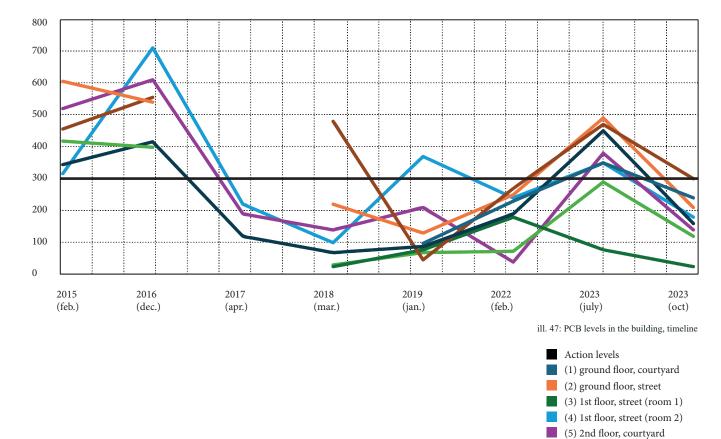
July

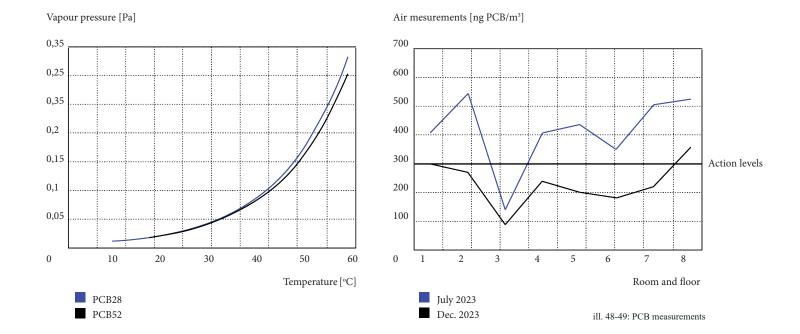
Measurements were taken at the same locations as in 2022, but now the values are highly elevated due to the increase in summer temperatures and overheating in the building.

October

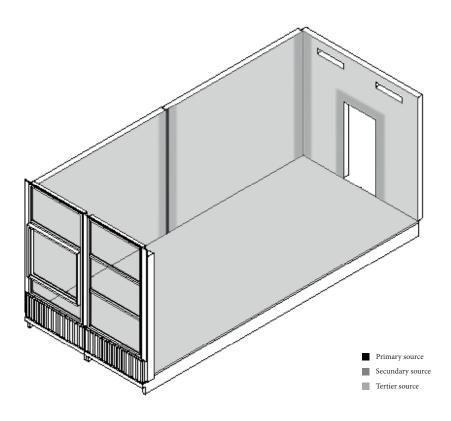
The measures are below actions levels again due to the more stable temperature in the winter.

Air mesurements [ng PCB/m³]





(6) 2nd floor, street
(7) 3nd floor, courtyard
(8) 3nd floor, street



ill. 50: identifiyng PCB in the building

sub-conclusion / PCB strategies

The building still contains primary sources of contamination in the exterior joints on the facade. While these are not the main factor affecting indoor concentrations, they are still problematic, especially during the summer period when the sun shines directly on the joints. During the remediation carried out in 2009, large-scale removal of PCB had not been attempted before, which means that secondary sources of contamination still remain in the building If the same job were done today, they would have removed some of the concrete around the primary sources, in this case the joints. The building is from a period when large glass areas on the facade were common, which creates a problem with overheating. The building contains PCB28 and PCB52, which react significantly on temperatures above 22 degrees Celsius. The presence of the secondary and tertiary sources, along with the overheating, is the main reason the building's PCB concentration is above action levels during the summer period.

Our strategies to prevent the building from exceeding action levels:

- -Removing and replacing the primary sources on the facade between elements and around windows.
- -Reducing the secondary sources in the concrete and tertiary sources on the surfaces through thermal stripping.
- -There will still be PCB in the building after thermal stripping, which will be managed by sealing the walls.
- -In 2018, a breakage of the sealing occurred, the municipality recommended preventing the sealing to break. Therefore, we will propose how to acturaly prevent breaches in the sealing by incorporating PCB strategies and sacrificial materials into the interior design.
- -To prevent overheating, a strategy for sun reduction and shading is investigated



Tectonics of everyday architecture

Gasværksvejens Skole is an interesting mix of its uniform modular, prefabricated system and the uniqueness in its façade by Hans Christian Hansen. Looking at the building through the lens of tectonics can help us understand these two architectures that make up the building; where modularity ends and individual artistic influence from Hansen begins, What ideas they come from, and how we can work within these tectonic ideas when transforming. First we look to Sekler's definition of tectonics.

"When a structural concept has found its implementation through construction, the visual result will affect us through certain expressive qualities which clearly have something to do with the play of forces and corresponding arrangement of parts in the building, yet cannot be described in terms of construction and structure alone. For these qualities, which are expressive of a relation of form to force, the term tectonic should be reserved" (Sekler, 1965, p. 72)

To understand the ideas that formed the modular building, we must, however, expand the term. For this, we will rely on the notion of everyday tectonics, which has been described in recent tectonic discourse. Through this perspective we can look to the building's functionality as the forming factor rather than the focus on materiality and structure of the traditional tectonic ideas (Bech-Danielsen, 2015). Claus Bech-Danielsen connects this perspective to the post war architecture that took form from ideas of mass production, standardization, and rationality with the aim to create an affordable architecture for everyday life. The resulting architecture of these ideas can be described as universal and uniform and has been criticized by Christian Norberg-Schultz for resulting in a 'loss of place' (Bech-Danielsen, 2015). The qualities in everyday architecture could rather be found in their functionality - their everyday tectonics, as they are arguably poor in a traditional tectonic sense.

"With the characterization of the challenging aspects of the everyday by Lefebvre such as; repetition, monotony, rationality, emphasis on functionality, we can understand how this sort of everyday practice compromises the ideal working conditions of the creating architect as well as the experienced quality of the 'end product' (Beim and Hvejsel, 2016, p. 182)

This outline of the challenges of the everyday, could describe the case of contemporary building design just as well as the framework that Hansen was designing within. A framework from which Gasværksvejens Skole's everyday architecture came to be a mix of the universal and Hansen's individual contribution.

The universal system

The main structure of the building is a clear representation of the described everyday tectonics. It is made by a building system designed by 'Centralkontoret for praktiserende arkitekter på Fyn' as part of the montageplan, Fynsplanen. To understand the building, we therefore look to the system and its logic.

The system enabled options to build in 1 to 3 stories and with a flat or raised roof. The system follows a rectangular grid of 1,8 m longitudinally, and across it is defined by set lengths of classes (8,4 m) and hallways (3,6 m). These modules could then be put together to form volumes of various formats (Centralkontoret for praktiserende arkitekter på Fyn, 1968). The volume toward Eskildsgade is made up by two rows of classrooms and one hallway, and therefore has a depth of 20,4 m.

The system has three sizes of classrooms; a normal class of 60 m2, a special class of 30 m2 and a small class of 45 m2, all with the same depth of 8,4 m and a width which follows the 1,8 m grid (Centralkontoret for praktiserende arkitekter på Fyn, 1968). For special cases, where other room formats were needed, light walls would be applied.

The reinforced concrete modules that define the spaces, both have the role as load bearing structures and as stabilizers. The columns in the façade are also part of the loadbaring system, but the facades are free of stabilizing elements, which allows for the freedom of façade design which was an important feature of the design (Nissen, 1975).

The gables are constructed by two reinforced concrete discs that perform as part of the stabilizing system, which is a principle that formed the basis of the dimension of the inner walls (Nissen, 1975). That explains the closed character of the gables and means that if new openings are made here, the loss in stability should be made up for.

If this modular premise is embraced in its transformation, the rationality of its design could hold a potential for the building's flexibility in use.

Unique, artistic idea

Contrary to the modular system, the façade design by H.C. Hansen holds a richness in tectonics. These tectonic qualities of his designs are studied in the PHD "The works of an architect – why tectonic matters" by Aida Espanol Vilanova (Español Vilanova, 2023). In her comprehensive studies of H.C. Hansen's works, her research is informed by his built works and their construction drawings. She makes several points about his work that can be recognized in the case of Gasværksvejens Skole as well.

First, she comments on the uniqueness of his design, which takes inspiration from traditional joinery of craftsmen and his background as a carpenter (Español Vilanova, 2023). In the Gasværksvejens Skole this unique quality and his material understanding is present in its facade design, which delicately joins round steel profiles and wooden battens with bolts.

Another theme pointed out by Vilanova, which is also present in the building, is how he works with secondary structures and uses depth in his façade design. H.C Hansens façade structure, which forms a brise-soleil has a superim-

posed character (Español Vilanova, 2023), and works within a tectonic idea which is fundamentally different to the idea of the modular system. Vilanova argues that the structure's relevance is in the created 'perception of depth and comfort' rather than in the need for reduction of solar heat* (Español Vilanova, 2023). With its simple and delicate design, it manages to support the lightness of the open facades, contrasting to the completely closed gables toward Istedgade.

The potential of the simple

H. C. Hansen's façade adds architectural qualities and uniqueness to the otherwise universal and placeless system building. But what does H.C. Hansen's tectonic qualities have to say in relation to everyday architecture? Although he takes a different approach in his application of material than the everyday tectonic modularity, H.C. Hansen's façade too speaks of optimization in its own way. It takes humble material and maximizes its spatial quality. So, H.C. Hansen's tectonic design can be understood as a means to make the most of what is available and therefore proves itself relevant for the design of an everyday building. The interplay between system and artistic influence becomes an exercise in making the most of what is possible architecturally. The modular system of Fynsplanen allowed for a high freedom of the façade, so as a result this is where H.C. Hansen's ideas are most present. But when do the modular ideas stop and H.C. Hansen's design start? How do they relate?

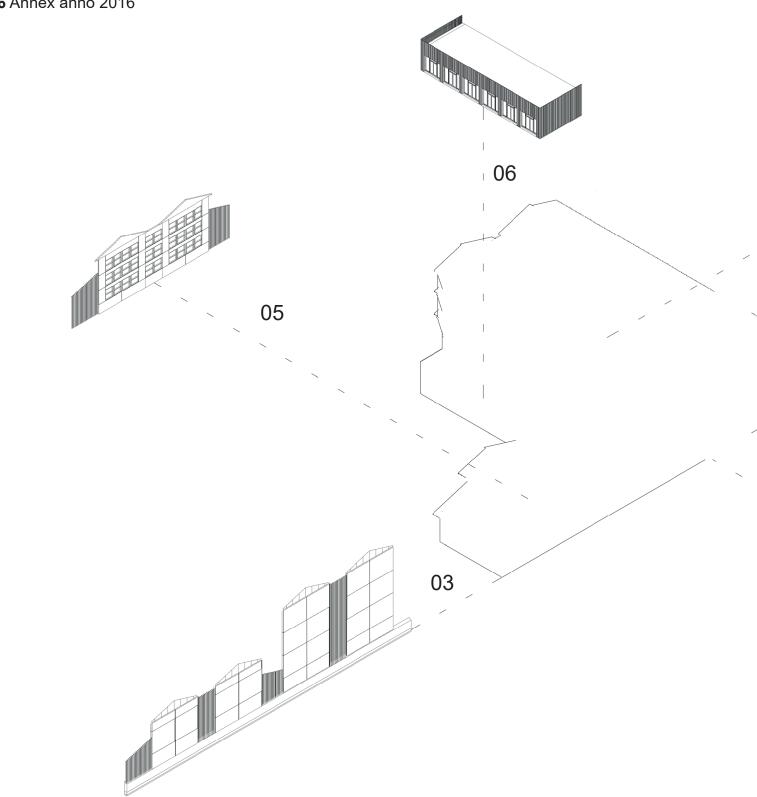
Interplay of universal and unique: roofs and façade

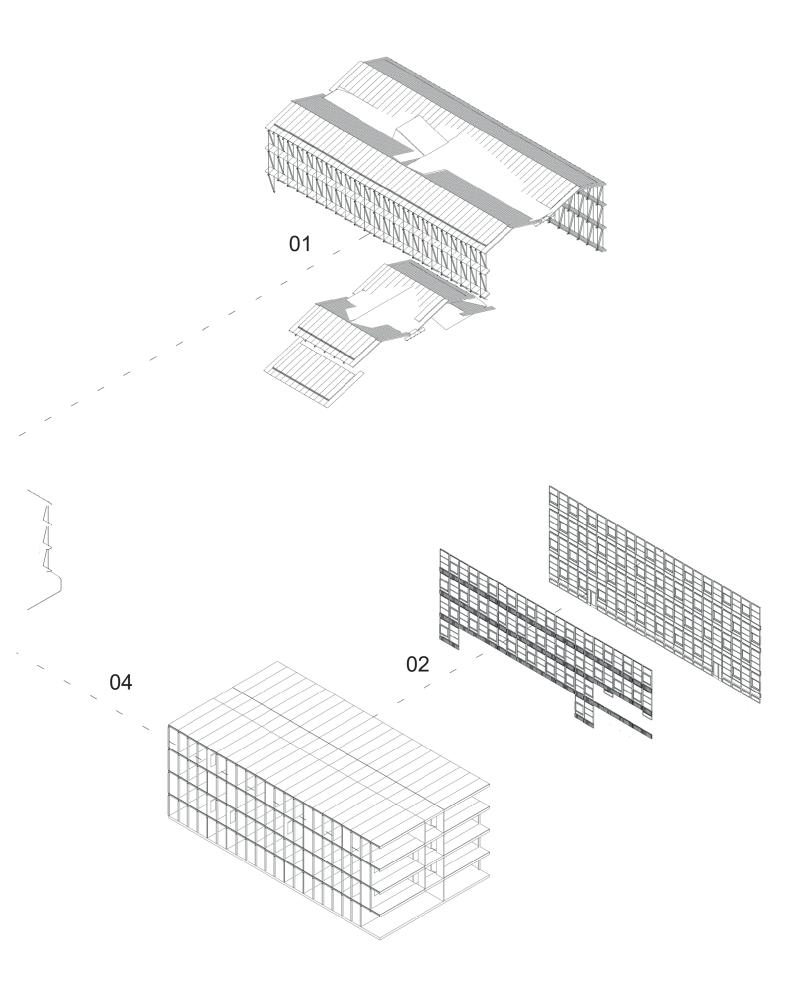
The raised roofs of the Annex follow the modularity of the classrooms; meaning they span their depths of 8,4 m. The deep building toward Eskildsgade therefore has two pitched roofs over the classroom modules connected in a roof valley over the hallway module.

In Hansen's works the pitched roof is a recurring theme, which demonstrates his consciousness of durability and weathering in his application of material (Hansteen, 2023). Since the rafters for raised roofs were part of the prefabricated system, it can be assumed that this defined the pitch angle of the roof. Hansen's design then elaborates on this otherwise prefabricated system element, in his repetition of the roof angle, in the brise-soleil on the facades and in the single slope roofs.

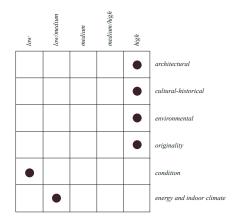
H.C. Hansen's ability to work into the prefabricated system fosters an interesting architecture and design concept worth analyzing further and bringing forth in the transformation of Gasværksvejens Skole.

- Hans Christian Hansens brise-soleil system
- Facade towards Eskildsgade
- Gables towards Istedgade
- Modular system
- South facing facade
- Annex anno 2016





ill. 51: dissecting the building



ill. 52: valuation of the building part

01 Hans Christian Hansens brise-soleil system

reconstruct

Preservation of an idea/architectural design even though the material itself is not preserved. (Japanese concept). The idea lives but is also unsentimental. Therefore, it should not become a museum piece, but rather continue to live its 'most pragmatic life'.

Preserve the essence and ideas of HC Hansen: the use of simple materials, the assembly/ tectonics as the primary approach, lightness, and tactility. These elements are core to retaining the spirit of his design philosophy.

Change is necessary to enhance durability and reduce maintenance requirements, which are unlikely to be met. This adaptation will allow the design to age 'gracefully', preventing the concept from being overshadowed by worn and weathered materials.

Evaluate whether the structure could be made to appear less like a 'scaffold' — should it include fewer steel tubes? Should it serve more explicit energy and indoor climate purposes?

Consider highlighting the tectonic ideas by emphasizing elements through color, or changing materials/colors to underscore his concept more distinctly.

When replacing elements, should they be made from the same material, or should a material that ages better be used to ensure the structure remains in good condition longer? When we replace elements, should they retain the same dimensions?



The architectural concept diverges from the principles of the modular system by introducing uniqueness into an otherwise universal system

Exhibits a rhythm/tact - a repetition both horizontally (eternit overhangs) and vertically (steel tubes)

The tectonic principles are visible in the joints with materials being assembled in new ways and the use of 'humble' materials to maximize spatial quality

Works in three axes and creates a sense of depth, both from the inside and outside

The roof pitch shows a material and craftsmanship understanding of the need for water drainage, and it becomes a fundamental architectural feature

The inclination of the overhangs follows the pitch of the roof and the overhang are detached from the facade, which contributing to the light expression and telling the story of it being a substructure imposed on the facade

There is a honesty and transparency in conveying the structure - everything is visible.

The structure consists partly of steel profiles, which are also used for scaffolding, thus giving the structure a temporary character reminiscent of scaffolds

Wood/timber profiles combined with steel elements creates a juxtaposition of robustness against delicacy, with variation in the dimensions of the elements

The 'waves' in the eternit overhang create a human scale in an otherwise large surface, complementing the imprint of the formwork on the parapet



The structure exemplifies the unique expression of the architect Hans Chr.

Hansen - showcasing his understanding of materials and craftsmanship - where simple materials are used with high architectural and tectonic quality

Since there is not much written material about Hansens' architecture, the substructure is important to tell about his architecture and work

Typical materials of the time; steel, asbestos cement, pressure-treated wood



Stands out from its architectural context, almost acting as a landmark

Adds a human scale to the building (a large surface is divided by the system)

Creates a 'buffer' zone between the street and the building



Original materials as the majority unchanged

Lost value of the substructure on the facade facing the courtyard, as the addition of a new building volume has removed a part of the structure, and the new termination does not follow the principles of the substructure



The wood has a surface treatment/is painted (less worn than the window frames),

and the paint is peeling off

The steel profiles are rusty

The eternit panels are crumbling/cracked and coated with moss and algae

One of the pitfalls of using these 'cheaper' materials is that they are of lower quality and therefore deteriorate more quickly



Harmful substances

The eternit roof panels contain asbestos

Secondary PCB source: steel brackets in contact with the facade joint

Indoor environment

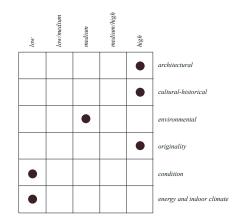
The sunshades have a small impact on reducing overheating:?

