CIRCULAR
DESIGN
ATLAS

PEOPLE'S PAVILION

Architects:
Bureau SLA & Overtreders

Year:
2017

Location:
Eindhoven, Netherlands

More info:
www.bureausla.nl
www.overtreders-w.nl

Scales:
Buildings

Resources:
Biological materials
Technical materials

Design Approaches:
Design for Disassembly

R-Strategies:
Rethink, Reuse, Recycle

Aspects:
Design, Technology

TU Delft
BK Bouwkunde

Credits | People's Pavilion: Bureau SLA| Photo: ©Filip Dujardin

The People's Pavilion was built in 2017 for Dutch Design Week (DDW). The pavilion was architecturally designed by Bureau SLA and Overtreders, in collaboration with Arup who designed the structural system. As the pavilion was a temporary structure, it was erected for 9 days, and then disassembled upon the end of the design week. The primary circular design approach of the project was its focus on designing for deconstruction. This required the designers to rethink the assembly and instead of using typical connection and fastening methods like screwing, drilling, sawing and gluing and instead they used steel straps and tension belts. All of the building materials including the concrete piles, pinewood beams, glass roof and partitions, recycled plastic cladding tiles, lighting and heating systems and interior furniture was borrowed and returned unharmed to their owners at the end of DDW.

Layers of Change and Lifecycle Duration

Site | **Ketelhuisplein**

The People's Pavilion was located at the Ketelhuisplein town square in Eindhoven. The pavilion was erected for 9 days, thus no permanent effects were made to the site, after Dutch Design Week ended, all materials were shipped back to the manufacturers or returned to whomever they were borrowed from.

Skin | **Recycled Plastic Tiles**

Pretty Plastic tiles were produced from plastic waste from Eindhovenarens that was sorted and molded into cladding tiles. At the tiles end of life they can be returned to Pretty Plastic and remolded into new tiles, this can occur up to 7 times without any loss of the tiles performance.

Structure | **Borrowed Wood & Concrete**

The structure is rough pinewood and reinforced concrete piles. The primary fastening method is steel straps and tension belts. This allows the wood to remain fully intact, with no damages caused by screwing, gluing, drilling, or sawing. Thus extending the woods lifespan. At the end of the Dutch Design Week, the materials will be sent back to the manufacturers and used again for future projects.

Services | **Borrowed Lighting & Heating**

The pavilion's lighting, heating and bar area were all independent systems. They were borrowed and returned at the end of the week. Thus the impact that the People's Pavilion had on the lifespan of these systems was minuscule, as they could be immediately reused upon there return. By not buying systems new, and disregarding them at the end of the week, there was much less waste produced and thus a lower environmental impact was achieved.

Space plan | **Open Layout**

The People's Pavilion plan was fully open concept, it accommodating 200 seated people or 600 standing. It was the main pavilion of the Dutch Design Week, and was used as a meeting place serving as a venue for music, presentations, theater and debates. This allowed for a flexible space that could easily adapt to the required programmatic needs.

Stuff | **Seating, Podium, Equipment**

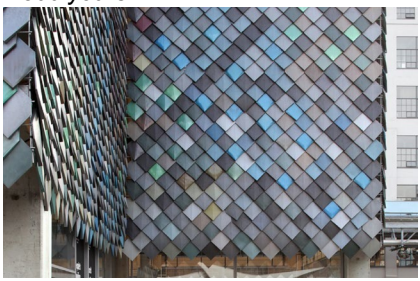
The seating was borrowed from a church in Amsterdam and returned at the end of the week. The concrete podium, bar, screen projector, digital equipment and lighting and heating equipment were also borrowed and returned at the end of the design week.

