THE BROKEN TAIL ON A LIZARD

The idea of repetition and algorithm have inspired me in my work to develop this system.

MASTERS THESIS

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University College of Arts,
Craft and Design
In Space
2015
ABSTRACT

In this project I have investigated how a set of rules can be applied to a particular sight and program. Inspired by the rules of the ‘divine proportion’ I applied its system of repetition and algorithm in a particular site and created a bridge with a diverse program beyond the simple intention of bridging two ends. This project is a way of approaching the complexity of designing an architectural space. It is a helping guide on how, through a system, I could evaluate and pay attention to spatial qualities.

My system is based on the divine proportion and its parts. I have broken up the divine rectangle and used the parts to create a structure that connects the two ends on this specific sight. In this project I have been investigating and testing how a set of rules can be applied on a site to create proportion, composition, and rhythm. The classic rule that is about movement in space, giving function to the space, the relation to the human body, and a space being more diverse. These rules are the basics of the foundation of our field.

The metaphor I have used is the broken tail of a lizard, that from the point of where it brakes takes another shape and creates a new structure, overlapping and connecting the old and the new. I have called this ‘the nature’s broken proportions’. By that I mean, when the symmetry in the creation in the new tail is broken or reduced, it no longer is a continuation of the lizard’s body in that time and space, but an individually separated continuity with its own symmetry. It exists in parallel and as an extension of its past. The system I have created have helped me to define the boundaries and provided a clear structure of my design.

This project is to me about connecting my intuition on how life is with how I design space. The structure and boundaries provided by this system of “broken proportions”, has given me the tools to evaluate the quality of the spaces I created. I found freedom in my abstraction of this system by breaking up the logarithmic spiral, which is about continuity. This is a designing tool I used to create my bridge.

My work is an illustration of a subjective idea, of breaking the continuity in space and time. Through using this system I could evaluate qualities like dimension, proportion, composition, rhythm, direction, sectioning, and levels. All these qualities given by this system, creates an abstract interpretation about my personal view of movement of this bridge.
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One of my absolute fascinations is how nature uses repetition to create its forms. These repetitions are not linear but irregular. The simple logarithmic spiral of the golden ratio\(^1\) or fractal geometry is coherent in many parts of our world. This divine proportion that has the irrational number 1.61803398875... is for me what in a simple way explains the complexity of everyday life. I have come encounters with this number in previously works, but this time I want to work with the space this number leaves behind in its surroundings when it is repeating in shapes. The order that comes from the chaos surrounding this number is what interests me.

Benoit B. Mandelbrot, the creator of the Mandelbrot set and the fractal theory, said “Bottomless wonders spring from simple rules, repeated without end.” and “that Fractal is defined as well by what has been removed as it is by what remains.”\(^2\) But I don’t just see the bottomless as the beautiful thing in nature, I see the broken chain in the bottomless, like the parts that are removed from the Fractals. I think that the combination of the never-ending and the broken is the reason for the golden ratios to existence in nature.

When I was a child, living in Iran, I used to chase and collect small gecko lizards, with the ability to create a whole new tail. This function is called Autotomy\(^3\), meaning self-severing, the lizard does this to save itself from predators and later regenerate a new tail. Bathroom paper comes with lines of small cuts between the individual sheets, so it is easy to tear one off at pre-determined places. A gecko’s tail works in the same way. The tails don’t break off at random places. Instead, they have sets of “score lines”, where the tissue on either side is loosely stuck together and can be easily separated\(^4\). The gecko’s tail effectively comes pre-severed along several easy-to-tear lines. But shedding a tail is more complex than it might seem. It’s not that a biting predator just pulls it off. The lizard helps the process along by contracting its muscles; typically the animal releases the tail just before the place where it was grabbed. After all, a tail is useful for communication, balance, storing fat, and even aerobatics—it’s not a thing to be casually lost, and the lizard benefits by detaching as little as possible.

