

Delft University of Technology

Design of construction - Imagine!

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Design of Construction – Imagine!

A collection of Future Façade Principles Façade Research Group

IMAG

Chair Design of Construction Prof. Dr.-Ing. Ulrich Knaack

Delft University of Technology

DESIGN OF CONSTRUCTION - IMAGINE!

Introduction Lecture – held at TU Delft on 23. of July 2006 by Prof. Dr.-Ing. Ulrich Knaack and a collection of Future Façade Principles by The Façade Research Group - Chair Design of Construction Faculty of Architecture

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Rector Magnifico, members of the university board, fellow professors and teachers, students, dear relatives and friends, ladies and gentlemen.

An introduction lecture is the one in your life, I was told. Explain all the complexity and your opinion about your discipline in society, education and research. So, what are the upcoming problems in a decreasing and energy wasting society with a globalizing market. Well, we have to take care, that we are able to leave a planet to our children on which they can survive. So we have to develop for their and our own future. If we do not develop, evolution and finally life itself will end.

Design of Construction is the title of this lecture and today I would like to add the subtitle "imagine" to it. The slide-show that just started is explaining some future façade principles. A collection of ideas, which has been developed by the Facades Research Group in my chair to inspire architects and students. It will run parallel through the entire lecture, so you will have the chance to drift away, when you find the text boring. During the lecture I will explain, how I see a possible development in architecture and in this faculty so that after all text and pictures will become one unity.

So - what is my position in architecture and what is my history?

Somehow architecture was in my family - father and stepfather are architects, I grew up during there studies with a lot of memories on that. I studied architecture at the RWTH Aachen and finished with a focus on design and construction.

Influencing characters to me were Frei Otto with all his work at the IL in Stuttgart, Jörg Schlaich from Stuttgart as an engineer with structural cleverness, Kurt Ackermann from Munich, who organized the knowledge of construction for me, Alan Brookes from Oxford with

his specific way of finding the artistic spirit of constructions and who's successor I am now and Mick Eekhout, an at that time about 40 years old Dutch architect and engineer, who had his special ideas about organizing constructions and the design-and-build process.

And, of course we all had the books by Renzo Piano, in which he talks about architecture, being one of the oldest professions, giving people shelter. About the "service-function", an architect has for the client and about responsibility for society, because we build experiments in a 1:1 scale without testing in advance and that no one can run away from – the buildings are existing, they were expensive and so they have to be used.

But parallel he questions development by focusing on the unexpected: constructions are supposed to be impossible, because they have never been done before. But development means to change and only the ones who tried, developed something new. And finally Piano asks us to take the risk and live in danger ⁽¹⁾.

Then I was asked to do a PhD. Wilfried Führer, one Professor of my final project, mentioned that one of his functions is to replace himself by forming upcoming personalities – in front of a copy machine, while I was copying for him as a student assistant. So I went into scientific work, prepared projects in the field of education, bionic structures, skyscrapers and finished with a PhD about the structural use of glass – a hot item at that time.

But I did not only want to be a specialist, I also wanted to work as an architect and build. So I joined, after some experience in my fathers' offices, the company RKW in Düsseldorf, one of the biggest German architectural offices. Here I worked as leader of a profit centre for Lars Klatte, one of the partners, and was responsible for several projects with a total of approximately 200.000 m². The specialty of our profit centre was fast track projects and general planning – and the idea to control the whole process of architecture: designing, controlling as general planer all the other planning disciplines, the construction site and finally hand the completed building over to the client.

The way back to University life came with a professorship for design and construction at the University of applied sciences in Detmold close to Bielefeld – a relation, I am still active in.

Then the invitation to the TU Delft showed up. The TU Delft! We had our conversations about my ideas, my visions and my personal development.

And the last question, I was asked and only allowed to answer with yes or no was: "Could a good architect be bad in construction?"

What did I learn during the years in architectural practice? Complex buildings are team work! Too many jobs and a limited time schedule are too much for just one person. And I learned much about financial pressure in projects. If you do not solve these problems, the projects will not be built. But what you always wanted, was to do good

architecture, to build it, so that it at least stands for some years – not to fashionable, related to the place and the people and at the state of the art. I learned, that it always needs a central person from the beginning of the project, keeping the ideas together, controlling architectural design, construction, finance, contractors and the work on site.

So of course the answer was "yes!". You can be a good architect and bad in construction.

Think about some projects of Mies van der Rohe or Le Corbusier with leaking roofs - no one would name them bad architects, even when they realized constructionaly bad details on purpose, just for design reasons.

Or Frank Lloyd Wright, placing glass tubes instead of windows and roof lights in his famous project Johnson Wax in Racine (USA). Glass tubes, sealed with mastix and placed by carpenters, because "the roof light is part of the roof". Of course it was leaking - but it was a break through in architecture and gave the client 10 times payback by being a perfect advertisement for the company. Frank Lloyd Wright was directly commissioned again for the client's private house. In parallel someone else solved the problem of roof lights with float glass ⁽²⁾.

But can we turn the question around? Can you be a good architect by being bad in designing? Risky question, especially in an architectural faculty. But when you think about the design team and the functions in it – why not? As long as you are controlling the process and believing in the ideas of the project.

And here the discussion is already turning political: in the development of architecture we have accepted, that urban planning is a separate discipline – with several links to Architecture but somehow a separate discipline. It is the same with civil engineering.

No one would expect the traditional "Baumeister" to be established again – disciplines are now too complex for that.

But to continue, we have to think about the differences between design and construction. At the Faculty of Architecture at TU Delft this is made by departments. Does that mean, the last combined elements are now educated separately and architecture is subdivided into design and construction? Developing this idea further, it would be possible to control architecture by doing a design and hire the rest. At a certain point this is already practiced by leaving the working planning to "bouwkundige bureaus" and contractors.

And once again we have to turn the question: can we control architecture by doing the construction and management and just hire the design? Well, being honest, from my personal experience I know that even the last version is happening.

But I am sure, we all agree, that this would be not the best way ⁽³⁾.