Bsim value with overhangs, hours above 26 degrees: xx

Bsim value without overhangs, hours above 26 degrees: xx

Energy

The joints are directly attaches to the load-bearing columns, creating a thermal bridge



ill. 59: valuation of the building part

02 Facade towards Eskildsgade

transform

Preserving architectural ideas involves maintaining key concepts such as openness, depth, rhythm, proportion, and the relationship between horizontal and vertical elements.

Simultaneously, a transformation and energy renovation of the facade are allowed, as it is crucial to transform the facade to meet modern energy efficiency standards while retaining its architectural integrity.

Should post-insulation be added externally or internally, or should the facade be completely replaced with a new one?

Do windows need to be replaced? A consideration in this process is how or if it is possible to effectively use natural ventilation through window openings in modules?



Follows the rhythm and adapts the logic of the modular system and brings the 'modularity' to the facade

The detailing and relief in the concrete create tactility in a 'simple' material

'Honest' in conveying construction and materiality, as concrete slabs and load-bearing columns are part of the facade

Cladding of window projections - structural protection where the frame is more exposed to wind and weather?, an expression of material understanding.

In combination with HC Hansen's substructure, both horizontal and vertical lines are formed depending on the viewer's perspective; from the front the proportions of the windows and columns create vertical lines and both the sunshades, concrete parapet, and concrete slabs in the facade create horizontal lines

Communicates where the windows can open/are operable, reflected in the changes of depth and materiality.

The two types of windows that appear alternately create a rhythm and variation

The elements are placed at different depths, which creates a visual differentiation between the horizontal parapets band and an 'open and light' band consisting of the windows and the columns. These are wrapped in a thin layer of insulation, thereby receding into the background and contributing to the facade's lightness. As the parapet band (height: 597 mm) is 'covered' by the sunshade, it creates a visual effect of an almost completely open glass facade



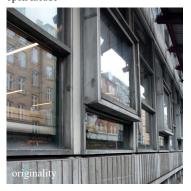
The principle of the modular system enables a free facade; there is no need for stabilizing, so apart from the load-bearing columns, it can consist of lightweight elements. This underpins the open/free facade which is characteristic of modernist architectural principles and was also a highlighted quality in the design of the "Fynsplanen" as it allowed facade freedom

The facade materials are characteristic of the industrial thinking and building culture of their time; concrete, asbestos cement (eternit), styrofoam insulation, and thiokol sealant/grout



The building features visual openness, yet it remains physically inaccessible and unutilized at street level due to the wall

The wall aligns with the lines of the buildings in the street (is there a need to emphasize this edge?), but the facade breaks the line by stepping back (distancing from the street it is part of). This creates a sense of privacy within an otherwise open facade



The facade is original, as it has not undergone renovations



There is algaes on the concrete elements and the concrete is eroded and with visible reinforcement

Holes in joints

The wooden window frames are weathe-

red (bleached/discolored) and there's thicked grout between the concrete elements, frames and glass



Harmful substances

Primary PCB source in joints between concrete parapet elements X mg/kg and the frame and glass in the windows

Secondary PCB source in the concrete parapets and the wooden window frames

Asbestos in the panels between the window sections

Indoor environment

Allows the user to naturally ventilate but not optimal due to the principle of single-sided ventilation and intake/outlet are in the same opening

The size of the windows (2920 x 1650 mm) and allow a large amount of daylight entering the deep rooms

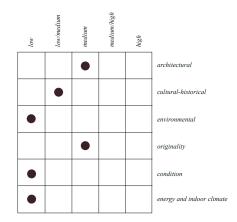
The high proportion of window area results in significant passive solar heat gain. Overheating?

Energ

Thermal bridge due to the concrete slab in the facade

High u-value in the parapet, the columns and between windows

High glazing area with non-energy-efficient windows creates both a heat loss and passive solar



ill. 66: valuation of the building part

03 Gables towards Istedgade

subtract - transform

Preserving the vertical gable motif and rhythm facing Istedgade is important, but there is a need to break down the facade's scale to make it more human.

Openness towards Istedgade (possibly removing the wall)? And breaking it down to a human scale with more depth and variation (e.g., greening)?

Create a gesture towards street life - facilitating places to stay and establishing entrances?



The gables facing Istedgade create a long, unbroken surface. This large scale is visually divided into four gables, separated by glazed surfaces and lamellas, yet they still maintain a large proportion

The facade's gable design on this 'large' volume communicates the underlying principle of the modular system behind it; two classroom blocks are integrated with a corridor in the middle

This principle is extended to the sports hall to create a unified motif and rhythm on Istedgade's facade. However, the facade of the sports hall do not reflect the internal system - instead, it opposes the sports hall's internal logic in favor of a cohesive external expression

The slats/louvers and lines in the concrete relief create a rhythm of vertical lines, which is emphasized in the original drawings of the gable motif.



An example of the modular system from "Fynsplanen"

The painted motif illlustrates the resistance to concrete in the 1980s

It represents an example of the material usage and modular system typical of its



The gables appears closed and unintiving to the context and do not contribute to the life of Istedgade

Breaks the rhythm in the street

Evokes associations with slums and graffiti

No sense of depth in the facade - there are overhangs, but they do not relate to a human scale - perhaps they make the building appear taller?



The 80s approach on the facade unites the otherwise divided gables and makes the surface feel larger, which weakens the effect of rhythm and verticality

Nets have been installed to prevent birds from nesting between the slats



Algae on the concrete

The slats/louvers are peeling and make it difficult to clean the windows, resulting in dirty windows

The panes and louvers appear dirty



Harmful substances

Primary PCB source in the joints?

Secondary PCB source in element around joints

Indoor environment

Limited amount of daylight

Energy

Low energy performance due to relatively high u-values

Potential thermal bridge at the junction of inner walls and facade?

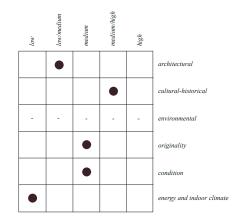
Indoor environment

Limited amount of daylight

Energy

Low energy performance due to relatively high u-values

Potential thermal bridge at the junction of inner walls and facade?



ill. 73: valuation of the building part

04 Modular system

repair - transform

Repair in the form of PCB remediation of the elements

An unsentimental approach emphasizes the quality of flexibility, the ability to rearrange and modify, allowing the spatial configuration to change without diminishing the value of the modular system. There's no need to preserve the building in its exact current form; an unsentimental and pragmatic approach to the building should follow the same rationale it was originally based on.

Preservation of modularity and flexibility means not working against the modularity in our intervention. Thus, preserving the logic of the system so that it can continue to accommodate flexibility in the future. We should work with the system, not against it.



High ceilings and open spaces define the large-scale spaces within the building

The concrete elements are both load-bearing and space-defining, contributing to the architectural integrity and honesty

The building offers potential flexibility due to its modular, simple plan; there are two circulation systems positioned at each end of the building, enhancing the flow and accessibility

Standard measurements and proportions

Uniform and monotonous hallways reflect a rational approach, emphasizing functionality over aesthetic diversity



An example of Fynsplanens modular system design

A general example of 1960-1970 welfare buildings and the post-war building practice (mass produced)



Some materials are removed due to the extensive PCB remediation

The walls are painted/sealed

Some of the materials do not look like concrete due to the high-gloss sealing, it looks like lacquered steel

New openings have been established



Wear and tear on surfaces, especially on doors and walls

The sealing is peeling, visible patches of the sealing

The surfaces have been painted multiple times



Harmful substances

Secondary PCB source only a small amount of concrete around the joints were removed (practice today is 0,5 cm).

Tertiary PCB source in the concrete and the indoor air (in some joints)

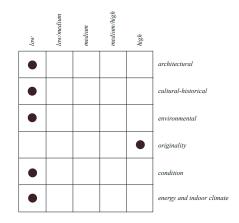
Indoor environment

The room depth is defined by the modular system, resulting in all rooms being 'identical'—and very deep (8,4 m) which gives a low amount of daylight in the central corridor and far from the windows in the rooms

Hard surfaces result in a long reverberation time and sound travels from room to room/flanking (down through the construction)

Energy

High thermal mass - heat accumulation - evens out temperature fluctuations throughout the day - (potential for) reducing the need for heating and cooling



ill. 79: valuation of the building part

05 South facing facade

transform

Rethinking the facade / The current design of the facade will not be preserved. However, the preservation of the overall intention is essential, so the transformed facade intervention should support this.

More specifically, the facade should communicate the principles it follows, adhering to the main approach. Therefore, it must be assessed whether the facade should follow the principles for gables or side facades.

Open up towards the courtyard - create physical and/or visual connection and break down the scale to make it more human.

Use passive strategies that are appropriate, considering the facade is south-facing to prevent overheating and high PCB concentrations.

How can the transformed facade maintain the original architectural intent while introducing new interventions?



Compromise with the analysed intention with the closed gables and open facades, as principles from both the gable (less open and saddle roof) and side facade (window bands and overhangs) are implemented

The clear contrast between very open, light facades and heavy, closed, vertical gables, is compromised here as the two facade concepts are combined, leading to a loss of the original design intent

Horizontal window bands are interrupted by changes.

The motif of two gables connected at the center is recognized from the gable of Istedgade, but the motif is much less clear

An attempt has been made to establish this through the grouping of the windows; where a group is formed on each gable, and then a connecting window section.

Combined with the horizontal sunshades, the motif becomes blurred, and the facade is perceived more as a cohesive whole with a horizontal character.

The meeting between the roof overhang and the facade's sun shading creates 'unfortunate' intersections



A (less clear) example of modular construction with a frame structure



No visual or physical contact (not at level) with the courtyard, due to the high placement of windows



The facade appears original without any modifications



Algae and worn patina are visible on the smooth concrete parapet

The window frames are weathered

The edges of the concrete are porous



Harmful substances

Primary PCB source in the joints

Secondary PCB source in the concrete elements

The PCB concentration may be larger due to possibly higher temperatures

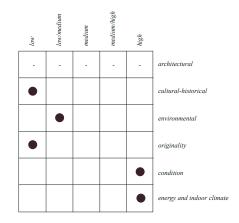
Indoor environment

South-facing facade where overheating can occur (there is sun shading, but its effectiveness is uncertain)

Energy

South-facing window openings potential for) passive solar heating.

High u-value in the exterior walls and windows



ill. 86: valuation of the building part

06 Annex anno 2016

subtract - transform

The extension needs to harmonize more with the architectural principles of the 1971 building. This entails adjusting it to the modular design of the 1971 facade and altering the railing to complement these lines.

Establishing a hierarchy among the building elements is essential.

Can greening be implemented?

Considering applying principles of window design to the rest of the structure, including aesthetic elements such as color. Is there a method to soften the appearance of the alley?

The principle of the modular system enables a free facade; there is no need for stabilizing, so apart from the load-bearing columns, it can consist of lightweight elements. This underpins the open/free facade which is characteristic of modernist architectural principles and was also a highlighted quality in the design of the "Fynsplanen" as it allowed facade freedom

The facade materials are characteristic of the industrial thinking and building culture of their time; concrete, asbestos ce-



The design creates an alley and a corner that 'clashes' with the building

Opens up the ground floor and first floor towards the courtyard, enhancing openness and connectivity with the outdoor space



that are not resolved according to its own principles





It creates issues within the HCH system



Appears in good condition



Harmful substances

Possible tertiary source of PCB as the PCB may have been transferred from some of the existing facades or internal

Indoor environment

Increasing the depth of the building consequently worsens daylight conditions

Window openings above doors enable natural ventilation

Energy

Lever op til nutidige standarder ift. energiforbrug med lavere u-værdi end det eksisterende og energieffektive vinduer



ding through its choice of materials, colour and by fitting into the rhythm of the vertical modular system

The railing or the upper line of the volume does not correspond with the lines of the building

The facade is two-dimensional

Reintroduces lamellas, similar to those in the gables, but in a different format

Utilizes the red color from the wood, incorporating it as a unifying or contrasting element



Programming of a welfare building

Everyday architecture

Gasværksvejens Skoles 1971 addition is an example of 1970s welfare initiatives aimed at enhancing conditions for Vesterbro's marginalized school children (Hansteen, 2023).

This thesis explores the potential for the building to serve a new welfare-generating role in the future. The fundamental ideas of the building and H.C. Hansen's vision is further developed – the idea that the building contributes to the city and the community.

We acknowledge that the concept of what constitutes a welfare-building expands, and there is a greater emphasis on the building being welfare-generating in more than one sense. To explore these possibilities, we need to consider the building's inherent flexibility and potential.

Can this everyday architecture accommodate a variety of programs? This we intend to explore.

Open and robust

Ballerup Pedagogical Seminary, designed in 1967 by Fællestegnestuen, aligns with the principles of post-war welfare architecture such as Gasværksvejens Skole, the seminary was built with a circular mindset, designed to be easily renovated and repurposed, as seen when Ballerup Municipality transformed it into housing and a day center for people with physical and mental disabilities. The transformation of the seminary highlights the importance of robust materials and solid architectural qualities. Vandkunsten, the architectural advisors for the renovation, discovered that the building's inherent flexibility made it an excellent candidate for adaptive reuse*. Despite initial skepticism about converting the multi-level teaching spaces into suitable housing, the variations in room height, large, light-filled spaces, and direct access to outdoor areas provided a strong foundation for the renovation. By stripping back to the building's original structure and removing unnecessary

layers, they revealed a robust house built from durable materials (Svarre, 2023).

When renovating Gasværksvejens Skole the intervention must allow for reprogramming and reconfiguration to meet diverse needs over time. Its circulation and interventions should be planned for longevity, ensuring it can support various uses beyond any specific program by retaining inherent flexibility.

The specific layer

Vesterbro Local Committee presents a vision in the District Plan to create better conditions for communities in the neighborhood. There is a particular focus on enhancing communities related to culture, leisure, children, and youth, and establishing a conducive environment for initiatives that can promote community (Vesterbro Lokaludvalg, 2023).

To test the building's potential and flexibility, a series of test programs are selected based on a brainstorm on what functions have a wide range of needs and to create a hybrid building where there is activity around the day. The functions include the women's center, REDEN, the music incubator, GEHØR, and student housing. The idea of having the building accommodate a diverse program stems from a desire to explore the wide range of possibilities of the 'universal' building. The example functions are described as follows;

Reden

REDEN Copenhagen is an organization under the KFUK's Social Work that serves as a safe space for women in addiction and prostitution in Vesterbro and Copenhagen. REDEN is currently located at Gasværksvej 24, functioning as a shelter and counseling center where women can take a break and receive support to change their life situations (KFUKs Sociale Arbejde, 2024).

REDEN's current location is not large enough to provide good, secure, and dignified facilities for approximately 300 affiliated women. There is a need for an expansion of bed spaces (women's shelter), space for safe substance intake, administration and documentation, and a health clinic. Additionally, there is a need for meeting rooms for staff meetings, supervision, education, presentations, and meetings. Furthermore, there is a desire for calm, secluded green outdoor areas where women can engage in social activities (Vesterbro Local Committee, 2024).

Gehør

Music Association Vesterbro, MUVE, is an organization working to promote music activities in the Copenhagen area (Musikforeningen Vesterbro, 2024). As part of this initiative, the association, in collaboration with Copenhagen Music School, Art School, Theater Shop, the Stands&Dans Association, and Rysensteen Gymnasium, aims to create a new type of music house that combines experience, immersion, and dissemination. As a musical incubator, GEHØR is intended to be a sanctuary for music enthusiasts, featuring live stages/showrooms, workshops/practice rooms, sound studios, teaching facilities, and a café, spread across approximately 1000 m2 (Vesterbro Lokaludvalg, 2024).

Student Housing

X

Based on interviews with the test program users and an analysis of their existing facilities a series of 'test rooms' are identified and used as scenarios to understand the requirements for creating unique and specific solutions within a flexible, modular system.

	Rum	Vari	Туре	Funktionskr	Atmosfære/	Indeklima*	Vedligehol	Body scale
REDEN		ghe d (bl.a . ift. PCB	(illustr ation)	av av	nøgleord	ruoruitta	d d	elementer
	1.1 Kontor	Kort < X timer	3,6x8,4 m modul	3x workstation for personale, garderobe/op bevaring uformelle møder	Overskueligt*, fokus** og uformelt*** *rene flader/ teknik ude af syne, **opdeling, afskærmning, ***flytbarhed		Rengøringsv enligt	
	1.2 Shared rooms with beds (one night)	Long	3,6x8,4 m modul	4x beds for brugere 4x storage	Hjemligt, trygt* og værdigt** *mindre skala, taktilitet **anti-sterilt, velholdt		durable and/or fixable for heavy use, rengoringsve nligt	
	1.3 Studieboli g tidligere:L ængereva rende ophold (herberg)	Long	3,6x8,4 m modul	1 x bed for bruger, storage, desk, 'pinboard'	Hjemligt, trygt* og værdigt** *mindre skala, taktilitet, personligt præg **anti-sterilt, velholdt		durable and/or fixable for heavy use, rengoringsve nligt	
	1.4. Meeting : (creative, presentati on, activity, yoga)	Short	7,2x8,4 m modul	plads til 10 siddende, brugere ifølge med personale (mix)	Fleksibelt*, imødekomme nde** *omprogramm ering af rum, flytbarhed **varmt og lyst		rengøringsve nligt	
	1.5 Spiserum	Short	7,2x8,4 m modul	spisebord med plads til op til 50	Fleksibelt*, hjemlig**, imødekomme nde***, overblik**** *opdeling af rummet ift. behov		durable and/or fixable for heavy use, rengoringsve nligt	
	Т							
					**mindre skala (nicher),			
	1.8 Cirkulatio	Short	Gang	(Kortvarigt ophold), opbevaring, cirkulation	skala (nicher), taktilitet, ""varmt og lyst """skabe visuelt udsyn over rum (tryghed for personale) Overblik", ingen 'kroge' hvor man kan gemme sig." hjemlig", anti-institution ell*" "skabe visuelt		durable and/or fixable for heavy use, rengoringsve nligt	
	Cirkulatio n			ophold), opbevaring, cirkulation	skala (nicher), taktilitet, ***yarmt og lyst ****skabe visuelt udsyn over rum (tryghed for personale) Overblik*, ingen 'kroge' hvor man kan gemme sig.* hjemlig **; anti-institution el!*** *skabe visuelt udsyn over rum (tryghed for personale) **varme, lys og ***jkke steril		and/or fixable for heavy use, rengoringsve nligt	
GEHØ R	Cirkulatio	Short	Gang 3,6x8,4 m modul	ophold), opbevaring,	skala (nicher), taktilitet, ""Varmt og lyst """skabe visuelt udsyn over rum (tryghed for personale) Overblik", ingen 'kroge' hvor man kan gemme sig." hjemlig", andi-institution el ^{***} "skabe visuelt udsyn over rum (tryghed for personale) ""varme, lys og		and/or fixable for heavy use, rengøringsve	
	2.1 Øvelokale (laves om til en tille koncertsc ene)		3,6×8,4	ophoid), ophoid), ophowaring, cirkulation or instrumenter operation of the cirkulation of	skala (nicher), taktilitet, ***varmt og lyst ****skabe visuelt udsyn over rum (tryghed for personale) Overblik*, ingen 'kroge' hvor man kan gemme sig.* hjemlig**, anti-institution el** **skabe visuelt udsyn over rum (tryghed for personale) **varme, lys og ***ikke steril inspirerende omgivelser, personligt*, ingen unødvendige moblement eller ellementer, kreativ, *mulighed for at tilpasse (dvs. fleksibilitet for personliggorel		and/or fixable for heavy use, rengaringsve nligt durable and/or fixable for normal use, rengaringsve rengaringsve	

Benchmark

Energy frame

191,4 kWh /m²/year

Atmospheric indoor climate

PCB indoor air concentration

Project demand 150 ng/m³ 300 ng/m³

Sundhedsstyrelsen limit value (Highest measured concentration) October 2023)

(--) (300 ng/m^3) (--) (3000 ng/m^3)

Relative humidity 25-60 % < 25%: 374 hours

> 60%: 493 hours

CO2 indoor air concentration Total exceeding: 867 hours

(standard class) 1000 ppm 246 hours above

Thermal indoor climate

Operative temperature

Jan - Dec: 20-23 °C

Tolerance exceedances:

Apr - Oct

Hours > 23 140 hours 867 hours Hours > 24 35 hours 601 hours

Nov - Mar

Hours > 23 70 hours 0 hours Hours > 24 14 hours 231 hours

Acoustic indoor climate

Reverberation time

125 Hz 0,9 s 1,2 s 250-3000 Hz 0,6 s 1,35 s

Visual indoor climate

Daylight

BR18 demand 300 Lux

Equivalent

Daylight factor 2,1 %

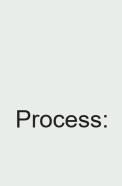
6 % We define the following indoor climate demands for the building (See Appendix A):

See Appendix C,I and J





ill. 93- photo-collage with process models





04: A brise soleil facade system

III. 74. 11.C. Hallsell lacade

design strategy

reconstruct



The existing system consists of: steel pipes, painted wood profiles, asbestos-cement roof, bolt connections.