Site | Ketelhuisplein

Eternal

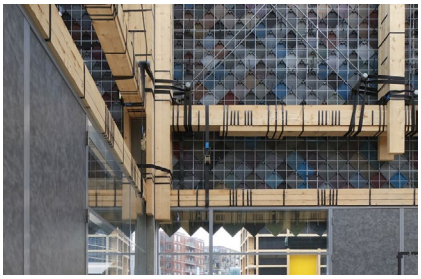
Skin | Recycled Plastic Tiles

± 300 years



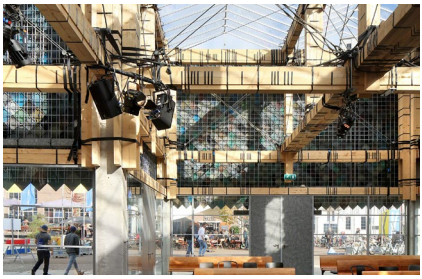
Structure | Borrowed Wood & Concrete

Indefinite



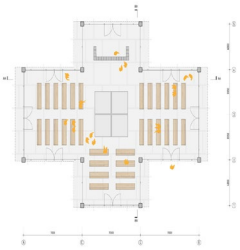
Services | Borrowed Lighting & Heating

± 15 years



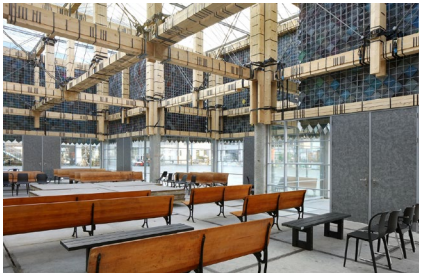
Space plan | Open Layout

9 days



Stuff | Seating, Podium, Equipment

Various



Credits | People's Pavilion: Bureau SLA & Overtreders| Photo: ©Filip Dujardin

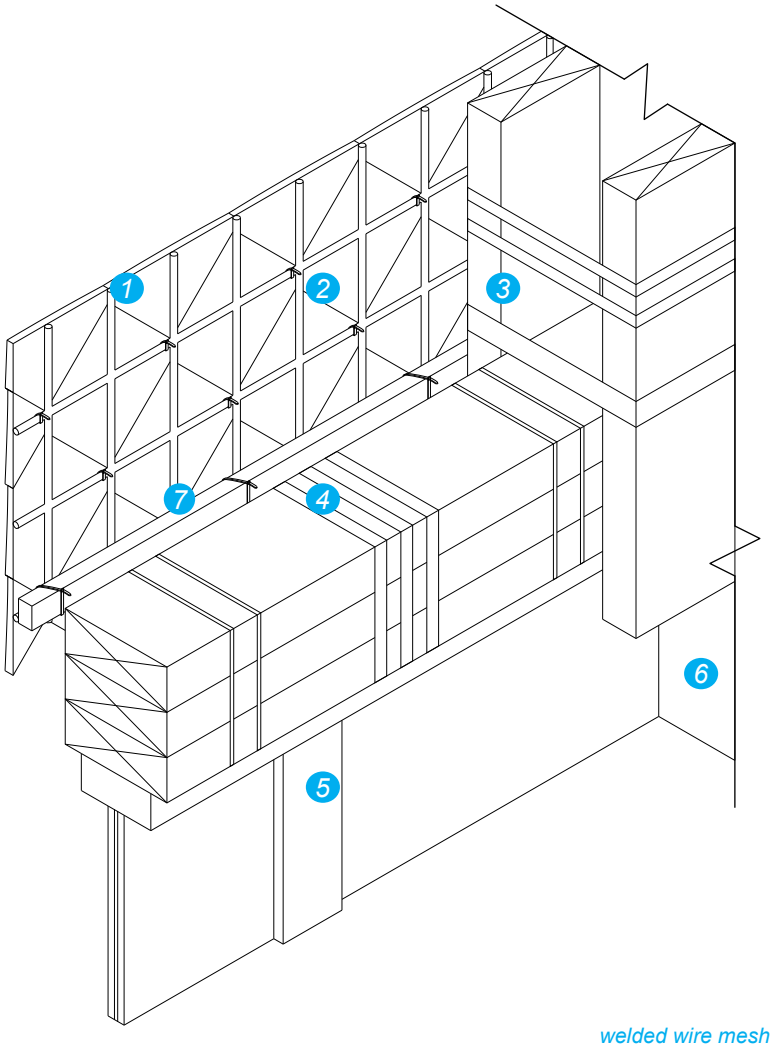
Carbon Footprint of Materials

Through the utilization of the CINARK construction pyramid, an estimate can be made for the CO_2 footprint of the 1m² of the People's Pavilion facade we examined. The calculation uses the CINARK CO_2 estimates for concrete for the concrete piles, aluminum frame window, for the ground level glass partition walls, construction timber for the rough pinewood structure and galvanized steel for the welded wire mesh and the hollow steel sections. The CO_2 estimates from CINARK did not consider the materials lifespan. As the materials used in the People's Pavilion were reused, borrowed or recycled their lifespan will impact their environmental impact, and thus should be considered in the CO_2 footprint calculations. Wood, steel and concrete materials result in almost half the carbon emissions is reuse scenarios (Grover, 2020). Thus, we estimate that the CO_2 impact of the reinforced concrete foundation piles, recycled glass partition walls with aluminum frames and the pinewood used will be roughly half compared to new materials that the CINARK pyramid uses. This is why we have included an additional calculation that includes these considerations for the materials that are present in the CINARK construction pyramid. Additionally, in this calculation we added the missing materials from our 1m² that were not included in the CINARK pyramid CO_2 emissions.