Seeing this upcoming development, I would like to ask the faculty to change their attitude in thinking in departments and come to a more combined solution for education and research, orientated on the architectural result. This does not mean to integrate everything, it's about giving the chance of combining. Like the idea of general planning, I mentioned before, you do not have to do everything, but you have to be able to speak the different languages, understand the problems and solutions in other fields, judge and integrate them in the design process for the best architectural result. The alternative, with a future subdivision between design and construction, does not look promising and would be a bad advertisement for the label "Dutch Architecture".

I would like to close this topic with a remark on the question "Can a good architect be bad in construction?" with the comment of the colleague, who asked me the question. Some months later he gave a lecture at the "Onderwijsconferentie Doelgericht Ontwerponderwijs" and mentioned, that "designing is the thinking about all necessary techniques" ⁽⁴⁾. So he thinks in the same direction – fortunately.

THE CHAIR DESIGN OF CONSTRUCTION AT THE FACULTY OF ARCHITECTURE / TU DELFT

And what is the position of the Chair Design of Construction at the Faculty, I have the honour to lead?

From my point of view it is the task of an architect to develop shelter for people and create space or sculpture - sometimes powerful and outstanding, sometimes with decent respect to the surrounding. He has to take into account the demands and wishes of the users and of society – he provides a service and they are paying him and the bill for the building. Last but not least sustainability in the means of efficiency and sensibility are important tasks.

In our current world the architect is one of the few, which combine culture, aesthetics, technology and management. And if we do not combine these matters, architects will lose their power and will be controlled by finance. Maybe sometimes architecture is seen as a self-contained and somehow independent aesthetic science, but the results of this science, the buildings done by architects, are extremely real.

So the architect has to know about urban planning, architecture, building technology and building management. From this point of view the faculty is not a "Faculty of Architecture", it is the "Faculteit Bouwkunde" - quite a difference.

Next point: the development of Architecture in means of design in the last centuries was enormous: classicism, modernism, structuralism, high tech, post modern, deconstructivism etc. and of course I am missing a lot.So architects are trained and used to develop new aesthetic styles but solve the assignment with standard and known technologies. The reason for that is a lack of development in building technology, especially when you look into other producing industries. Of course there are developments in technologies but we are still

extremely far from industrialized processes. And in this case I am not thinking about mass production, I am thinking about an individualized mass production leading to individual buildings. A technology, which is already existing.

Here I see the big chance for the "Faculteit Bouwkunde". The label "Dutch Architecture" is known for fresh ideas, spirit and unconventional solutions.

But there is a fear of technology. It is so complex, you have to know it all and any mistake will blame you or even cost finally your fee. In German we have this nice word "Bedenkenträger" which explains the fear of making a mistake.

So better do noting or try to get out of the responsibility. Let's just make a design idea and others do the final working drawing.

But technology is necessary, otherwise you do not build. And it also could be fun, an inspiration, it could be the driving force for a design idea. So do not let that chance pass by. Or could you imagine Piano, Foster or Calatrava doing their architecture without a technical inspiration?

Let us combine the advantage of a label "Dutch Architecture" with a vision for visionary technical impact. Time is fine for this; various new technologies are available in the Faculty and in the TU Delft. This is one of the leading technical universities in Europe - a lot of knowledge is established here, we just have to find and use it.

These ideas guided me in developing the vision for the chair Design of Construction. We have to supply students with profound basic knowledge, educate them with strategies to develop and judge technology and finally bring innovation in the research at building technology.

In education the chair is positioned in the BSc with principles of construction. Here the idea is, to integrate the construction into the design process, even if this always causes difficulties. But, architecture is about solving design and constructional problems.

In the MSc-Program the chair provides consultancies in designassignments and organizes the programs "high-rise" and "XXL", both integrated programs with a combination of complex design and technology. In the MSc-Program of building technology we are concerned with the topic facades. Additionally a program "international façade master" will be developed with national industrial contacts and international scientific relation.

The program is mainly coordinated by Maarten Meijs, supported by the colleagues Nelly Schut, Tillmann Klein, Jan Bos and - of course - a important number of guest docents. It is to be developed further for an intensive integration between architecture, technology aspects and new technical developments. And here I would like to announce, that our doors are always open for collaboration.

In the field of research the driving force is the search for new principles, the integration of technologies in the architectural design and the technical solution:

Related to the educational program we are organizing technology by developing knowledge structures and preparing a series of books on this topic.

In the research unit "zappi" the chair is active in the promising fields "composite" and "material research".

The research unit "industrialized buildings" is supported by the chair with the program systemized buildings, run by Reinhard Hasselbach.

Finally the facade research group has been developed.

Reason for that is the European façade technology, which is world leading. It is an export product, especially in the Asian and American marked with a combination of design and technology topics.

The group is led by Tillman Klein with the PhD's Daan Rietbergen, Thiemo Ebbert and Marcel Bilow.

It is supposed to be a leading and internationally linked research unit. Using the network of my professional history, the support of my colleges and the value of the TU Delft, scientific collaboration with European universities and façade-industry have been developed.

Because of being related to design and technology, facades are a perfect possibility for using the Delft idea of "design driven research" – the search for new technologies for design question and "research driven design", using developed technologies for new architecture. The topic of the group is the development of pure technical solutions, façade principles, thinking methods and technology transfer.

FUTURE FAÇADE PRINCIPLES

To explain one working methods of the research I would like to show the program "future façade principles" – the slide show, you are seeing during this lecture.

Using the working methods of Frei Otto or Richard Buckminster Fuller by combining different disciplines and technologies we are developing possibilities for facades - or better "skins" - by using alternative, new and maybe even not yet developed but only mentioned technologies ⁽⁵⁾.

The façade technology of the 20th century is related to the dissolution of the massive wall into a separation of structure and facade. Looking at the development of façade technology now, after 60 years of curtain wall systems, 30 years of element façade systems and 10 years of experience with the integration of environmental services in double facades, the peak of optimization has been reached. By continuing the path of adding extra layers for each additional technical function, no further technical developments can be expected.

The task for the future are "networks": Systems, - but also methods of thinking - which provide the possibility to develop different aspects parallel and combine them, as required.