Steel pipes are attached to the facade at each concrete column with a center-to-center distance of 1800 mm.



Under the asbestos-cement roof, three painted wood battens are placed at 1000 mm intervals.



The junction is simple: all elements meet in a bolted connection.



Two angled steel pipes and one vertical pipe at each bracket.



The asbestos-cement panels are corrugated.

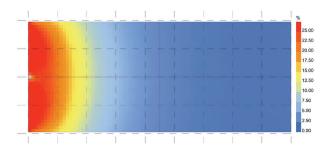


A bracket is positioned between the parapet elements and secured to the concrete column.

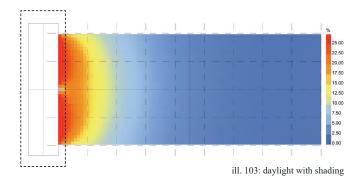
ill. 95-101: 1:5 model of facade system

Understanding the elements and assemblies of the system

To familiarize ourselves with the façade system, as part of the understanding, analysis, and evaluation of the building, we constructed a section of the façade and its substructure by Hans Christian Hansen. This provided a greater understanding of the joints, materials, dimensions, fastenings, and the intersections between these elements.



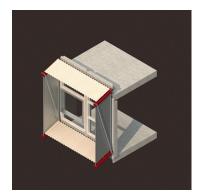
ill. 102: daylight without shading

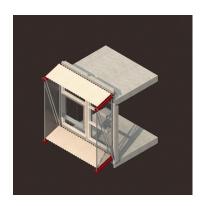


Understanding the elements and assemblies of the system

To test the effect of the sunshade, we conducted a series of indoor climate simulations in BSim, where we tested the temperature with and without the sunshade. This study showed that without the brise-soleil, there were 923 hours above 23 degrees Celsius, while with the overhang, there were 867 hours above 23 degrees Celsius (see Appendix I).

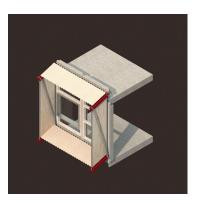
Possibly a deeper overhang could reduce overheating more efficiently, however we did not pursue this, based on the valuation assessment of the brise-soleil system, that limited the extent of possible interventions.



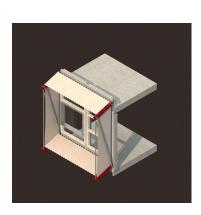
















ill. 104-112: testing sidefins in 3D and 1:5 model

Addition of sidefins: Possible variations, overall expression, and testing the effectiveness

Since the shading is placed on a southwest-facing facade, we considered that side shading could impact overheating. This was investigated in BSim and Be18, where we tested for sidefins places in the H.C. Hansen structure per every 3600 mm, which did not have a significant impact, as it reduced temperatures above 23 °C from 867 hours to 848 hours per year (hours of occupation), and the energy from passive solar from 4788 kWh to 4525 kWh. The impact on the Energy frame was small, decreasing it by 1 kWh.

In Bsim the same design was tested with 1800 mm distance which reduced hours above 23 to 828. (Appendix I.)

To understand how these side shades could be aesthetically designed, a study was conducted on a 1:20 model and in 3D visualizations of materiality, transparency, and expression of these on an element. We then implemented these shading elements on the facade to experience their overall effect.

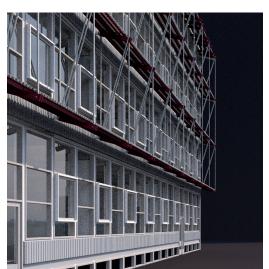
existing





with every 2nd substructure





ill. 113-116: testing the rythm of the substructure

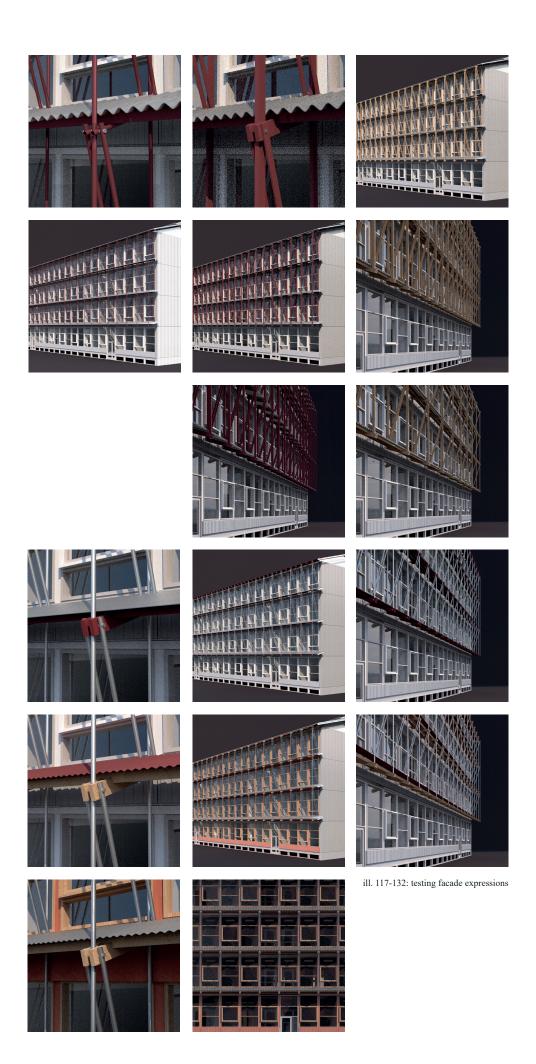
Dimensions, rhythm, material, and colour

To support the choice of preserving the design and making a reconstruction, we explored the possibilities for variants with slight adjustments in material and/or color changes, rhythm, and dimensions.

This study showed that replacing the metal elements with standard wood profiles gives the structure a heavier appearance, while replacing the wood with metal, conversely, removes the tactile quality.

Removing vertical elements can reduce the 'scaffolding' feeling, but also diminishes the system's value and clarity when viewed from the front.

Introducing more of the reddish color creates a warmer and less industrial expression, but at the same time, it obscures the understanding of the different elements and the substructure loses its light appearance and becomes more dominant.





05: Facades towards Eskildsgade

Design strategy

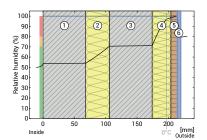
transform

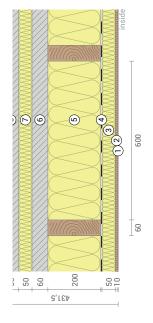
To understand the existing building envelope, the facade facing Eskildsgade was examined. The supporting strategy for the facade involved preserving key architectural concepts such as openness, depth, rhythm, proportion, and the relationship between horizontal and vertical elements. A Be18 analysis indicated a benchmark energy frame of 191,4 kWh /m2/yr, with the current U-value of the parapet element being 0,842 W/m²K with 36 mm of stone wool insulation. The floor slab penetrates the building envelope, creating a thermal bridge, while the column is insulated with 20 mm polystyrene insulation (see Appendix B, describing the existing building properties). An energy renovation is necessary to meet contemporary energy efficiency standards while retaining the building's architectural integrity. The question arose whether to insulate externally, internally, or create a new building envelope as the most appropriate solution. The post insulation methods are compared with moisture curves, The u-value, energy consumption and the design strategy for the facade. See Appendix D for all BSim and Be18 input and results.

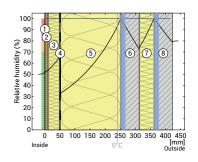
Post insulation / exterior

Post insulation / interior with bio

Post insulation / interior







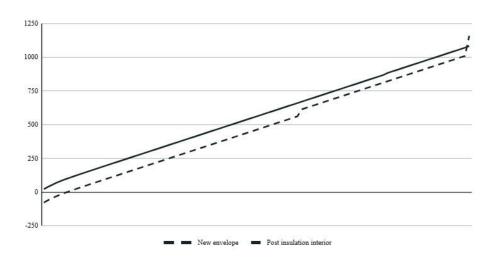
30 mm of insulation is possible to add without moving the position of the HCH substructure.
U-value: 0,182 W/m²K
Energy frame: 187,4 kWh/m2

Energy frame: 187,4 kWh/m2 year

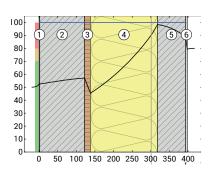
- -Primary PCB sources of contamination are present in the exterior joints, insulating externally creates the risk of PCB spreading into the indoor air.
- Losing the architectural value of the relief concrete elements

Interior post-insulation will cause moisture within the wall, as the temperature in the wall will be lowered and vapor will condense within the structure. Biogenic material will be prone to decay or mold. Therefore this not considered an option.

- -U-value: 0,112 W/m²K
- -Energy frame: 187,1 kWh/m2 year
- -To avoid moisture issues with internal insulation, non-biogenic materials must be used. Additionally, the construction must be extremely tight and dry with the use of a vapor barrier to reduce the risk of moisture.
- resource-intensive?



New envelope



ill. 134-137: testing the additional insulation in Ubakus

-U-værdi: 0,14 W/m²K

-Energy frame: 187,3 kWh/m2

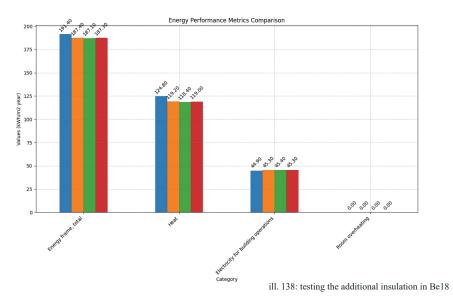
year

-Using biogenic materials

-By removing the existing wall the PCB is removed too

- resource-intensive?





The exterior post insulation is not efficient enough with the amount of insulation possible without changing the position of the HCH substructure. The interior post insulation cannot be carried out with biogenic materials because of the high risk of moisture in the construction. To reduce the risk of moisture non-biogenic materials and a vapor barrier are used, while this is beneficial for the construction, non-biogenic materials cannot absorb and release moisture, which may necessitate the use of other elements with these properties. The new envelope can be constructed in biogenic materials with no vapor barrier, and by removing the existing wall the PCB between the joints is removed. The aesthetic of the façade can be compromised by creating a new envelope.

The internal non-biogenic facade and the New envelope can be resource-intensive and will be tested in an LCA analyses

LCA analysis

The internal post insulation is resource-heavy due to the use of non-biogenic materials. The New envelope is built in biogenic materials which gives a negative GWP (Global Warming Potential) value because of the CO2 stored in the materials. The existing wall being demolished is taken into account (Appendix E). The GWP of the demolishing is small compared to the gains of the stored CO2. The disposal of biogenic materials is resource-heavy due to the assumption that the material's end of life is being burned which releases the CO2 stored in the materials. Shown in the graph when the new envelope rises to a higher GWP value than the non-biogenic.

The internal post insulation is slightly better from an LCA perspective. The New Envelope is slightly better when looking at the materials properties and the removal of the PCB.

The new envelope is tested to see if it is possible to preserve the architectural and aesthetic values of the facade.

Iterations / facade rhythm

A study was conducted to determine the possibility of preserving key architectural elements such as openness, depth, rhythm, proportion, and the relationship between horizontal and vertical elements in a new building envelope. A 3D analysis was undertaken to evaluate dimensions, rhythm, and patterns. Through experimentation with various facade cladding materials, it was determined that replicating the aesthetics of the existing relief parapet element while maintaining depth in the facade using new cladding materials, was not benefitting to the overall aesthetic. Notably, at the junction of the facade on Eskildsgade with the gables of Istegade, the introduction of different materials creates a discordance, detracting from the vertical lines in the gables. Additionally, the intrusion of the floor slab disrupts the continuity of the new wall lines, necessitating localized exterior insulation of the floor slab - an operation that poses practical challenges. Alternatively, relocating the new envelope outward exacerbates conflicts with the existing HCH substructure, as observed in the external post-insulation illustration.



ill. 139-147: testing expressions on the large surfaces



with an integrated bench









ill. 147-152: testing additional insulation expression

The interior Post insulation, with non-biogenic materials, is detailed further.

Detailing

Post insulation, interior

(non-biogenic materials)

insulating with vacuum

The post insulation is 45 mm with an U-value om 0,182. The insulation material is not commonly used.

insulating with Pur/pir

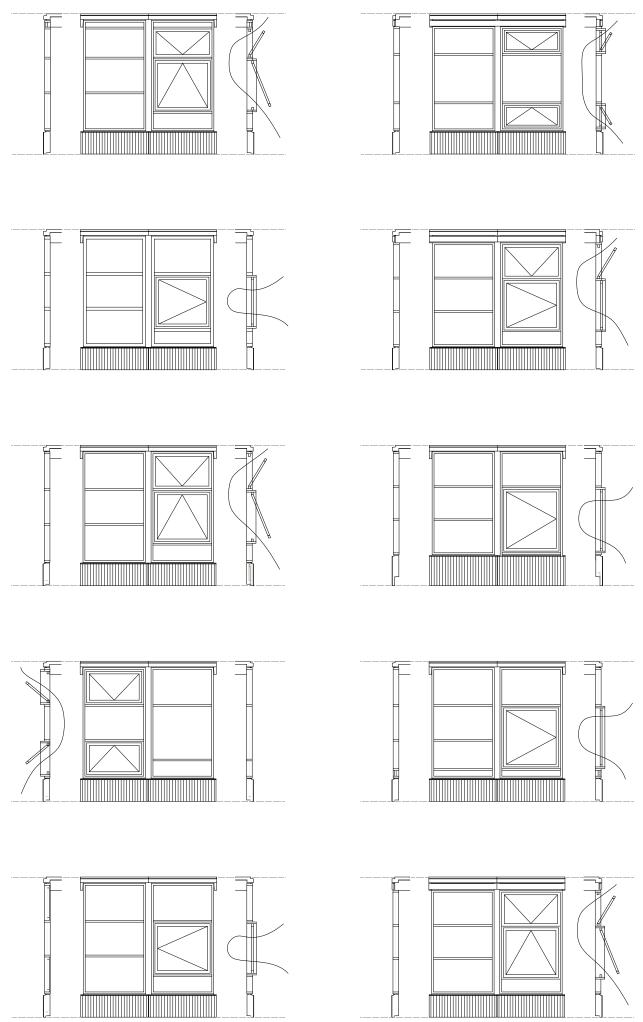
pur/pir is a product performing well as interior post insulation due to the airtightness of the product reducing the risk of moisture. The wall is 180 mm with a U-value of 0.112

insulating integrating a bench

To benefit from the extra depth of the interior wall implementing a bench is tested. The optimal seating height is lower than the still which results in the bench+wall being very deep crossing the internal grid line. If the bench+wall is reduced in depth it results in some of the parapet elements being less insulated.

insulating integrating the existing radiator

We intend to use the existing heating system of the building, which makes it ideal to implement the radiator in the insulation strategy. Using Pur/pir The post insulation is X mm following the internal gridlines. leaving 150 mm to implement the radiator. The existing radiators dimension is 1000x450 mm.



ill. 153-162: different window principles with natural ventilation



Iterations / windows

The windows are the existing from 1971, containing PCB in the sealant between the glazing and the frame. The glazing area of a classroom is 15,66 m2 and for the benchmark simulation (Se Appendix C) this causes 867 hours above 23 °C. As the windows will be replaced this provides a chance to change the glazing area. In this study it is explored whether there are ways to reduce the glazing area without compromising the architectural value of the openness (See Appendix H).

The materiality and dimensions of potential windows are explored in 3D, looking both at the changes from the inside and outside.

The design proposal had some impact on lowering the temperatures above 23 °C, mosly for a case of thicker frames (glazing area total 12,52 m2). However, it was concluded that the delicateness and openness of the facade was too compromised.

Microclimate and natural ventilation

The possibility of using natural ventilation as the primary ventilation strategy is tested. However as a strategy it is problematic in several ways.

The dimensions of the room are not compatible with one-side natural ventilation. The noise map shoves data from 1,5 m and 4 m above ground level. The traffic is heavy on Istedgade. The PCB between the joints evaporates more when it is exposed to heat from the sun, the summer is a typical period for using the window for venting. Due to The pollution caused by traffic, natural ventilation is not possible as the primary ventilation strategy.