Material	CINARK Pyramid Impact **Not** Considering Material Lifespan/ m³	Volume [m³]	Result kg CO_2eq
Concrete	229.0kg CO_2eq/m³	0.012 m³	2.75kg CO_2eq
Aluminum frame window	1172.7kg CO_2eq/m³	0.02 m³	23.45kg CO_2eq
Construction timber	-680.0kg CO_2eq/m³	0.058 m³	-39.44kg CO_2eq
Galvanized steel *	22923.1kg CO_2eq/m³	0.011 m³	252.15kg CO_2eq
			317.79kg CO_2eq

Material	Impact **Considering** Material Lifespan/ m³	Volume [m³]	Result kg CO_2eq
Concrete	114.5kg CO_2eq/m³	0.012 m³	1.37kg CO_2eq
Aluminum frame window	586.4kg CO_2eq/m³	0.02 m³	11.73kg CO_2eq
Construction timber	-1360.0kg CO_2eq/m³	0.058 m³	-78.88kg CO_2eq
Galvanized steel *	11,461.6kg CO_2eq/m³	0.0015m³	17.19kg CO_2eq
Pretty Plastic Tiles	0.6kg CO_2eq/m³	0.011 m³	0.0066kg CO_2eq
Steel Straps	2.8kg CO_2eq/m³	0.0005 m³	0.0014kg CO_2eq
Nylon Zip Ties	5.0kg CO_2eq/m³	0.00001 m³	0.00005kg CO_2eq
			-48.58kg CO_2eq

** Galvanized steel includes steel from welded wire mesh and the hollow steel sections*



welded wire mesh 1
recycled Pretty Plastic tiles fastened by zip ties 2
rough pinewood 3
steel straps 4
recycled glass partition walls with aluminum frame 5
reinforced concrete foundation piles 6
hollow steel section 7

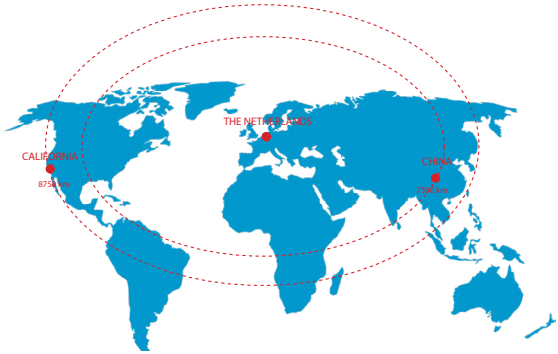
Credits | Axonometric Detail 1:10 : Anna Halleran and Emilie Waldstrom

Building Material Origin

The architects write ”The pavilion is a design statement of the new circular economy, a 100% circular building where no building materials are lost in construction”. They have accomplished this radical goal by borrowing all the materials from traditional suppliers and producers, but also from Eindhoven residents themselves. All the material was, as describes, delivered back to the original owners in unharmed condition after the DDW. Even the plastic tiles made from plastic household waste materials collected by Eindhoven residents, was distributed among those very residents at the end of DDW.

On the picture to the right, one finds an overview of the companies, materials and locations. Most of the companies that the materials were borrowed from are located in the Netherlands, only one of the companies are located in Belgium.

All though most of the material was borrowed from companies located in the Netherlands, some of the material was not produced or fabricated locally. We did an investigation into the companies and their materials, in order to understand where the materials were harvested, fabricated and produced. A general note to this investigation is a general lack of transparency of the companies’ websites. Many of the websites did not contain information about where from the material originates. The list of origin is therefor rather short, however it shows that some of these “sustainable products” was transported from countries far away, such as zip ties from China and timber from the US. These materials, despite the intention, are therefore not as sustainable as first concluded.



1. Foundation piles: IJB groep, Lemmer
2. Wood, steel mats: Stiho group, Nieuwegein
3. Facade tiles: Govaerts, Hasselt (B)
4. Ground floor facade: Tetris, Amsterdam
5. Glass roof: DEGO, Monster
6. Concrete floor: Heezen, Eindhoven
7. Tensioning straps: Logistiek Concurrent
8. Containers for plastic waste: Van Happen, Eindhoven
9. Plastic washing/shreddering: Morssinkhof, Haaksbergen
10. Church benches: Keizersgrachtkerk, Amsterdam

Credits | Diagram: Anna Halleran and Emilie Waldstrom

R-Strategies

SMARTER USE & MANUFACTURING:

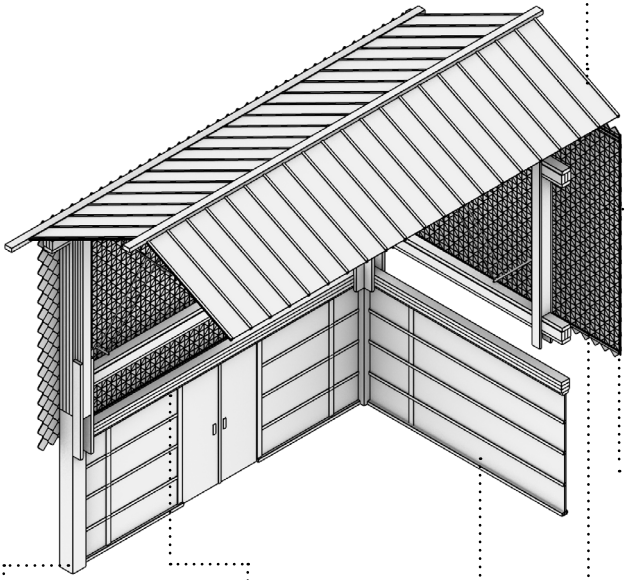
Refuse
As the People's Pavilion is a temporary building with only necessary systems of enclosure there are little redundant building elements. But perhaps as the People's Pavilion is not a thermally enclosed building the need for the recycled glass partition walls and aluminum frame at grade is not necessary, and the building could be open to the exterior.