Unfortunately building industry is conservative. The façade industry claims to be the most industrialised and high tech part in building industry but when you are coming up with new developments, these industries tend to be very reserved. The bigger - the more. Innovation is always a risk and the direct payback may not be easy to see. So what they do, is telling a lot about innovation - the bigger the more – but doing less.

The motor for innovations are the architects. They are the pioneers for new developments like the high tech architecture; the climate orientated architecture or the current trends of materials and virtually generated buildings. But they are only searching for new trends to promote their architecture; they are not researchers ⁽⁵⁾. The ideas are taken from researchers, developers, scientists and sometimes even students - and the architects are transforming them.

And that is what we want to provide with this collection of future principles for façade. They are public, to be published and to be used by others. They are an offer of technology for designers.

The interest of the group is to enlarge the possibilities and not to keep ideas in stock, because then they are not used and worth nothing. The result will be a growing amount of ideas for facades or skin structures, principles or even methods of thinking.

Having used this principle with my PhD about the structural use of glass ⁽⁶⁾, I know what I am talking about. Some ideas of that books are still under development and I quite remember the conference of Prof. Werner Sobek at the ILEK in Stuttgart, when a manager of a glass company was complaining, that they do not know, how to build my proposals ⁽⁷⁾. So I had to build them myself.

Moving the border of the possible is the driving force for developments. And as long, as the construction in research does not fail, the border is not reached.

CONCLUSION

The current situation for architects is difficult enough. Market chances are not increasing in a decreasing society, projects are mainly controlled by finance and time schedules and the personal risk is quite enormous, compared to other businesses. What is left to the next generation is not really the best situation.

But mankind will always build – standards and visionary developments, for which architects need to be educated. But if you stay with standards, you are not inventing new, your evolution stops and you will eventually close business. Continuing this thought, innovations are to be invented, even if the questions are varying.

TU Delft is one of the largest education institute for architecture in Europe. Here we are educating the future architects – for a national and an international market. It is a good place – the school is large, the spirit is innovative, the label "Dutch Architecture" is still accepted, the circumstances for research are the best, I ever saw.

In this innovation orientated society design and technology can be developed further.

It is a chance. But we have to face it together – designers and technologists.

Frei Otto was not popular in Stuttgart. He was placed in the field between architecture and civil engineering, not fully excepted by both. But finally he is the most recognized figure from Stuttgart of that time.

One of my PhD's was recently asked, if he wanted to start a revolution in the field of facades with the proposal for his PhD, working on the network idea. Careful as he is, he answered "I do not think about making the revolution – but I would like to draw the map for it" That's what I hope to develop – the next generation. They are already here – watching us, the docents and professor, seeing with open eyes our strength and – of course - our weakness. And the only chance we have, is to let them honestly participate in our development – scientifically and personally.

So, dear students, the books are open and please do not look for existing possibilities. Do ask, what is thinkable. Imagine and - to close with Renzo Piano - live dangerous!

Thank you for your attention.

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Invented by Torben Inderhees

Supported by Ulrich Knaack & Marcel Bilow

Keywords: mono material, freeform, load bearing, transparency, solid, facade.

In-situ Glass / Ortglas

different moulding surfaces.

In the future site glass could be possible. Moulding glass in situation concrete is a idea to create freeform or rectangular shapes out of monolithic glass. The mobile had to be resist the high temperature of the liquid glass. The reinforcement of the "site glass" is possible with glass fibres knitted or woven textiles, creating glass textiles that becomes highly transparent when the liquid glass is inserted into the mould. In fact of that, every surface of the glass is possible using

Fiberglassinforcemen

16-06-2006

Invented by Ulrich Knaack & Marcel Bilow Pictures by Torben Inderhees

Keywords: mono material, freeform, load bearing, transparency, solid, facade, roof, structure, 10-20 years, glass.

Welded Glass

In the future welding glass could be possible. If it possible one is able to create free formed high transparent load bearing structures shaped like the trade roof in Milan but without steel. Pieces of molded curved glass trimmed in exact shapes are welded together on site. Only a supporting structure that holds the panes in position during the welding is necessary. After welding glass diamond grinding tools smoothes the welding seams to a high transparent monolithic glass envelope

16-06-2006

Invented by Ulrich Knaack & Marcel Bilow Pictures by Torben Inderhees

Keywords: mono material, freeform, load bearing, transparency, solid, facade, roof, structure, 10-20 years, glass.





Edged Glass

In the future glass could be shaped into shapes the steel or other metals. Creating a tool that heats up a line in a glass pane edged glass construction are possible. Using these folded glass elements a transparent construction is useable.



16-04-2006

Invented by Ulrich Knaack & Marcel Bilow Pictures: Michael Schmitz

Keywords: mono material, prefabricated, load bearing, transparency, structure, glass, 10-20 years.

Glass Bridge

In the future glass becomes more stiffer just like steel constructions. When the development of these glass is finished, load bearing structures are possible. So just like these sample a prefabricated bridge molded out of glass sections uses the possibility of prefabricated molded glass.

The aim of these technique is to create high transparent load bearing structures. As seen on the pictures steel traction relieves supported the external tension forces.





13-03-2006

Imagined by Ulrich Knaack Keywords: system, load bearing, transparency, façade, glass.

Glass Bracing Structure

The bracing system of this idea is using the capacities of glass for load bearing. It could be use as a structural system of buildings. Additional different components of facades could be filled in the fields by solving offer necessities of facades (ventilation ect.)



15-06-2006

Invented by Ulrich Knaack & Marcel Bilow Pictures by Michael Schmitz

he light from the top.

Keywords: layered construction, transparency, roof, lighting, building physics, glass, 10-20 years.

Glass Sandwi

In the fue every sh The idea highly sandwid spaces Using using So new getti

ure glass welding or gluing is also possible as molding it into pe wanted. is to create glass panes out of two panes glued or welded nsparent together with glass spacers to create a load bearing

used for roots of facades. Supporting the inner forces the sare arranged into closer gabs on the corners of the elements. It is elements as high transparent roof sections a natural light moseum is possible without any prcessary windows or facades. It is provide the same section of the corner of the section of the sectio



13-03-2006 Imagined by Ulrich Knaack

Keywords: Layered construction, load bearing, transparency façade, glass.