What is interesting in this action is way the new tail looks different. The original proportional shape of the lizard’s tails is not reshaped. Instead, the tail takes a new structure and the new tail is created, overlapping and connecting the old to the new. How come the cells and the genetic structure of the lizards tail reproduce a different result? This action is to me an illustration of breaking the continuity in space and time. When the symmetry in the creation in the new tail is broken or reduced, it is no longer a continuation of the lizard’s new body in that time and place, but rather an individually separated continuity with its own symmetry. Existing in parallel and as an extension of its past. I call this “the nature’s broken proportions”.

Like the broken branches on a tree it changes its direction in its form and continues from where it broke with a new direction. I think this is just the way this phenomenon of the golden ratio works, small changes in its structure results in a spiral that creates a different expression in use. It is the combination of the broken and the perfect that makes this phenomenon so beautiful and aesthetically appealing to me. I would like to illustrate this subjective idea of breaking the continuity in space and time, by using a system of broken proportions.

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1. The golden ratio, also known as the divine proportion, golden mean, or golden section, is a number often encountered when taking the ratios of distances in simple geometric figures such as the pentagon, pentagram, decagon and dodecahedron. It is denoted phi, or sometimes tau. http://mathworld.wolfram.com/GoldenRatio.html
3. Autotomy (from the Greek auto- “self-” and tome “severing”) or self-amputation is the behavior whereby an animal sheds or discards one or more of its own appendages, usually as a self-defence mechanism to escape a predator’s grasp or to distract the predator and thereby allow escape. The lost body part may be regenerated later. 4. To cut short the short: a review of lizard caudal autotomy studies carried out over the last 20 years, 2008, doi:10.1111/j.1469-7998.2008.00484.x
NATURE'S BROKEN PROPORTIONS

For example what about the numbers missing from the Fibonacci sequence? The beauty of the tree is not only the golden ratio in the growth of the branches but also the space between the branches and the leaves, and the space between the tree and the clouds. It is this space in-between I’m interested in working with. It might not have the qualities of the divine proportions in themselves as forms but the quality are embedded in its existents because of the branches growing around them. I also want to illustrate that it is not just the system of the divine proportion so often illustrated in how the golden rectangle can produce a spiral of proportional cubes, increasing or decreasing in size that make this phenomenon of the divine proportion so beautiful, but the unseen gaps in space around and within the golden rectangle that makes it complete.

My aim is to create a system working like a toolbox applicable in different situations depending on what tool is required to solve a particular problem. My intentions are to understand how this system that is based on the broken parts of a whole, could help me to create an architectural designed space and help me to evaluate the qualities in that space.

In everyday life we use the word “proportion”, either for the comparative relation between parts of things with respect to size or quantity, or when we want to describe a harmonious relationship between different parts. Plato in his Timaeus said, “It is impossible to combine satisfactorily two things without the third one. We must have between them a correlating link... such is the nature of proportions”.

The unique quality of divine proportioned elements is, when adding parts together it always maintains an exact and consistent proportion. The quality’s of the divine proportion is in the logarithmic spiral that in its width increases at a fixed ratio to the length in the continuity of the turn in the spiral. The logarithmic spiral makes the relationship between symmetry and asymmetry visible in the comparative relation between parts. It also acts as a precise and flexible resources of changing scale and gives dimensional meaning to the additional similar proportioned forms at different scales.

In Fibonacci series (1,1,2,3,5,8,13,21,34,55,89...), which each number is the sum of the two preceding numbers. It is also a link between symmetric and geometric form. Comparing with the equal division of a space. Mathematical symmetry may be observed with respect to the passage of time as a spatial relationship, through geometric transformation, such as scaling, reflection and rotation. It could also be used to describe other kinds of functional transformations.

The golden rectangle plan is a geometric basis of a spiral, the divine proportion progression occurs in the increase or decrease in size of units. The divine proportion relations in dimensions of vertical turn, horizontal turn and radius, always maintains an exact and consistent proportion where each numerical value is the sum of the two preceding values.
NATURE’S BROKEN PROPORTIONS

What I want to test is when designing a space with the broken up parts of the divine proportion. What spatial qualities would the created spaces have, if the golden rule were only present in some parts of the built space? It is the overlapping of the divine proportions and its parts that is the aim for my way of illustrating an architectural space.