Rethink
Many of the building components are reused and recycled already, which is a great circular design approach. Although, by altering the design of the plastic slates, perhaps they could be designed to include a fastening joint that could enable the tiles to be secured to the welded wire mesh, so that the zip ties would not be needed.

Reduce
As almost all of the building materials for the People's Pavilion were borrowed and returned to the original owner/manufacturers, a key environmental impact was the transportation of materials. All of the building materials were borrowed from manufacturers in the Netherlands with the exception of the facade tiles which were produced in Hasselt, Belgium. The building material which traveled the farthest were the zip ties that fasten the facade tiles, which were made in China. Since most materials were returned after the 9 day event. The transportation impact was double. As such, it would have been preferable to create a smaller transportation radius.

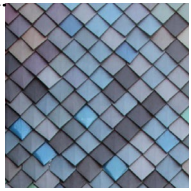
EXTENDING LIFESPAN OF PRODUCT AND ITS PARTS:

Reuse
The cladding tiles were given to the local residents of Eindhoven as a 'keep-sake' to remember the event. While this is a nice community centered approach to reusing building materials, perhaps a better use would have been to collaborate with a local design firm and use the tiles for a new project in the area. For the rest of the fragment building materials they could have also been donated and reused by more local manufacturers and design teams for future projects. Since there was no screwing, gluing, drilling or sawing to construct the People's Pavilion, the materials are in excellent condition for future.



Borrowed Greenhouse Roof

400m²



Pretty Plastic Skin 420m²

Zip Ties

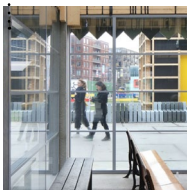
~12,000 ties

Concrete Piles

9 Piles (315x315x3300mm)

Rough Pinewood

48m³



Recycled Glass Partition

232m²

Welded Wire Mesh

420m²

Credits | Diagram: Anna Halleran and Emilie Waldstrom | Photos: ©Filip Dujardin

R-Strategies

Repair
The only building material from the facade fragment detail that cannot be reused in the same way it is used in the People's Pavilion are the zip ties. Although, perhaps when the building is deconstructed the zip tiles can be collected and the plastic can be reused in the base for future recycled Pretty Plastic tile production.

Refurbish
To upgrade the building fragment system for future more permanent use, weatherproofing and higher quality thermal comfort should be provided. This could be implemented by fully enclosing the building envelop with insulation, an air barrier and any missing finishes.

Remanufacture
The recycled plastic cladding tiles can be taken back to the fabrication facility, re-melted and reformed into new tiles with new profiles and sizes. This can occur up to 7 times without causing any decrease in the tiles performance. Additionally, while the zip ties which fasten the tiles cannot be reused after they are cut during disassembly, we are proposing that the ~12,000 cut ties be collected and molded into new recycled tiles, reforming roughly 19 new tiles.*

Repurpose
None of the building materials were screwed, glued, drilled or sawed, thus all the borrowed building materials are in ideal condition for reuse.

END OF LIFE SCENARIO:

Recycle
The Plastic cladding tiles can be recycled up to 7 times. The rough pinewood can be used as feedstock, or used for future construction projects as they have not been damaged due to the construction technique which used steel straps and tension belts. These elements can also be reused for future projects. The welded wire mesh and concrete foundation piles were also returned to the manufacturer and can be used again. The ground floor glass partition walls were left over from renovations of an office building in Utrecht and after design week, were used for another project. The glass roof structure was also borrowed from a greenhouse supplier and returned.

1.6g/zip tie x 12,000 zip ties = 19,2kg of plastic* ⟶ ***19 tiles*
~1kg of recycled plastic needed to make 1 Pretty Plastic tile

Credits | People's Pavilion: Bureau SLA & Overtreders| Photo: ©Filip Dujardin

The NEW Nexus

As the Peoples Pavilion is a temporary structure that was completely disassembled after the 9 day-long Dutch Design Week, nothing about the building was permanent. It did not require plumbing and the lighting, heating and bar were all independent systems that were borrowed and returned to their owners at the end of the event. However, below you will find some ideas for how a future People's Pavilion that is more permanent could implement the NEW Nexus systems.

Nutrients

As the People's Pavilion was only in operation for 9 days, food production on site was not considered. However, if this project was more long term, perhaps there could be an elevated hydroponic growing center, that could be used to grow herbs and vegetables on site, as seen through the section. Perhaps a pulley system could lower the planting racks and raise them to ensure the main even space remains open concept.