However as a supplement and for providing users the ability to operate windows, there will be operable windows as in the existing design. With natural ventilation possible, it stresses the need to remove remaining PCB primary sources for the exterior.



ill. 173: 1:100 model of the modular system

06: Gables towards Istedgade

Design strategy

subtract - transform



'existing gable'



open more up between the concrete surfaces



open up the ground floor, horizontal



translate the original drawings into a facade intervention



working with asymmetry



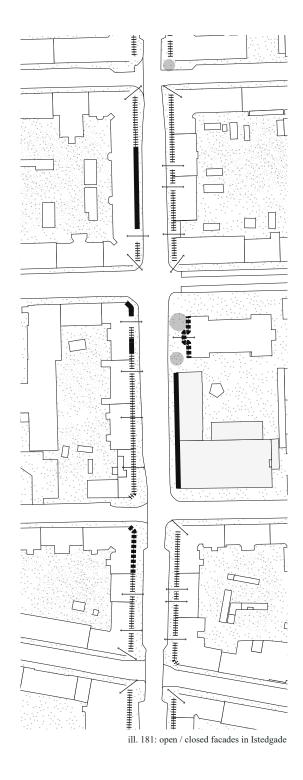
working with asymmetry

ill. 175-180: iterations of window design towards the street

Initial studies of the gables in 1:100

ill. 174: original elevation

Initially, variants of the gable motif were examined in a 1:100 scale model study. The focus of the study was on the entire gable motif and its rhythm, and the 1:100 scale made it possible to have the complete context in all variants, thus understanding how an iteration worked in the entire gable. Asymmetry, openness in the ground floor, verticality, and a checkered division inspired by original drawings were tested.

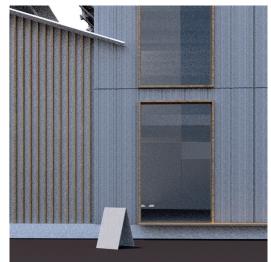


An analysis of Istedgade's degrees of openness/closure

The mapping highlights open or closed facades and the activity - both during the daytime and in the evening hours.

The mapping reveals a mix of functions in the area, with a predominance of bars, restaurants, and hotels, and to a lesser extent, cultural establishments. The site is surrounded by a wall with no openings in the facade, and it hosts functions that only operate during the daytime, which contributes to a sense of insecurity.

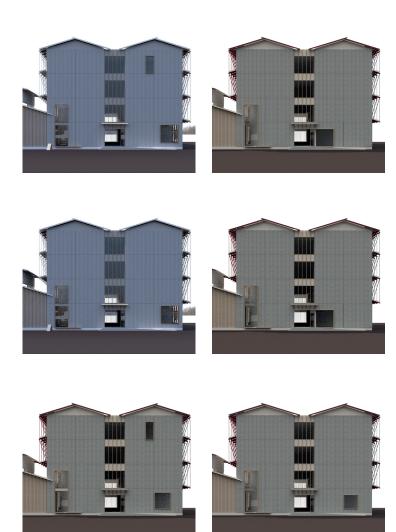
To obtain a comprehensive picture, the mapping must be complemented by a phenomenological analysis of how Istedgade, and especially the area around Gasværksvejens Skole, is experienced. Therefore, during a visit to the site and its context, a field study was conducted on the degree of openness/closure in facades and its impact on the sense of security in the street space. This investigation was carried out both in daylight and after dark to understand the differences in perception and security.







ill. 182-190: facade expressions of the gable



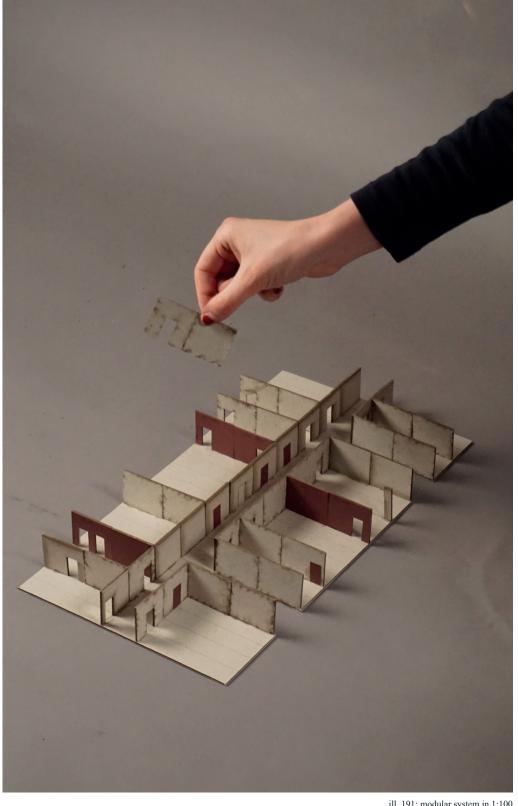
Placement of openings: Follow the lines of the elements or oppose them? The relationship between the street and the interior space

In the initial facade study, it was decided to proceed with a few selected windows that could help frame the life within the building. This was done through iterations that followed and contrasted the lines of the facade elements. The visual relationship of the double-height foyer to the street was also considered—whether this window section should stay within the floor lines to provide additional flexibility or offer a unique gesture to the street and space.

Just like the facade facing Eskildsgade, the gables required additional insulation. As shown in drawing X, the gable was constructed from the inside out with load-bearing concrete elements, mineral wool, an air gap, and concrete elements. The work involved both adding external insulation or removing the concrete cladding, adding a layer of insulation, and reattaching the elements. With this solution, the U-value of the gable would improve from X to X and the depth would increase by X mm.

The rhythm of A-B-C-B-A-B-C-B was used, and particularly in the glass section, how louvered elements could be employed to create a more open and inviting expression was considered. This was examined through street visualizations to understand how deep and closely spaced the louvers needed to be to achieve the desired effect.

To further create depth on the large surfaces, the potential for greening the louver sections of the facade was tested to see how it would be experienced from the street.



ill. 191: modular system in 1:100

07: Modular system

Design strategy

repair - transform





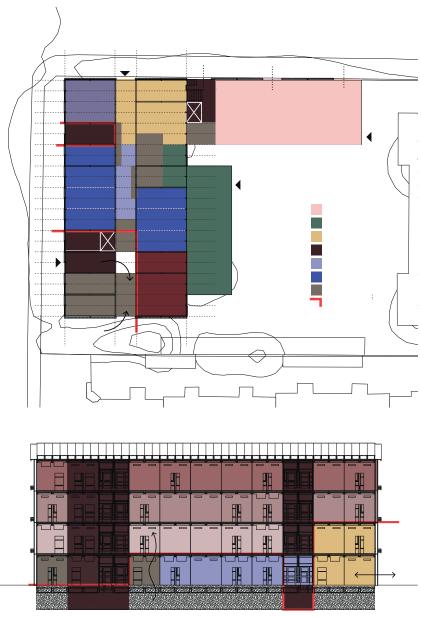
ill. 192: original drawing in 1:100



ill. 193-194: creating 'uniqueness' in the modularity

To understand the building's modularity, we built the structural system and the building's facades early in the process as a rough process model, where floors could be removed and reprogrammed. This provided an understanding of how the longitudinal concrete slabs and the columns in the facade are load-bearing, while the transverse concrete slabs that divide the rooms, as well as the gables, are stabilizing. This insight showed us the importance of inserting load-bearing beams when opening up towards the hallway, indicating that this intervention cannot be done just anywhere.

Therefore, we worked on how to create a more interesting hallway between these load-bearing slabs.



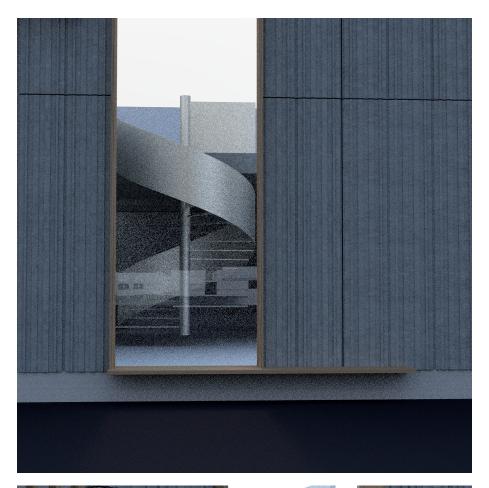
ill. 195-196: programming the building

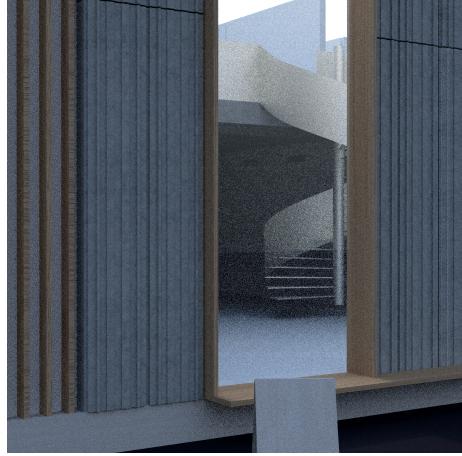
A specific program in a modular system: How to create a plan with specific needs that is flexible enough for a future change of function?

Initially, we envisioned the building to function multifunctionally, where different user groups could share facilities, maximizing the building's utilization.

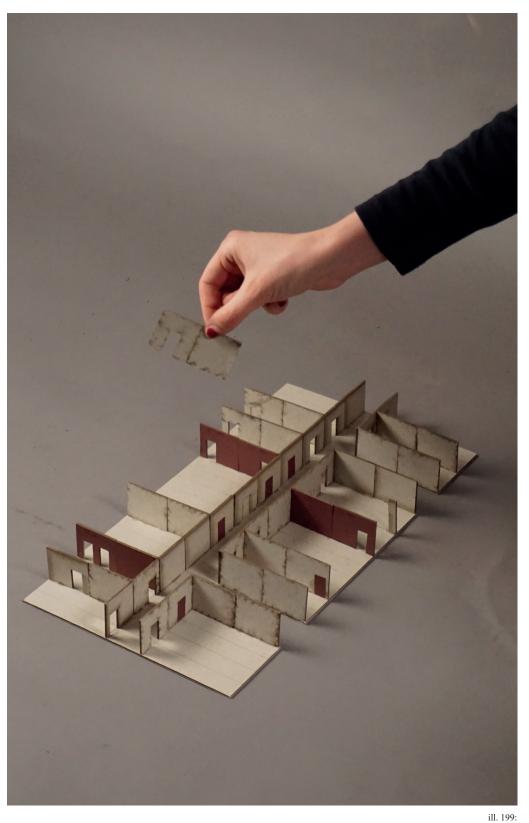
However, we then met with Stinne, the director of Reden København, to understand Reden's needs for a future expansion. This meeting provided us with an understanding that Reden is not a program that can share facilities. Instead, it is an introverted program with high demands for safety/security for both the women and the staff.

We incorporated these insights into the initial plan studies, quickly concluding that the ground floor should house a more extroverted function that could relate to the city, while Reden should be more secluded.





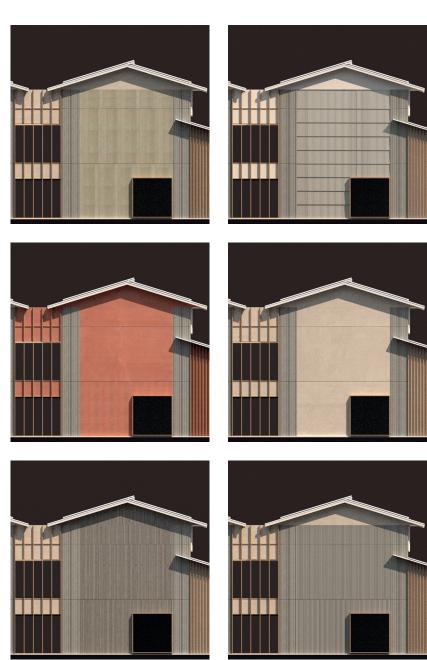
ill. 197-198: framing the circulation



08: Facade towards the courtyard

Design strategy

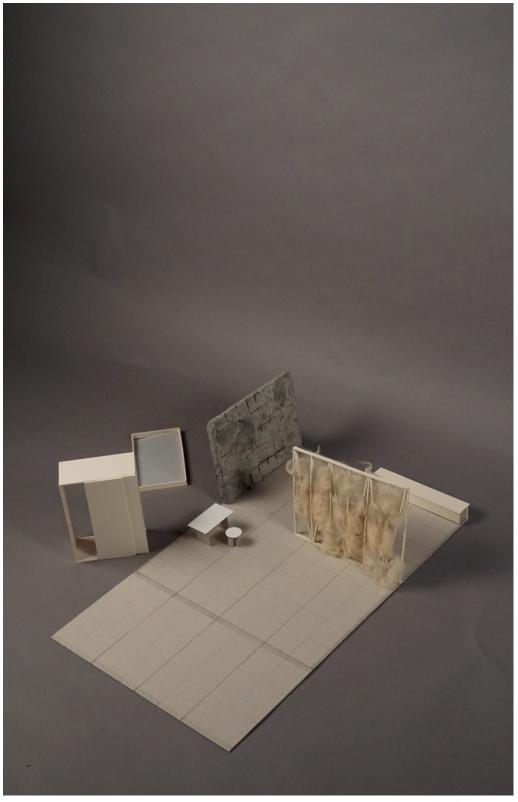
transform



ill. 200-205; material studies and facade expression on the gable towards the courtyard

Based on the evaluation, we allowed ourselves relatively free rein to interpret this facade, keeping in mind that it should either relate to the gable motif or the open facades with overhangs, not a mix as in the existing one. Initially, we sketched elevations, to understand the two-dimensional lines and rhythm of the facade.

Similar to the north-facing gable towards Istedgade, we incorporated a few 'staged' window openings to create a visual connection between the concert hall and the courtyard.



09: Designing the body-scale system



ill. 207: body scale system meeting the modularity, 1:20

Initial inspiration: The grid meets the biogenic

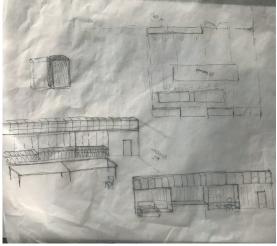
Initially we did a 1:20 model workshop on biogenic interior elements, prior to having any specific demands defined for what needs they had to meet. We were inspired by the idea of biogenic material contrasting the sleekly sealed prefabricated walls. At visit at Havnens Hænder in Copenhagen, had encouraged our growing fascination of biogenic building materials and their sustainable and aesthetic qualities. We thought it could potentially hold answers to indoor climate concerns or even the contamination challenges, but first we simply followed the aesthetic concept of grid meets organic. We produced mainly partitioning elements and furnishing, imagining a variety of materials that could be introduced; delicate, bulky, soft, light-diffuse, and so on.

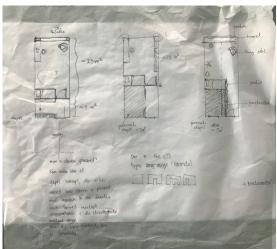


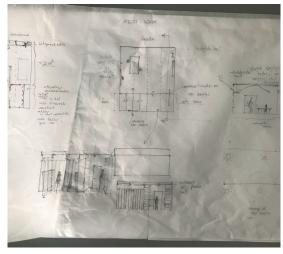
ill. 208: tactil materials

Mad professor phase

Parallel to evolving the concept of biogenic interiors, we were researching on the topics of PCB contamination and ways to remediate it. Naturally arose the question: Could there be biogenic remediation strategies? In this phase our design process was about imaging and speculating on how a connection like that might be adapted as a solution on a building scale. We found research that concluded mycelium (oyster) had the capacity to bioremediate PCBs (KILDE). We were thrilled by the image of mycelium overgrowing the concrete: Nature curing us from man made mis-steps. But the concept stayed as a speculative thought, as we realized mycelium will set fungi in time, leading to fungi spores in the indoor air and thus be very harmful to health. However, it fostered a further investigation in what material qualities might be advantageous in relation PCB contaminated spaces. That some would hardly absorb it, and some materials would absorb it but hardly rerelease it until saturated (e.g. activated carbon). We imagined how both could be productive; Either making sure that new materials would absorb minimal PCB to not form new tertiary sources, or perform as PCB 'flypaper', absorbing for a period to then be safely discarded and replaced (a concept also described in SBI XX, see page). While the concept is not applied in Danish PCB remediation practices, it seemed interesting to us, as it could be imagined as an architectural element; something that allows for easy demounting and replacement.





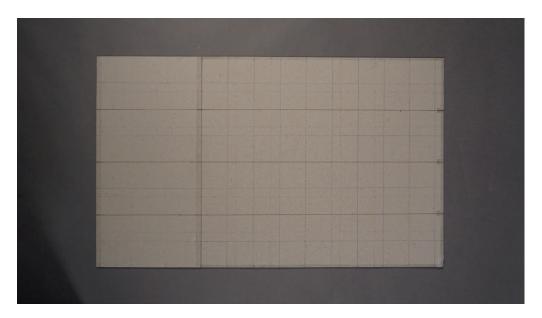


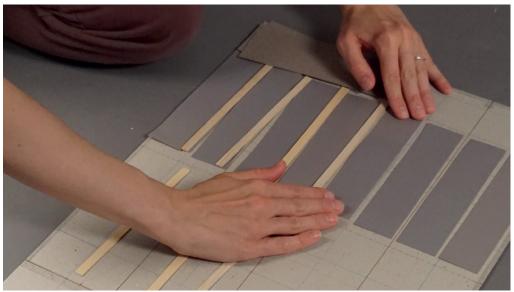
ill. 209-211: sketching on the systems answer to the users needs

Defining what the system needed to answer to

We returned to defining more tangible needs for the interior system to meet, defining the program of eight 'test-programs' (See XX). These spaces served as design catalysts, providing us concrete spatial layouts to sketch upon and design problems to solve; The need for a daylit desk, spatial separation, acoustic settings or homelikeness, which we translated to a question of providing softness, texture and introducing smaller scales.

We also defined another way the system could be productive in terms of PCB remediation, as a means to prevent sealants from suffering scratches in daily use. When visiting the school we noted that the building walls looked worn from use, and it seemed likely that the sealant could have been compromised.