Glass-Sandwich structure with timber spacers or aluminiur spacers for the structural connection of the glass plates.

Glass Sandwiches 2

The idea of this façade is to use the principle of sandwich constructions to provide a water tide surface;

- · possibility of structural use
- maximal spans with minimal constructional weight
- possible to implement other technical solutions in the interspace
- possible materials: Glass, plastic, various infills





Glass-Sandwich structure with laminated pneu cushions or plasti tubes for the structural connection of the glass plates.



15-06-2006 Invented by Ulrich Knaack & Marcel Bilow Pictures by Michael Schmitz

Keywords: layered construction, energy generating, sun shading. Transparency, liquid, facade, building physics, glass, 10-20 years.

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Medium Inserted Glas

In the future glass welding into every shape wanted. The ground panes glued or weld a waterproof channel system like water, oil or other med wide range of solutions are

The panes could used as: • Sun shading componen • Energy generating colle

Shutters or blinds

The grid of the medium lir for. e as molding it anes out of two ether to create erted a medium or functions a

ction used





22-02-2006 Imagined by Daan Rietbergen

Keywords: layered construction, free-form, sun shading, adapting, envelope, 0-10 years, smart material.

Info: http://futurefeeder.com/index.php/ archives/2006/04/23/pixelskin02/



Moiré-Façade

An array of tiles shift over each other in order to block or let in sunlight.

Each tile reacts individually on the sunlight. When this system is used on a curved surface, all tiles will receive a different amount of sunlight making every tile shift differently, creating a Moiré-effect.

The technique for the shifting could possibly be done with Bi-metallike materials directly reacting on light. The tiles could be made of PV-cells activating the Bi-metal.



22-02-2006 Invented by Stephanie Erben, supported by Marcel Bilow

Keywords: prefabricated, modular, system, facade, international facades.

4 Gewinnt Facade

Modular frames that combines a set of frames to install like a element façade.

- Moulded out of fibre reinforced plastic
- Every element can save a single problem
- A wide range of design available

The model shows an abstract detail of assembling, normally it is designed to fix the elements an the ceiling line



08-05-2006 Invented by Ulrich Knaack

Keywords: bionic, energy generating, sun shading, transparency, adapting, organic, facade, glass.

Leaf Façades

Integrating fern into the space of two glass panes will work as a periodically sun shading.

In winter the plants has no leafs and the sun can come trough, but in the summer there is a good shading.

For water reservoir the elements had to store rainwater to let the plants grow



15-05-2006 Imagined by Ulrich Knaack & Tillmann Klein.

Keywords: prefabricated, modular, moving, lightness, transport, vision,



Personal Container

Every staff that is needed is stored in a personal container. This container contains a bed, a cupboard, books and also something that is needed to travel around.

The Container can handled in different ways to pick it up. For examples a little car, (shown) train, airplane or something different is possible for transportation.

At the destinations there will be a system to dock on, from where you have access to a shower, toilet, electricity and everything that one need to live.



08-05-2006 invented by Ulrich Knaack & Marcel Bilow

Keywords: prefabricated, decentralized, modular, system, moving, adapting, façade, interior, installations.



Furniture Elements for Façades

• Just like modular facades elements furniture is designed to fit into the façade grid. These elements can include tables, cupboards, beds, or showers.

• Prefabricated just like the shown airplane door its easy to handle with different styles and designs. Different materials are possible.

• For easy assemble and a bigger range it would be nice if a regulated grid is possible, just like the I Pod standard connection, today there are over 1000 components available to handle with the I Pod.

• The modules also can be take with the user as a personal equipment and part of a living unit.



13-03-2006 Imagined by Wiglinghoff Supported by Ulrich Knaack

Keywords: pneumatic, prefabricated, freeform, moving, lightness, transport, textile, foil, membrane.

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Take your home with you

A rope is a tent is your home....

Using combinations of textiles and structural pneumatic beams, you are able to handle a small room or tent for travelling around. Everything you need is in the coat, it can also named as "coating" in a different way of seeing....



VACUUM + PNEUMATIC

18-06-2006 Imagined by Wouter Blondeel, Supported by Tillman Klein, Marcel Bilow & Thiemo Ebbert

Keywords: freeform, pneumatic, system, load bearing, lightness, structure, envelope, 0-10 years, foil, membrane.

Deflatable Freeform Structures

The inherent force of air-pressure can be used as an integrated element in the structural system of facades.

The goal is to design structural elements that allow free form constructions that are finally stiffened by vacuum. The elements are put in form first and than interlock through the pressure force so that the shape of the construction gets fixes.

"Peanut" Bridge

There are different possibilities to build a deflated bridge. One possibility is the Peanut solution. A Material is packed into a pre-shaped bag. In hanging position the ideal "arch-form" can be practically discovered. After evacuation of the air the construction is stiff and can be turned into the upright position. The "Peanut" represents all positive characteristics this Material must have: Good packing possibilities because of shape, friction because of rough surface, lightweight.



22-02-2006 Imagined by Marcel Bilow & Tillmann Klein

Keywords: pneumatic, sun shading, transparency, lightweight, facade, envelope, installations, building physics, 0-10 years, foil, membrane.



Balloon Sun shading

Within a deflated construction balloons with hose connections to the outside of the system are placed in sections of defined size. These balloons can be separately inflated by letting air in. The balloons will grow and fill out the vacuum until they reach the size of the section. This way a regulated sun shading can be realized.



22-02-2006 Imagined by Jürgen Heinzel, supported by Marcel Bilow

Keywords: modular, system, ventilation, pneumatic, transparency, organic, facade, installations, foil, membranes, air.

HoneycombPneuEnvelope

A real good illustrated idea with a new fresh look.

The solutions:

• Modular frames that combines a set of frames to install like a element facade.

- Ventilation through a Gore-Tex Membrane breathy but watertight.
- Moulded out of fibre reinforced plastic.

• Good solution to fit the ceiling lining by adding mechanical service components like ventilation, cooling and also cable conduits.

• Innovative Idea for shading: In the chambers of the pneus a can with a pneumatic balloon is filled into the pneuchamber to regulate the shading.