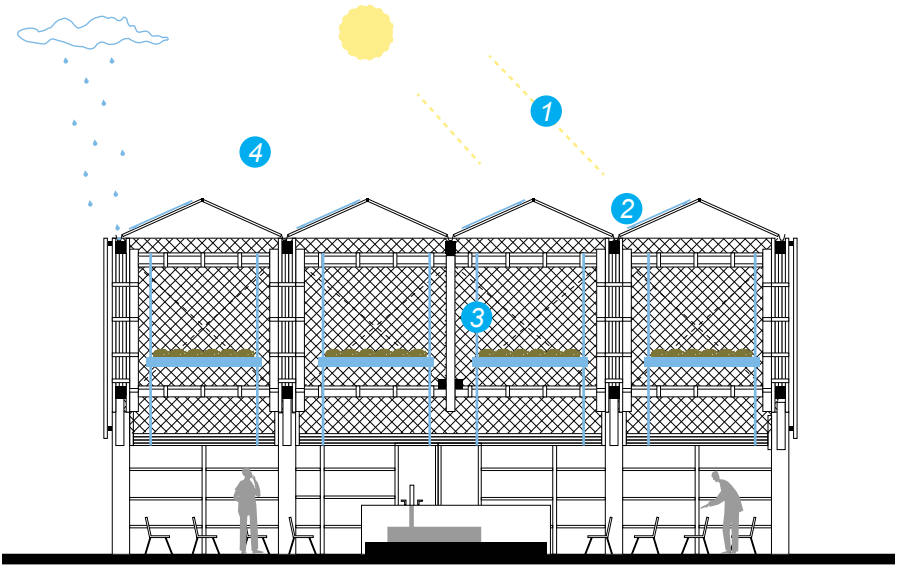
Credits | Site Plan 1:1000 Redrawn by: Anna Halleran and Emilie Waldstrom

Energy

The People's Pavilion used a independent electrical and mechanical systems that were borrowed and returned after the 9 day event. Although, perhaps if the building was more permanent, photovoltaics could be installed on the roof of the pavilion and the energy generated on site could be used to power the building's heating and lighting systems.

Water

There was no plumbing or water systems included in the design of the People's Pavilion, due to its temporary nature. Although, if the building was more permanent, plumbing may be needed to supply the bar for a sink. In this case, a gray water recycling system could be installed for the used sink water and rainwater could be collected from the roof, treated and then used to water the hydroponics.



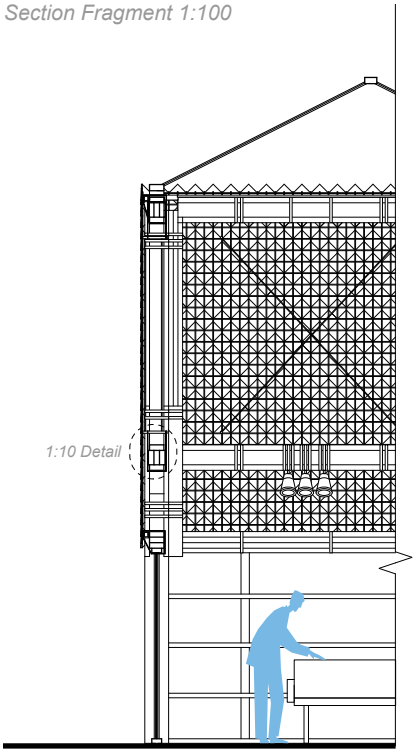
photovoltaics - on site energy production 1
hydroponic growing center 2
greywater recycling 3
rainwater collection 4

Credits | Section Diagram 1:250 : Anna Halleran and Emilie Waldstrom

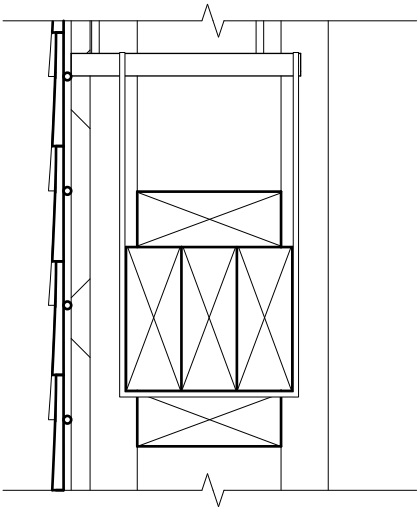
Design Approaches

The recycled plastic tile skin uses plastic zip ties that secure the tiles to a welded wire mesh. The mesh is also connected to a steel hollow section with zip ties. Then the steel section is secured to the primary wood structural shearing layer with steel straps and tension belts. The wood structure is then secured with additional steel straps and tension belts The servicing shearing layer consisting of lighting, sound, technology and heating are independent mobile systems that are fastened to the wood structure with steel straps. The services do not impact the space plan shearing layer as they are hung from the wooden beams above, allowing the plan to remain free. Due to the nature of the open space plan and flexible seating of the stuff shearing layer, there is minimal impact of these layers on each other. The circular design approach used for this project is to design for disassembly. This is why the shearing layers are connected by reversible fastening techniques that do not impact the material for future use. This is through steel straps, tension belts and zip ties. As the connection between the skin and structural shearing layer uses zip ties, which are cut and discarded after deconstruction, they cannot be reused, thus conflicting with the circular design approach.