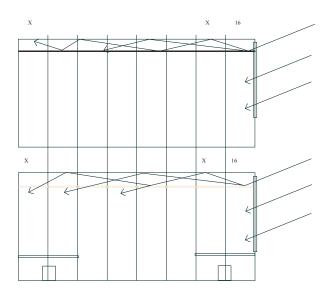


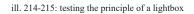
ill. 211-213: working WITH the modular system

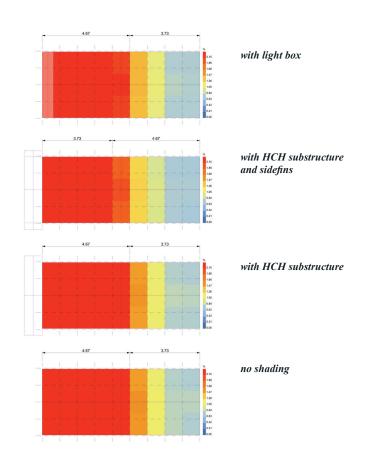
Tapping into the modular

As we started to give more form to what elements the system could consist of, we needed to get more specifically into the measurement and 'rules' of the existing modules. We intended for the interior system to tap into the modularity, only on a smaller scale. So we began to divide the modular 1800 mm; 600, 900. In aiming to establish the interiors as a system design, we realized we were met with exceptions, when meeting the walls. A main takeaway here was that the grid of the interior system needed to take the wall depth into account; meaning the rhythm would be $150 + XXX + 150 + XXX + \dots$. To decide on the scale of the system, we tried 600 (150+450), 900 (150+750) and 1200 (150+1050). We deemed 600 was visually too busy with the number of verticals introduced, and 1200 didn't add up to the decks of a 1800, resulting in an unlogic meeting in the ceiling. Therefore, we decided on the 900 mm module.

Ceiling; acoustic, daylight





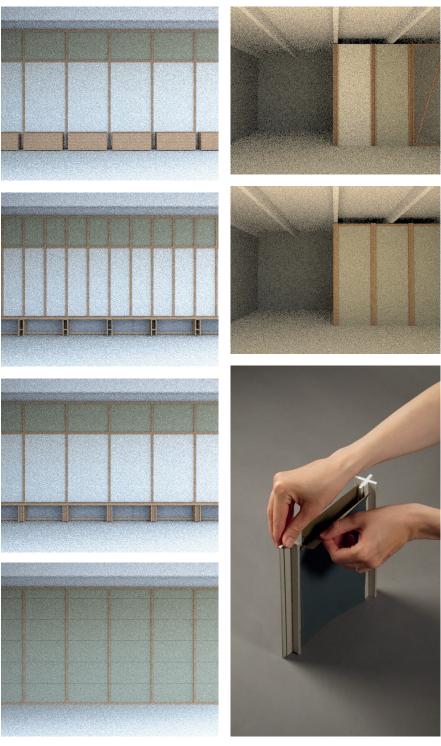


ill. 216-219: testing daylight

Analyzing daylight conditions and forming concepts for improvement

With the highly open façade and quite deep spaces (8400 mm), we realized that the spaces would have an uneven daylight distribution. Within the design strategies set out for façade and interiors the daylight conditions would be relatively fixed. Therefore, we sought to develop ideas on how interior interventions might improve the daylight setting of the spaces.

- 1) could the principle of a light shelf be beneficial to distribute the daylight more evenly? We deemed it could work well architecturally, although a daylight study done in grasshopper didn't show significant improvements to the daylight factor distribution.
- 2) Another concept was about accepting the daylight variation, and making the design about utilizing the spaces in the best way possible according to that. Specifically by defining the deepest zone as a storage zone, and the zone nearest the façade as 'living/ophold' area divided by a separating wall.
- 3) Another concept was concerned with the fact that the window glazing continues up past the suspended ceiling. An original design concept that we decided to keep in the new windows. We sketched up a concept of a diffuse suspended ceiling, that could possibly allow in this otherwise 'lost' daylight amount. And further, that the first section of the ceiling might be reflective, so as to perform as a light shelf.

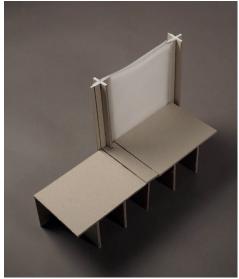


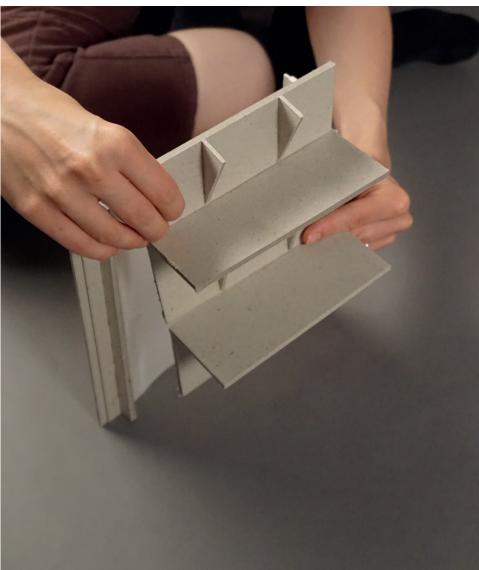
ill. 220-226: working with the body scale system

Solving the joining element: 1:5 studies

We tested variations of how panels (of 750) could join in an element (of 150). We did 1:5 models to understand the assembly of the elements better and 3d tools for visualizing it in a spatial setting. We realized that solving the corner was a challenge for several of the versions, and followed the cross, as it solved this challenge well.







ill. 227-230: working with the body scale system

Elaborating on the system

We did further model studies of how shelving and benches could meet these joining elements. We realized that the existing walls would need to provide a similar assembly concept to be able to use the system element both out in the space and along the walls. Therefore we developed a mounting system on the wall that mimics what 'happens' in the meeting between columns and elements (panels, benches, shelving).

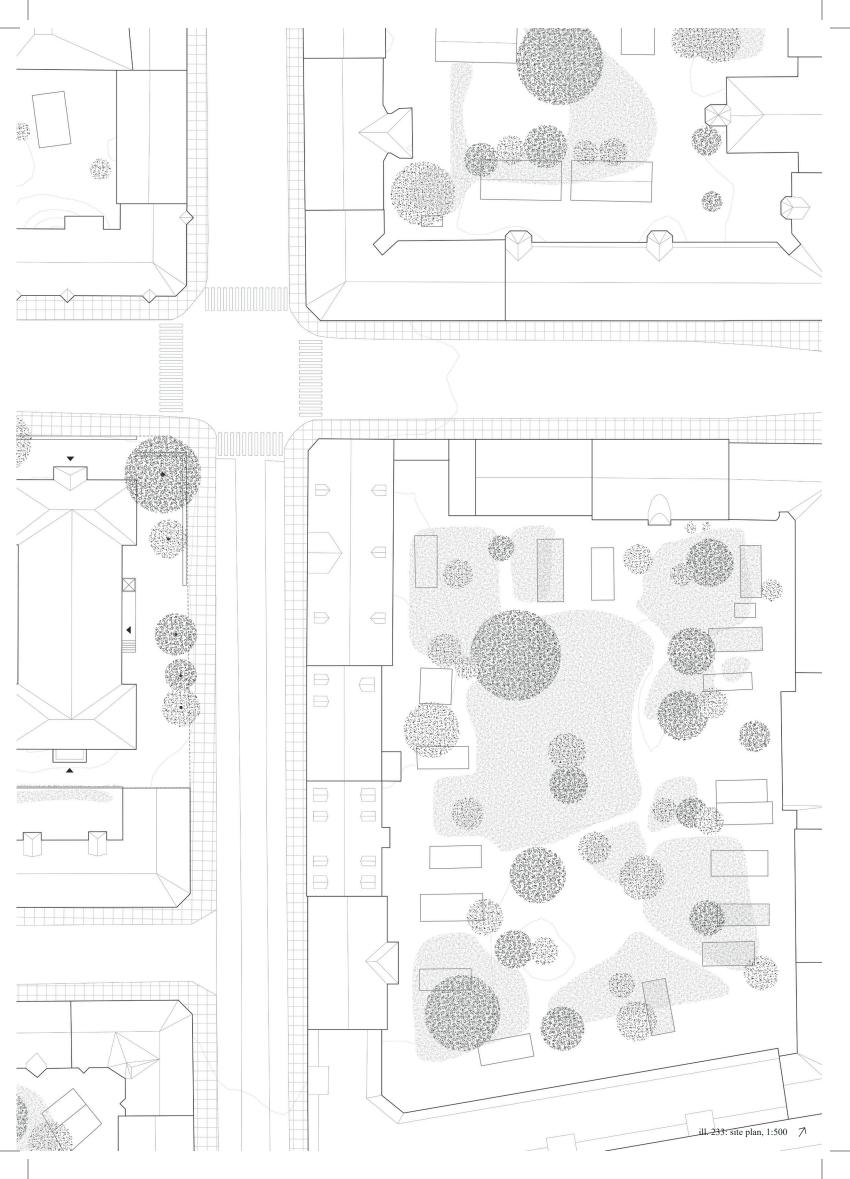


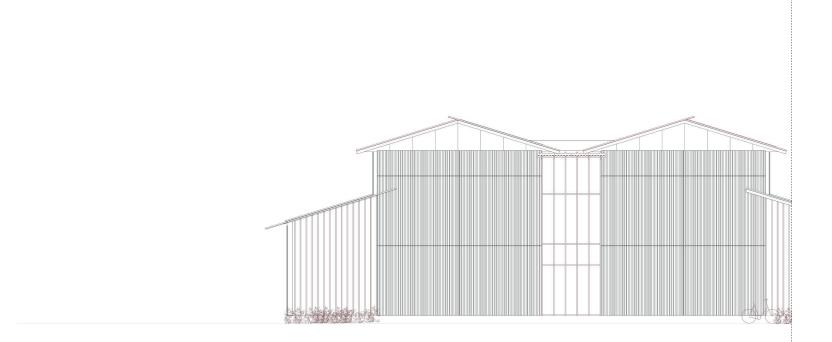
ill. 231: universel / unique concept



Gasværksvejens Skole is a flexible everyday building capable of adapting to the changing needs of its users and the local community. The entrances of the building are visually open to the surroundings, inviting people in and bridging the gap between the building and the pedestrian. The courtyard is a green space for the community and the users of the building. Solar panels are installed on the roof to benefit from the dimensions of the building.





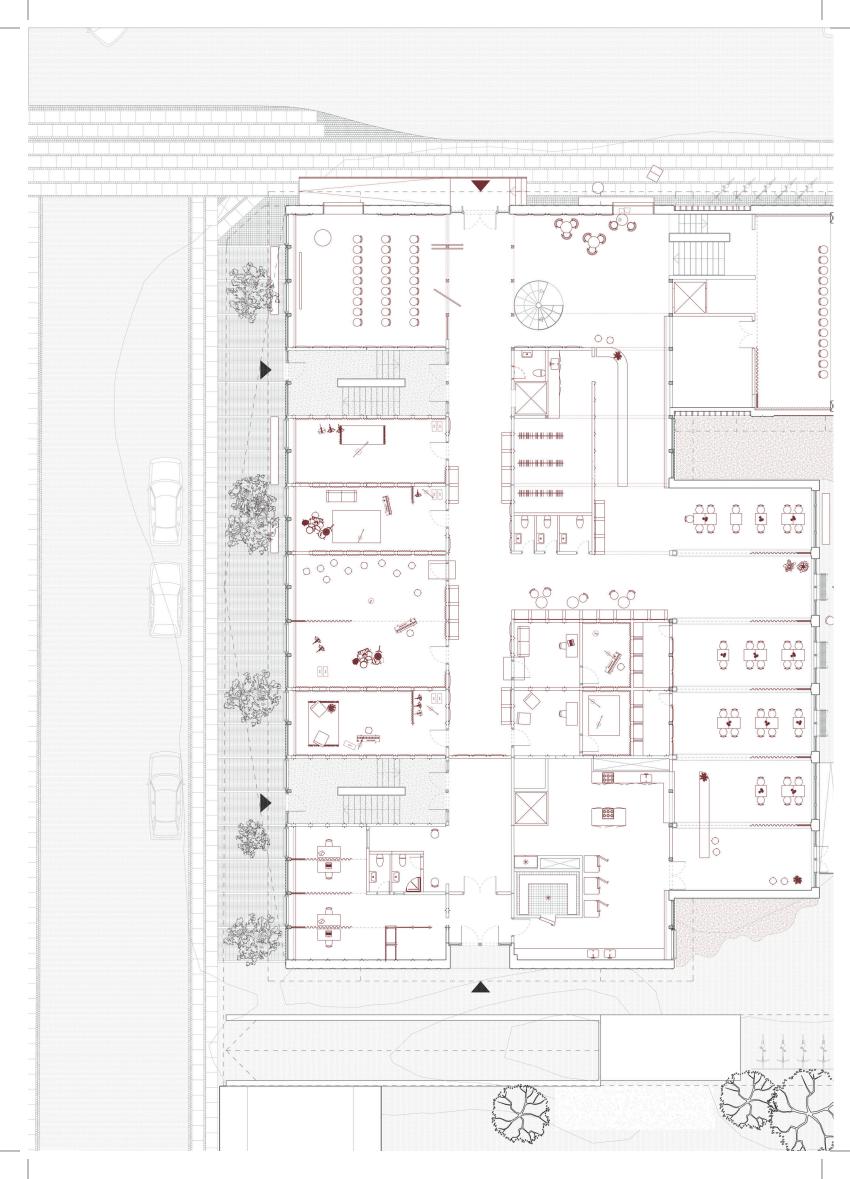


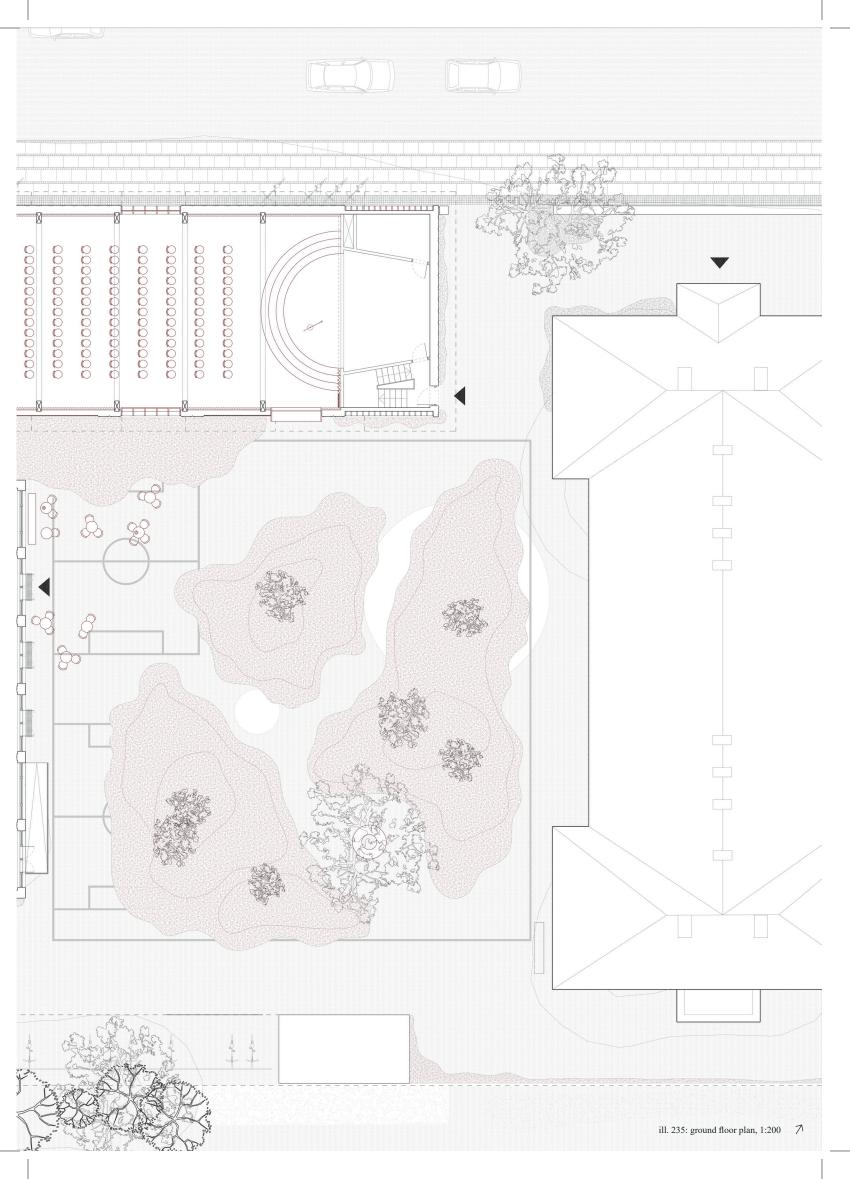
Facing Istedgade, the architectural intention with a rhythmic, vertical gable motif is preserved, but at the same time, the scale of the facade is broken down to create an interaction with the context in a human scale. With the extroverted function, Gehør, on the ground floor, increased fenestration is introduced, and the barrier wall surrounding the building is removed, creating visual and physical contact with the context through a more inviting expression. As a gesture to street life, stay, openness, and extra 'eyes on the street' are facilitated. A new main entrance is established on Istedgade for Gehør, while the entrance to Reden is placed more discreetly in one of the existing stairwells facing Eskildsgade. On the south-facing gable, the existing entrance area is used as a staff entrance for Reden's staff and for deliveries to both the café and Reden.



New windows are established in the gable section between the saddle roof motifs. The existing slats are removed, and vertical slats with the same center-to-center spacing as the window frames are added. This, to make maintenance/cleaning easier, to provide a greater amount of light indoors, and to improve the viewing opportunities. The depth of these slats is still perceived in the same rhythm and density when viewed from the street, due to an increased depth.

The depth of the gable is increased by 110 mm, as insulation with 220 mm of insulation material is installed between the concrete elements. The concrete elements are cleaned of the gable painting from the 1980s, so the raw concrete elements are not disturbed and can highlight the original intention with the vertical lines, variation, and depth in the relief.







The south-facing facade towards the courtyard is transformed based on an analysis and understanding of the original architect's principles and overall intention. It adheres to the building's rules without mimicking the existing structure, instead adding a new layer of transformation. The existing window band is reduced to two selected window sections — one at sitting height to invite to stay and create a visual connection to the concert hall, while the other window provides a sky view from the first floor of the wing. Anodized aluminum corrugated sheets, referencing Hans Christian Hansen's substructure overhangs, are used to create depth and give a human scale to the surface.

The 2016 extension, which houses Gehør's café, is stripped of its slats, revealing a raw concrete shell that, rather than drawing attention, submits to a considered hierarchy and allows the substructure to stand out. This extension physically connects to the courtyard – with its existing schoolyard paving telling the building's past – while a new layer of wildflowers and planting narrates the building's healthy, more biogenic future.



ill. 237: ground floor plan, 1:200

Transitions, rhythm, lines:

When applying this layer of transformation, it is done with an analytical eye and respect for the existing and the intention behind it. Therefore, there is a particular focus on how the transitions between the existing and the new are experienced and how the new materials relate to the existing lines and rhythm.



Oak (hardwood)

Oak is used to provide warmth, create a contrast to the gray concrete, and relate to the red wood profiles, as well as to create a more tactile expression. Additionally, the wood speaks to a more biogenic layer of transformation, which is further developed in the interior "body-scale" layer of transformation.