This abstract way of building with a system has been used by many architects before. Eisenman’s House X Project is a good example of letting the system provide a pallet of signs with its one grammar that can allow an objective composition of form in space. Eisenman complements this ide also by using the cubic square. "A square is a shape which only becomes a sign when seen in relation to another square or to a circle, the sign value then being equal or different". He then divides this square in equal parts that are reassembled by the rules of his system.

Eisenman system demonstrates the way to overcome the functional meaning and go beyond the established architectural notion. In every stage of his process of giving shape he has rules that permits him to select what can be called “correct composition” in his terms, not to deal with beauty or meaning. The compositions in these houses are for me a representation of time standing still in space; it is an illustration on an objective described moment in time. Not a continuity of movement in space and not about the brake of continuity and change in the geometric transformation. This may explain what Eisenman says- the “real architecture” only exists in the drawings. The “real building” exists outside the drawings. The difference here is that “architecture” and “building” are not the same.

My work is about the rectangle and the directions it provides, it is an enclosed shape with symmetry and asymmetric quality.

My work is on the contrary a very personal translation of my intuitive notion of change in continuity through space and time. The symmetry that is broken or reduced is the inspiration to the development of my system. My aim is to illustrate this broken and reduced symmetry in creating a bridge from parts of the divine proportion. My system will provide me with tools that make the aesthetic decision meaningful by a system. I have also made my system free for interpretations through breaking up the logarithmic spiral, which allows translating the system in to a given place.

This project is important to the field of architecture because it is a way of approaching the complexity of designing an architectural space. It is a helping guide on how, through a system one could evaluate and pay attention to spatial qualities. It also articulates the subjective description of how we perceive movement through space and time.

INSPIRATION - broken proportion

The inspiration for my master thesis is the broken tail on a lizard. When I was a little girl living in Iran I used to chase and collect small gecko lizards, now it might seem a little bit disturb, but I used to twitch the tail of the lizard and then observe how the new tail grew in time. This is something that has stayed with me and I still find interesting. Today I know that the tail comes with score lines, like bathroom paper, with parts that easily breaks off. What is interesting is way the new tail looks different.

I wanted to take this chance to see if I can work with the concept of the broken tail in my master thesis. I can easily see the lizard as an building, with a structural body that changes through time. Here I see me as an architect, have the opportunity to create the new tail as an extension in a structure, that changes movement through space and time.
INSPIRATION - broken continuity

Another example is the broken branch on a tree that changes direction in its form and continues from where it broke with a new direction, creating change in the rhythm of the tree.

The branches are part of a system that has been broken and a new structure is built from its parts.
INSPIRATION - divine proportion

I interpret the lizard and the branches as an result of the divine proportion crating its forms in nature.

Proportion - the comparative relation between parts of things with respect to size or quantity, or when we want to describe a harmonious relationship between different parts.

Divine proportion - golden ratio is when adding parts together it always maintains an exact and consistent proportion.

Logarithmic spiral - has the qualities of its width increases at a fixed ratio to the length in the turn. The spiral makes the relationship between symmetry and asymmetry visible.

Fibonacci series - which each number is the sum of the two preceding numbers. It is also a link between symmetric and geometric form.

The divine proportion is hence a tool for investigation of space. Questions of shape, size, position of figures and properties.
INSPIRATION - related work

This abstract way of building with a system has been used by many architects before. Peter Eisenman House X Project is a good example of letting the system provide a pallet of signs with its one grammar that can allow an objective composition of form in space. Eisenman complements this idea also by using the cubic square. The compositions in these houses are for me a representation of time standing still in space; it is an illustration on an objective described moment in time. Not a continuity of movement in space and not about the brake of continuity and change in the geometric transformation. This may explain what Eisenman says- the "real architecture" only exists in the drawings. The "real building" exists outside the drawings. The difference here is that "architecture" and "building" are not the same.
This is a description of the development of my system. You will read a fictive fragmented story of my process. This is a story of how the lizard becomes a system with architectural qualities.