Section Fragment 1:100

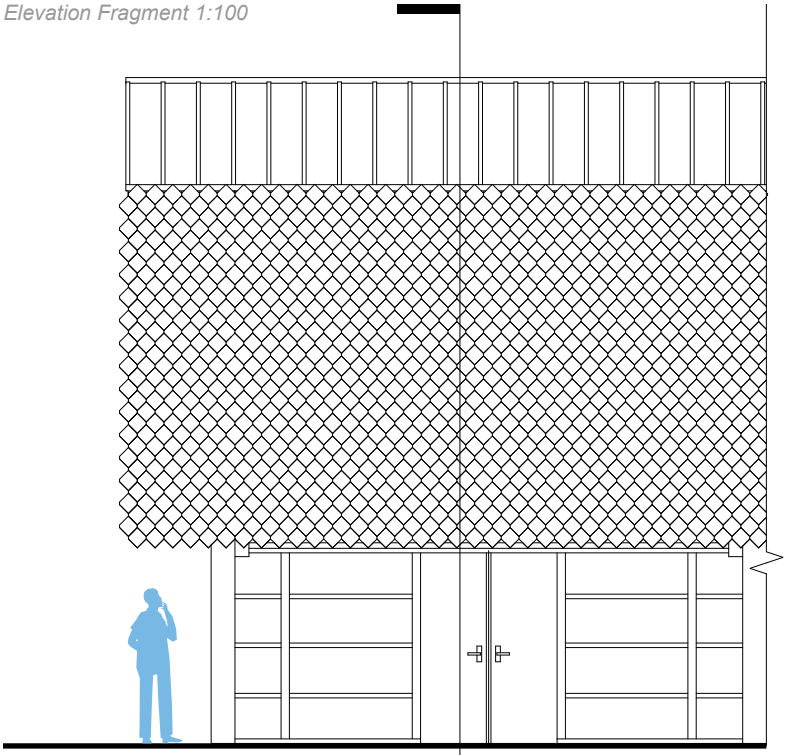


1:10 Detail

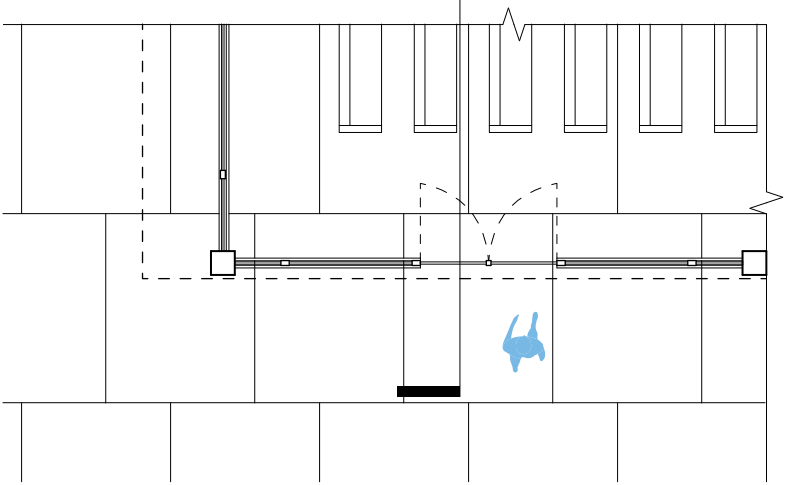


Credits | Drawings: Anna Halleran and Emilie Waldstrom

Elevation Fragment 1:100



Plan Fragment 1:100



Credits | Drawings: Anna Halleran and Emilie Waldstrom

Stakeholders & Value Chain

Stakeholders:
Architecture firms:
Bureau SLA & Overtreders W
Main Designers: Peter van Assche, Hester van Dijk, Reinder Bakker
Client: Dutch Design Foundation
Construction: Arup
Urban Mining advice: New Horizon
Main contractor: Ham & Sybesma, Amsterdam
Municipality: Eindhoven
Suppliers: Pretty plastic and many more
Users: The public, People of Eindhoven

The overall goal of this project is to advocate for sustainable design. However, it is crucial to acknowledge that various stakeholders involved also have alternative objectives, such as self-promotion, economic interests, and political considerations. In the following sections, we will go over the two most important stakeholders in this project and in our profession: The architect and the client.

The Architect:
Architects are, in essence, the custodians of value in this context. They bear both the opportunity and the responsibility to persuade the client towards a more sustainable project and approach. However, it is imperative to recognize that the objectives of architectural firms are not entirely altruistic. They stand to gain promotion and revenue from successfully executing projects.