The window frames are treated with a wood primer that seals the pores of the wood, after which it is oil-treated for a natural expression. However, hardwood frames require maintenance in the form of cleaning and re-treatment.



Anodized aluminum corrugated sheets

Anodized aluminum corrugated sheets with are used for over-hangs in the substructure and as facade cladding on the concert hall's south-facing facade.

Anodized aluminum is chosen because it is a lightweight, long-lasting material, naturally resistant to corrosion and rust.



Render



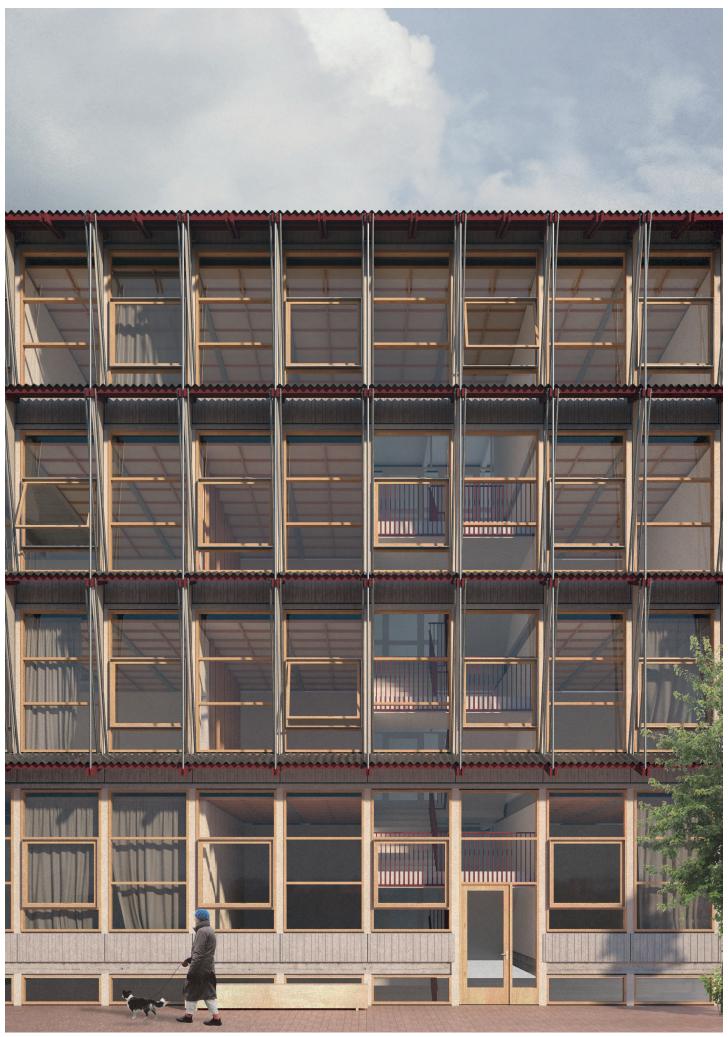
Cleaning and repair of concrete elements:

The concrete elements on the facade are pressure washed to remove algae and dirt, after which any damages are repaired using concrete repair mortar.



Triple-glazed windows and depth of window frames

The building already incorporates depth through projections and materials, and in this layer of transformation, deep window frames are added to create variation and reduce passive heat gain from the south. Additionally, the building's 2-layer thermal windows are replaced with triple-glazed energy-efficient windows, and for the south and southwest facades, windows with a lower solar heat gain coefficient of X are used to reduce overheating.



ill. 244: visualization of Eskildsgade

Facade toward Eskildsgade

The southwest-facing facade towards Eskildsgade is primarily transformed with a focus on preserving the original architectural intervention, addressing the facade's challenges with overheating and heat transmission, and making the facade more valued.

The rhythm, proportions, openness, and relationship between the horizontal window bands and overhangs, and the vertical elements, are preserved, but due to wear and lack of maintenance, large parts of the facade have been replaced and reconstructed.

Hans Christian Hansen's substructure is deemed worthy of preservation, so the design language, dimensions, and material type are retained, but due to the condition of the existing structure, the framework is reconstructed.

The window frames, which constitute a large part of the facade area, are replaced with oak frames to create tactility and warmth. However, a lightweight aluminum frame is used around the operable window areas, which are extruded. This is done both to protect the wood and to indicate their operability. A more user-friendly opening is established in the window, allowing for natural ventilation to complement the mechanical ventilation system during summer.

129,4 Benchmark

Final design **Energy frame** 191,4 kWh /m²/year 129,4 kWh /m²/year Atmospheric indoor climate PCB indoor air concentration 150 ng/m³ 300 ng/m^3 150 ng/m³ Project demand (See Appendix L) (Highest measured con-Sundhedsstyrelsen limit value centration) October 2023) (--) (300 ng/m^3) (--) (3000 ng/m^3) Relative humidity 25-60 % < 25%: 374 hours < 25%: 374 hours > 60%: 493 hours > 60%: 493 hours CO2 indoor air **Total exceeding: 867 hours** Total exceeding: 867 hours concentration 246 hours above (standard class) 1000 ppm 257 hours above Thermal indoor climate Operative temperature Jan - Dec: 20-23 °C Tolerance exceedances: Apr - Oct Hours > 23140 hours 867 hours 653 hours Hours > 2435 hours 601 hours 396 hours Nov - Mar 70 hours 0 hours 0 hours Hours > 23Hours > 2414 hours 231 hours 113 hours Acoustic indoor climate Reverberation time 125 Hz 0,9 s 1,2 s 1,2 s 0,33 s 0,6 s 1,35 s 250-3000 Hz Visual indoor climate Daylight BR18 demand 300 Lux Equivalent

6 %

6 %

See Appendix C,I and J

Daylight factor

2,1 %

Reflecting on the impact of the façade renovation

The energy frame is reduced from 191,5 kWh/m2/year (benchmark) to 129 kWh/m2/year with the facade renovation. The energy for heating is reduced from 124,7 kWh/m2/year to 47 kWh/m2/year (See Appendix J). We conclude that the facade renovation has had a significant effect on reducing thermal losses, which is particularly due to the replacement of the windows, as they account for a big area of the facade. What results in a relatively high energy frame regardless of this, is the high ventilation rates that serve to reduce indoor air temperatures.

The final design does not meet the thermal indoor environment demands set for the project. This means overheating will still pose an issue and thus also lead to increased PCB levels, in the case calculated for the final design. Based on the design iterations carried out on the façade, this is how much overtemperatures could be reduced, when also considering the valuation assessment of the façade, that deems the openness an important design concept. Out of the measures taken to reduce the overtemperatures, the choice of glazing with low g-value is by far the most efficient, as it reduces heat gains by passive solar significantly (See appendix I.). Few architectural interventions seemed to both have a significant effect in reducing overheating and work within the tectonic ideas of the facade. The design intervention of adding fabric side fins has some effect but not significantly (See appendix I.)

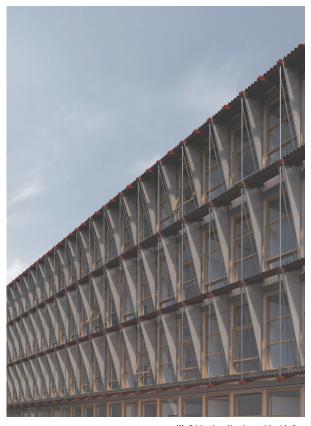
If the façade was not deemed worthy of preservation, more impactful passive strategies could be taken to reduce overheating. However a strategy forward for the specific case of Gasværksvejens Skole could be to implement cooling in the ventilation system, to reduce overheating further. This would take energy for a cooling element but would possibly reduce ventilation rates (as the VAV system is controlled by CO2 and temperatures), that are relatively high, and thereby possibly decrease fanpower for the ventilation system.

The exceedances for CO2 levels could be due to the setpoints defined in the model. The modeled ventilation system is VAV controlled by C02 values and

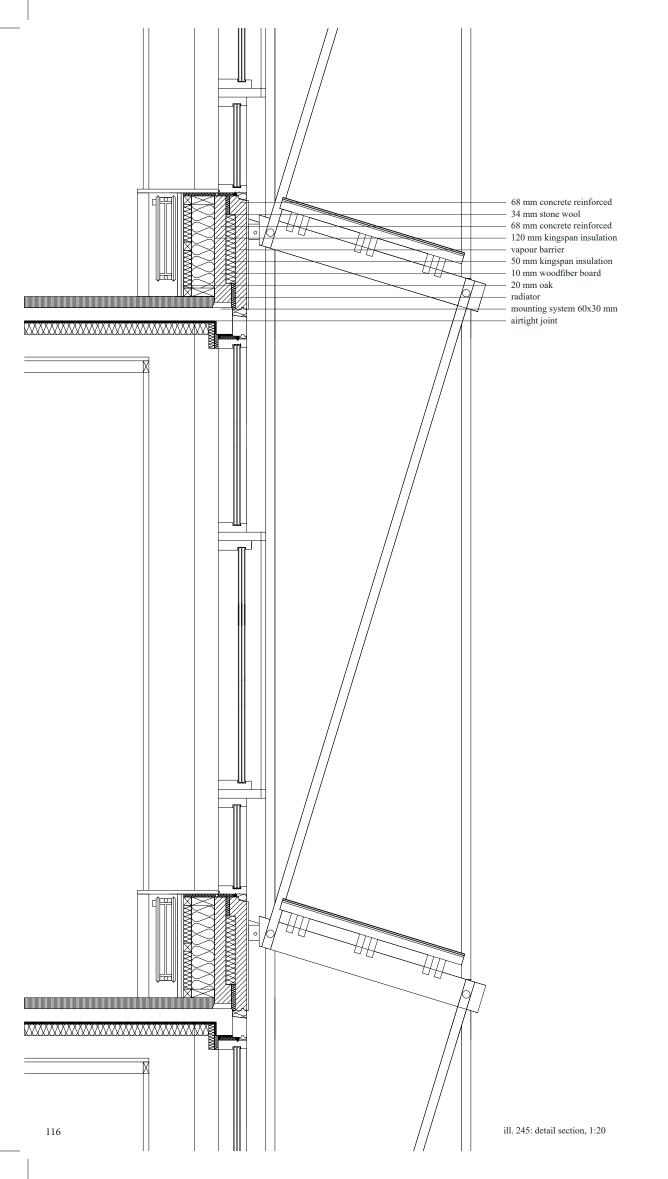
temperature setpoints, the ventilation has 1000 ppm as a setpoint for C02, so possibly the hours outside the frame could be due to the period from the ventilation 'reacts' to the need for increase of ventilation.

The acoustic environment is improved with the introduction of the body-scale system, which lowers the reverberation time, so that it is within the project demand.

The daylight factor of the space is generally plenty high. The design process concerning this, has been on a qualitative level to harness it better.



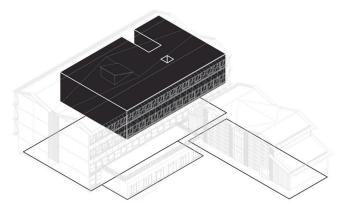
ill. 246: visualisation with sidefins



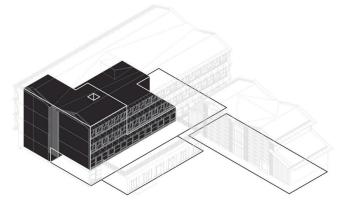
An internal insulation has been carried out on the facade facing Eskildsgade to improve the building's energy performance. To conduct internal insulation of the parapet elements and reduce the risk of moisture, non-biogenic materials are used, along with a robust vapor barrier. The U-value of the insulated parapet element is x. The existing radiator has been removed and repositioned on the other side of the insulation. A radiator cover extends from the insulation in the same height as the sill.

l. The windows have been replaced with wooden frames, with a g-value of 0,32 to reduce overheating. The dimensions of the new windows match the existing ones to maintain the aesthetics of the building. The column has been externally insulated with x, while the thermal bridge in the penetrating floor slab has been insulated internally along the slab.

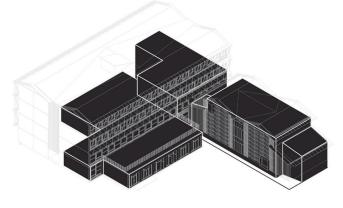
04: Student housing



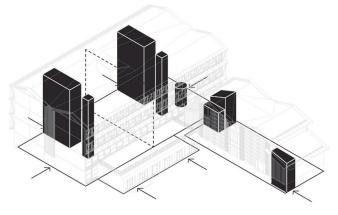
03: Reden



02: Gehør



01: Circulation



A testing program to demonstrate the building's potential/flexibility

Once the building has completed housing schools and has been cleaned and decontaminated for PCB, the project's three test functions will move in: the music incubator, Gehør, the women's center, Reden, and the student housing. These functions propose a possible scenario for a diverse program. Illustration 247-250 shows how the building is divided for this scenario, where users cannot share functions and entrances (due to Reden's confidentiality requirements), but also how, in a future scenario, the building might need to be divided with more circulation options within the modular system framework to create flexibility.

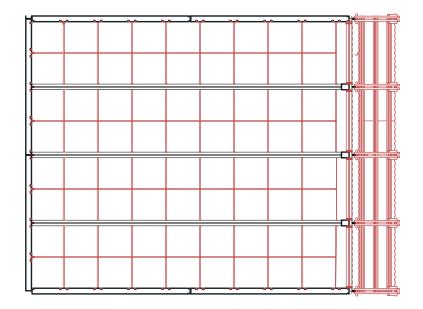
The ground floor plan indicated that the outward-facing function, Gehør, was primarily located on the ground floor, but that Reden also had an entrance, observation room, fix room, and office on the ground floor with direct access from Eskildsgade. On the first floor, Reden additionally has X m², comprising living rooms, dining area, office, kitchen, dormitories, and meeting rooms. Furthermore, Gehør's more introverted function, the studio, is located in relation to the double-height foyer in the northwest gable



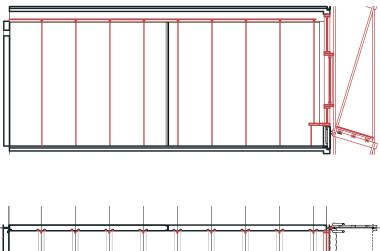
ill. 251: universal / unique

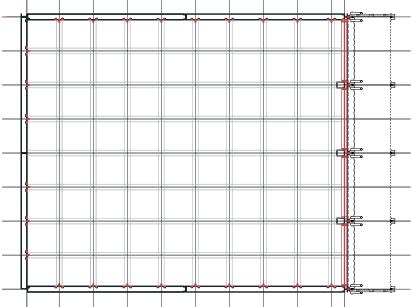
Addition: A biobased, human-scale, interior concept

The introduction of a 'body-scaled' system, that immerses itself in the logic of the existing modular system and subdivides it into a scale that relates to the human body. It forms light walls, storage, seating and paneling, that mediate between the universal character of the modular spaces and specific, various programmatic needs. It serves to improve the indoor climate of the spaces, dealing with acoustics, daylight and moisture conditions. By protecting PCB sealants and suggesting a concept for collection of PCBs, the 'body-scaled' system supports PCB mediation of the building.



Making the contaminated surfaces approachable





ill. 252: plan and sections, 1:100

With the implementation of a mounting system, the user can now approach anthe wall, hang things, redecorate /personalize / ibrugtage / gøre til sit eget /occupy/inhabit the space while avoiding unintended release of PCBs to the air and without compromizing the PCB sealant.



ill. 253: use of the body scale system

ill. 252: wall panels

Deisign guide:

Maintenance

by Building owner

Installation

by professionals

1) cut + drill

While wearing protective gear

Removed materials are disposed as hazardous waste

2) Thermal stripping

Three day long thermal stripping at 50-60 °C

According to the method described in SBI (Andersen, 2017) and by Thomas Hougaard. See appendix L: Duration of thermal stripping of PCB (dimensioning calculationsheet)

Building closed off and watched.

3) Resealing of surfaces

Painting of walls in sand RAL 1030

Installation of steel XXX and wood battens.

- measuring PCB concentrations in indoor air with regular intervals.
- Observing wall conditions
- In case of damage to the paint and sealant, the previous paint colors will show: white, red, green or yellow

- 1) Resealing of breached areas
- 2) repainting with RAL 1013

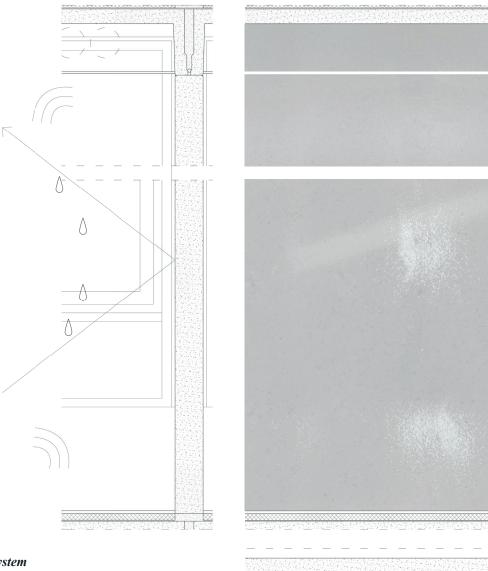
Use

by building occupants

! No drilling or mouting directly into the buildings surfaces.

! No repainting of the walls, as it will make prevent building owner in observing wall conditions..

- Adapting the space with the body-scale system elements;
- shelving, benches, panels, suspended ceiling
- Instead of painting walls can be covered with panels or fabrics on the mounting system.
- Hanging of artworks on the mounting system.



With body-scale system breathes, moisture absorp...

on, 'battery', leveling mositure loads over the day.

Sound absorpiton -- material, and sound 'fraktering' depth /profile of the wall.

Mounting of pannelling protects the PCB sealant from damage /scratches.

Makes it possible for users to interact with the wall without breaking the selant, and mount demount /personalie the space -> flexibility in use.

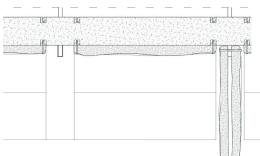
Existing

no moisture absorption / not breathing

'_'sorption, and no profile/scattering of sound sed to 'breakage'

two user, nexibility; its not possible for users to mount furnishigg, panels, shelving, etc. without damaging PCB sealant





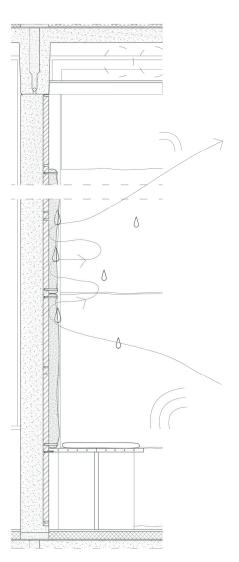
With body-scale system

breathes, moisture absorption, 'battery', leveling mositure loads over the day.