18-06-2006 Imagined by Tillman Klein & Thiemo Ebbert

Keywords: freeform, pneumatic, system, moving, load bearing, lightness, adapting, facade, envelop, structure, transport, 0-10 years, foil, membrane, aluminium.



Deflated Facade Constructions 1

The benefit of evacuating an entire façade (-panel) lies in the combination of stabilizing the structure by bringing in a defined prestress with a high insulation potential. Space frame constructions are developed that are adjustable in size and height.

Adjustable Facade Element

In combination with vacuum skins, flexible facade elements are created. During transportation the construction takes minimal room. The use can be temporarily as well as permanent.



18-06-2006 Imagined by Lourdes Lopez Garrido AR0645 Supported by: Tillmann Klein & Thiemo Ebbert

Keywords: pneumatic, system, insulation, , lightness, transparency, structure, facade, envelope, transport, building physics, 0-10 years, foil, membrane.



Deflated Facade Constructions 2

The benefit of evacuating an entire façade (-panel) lies in the combination of stabilizing the structure by bringing in a defined prestress with a high insulation potential.

"Honeycomb-panel" Facade

Deflated constructions need spacing. Honeycomb cardboard has great stability in directions of the wholes. If an outside frame is provided, honeycombs can be used as filling of the panels in combination with an deflated foil. Good insulation value, light weight and transparency of the panel will be the result. Also the combination with a frame that can de disassembled is possible.



18-06-2006 Imagined by Lourdes Lopez Garrido Supported by Tillmann Klein & Thiemo Ebbert

Keywords: freeform, pneumatic, system, insulation, load bearing, lightness, structure, facade, envelope, structure, transport, 0-10 years, foil, membrane.



Deflatable Freeform Structures 1

The inherent force of air-pressure can be used as an integrated element in the structural system of facades.

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"Bookshelf" Facade

The construction is based on a grid-structure out of cardboard or other board-material. The elements are pre-cut and pre-shaped and are assembled on site to 3-dimensional facade structure like a bookshelf. The deflated foil provides water-tightness and stiffness in all directions.

The Facade System combines a quick and simple assembly, good transportation, and transparency with excellent insulation values.



18-06-2006 Imagined by Lourdes Lopez Garrido

Keywords: freeform, pneumatic, system, moving, load bearing, lightness, adapting, facade, envelope, structure, 0-10 years, foil, membrane.



Deflatable Freeform Structures 2

The inherent force of air-pressure can be used as an integrated element in the structural system of facades. The goal is to design structural elements that allow free form constructions that are finally stiffened by vacuum. The elements are put in form first and than interlock through the pressure force so that the shape of the construction gets fixes.

Rubber Vacuum Facade; The façade is design using rubber material. The neoprene for instance has good, both thermal and acoustic, insulation qualities. In this particular design huge rubber pneumatics are placed next to each other creating a singular composition. The gapes within and among them can be filled in with glass, but in this case the whole façade is vacuumed. To counteract the material tendency to shrink inwards due to de vacuum-effect, we have designed a device that placed in the triangle gap left every 3 pneumatics, maintains the rubber components tied to each other. This device can be made out of metal or hard PVC.



13-03-2006 Invented by Luise Lauerbach, Thomas Hofberger Supported by Ulrich Knaack

Keywords: pneumatic, interactive, lightness, envelope, foil.

Le Cadeau, Cubic Pneu Wall

This Idea is imagined, in a design project for a presentation system for the new Airbus A380.

A lightweight presentation pavilion is build out of helium filled cubicle Pneus, added on ropes like pearls. When you lose the ropes the wall starts to open by flying above.

A technical solution handles with the control of the ropes in the construction below on the bottom



13-03-2006 Invented by Sander / Schütte Supported by Ulrich Knaack

Keywords: layered construction, pneumatic, insulation, load bearing, low cost, envelope, structure, textile.

Pneumatic Structures - Sand Dome

The idea of this façade is to use the possibility of the thermal mass of sand for tent structures in the desert.

By mixing air and sand, sand could be use as a liquid material to be transported. In this design the structure has to be a dome to give maximal space by minimal surface.



3-D structure for the fabric to give the shall of the dome a structural dimension



First test mocup by Sander / Schütte
15-06-2006

Invented by Jürgen Heinzel Supported by Ulrich Knaack Marcel Bilow

Keywords: freeform, pneumatic, moving, adapting, facade, structure, adjustable mould, foil, air.





Bubble Wall

Using air filled balloon I a flexible airtight bag a adjustable wall could be created.

A few ideas are possible;

- Fill all the balloons and have a rectangular wall after deflating
- Fill lines of balloons to create a mowing wall
- Fill each balloon separately to have the most individual shape

 The pipes can also be attached to a computer controlled valve system, to let the wall moving under different situations





28-06-2006 Invented by Ulrich Knaack Marcel Bilow

Keywords: layered construction, composite, load bearing low cost, structure, facade concrete, textiles.

Fibre Concrete Facade

Within the course of glass construction a modular facade in fibre reinforced concrete with an integrated building services element has been developed. Until now classical materials for extensive curtain walls such as aluminium, steel, wood or glass have been used.

The development of fibre-reinforced concrete makes it possible to produce slim profiles and frames tat have nearly the dimensions of those manufactured in aluminium or steel. The approach of a modular facade in fibre reinforced concrete shows the future field of application of this material as an extension of existing scopes for design.

The use of fibre reinforced concrete within a facade has been common for panels of curtain walls the utilisation for supporting constructive elements of façades is new. With its face site dimension width of only 60mm the mock-up model still shows a large potential for development. The supporting pillars are filled with rigid foam and have an average thickness of 10 mm.

This project was supported by the companies Metallbau Holz / Leopoldshöhe (elements of the facade and glass), Fa. Durapact / Haan (fibre reinforced concrete), Fa. Krülland / Kaarst (shading device)



15-05-2006 Imagined by Tillman Klein

Keywords: freeform, layered construction, ventilation, insulation, moving, organic, beauty, facade, envelope, building physics, technology transfer, 10-20 years, unknown material.