Project specifics: The pavilion in question is designed by Bureau SLA & Overtreders W. They define their primary objective as follows: “The pavilion is a design statement of the new circular economy, a 100% circular building where no building materials are lost in construction”

Supplier overlap: In this project, there exists an intersection between supplier and architect roles, potentially giving rise to internal conflicts. One of the main materials used in the construction is a plastic tile made from recycled plastic waste, produced by Pretty Plastic. Consequently, the building serves not only as a platform for advocating sustainable materials in general, but also as a means of promoting Pretty Plastic. Worth noting is that Pretty Plastic is co-owned by the primary architect at Bureau SLA, Peter van Assche. In summary, while the primary aim may be to advance a more sustainable approach to design and thinking, the building also serves to promote and enhance the value of the architecture firms and Pretty Plastic.

The client:
in general, the client has the last say, seeing that they are often the financial stakeholder. The project's budget holds significance for all stakeholders, as it dictates the choice of materials and approach. Unfortunately, this frequently results in sustainability taking a backseat, as the paramount objective for many clients (particularly developers) is profit.

Project Specifics: The client for the People's Pavilion is The Dutch Design Foundation. The foundation, a non-profit foundation, main objective is dedicated to advocating for (sustainable) design for the future. Given that its non-profit foundation, the foundation operates without economic motives. However, it's worth noting that foundations of this nature often collaborate with partners who may have political interests. Furthermore, it's essential to highlight that the pavilion received the Dutch Design Award in the Habitation category, an accolade bestowed by The Dutch Design Foundation (the client).

A new value chain?:
Given the radical nature of this project and its pioneering approach to sustainable design and disassembly, it raises the question of a new form of value chain. This entails a shift away from the linear business models traditionally employed, towards a more dynamic and circular model. The issue of ownership in this specific project is particularly interesting. Since the pavilion was constructed for disassembly, most of the materials could be returned to the suppliers in unharmed condition. This implies that the materials can be resold and reused. This, in turn, prompts the question of how suppliers will manage materials in the future. Perhaps materials will be offered for rent rather than sold outright, or maybe the new owners of these materials will have the option to resell them to subsequent buyers. Regardless, this necessitates a new mode of thinking that's essential for creating a new and more sustainable future.

The role of the architect:
To sum up, we see the architects as responsible for being the stakeholder of values – including then arguing and promoting for sustainable and circular solutions. In this specific project the role of the architect was challenged immensely, because of the very uncompromising circular design brief. This meant that instead of only advocating for existing sustainable solutions they needed to invent a new language and standard for sustainable design. The architects had to then completely change the way they normally design and construct buildings, moving towards a new way of creating circular design that challenges both the traditional teachings of architecture and the management of materials as discussed in the previous section.

Lessons Learned

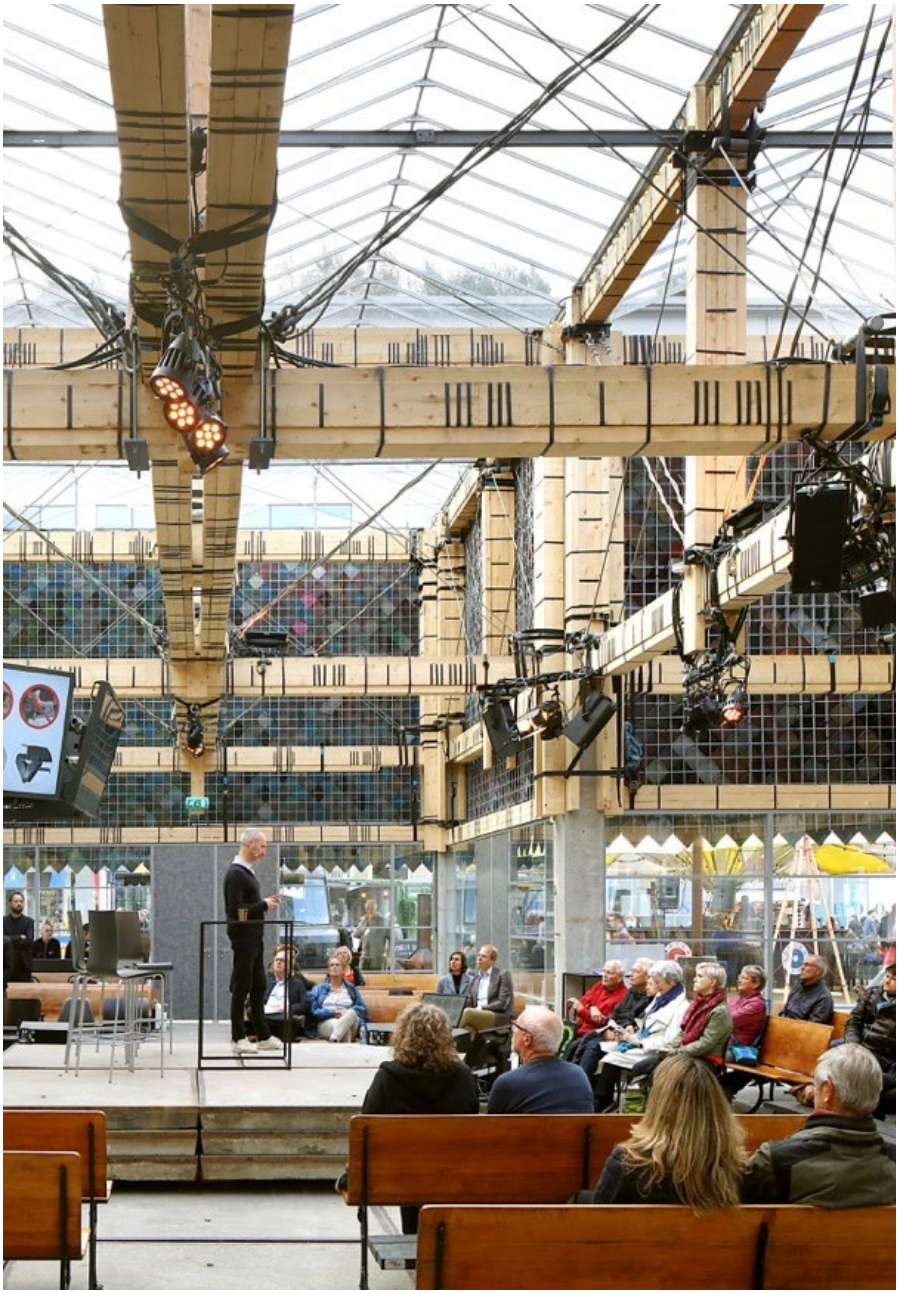
The pavilion stands as one of the pioneering examples of a building designed for almost 100% deconstruction and reuse. It introduces new techniques and design approaches for sustainable architecture, which can serve as inspiration for a fresh perspective on construction and approach.