Sound absorpiton -- material, and sound 'fraktering' depth / profile of the wall.

Mounting of pannelling protects the PCB sealant from damage /scratches.

Makes it possible for users to interact with the wall without breaking the selant



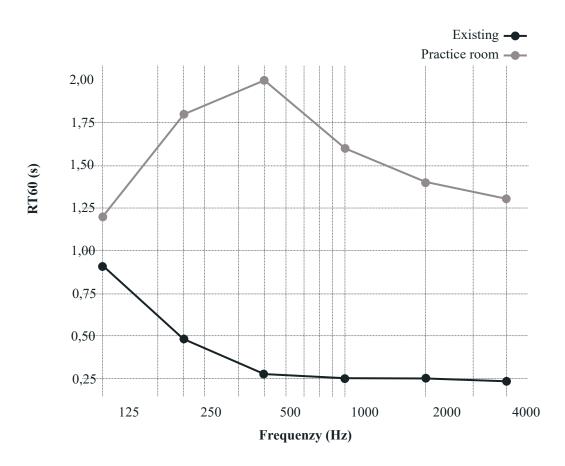
With body-scale system

breathes, moisture absorption, 'battery', leveling mositure loads over the day.

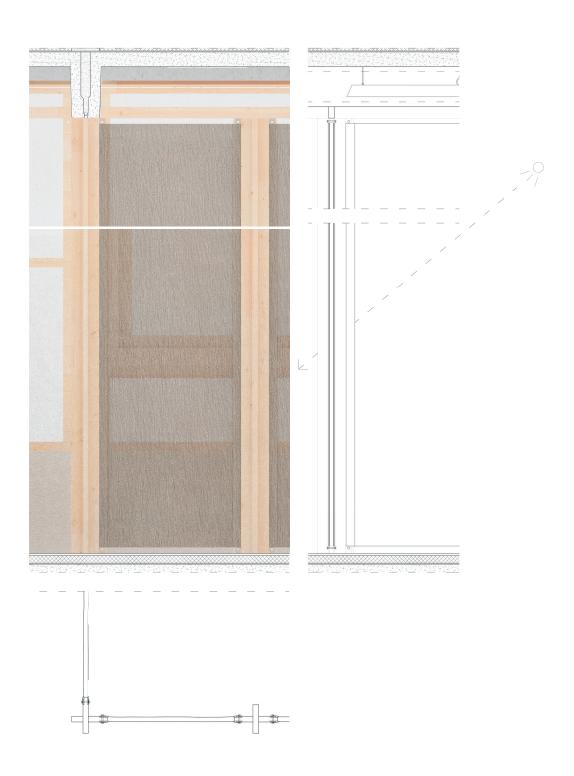
Sound absorpiton -- material, and sound 'fraktering' depth /profile of the wall.

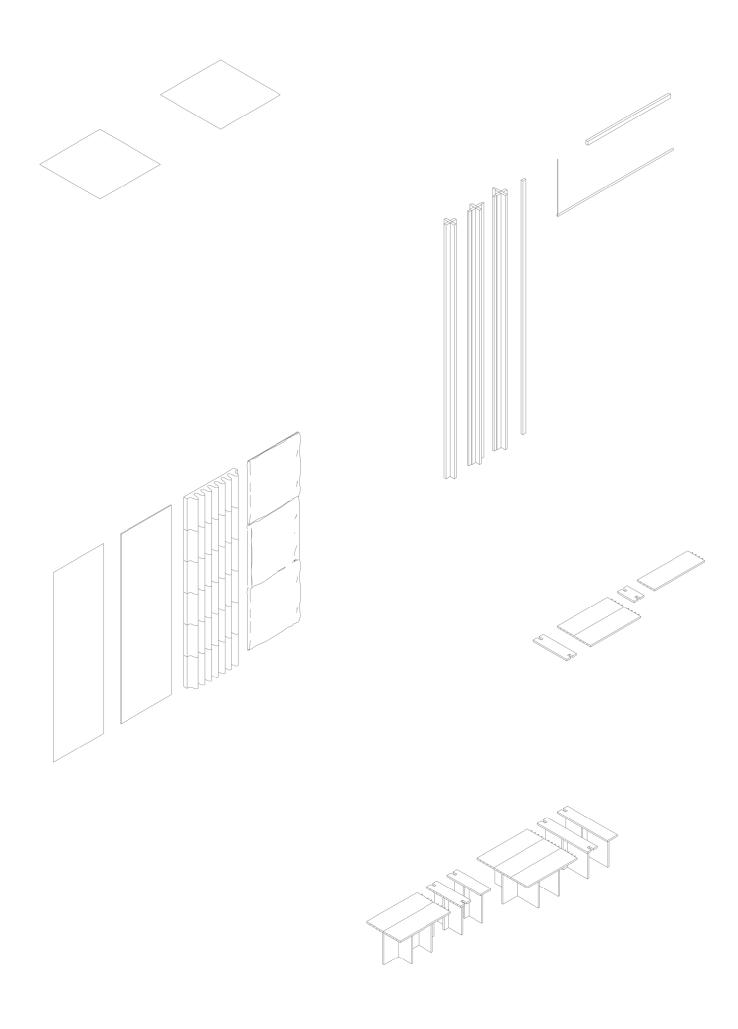
Mounting of pannelling protects the PCB sealant from damage /scratches.

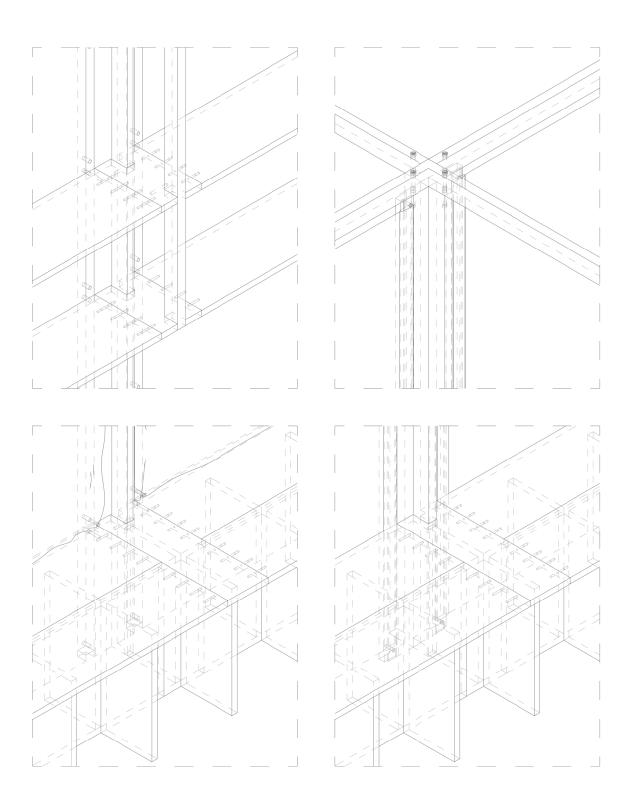
Makes it possible for users to interact with the wall without breaking the selant, and mount demount /personalie the space -> flexibility in use.



ill. 255: reverberation time, before and after





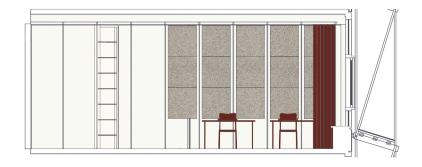


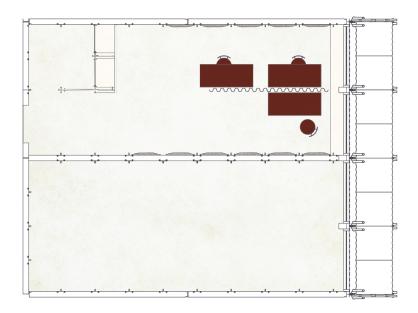
System elements:

Vairety/ options for flexible use and personalization.

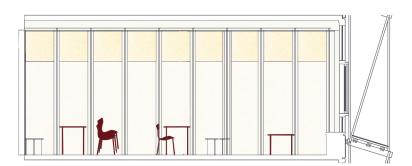
Panelling

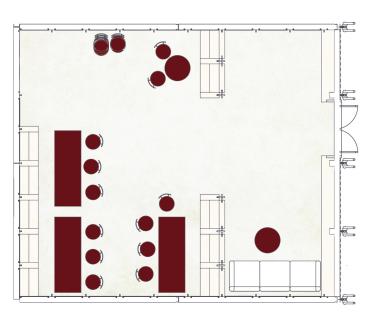
Catalogue : testprograms





Office space

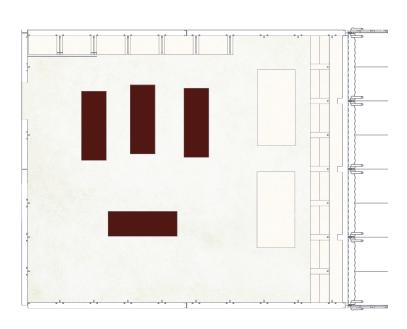




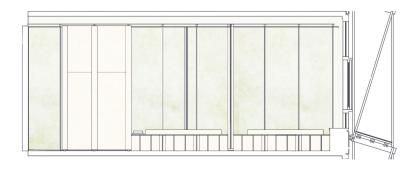
Dining room

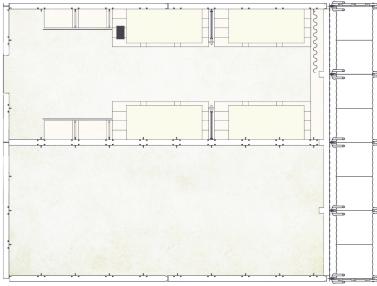


Multi- yoga, presentation space



shared overvatning





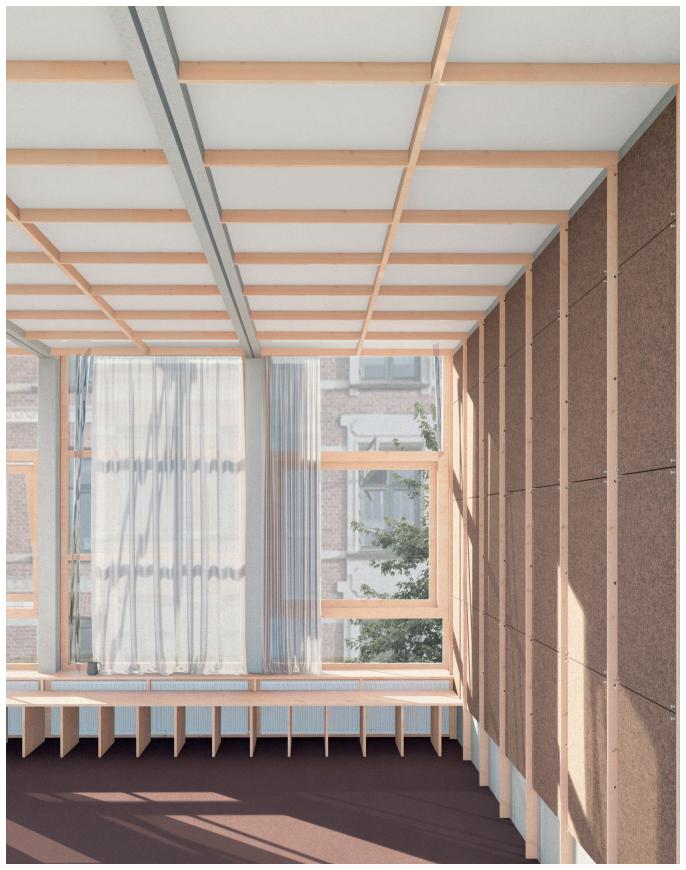
ill. 258-261: plans and sections of the body scale system in the test modules

'raw space, former classroom'



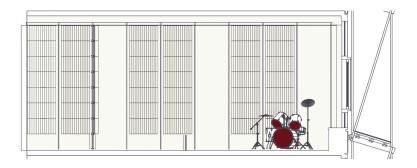
ill. 262: existing building, classroom

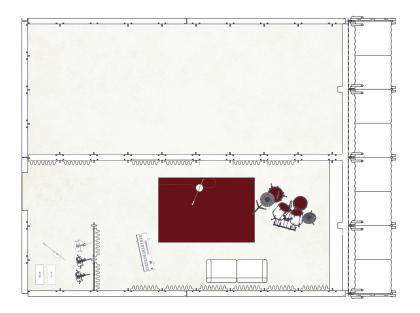
'example programme'



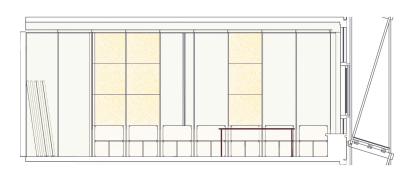
ill. 263: the same room with the body scale system

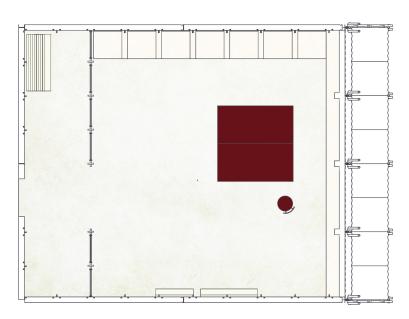
Catalogue : testprograms



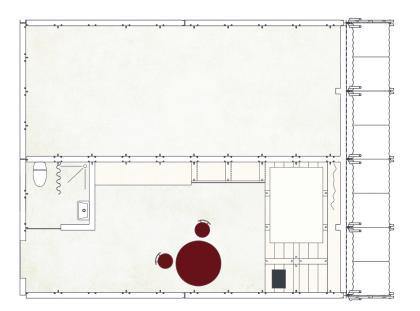


Band lokale

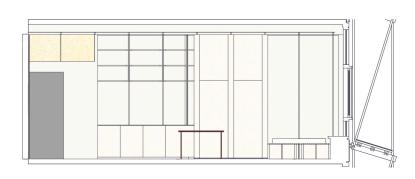




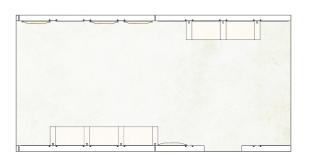
Atelier

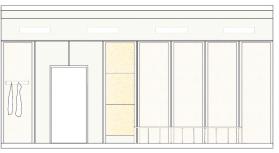


Student housing



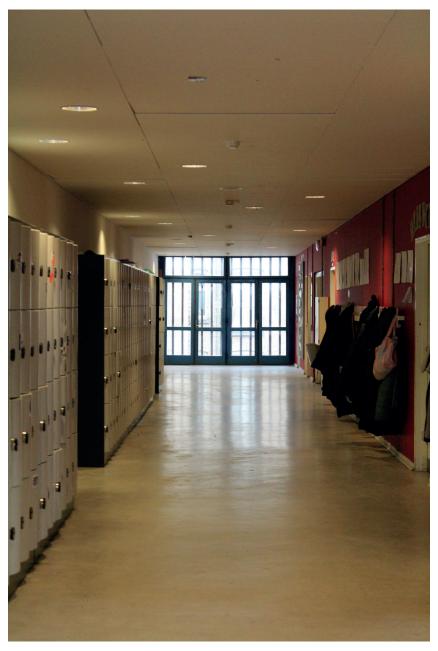
Circulation space





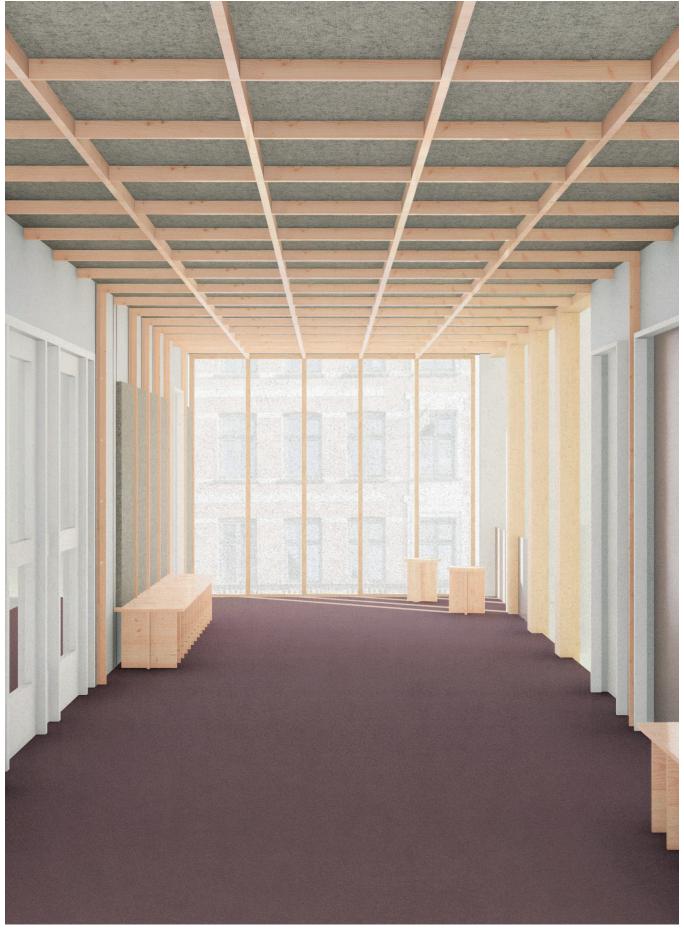
ill. 264-267: plans and sections of the body scale system in the test modules

'raw hall'