Feather Envelope

Houses could be covered by feathers. They provide a water tide and insulating surface which in the same time can adjust to movement and is permeable for ventilation if needed.

There are two types of feathers in nature: Contour-Feathers are building the outer layer. They are strong and are used for steering and protection. Down-feathers are more fine and responsible for insulation. The free part of the Federkiel outside of the skin is called shaft. It carries the Fahne which itself is divided into air filled Äste and Strahlen. The Strahlen can be melted together or have little hooks to provide more connection and strength. Water tidinesss is made to the dense.

Blue colours a created by distribution of light. Green and violet are created by yellow or red layers on top. Changing colours come from interfering white light.



22-02-2006 Imagined by Thiemo Ebbert

Keywords: sun shading, energy generating, adapting, 0-10 years, smart material.

Be-Me

Bi-Metal strips react to temperature. Used as sunblind they move, when temperature rises and thus can shut blinds automatically, before the interior gets too warm. The dimension could be anything between Venetian blinds and entire shutters.





19-06-2006 Imagined by Marcel Bilow & Ulrich Knaack

Keywords: pneumatic, load bearing, insulation, lightness, façade, envelope, composite, air.

Vacuum Wave

At this time vacuum isolation panels VIP are only used as flat panes. The idea is to increase the static height with waving up the Sandwiches to create load bearing elements used for claddings.

These Elements could combine insulation and self-support for easier mounting with less fixing points.

-

Sandwich VIP with metal-layers

Standart VIP with foil



Waved Sandwich VIP with metal-layers to increase the static height

19-06-2006 Imagined by Ulrich Knaack

Keywords: layered construction, pneumatic, ventilation, lightness, envelope, façade, textile, glass, metal.

Vacuum Wave Facade Panel

Using the vacuum wave principle a closed and transparent façade panel could be possible using sandwich structures hold together with vacuum.

For the solid areas a metal sheet covers a powdered silica core - the same used in vacuum isolation panels. This is a good isolation and also a self supporting benefit.

The transparent area could be possible like the developed vacuum panes using glass marbles as a spacer to create space for the vacuum.



10-05-2006 Invented by Ulrich Knaack & Daan Rietbergen

Keywords: layered constructions, composite, load bearing, lightness, facade, roof, composite.

Super Exclusive Sandwiches

Sandwiches are a combination of supplementary materials. For claddings many combinations are imaginable. To create lighter, cheaper or stronger panels, and probably a combination.

This concept is to produce super sized panels with exclusive materials such as mahogany-wood or marble, which normally are unmanageable and unaffordable.



22-02-2006 Imagined by Thiemo Ebbert

Keywords: sandwich, pneumatic, insulation, loadbearing, structure, wood.

More Info: www.conbam.de



Vacu-Bam

A floor high structure from vertical bamboo-columns forms the supporting structure. Two layers of transparent foil provide transparency and weather-protection.

2.01000



H- section





05-05-2006 Invented by Philip Mannaerts & Martijn de Geus Supported by Ulrich Knaack & Thiemo Ebbert

Keywords: bionic, self organizing, insulation, sun shading, low cost, organic, facade, wood.



The concept of this facades is to develop a vertical meadow as a surface of buildings. The system is currently used for interior decordion but could be also used for external surfaces.

The idea was developed for the winning concept of Philip Mannaerts and Martijn de Geus for the stylos-project, the pavilion of the student association at the faculty of TU Delft.

The material for the surfaces is coconutfibres, which would be penetrated with water supply pipes to guarant, the growing of the plants.



28-06-2006 Invented by Herbert Funke & Marcel Bilow

Keywords: layered construction, composite, load bearing low cost, structure, composites.



Folding a sandwich boat

A glass-fibre reinforced plastic (GRP) boat has been developed in the framework of a plastic seminar. This hull has been constructed as a blank and has been built as a plain layer as opposed to usual constructions of boat hulls. The boat has been folded to the final shape only after laminating a planar level with rigid foam.

After testing the construction it has been secured that a delamination would only take place in the direct area of the bend. On the basis of this small sample that could have been coped in the seminar this type of construction has been verify ed. It has been shown that the use of accurate edges for architectural purposes is possible. Those edges can be manufactured economically.

This project was supported by the companies; Gebr. Becker GmbH & Co KG / Wuppertal (vacuum pump) Hyco-Vakuumtechnik GmbH / Krailling R&G GmbH Faserverbundstoffe / Waldenbuch (GRP) Epurex films / Walsrode (foil for vaccuumpressing)



10-05-2006 Invented by Ulrich Knaack, Marcel Bilow & Daan Rietbergen

Keywords: layered construction, composite, load bearing, strength, structure, composite. More Info: see also 3F board







Folding a Construction

This idea uses standard sandwich panels to create e.g. furniture. By milling out splices, a panel can be folded into any application. Many shapes are possible, a study needs to be done in folding.



Invented by Ulrich Knaack & Daan Rietbergen

Keywords: layered construction, composite, load bearing, strength, structure, composite.

More Info: Axel Kilian, designed a chair using this system http://destech.mit.edu/akilian Examples of possible hinches. E.g. wooden elements are glued to a continuing plastic panel.









Folding a Construction 2

Concept of this idea is taking some easily transportable flat elements and folding them on-site into the final shape.

These elements could be used in temporary structures such as emergency shelter, pop podiums, exhibition pavilions, party tents.

Research will be in possible materials, shapes, joints/folds (how to fix these) and folding/cutting patterns.

As an possible construction: A foldable bridge from one single panel.



22-05-2006 Invented by Marcel Bilow

Keywords: pneumatic, moving, adapting, structure, tool, 0-10 years, textile, paper, composite.

Vacuum Kinetic Structures

Inserting a roll able structure in to a airtight bag increases a kinetic structure.

The used cardboard rolls in under vacuum and rolls out when inflated. So it's a phenomena that everything under vacuum takes place in its smallest dimension and shape.

This technique is possible for packaging, for covering and also structures use because of the high stiffness of the evacuated core.



15-06-2006 Invented by Marcel Bilow

Keywords: pneumatic, moving, load bearing, adapting, structure, foil, composite.