The carbon footprint of the structure is nearly zero, considering that most of the material was returned to the suppliers intact, with the exception of the zip ties. This enables the materials to be reused and resold, thereby reshaping the traditional value chain. This new approach to construction and material handling raises new questions about ownership and organization. The conventional linear business model is replaced by a dynamic and circular one, potentially paving the way for a future where materials are rented instead of sold, creating a more circular flow of materials.

While most of the suppliers were local, primarily situated in the Netherlands with one exception in Belgium, some products were not produced or sourced locally. For instance, the timber origins from California, and the zip ties were manufactured in China, significantly increasing the carbon footprint.

Considering that the pavilion was only in place for nine days, its temporary nature leaves many questions unanswered. In the NEW NEXUS chapter, we have attempted to envision the pavilion as a permanent structure. In this scenario, the structure would necessitate permanent installations like lighting, plumbing, and power. As a permanent structure, the pavilion could include features such as a hydroponic growing center (Nutrients), photovoltaics on the roof (Energy), and a gray water recycling system along with rainwater collection (Water). Many options remain to be explored if the structure were more permanent, such as its actual lifespan, permanent installations, and construction.

In summary, the project stands as a remarkable example of a new approach to architectural thinking and construction. Despite being a temporary structure, it offers valuable insights into how to design for disassembly, even in the context of more permanent buildings. The pavilion proudly touts that it was built with materials that can be 100% reused. While this is largely true, considerations like the non-reusable zip ties prompt reflections on potential alternative approaches



Credits | People’s Pavilion: Bureau SLA & Overtreders | Photo: ©Filip Dujardin

Colophon

Students:
Anna Halleran
Emilie Waldstrom

Studio:
Urban Architecture

Tutors:
Georgios Karvelas
Joost Woertman

Image credits:

www.bureausla.nl// Photo: © Filip Dujardin

References:

https://bureausla.nl/project/peoples-pavilion/?lang=en

www.overtreders-w.nl/en/peoplespavilion

https://www.archdaily.com/915977/peoples-pavilion-bureau-sla-plus-overtreders-w

www.arup.com/projects/peoples-pavilion

https://archello.com/project/peoples-pavilion-by-bureau-sla-overtreders-w

https://www.dezeen.com/2017/10/27/peoples-pavilion-dutch-design-week-low-ecological-footprint-bureau-sla-overtreders-w/

https://www.dutchdesignawards.nl/en/gallery/peoples-pavilion/

https://www.detail.de/de_en/hands-on-waste-avoidance-peoples-pavilion-in-eindhoven

https://www.world-architects.com/en/architecture-news/works/the-people-s-pavilion

https://www.prettyplastic.nl/projects/exhibition-pavilion

https://www.materialepyramiden.dk/

www.stiho.nl

https://ijbgroep.nl

http://www.govaerts.be/

https://heezenbv.nl/

www.logistiekconcurrent.nl

https://morssinkhof-groep.nl/

Grover, R. (2020). Design guidelines to achieve low embodied carbon buildings: Manual for architects, engineers and project managers (thesis). TU Delft Repositories.