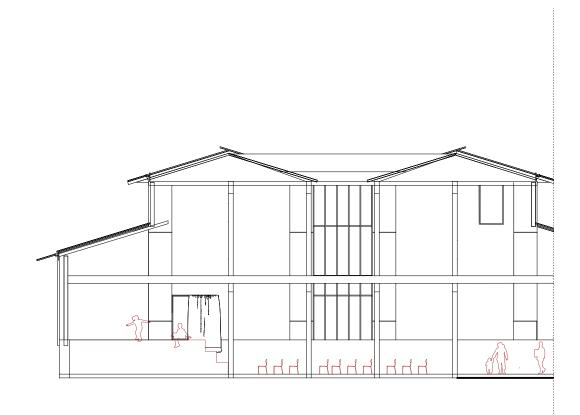


ill. 268: existing building,

future scenario hall

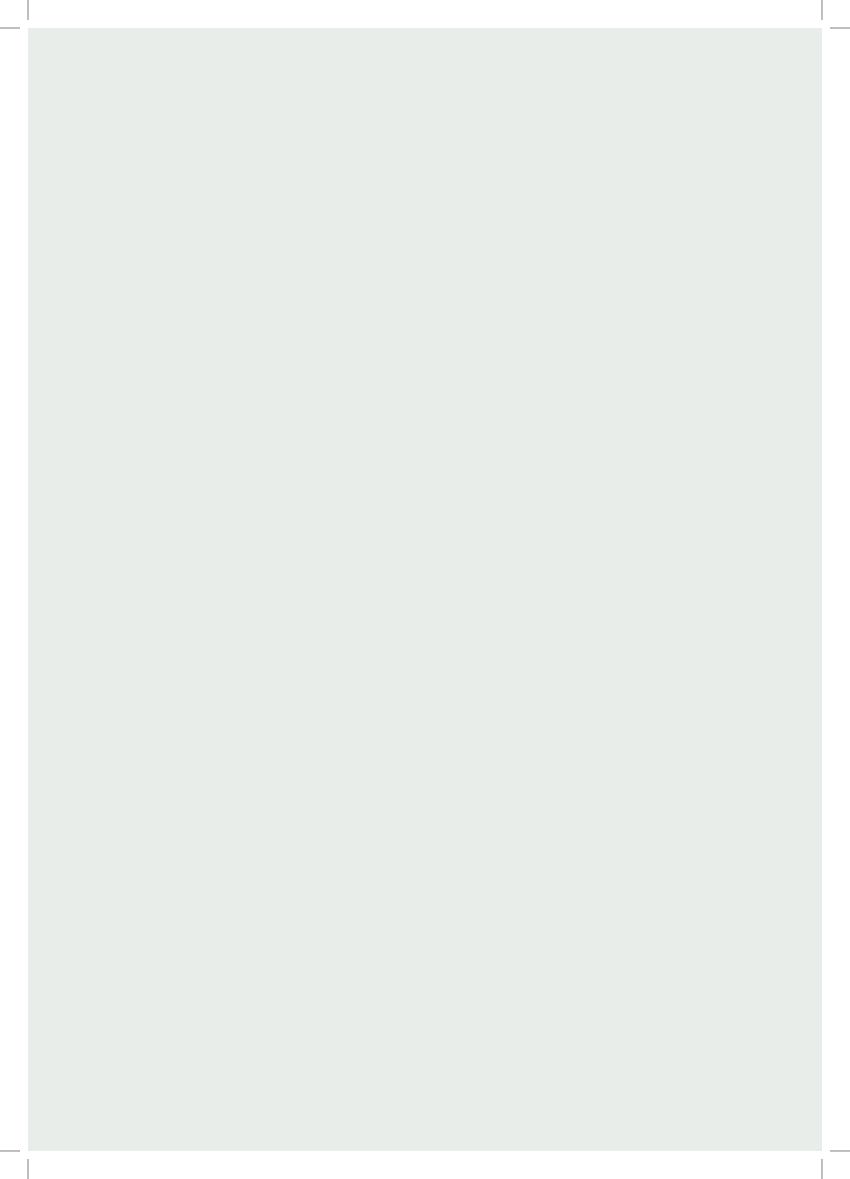


ill. 269: body scale layer in hall way



In the Foyer sections of the floor slabs have been removed, resulting in a double-height space. The intervention makes a unique space designed with flexibility in mind. By adhering to the modular grid of the building, it remains adaptable. Crucially, this flexibility extends to reversibility; the intervention can be undone, ensuring that changes made today do not irreversibly dictate the building's future.





Closing Reflection

As the sustainable agenda changes the perspective on how to utilize the existing building masse evolves. Historically transformation has been carried out because og economic and functional reasons, rather than care for cultural heritage and sustainability. Gasværksvejens School's addition is an example of a building representing a time characterized by industrialization. In this thesis we have tried to open up for the possibilities for a building which future existence is in the hands of Copenhagen municipality. The theses is a test of the modular system and what future possibilities it holds. In our example we tried different functions to see weather the universal form could hold something unique. The grid is at first assumption leaving no room to chance, but at closer investigation even the system has exceptions. Showcasing the difficulty of making something so adaptable and anonymous that everyone and anything can occupy the space inside it. At Gasværksvejens skole addition we are tapping into an idea which Hans Christan Hansen started in 1971 by trying to bridge the building prefabricated concrete building provided by Fynsplanen with a unique facade. He broke down the scale wanting to humanize the architectural expression. The body scale system is the intention of doing something similar on the inside. Realising the difficulties combines with fitting a new scale into an existing.

Cases such has Brønby strand is a perfect example of what happens when a building is no longer worthy of taking care of. Brøndby strand was contaminated with PCB such as Gasværksvejens skoles addition. In this project we have experienced thereality of having a specific agenda. When talking to the municipality of Copenhagen who is taking the decision on the life of Gasværksvejens skole addition. Thay did not know about the remediation of the school in 2009, which is a significant question when talking about resources being put into the building. We applied for access to document after experiencing several instances where we were unable to obtain sufficient relevant material from the municipality. Upon reviewing the documents, it became clear that the aim for the building has been to keep it just below 300 ng PCB/ m2, which is a requirement from the Danish Health Authority. Which means that the building are held on the tipping point of being just healthy enough, or harmful to health. In the summer period the building is above action levels due to the heat increase, but the temperature i corrected to 21 degrees. reflecting on the correcting action levels, the PCB concentration should be significantly below 300 ng PCB/m2, to make sure that the concentration is below in all temperature situations. Due to the increased focus on resources and life cycle assessment (LCA), it has become more difficult for municipalities to demolish buildings unless they are harmful to health. The fact that the building is on the verge of being hazardous to health gives the municipality the opportunity to assess whether they want to keep it or not. In our approach to the project, we have investigated whether a building containing these issues can once again become something that people are happy to have in their local environment, and if the municipalities can see the potential in transforming it rather than simply seeing an empty construction site every time an underutilized prefabricated concrete building arises.

Litteratur

Yin, Yuefen, et al. "Capability of Polychlorinated Biophenyl (PCBs) Degrading Fungi Segregated from Sediments." World Journal of Microbiology & Biotechnology, vol. 27, no. 11, 2011, pp. 2567–74, https://doi.org/10.1007/s11274-011-0728-0.

Andersen, NB~2015, `Arkitekturens~transformation-fem~metoder'.~i~C~Harlang~and~A~Algreen-Petersen~(red), Om~bygningskulturens~transformation.~GEKKO~Publishing,~Kbh.,~s.~72-87.

Plevoets, B., & Van Cleempoel, K. (2019). Adaptive Reuse of the Built Heritage: Concepts and Cases of an Emerging Discipline (1st ed.).

Harlang, J. (2020), From Venice to Palimpsest. Available: https://arkitektforeningen.dk/arkitekten/fra-vene-zia-til-palimpsest/ [2024, May].

Renauld, M.-M. (2021, September 25), Eugène Viollet-le-Duc: The Architect Who Saved Notre Dame de Paris. The Collector. Available: https://www.thecollector.com/eugene-violett-le-duc-notre-dame-de-paris-architect [2024, May].

Moore, L. (2022, October 11), The Reinvented Beauty of Château de Pierrefonds. Story of a City. Available: https://www.storyofacity.com/2022/10/11/chateau-de-pierrefonds/ [2024, May].

Danish Architecture Center. (n.d.), Koldinghus. Available: https://dac.dk/viden/arkitektur/koldinghus/ [2024, May].

Andersen, H.V. (2015) SBI-anvisning 241 udgave 2: undersøgelse og vurdering af PCB i bygninger. Aalborg: Statens Byggeforskningsinstitut, Aalborg Universitet.

Andersen, H.V. (2017) SBI-anvisning 268: PCB i bygninger - Afhjælpning, Renovering og Nedrivning. Aalborg: Statens Byggeforskningsinstitut, Aalborg Universitet.

Gontmil og Cowi (2013) 'Kortlægning af PCB i indeluft og materialer', 10 December. Available at: [chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.sbst.dk/Media/638206863989327507/Kort-1%C3%A6gning%20af%20PCB%20i%20materialer%20og%20indeluft.pdf] (Accessed: 29/05-2024]).

PCB er et giftigt stof, der er svært nedbrydeligt, og som kan skade mennesker og miljø' (n.d.) Miljøstyrelsen. Available at: [https://mst.dk/erhverv/groen-produktion-og-affald/affald-og-genanvendelse/affaldshaand-tering/affaldsfraktioner/pcb] (Accessed: 29/05-2024).

MT Højgaard. (no date). Renovering og PCB-sanering af Gasværksvejens Skole. Available at: https://mth.dk/Vores-Projekter/Gasvaerkvejens-Skole

Nissen, H. (1975). Modul og montagebyggeri. available: https://danskbyggeskik.dk/publikationer/1415%20 -%20montagebyggeri,%20s.%201%20-%20226.pdf [online] pp. 295-429

Energiforbrug og klimapåvirkning (§ 250 - § 298) 2023,

Bekendtgørelse af lov om bygningsfredning og bevaring af bygninger og bymiljøer 2018, .

Andersen, A. 2024, Nu er Danmarkshistoriens største nedrivning overstået, Fagbladet Boligen.

Andersen., M. 2023, Bygningsforsker: Vi bør tale om et midlertidigt stop for nybyggeri, Altinget - By og Bolig.

Architects for Future, (., Bund Deutscher Architektinnen und Architekten, B., Deutsche Umwelthilfe, (., Denkmalnetz Bayern, KulturerbeNetz Berlin, Initiative Abrissmoratorium, Leibniz Universität Hannover & Theatrum e.V. n.d., n.d.-last update, Abriss Atlas. Available: https://abriss-atlas.de/ [2024, Apr].

Arkitektforeningen 2022, Leder: Lad tvivlen komme den anklagede til gode. Available: https://arkitektforeningen.dk/arkitekten/leder-lad-tvivlen-komme-den-anklagede-til-gode/ [2024, Mar.]

Christensen, J. 2023, "I Danmark er vi vilde med at rive bygninger ned, men det tærer på klimaet", Altinget - Klima, .

 $CORRECTIV\ CrowdNewsroom\ gGmbH\ n.d., n.d.-last\ update, Abriss\ Atlas.\ Available:\ https://abriss-atlas.\ ch/\ [2024, Apr.].$

Københavns Kommune 2024, Jan.-last update, Hjælp, hvad skal vores skole hedde?. Available: https://www.kk.dk/nyheder/hjaelp-hvad-skal-vores-skole-hedde [2024, Apr.].

Lindberg, I. 2024, Mar.-last update, Kronik: Vi må alle lære at elske også de grimme bygninger. Available: https://overbyen.dk/kronik-vi-maa-alle-laere-at-elske-ogsaa-de-grimme-bygninger/.

Midtiby, J. & Mortensen, E. 2021, Omstridt liste skrumper: Hundredevis af boliger skal stadig rives ned, Danmarks Radio.

Miljøstyrelsen 2022, Selektiv nedrivning i byggebranchen - Samlet rapport om nedrivningsplan, livscyklusvurdering (LCA), samfundsøkonomisk konsekvensanalyse, uddannelse og ordninger for selektiv nedrivning

Muelas, N. 2019, "Skoleparken - nedrivning af et alment mesterværk", Fagbladet Boligen, .

Pedersen, M. 2024, "Lad os vende skuden: Besværliggør nedrivning og tilgodese renovering", Buildingtech

Realdania, Teknologisk Institut & VCOB 2021, Temaark#1 Affald som ressource, .

Slots- og Kulturstyrelsen n.d., n.d.-last update, Fredede og bevaringsværdige bygninger. Available: https://kulturarv.dk/fbb/index.htm [2024, Apr.].

Slots- og Kulturstyrelsen 2024, Apr.-last update, Bygninger der kan fredes. Available: https://slks.dk/omra-ader/kulturarv/fredede-bygninger/fredningssager-og-hoeringer/bygninger-der-kan-fredes [2024, May.].

Sverrild, P. 2008, Velfærdssamfundets Bygninger, Kulturarvsstyrelsen.

Toftgaard, J., Jørgensen, C., Asmussen, E. & Larsen, N. 2022, De fredede bygninger skal fortælle Danmarks historie - stategi for prioritering af bygningsfredningen 2022, Det særlige bygningssyn, Slots- og Kulturstyrelsen.

Andersen, U. (2013) 'Derfor er miljøgiften PCB så udbredt i danske skoler', Ingeniøren, 13 September. Available at: https://ing.dk/artikel/derfor-er-miljoegiften-pcb-saa-udbredt-i-danske-skoler

Zøllner, K. 2022, Jun.-last update, Krig og fredning: Er det kun Arne Jacobsen, vi skal huske for eftertiden? [Homepage of Heartbeats], [Online]. Available: https://heartbeats.dk/krig-og-fredning-er-det-kun-arne-jacobsen-vi-skal-huske-for-eftertiden/.

Christensen, J.B. Kommentar af Jens Bomann Christensen. I danmark er vi vilde med at rive bygninger ned, men det tærer på klimaet (2023)

https://www.altinget.dk/by/artikel/vi-er-vilde-med-at-rive-bygninger-ned-men-det-taerer-paa-klimaet-og-hindrer-vejen-mod-en-cirkulaer-fremtid

20. november 2023

Realdania. Teknologisk Insitut. VCOB. Temaark #1 Affald som ressource (2021)

Bech-Danielsen, C. (2015) Renewal of postwar housing architecture: different approaches to the original tectonic ideal. Nordic journal of architectural research. 27 (1)

Beim, A. & Hvejsel, M. (2016) "Everyday tectonics? – Clarification of concepts," in Structures and Architecture - Proceedings of the 3rd International Conference on Structures and Architecture, ICSA 2016. [Online]. 2016 pp. 179–186.

Kristoffer, Z. (2022) Krig og fredning: Er det kun Arne Jacobsen, vi skal huske for eftertiden?

https://heartbeats.dk/krig-og-fredning-er-det-kun-arne-jacobsen-vi-skal-huske-for-eftertiden/

Hansteen, M. (2023) Hans Christian Hansen (1901-1978). [Podcast]. 07.12.2023.

Andersen, M. A. Debat. Bygningsforsker: Vi bør tale om et midlertidigt stop for nybyggeri. (2023) https://www.altinget.dk/by/artikel/bygningsforsker-vi-boer-tale-om-et-midlertidigt-stop-for-nybyggeri [01.03.24]

Reetz, K.: Et renoveret enfamiliehus bør blive vores hedeste boligdrøm (2024)

https://www.danskeark.dk/content/et-renoveret-enfamiliehus-boer-blive-vores-hedeste-boligdroem [01.03.2024]

Muelas, N. R. Skoleparken - nedrivning af et alment mesterværk. (2019)

 $https://fagbladetboligen.dk/alle-nyheder/2019/august/skoleparken-nedrivning-af-et-alment-mestervaerk/\\ [01.03.24]$

Sekler, E. 2018, "Structure, Construction, Tectonics" in Reader on Tectonics in Architecture, eds. I. Foged & M. Hveisel. 1st edition edn. Aalborg University Press, Aalborg Ø. pp. 71-82.

Buus, T. 2022, Et stykke velfærdsarkitektur rives ned: »Ringbo kan være et svært hus at elske«.

Centralkontoret for praktiserende artkitekter på fyn 1968, Rationelt skolebyggeri, Odense.

 $Espa\~{n}ol\ Vilanova, A.\ 2023,\ The\ works\ of\ an\ architect\ ,\ Aarhus\ School\ og\ Architecture,\ Design\ School\ Kolding,\ Royal\ Danish\ Academy.$

Vorre, M. H., Wagner, M. H., Maagaard, S. E., Noyé, P., Lyng, N. L., Mortensen, L. (2017). Branchevejledning for indeklima (1st ed., 2nd printing). Uddannelses- og Forskningsministeriet. Available at: chrome-extension://efaidnbmnnnibpcajpcglelefindmkaj/https://bygst.dk/media/9721/branchevejledning-for-indeklimaberegninger_opdateret-version_final_web.pdf

Bygningsreglementet 2018 (BR18)

Available at: https://bygningsreglementet.dk/

Arbejdstilsynet. (2008). Indeklima At-vejledning-1,2-1. [Online]. Available at: [https://at.dk/regler/at-vejledninger/indeklima-a-1-2/]. [Accessed: 28/4-24].

MOE Atelia Group. (2021). Office Bsim Template, December 2021, Version 1. Af Nanna Dyrup Svane. Kontrolleret af Torben Østergård. Godkendt af Steffen Maagaard. [Sted: MOE Atelia Group].

references: access to documents

Københavns kommune (2008) Gasværksvejens skole – anmeldelsesskema (aktindsigt d. 22/4-2024)

Københavns kommune (2009) Opgørelse vedrørende PCB. Mailkorrespondance (aktindsigt d. 22/4-2024)

Københavns kommune (2012) 2009-27374 vedr. sag om PCB på Gasværksvejens skole. Mailkorrespondance, rapport (aktindsigt d. 22/4-2024)

Københavns kommune (2015) 0170613-1-27374 SV. Gasværksvejen 22, skole, anmeldelse af byggeaffald vedr. byggetilladelse af dato 20 juni 2015 sagsnummer 511035-001. Mailkorrespondance (aktindsigt d.

22/4-2024)

 $Københavns\ kommune\ (2016a)\ Gasværksvejens\ skole,\ bygning\ 2,\ forsegling\ af\ overflader\ med\ PCB.\ Rapport\ udarbejdet\ af\ NIRAS\ (aktindsigt\ d.\ 22/4-2024)$

Københavns kommune (2016b) 2009-VS. Gasværkvejens skole Bygning 2, luftmålinger 6. februar 2016. Rapport (aktindsigt d. 22/4-2024)

 $Københavns\ kommune\ (2016c)\ Gasværksvejens\ skole,\ PCB\ i\ luft,\ Analyserapport\ (aktindsigt\ d.\ 22/4-2024)$

 $Københavns\ kommune\ (2017a)\ Sanering\ og\ nedrivning,\ Analyserapport\ af\ EKJ\ rådgivende\ ingeniører (aktindsigt\ d.\ 22/4-2024)$

Københavns kommune (2017b) luftprøver, (aktindsigt d. 22/4-2024)

 $Københavns\ kommune\ (2018a)\ PCB-forsegling\ og\ drift\ af\ ventilation\ på\ Gasværksvejens\ skole,\ notat(aktindsigt\ d.\ 22/4-2024)$

 $Københavns\ kommune\ (2018b)\ PCB\ ubdersøgelse\ på\ Gasværkvejens\ skole,\ resultater\ og\ anbefalde\ fremtidige\ målinger,\ Report\ (aktindsigt\ d.\ 22/4-2024)$

Københavns kommune (2019), Registrering ved måling af PCB i indeluft, Report (aktindsigt d. 22/4-2024)

 $Københavns\ kommune\ (2022a), AR-22-01007654, Analysereport\ (aktindsigt\ d.\ 22/4-2024)$

Københavns kommune (2022b), Registrering ved måling af PCB i indeluft, Analysereport (aktindsigt d. 22/4-2024)

Københavns kommune (2023), måling af PCB i indeluft, Analysereport (aktindsigt d. 22/4-2024)