Self Erecting Construction

Inserting pre-cut elements into a airtight bag creates a self erecting construction. In fact of this phenomenon a biform construction is possible. For easy handling and transportation the elements need less space than in its deflated erected position. So every construction has two shapes one in his starting and a second after deflating. It is also a kinetic principle cause of "growing" or moving into its final shape.



15-06-2006 Invented by Ulrich Knaack & Daan Rietbergen

Keywords: layered construction, freeform, load bearing, structure, composite. More Info: Axel Kilian, researched cutting patterns for freely curved panels http://destech.mit.edu/akilian Lines are cut in core material





Vacuuming Freely Curved Panels

Concept of this idea is creating curved panels by using intelligent cutting patterns and vacuum.

The sandwich panels are made of a soft (bendable) surface with a stronger core. Lines in the core-material are milled, creating possible folds. The core is wrapped with foil and deflated using a vacuum pomp. By deflating, the sandwich will fold.

In order to calculate the cutting patterns for freely double curved surfaces, research needs to be done. (see research of Axel Kilian)

In order to create double curved panels, appropriate cutting patterns need to be researched



Invented by Ulrich Knaack & Daan Rietbergen

Keywords: layered constructions, freeform, composite, load bearing, lightness, facade, roof, composite.

2 The moulds take their position, the sheets are pushed more or less in place.

moulds.



This concept is to produce freely-curved sandwich panels with a PUcore and an aluminum surface.

The method is described in the following pictures. The panels can be of varying thickness, giving extra stiffness to certain parts of the panel. Extra stiffness is also possible by using several densities of the polyurethane.

By injecting the polyurethane, the sheets are pushed in their final position.

Two sheets (e.g. aluminum) are positioned between two adjustable

Next step would be the detailing of the panel.









Invented by Ulrich Knaack & Daan Rietbergen

Keywords: layered constructions, composite, load bearing, lightness, facade, roof, composite.

Moulding Foam for Freely Curved Panels 2

By using a two-sided adjustable mould, a freely curved volume can be foamed. To keep the foam in place, a temporary plastic bag can be used. After the foam has stiffened the sides are cut of by laser and the shape is finished with fibres and epoxies.



3

Invented by Ulrich Knaack & Daan Rietbergen

Keywords: layered constructions, freeform, composite, load bearing, lightness, facade, roof, composite.

Zipper Sandwich

By using the principle of a castellated beam (see photo) freely (single) curved panels can be produced. These panels could be used for cladding blob buildings or to give more optimal structural possibilities.



expand, fold and clamp.

10-05-2006 Invented by Ulrich Knaack & Daan Rietbergen

Keywords: layered constructions, freeform, composite, load bearing, lightness, facade, roof, composite, foil.



Freely Curving using Shrink Foil

Concept of this idea is using shrink-foil in order to bend panels.

Steps in the process are:

- 1. Creating sandwich of flexible, insulating core with shrink-foil surfaces.
- 2. Heating the foil in the folding areas.
- 3. Stiffening the panel by injecting a raisin into the core.

Research needs to be done in the appropriate materials, in the mathematical relation of heating and bending, how to heat the foil, how to create single-curvature (the plastic shrinks in all directions) and how to inject the raisin. (is vacuuming possible?)



15-05-2006 Imagined by Tillman Klein

Keywords: freeform, commercial, adapting, tool, 0-10 years, unknown material.

Extrusion Mould

The aim is to create a tool that continuously produces freeform elements that can be assembled to a bigger structure. The extrusion mold can be adjusted in two dimensions. The third dimension is introduce by the flow of the material itself. Temperature, pressure, speed of the process are important factors. Flexible core-materials can be introduced. Reinforcement of the outer material can done with fibers. The cooled material is to be cut into certain sizes. With complex cutting machines different edge types can be produced.

If a load bearing construction is necessary, the parts of it will only need to be formed in two dimension as result of the rectangular projection of the elements.





13-03-2006 Invented by Ulrich Knaack

Keywords: pneumatic, controlling, liquid, facade, foil, water.

Liquid Façade

The liquid façade tries to deal with:

- load bearing
- thermal mass for energy
- storing
- different possibilities of thermal insulation

By using water in the middle pneumatic element, the thermal mass can be used for storing energy. By using different positions of insulation pneumatics at the outer surface the insulation against cold and sun can be controlled.



13-03-2006 Imagined by Ulrich Knaack

Keywords: pneumatic, energy generating, liquid, envelope, glass, foil.

Changeable Envelope

The changeable envelope is related to semi permeable and three dimensional fabrics. This gives the possibility of integrating humidity control in closed surfaces.

In addition the principles of vacuum and pneumatics could be used to steer the functions of the envelope.



23-23-2006 Invented by Linda Hildebrand, supported by Marcel Bilow

Keywords: layered construction, interactive, lighting, ventilation, insulation, sun shading, facade, envelope, textile, membrane.

Textile Envelope

An envelope created with a various layers of textiles. Sun shading is solved with aluminum or silver coatings on the textiles. Ventilation is possible through Gore-Tex Membranes.

Inserted grassfires collect sunlight over the whole envelope and collect it to a central PV Element. (the solution is a grassfire that collects light alongside). Through the fibers also light effects are possible.



28-06-2006 Invented by Ulrich Knaack & Marcel Bilow

Keywords: decentralized, heating cooling, transparency, installations, facade, concrete.

Integrated Module Facade

Add new functions into a façade module is the aim of this prototype project.

A decentral climate unit is added into the façade frame, also a cable duct to support the data and electric power to the office is added to the system.



22-02-2006 Imagined by Tewes / Heine, supported by Marcel Bilow

Keywords: energy generating, insulation, sun shading, cooling, liquid, facade, installations, water.

Liquid Medium Facade

The idea is to collect the sun power in a liquid medium like water or oil. This medium is placed between two layers of glass, just like a thermopane glazing.

The temperature can taken out of the interspace into a storage. This Idea is created for facades in hot areas like Dubai etc. Heating over the medium is also possible.



29-03-2006 Invented by Ulrich Knaack

Keywords: layered construction, composite, energy generating, solid, facade, composite.

Sandwich Façade

The idea of this façade is to create a sandwich structure which uses different possibilities of sandwiches to solve different needs of facades.

The main structure is made out of acrylic and glass fibre surfaces and foam in the middle. This should solve insulation and structural issues. Windows are to be made out of acrylic. Reflection and light transport could be made by using "TWD" (Transparente Wärmedämmung).

Finally the water tubes in the surface can collect sun energy for heating. The energy could be stored in geothermic stores.



19-06-2006 Imagined by Ulrich Knaack

Keywords: layered construction, freeform, interactive, ventilation, lightness, envelope, façade, textile, foil.

Skin Envelope

Creating a light but quick reacting envelope with only a few centimeters in thickness.

The aim should be an envelope that's – watertight, transparent, sun reflecting, added with a quick heating and cooling system. Open to diffuse air or water steam.





18-04-2006 Imagined at AR0645 & Tillmann Klein

Keywords: modular, system, commercial, low cost, facade, envelope, 0-1 years, unknown material.

1 Euro Facade

Costs are a growing factor in facade constructions. But what happens, if costs will be the dominating part in the design discussion? How far can we get and what performance can a cheap facade have? Is it our limited imagination or fixed claims about the facade functions that directs us to build the facades we always build?

The 1 Euro facade is an experiment. The rules have to be defined and set before the game begins. Scenarto:

- Step 1: Research about the absolute basic needs of facades. (Functions, climate, protection, loads, etc.)
- Step 2: Definition of design goal. (for whom, what climate, type of building, etc.)
- Step 3: Finding materials an strategies for combining them with the brainstorm method.
- Step 4: Evaluation and mock ups.



10-07-2006 Invented by Marcel Bilow

Keywords: layered construction, freeform, other functions, organic, envelope, textile.





Wrap it Textile Facade

An envelope looking like a curtain wall wrapped around a building is possible for cladding elemenents using a glue or matrix soaked textile that will held the matrix. A good idea is to use a 3D fabric.

1. You are able to wrap the dry textiles around a building as you wand just like Cristo did it with the Reichstag in berlin. When the shape is perfect you can fill in the liquid matrix, and let it dry. A supporting loadbearing grid is necessesary only for the moment of drying. After the form should hold itself.

2. A second idea is to spray resin or concrete on the wrapped skin to harden it.

3. A third but dirty solution is to wrap the soaked textiles around the building just like doing a gypsum bandage.



18-04-2006 Imagined at AR0645

Keywords: layered construction, ventilation, insulation, sun shading, moving, beauty, facade, 10-20 years, textile.

The Woven Envelope

High performance textiles. Building envelops like cloth. The beauty of woven materials. The "Curtain wall" becomes meaning in an other dimension.

Textiles can be layered. They can be tailor made they can adjust their form. Ventilation an water proofing in the same time is possible.

Scenario:

Research about textiles in general. Methods of weaving and the combination with plastics and fibers.

How can the functions be solved with textiles? Layering, structure, load bearing, ventilation, vision, etc..What are the special opportunities textiles offer for facade constructions? Mock-ups, models, drawings...



22-02-2006 Imagined by Tillmann Klein

Keywords: freeform, lighting, transparency, adapting, facade, envelope, technology transfer, tool, vision, unknown material.

Invisible-Façade

Scientist have just discovered how light reacts with material. They already developed a special material that get transparent, when hit by laser beams.

This opens new possibilities for building materials. Massive load bearing structures can be made invisible by using a switch that turns the laser on. Opening can have any wanted form and change continuously. The problem of sun shading is solved

It is a façade made out of one multi purpose material.

richtet Phillips. Der Trick funktioniert, weil sich die Lichtwellen des Lasers und die Elektronen des Materials ähnlich



wie zwei Wellen auf dem Wasser cegenseitig beelp-Gussen können. Noch sich der Effekt nur bei S zialmaterial erreichen, P lips hilt es jedoch aur filr eine Frace der Zeit, bis der Romenblick auch normale Tilmen oder Mauern durchdrimeen wind: Wir beginnen zu verstehen, wie Light mit fester Materie interaciert", sant Phillips. And Basis dieses Wissens wind as konftig möglich sein. Soeziallaser zu entwickeln, die eine Vietrahl won Materialien lichtdurch Linde machen können."

028 SP12021 9/3004



13-03-2006 Imagined by Marcel Bilow

Keywords: layered construction, composite, modular, energy generating, load bearing, strength, facade, envelope, textile, concrete, 3D fabrics, composite.



Solar Energy Plant

The Idea is to create collectors of areas that are usually used for traditional solutions. Walls or roofs can used as solar energy plants with inserted capillary tube systems, so the functions load bearing, insulations and weather protection can be added with the function of solar energy input. The material is fibre reinforced concrete

Main ideas are industrial roofs or facades, also a prefab Roof for housing. To store the energy a geothermic storage space would be possible.

10-04-2006 Invented by Marcel Bilow

Keywords: commercial, security, ventilation, controlling, low cost, tool.



Low Tech Ventilation

Ventilation is very important, but when you open your windows too long, you will have no energy saving.

The idea is to create a smart sensor attaches to the façade or the walls to have an optical signal when the carbon oxygen level raises high to starts ventilation, when the level sinks you can close the window.

There are solutions with electrical components, the better ones should react without electrical energy, just like the thermometers attaches on wine bottles.


20-04-2006

Imagined by Gillian Baarslag, guided by Daan Rietbergen

Keywords: layered construction, prefabricated, decentralized, self-organizing, modular, moving, other function, lightness, other-property, envelope, technology transfer, vision, textile, membrane, smart-material, unknown material.

Mobile Facade

The idea behind this facade is that in the near future the environment will be so polluted that everybody will need a mobile facade 24 hours a day.

All personal facades together make up a building, this way resources are saved, since the building is only as large as the amount of people it keeps.



Design of Construction – Imagine!

Introduction Lecture – held at TU Delft on 23. Of July 2006 by Prof. Dr.-Ing. Ulrich Knaack and a collection of Future Façade Principles by The Façade Research Group Chair Design of Construction / Faculty of Architecture

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