I have interpreted the mathematical views of the golden ratio, in an abstract way and applying it in my system. This is a way for me to introduce my thoughts of change in continuity through space and time. A system created by me which will help me evaluate the qualities in my design of that space.

PROCESS
- choosing an act
- creating a system

USE OF THE SYSTEM
- creating value
- giving a function

CREATING A BRIDGE
- growing into the landscape

CREATING THIS SPACE
- transformation
- what could it become
- engaging with the environment
PROCESS - choosing an act

Repetition

The word repetition is in my mind making me tingly, excited and ill. I have resisted but been forced to repeat.

Repetitions is my life but at the same what i’m training to get away from

Repetition kills my creative and give life into my unconscious mind

I own the narratives of my reality copying and creating a new reality linking the past and the future the action of the repeating

I’m mirroring life in a geometric order.
PROCESS - creating a system

Rectangle

My blood is leaking
the continuity has been broken
and i have made my choice.

The contraction creates a shape with a direction
The angled cross is the point from where i will expand.

The divine proportion is the beat of my growth
creating the shape within the shape.

The frame is my body now
my boundaries and structure.

It is restricting me having no alternative then to follow and obey the given directions.
PROCESS - creating a system

Separating the spiral

The proportional order creates progression. a body within a body, a scal reppetation.

My body parts ar skatterd, the spiral is broken. i'm now separated from my the past.
PROCESS - creating a system

Score lines

The score lines enables my bodies freedom
I could easily break into four parts
every part connected with a number
telling me its use.
PROCESS - creating a system

Plan, section, volume

I turn my plan in to a section providing me with the third dimension

My body now talks in terms of thickness, length and volume

I see myself in three dimensions.

Repeating levels through perspektiv crates structural hierarchy.
PROCESS - creating a system

Mirroring

This is my way of generating variation
I seek personality

my body is interacting, mirroring itself

The reflektions create different body compositions
some have more space within, others are narrow
some have space within space
others are isolated from each other.
PROCESS - creating a system

Direction

All my body compositions have different directions
I combined the directions to lead motion through
time and space

moving through a small space
into a wider

taking a turn from the inside
to the outside

looking over one part
seeing into the next

telling a story of how they are related
where they all come from.
PROCESS - creating a system

Exploding

Exploding into body parts
making openings
dividing the path
allowing me to enter
and to experience the space.
PROCESS - creating a system

Construction

The thickest body part is supporting the smaller

The thinnest almost lining on the bigger, giving the notion of lightness.

The tallest obscuring the view and lowest providing sight.
THE QUALITIES THIS SYSTEM PROVIDES

Rectangle
The rectangle is an enclosed shape providing boundaries and structure, it also have direction, providing movement through space.

Repeating
The repeating in this system provides continuity in movement in space.

Change of scale
The change of scale gives a sense of relation to the human body and gives functions to the space.

Volume and the dimensions
The volume and the dimensions enhances the spatial qualities and reinforces the experience of the space being more diverse.

this system is about the aesthetics of proportion, composition and rhythm.
USE OF THE SYSTEM - creating value

The Khaju Bridge

This bridge has a body within its body. Different levels where you can rest. Openings where you can look out and enclosed rooms for private meetings. One can move over, under and inside this bridge. It has changing scale and a clear direction.
USE OF THE SYSTEM - giving a function

This space is a wetland
A flat area in an open landscape
There is two slopes rising on each side
One slowly one fast.
Bloks of houses and old industries rears up on land closing in on the wetland.
The rails are dividing this city in tow parts.
On the wetland wood is growing from beneath rising through the water and connecting the water to land.

The sight Is Frösjö strand in GNESTA.
Gnesta is a municipality in the heart of the Sörmland cultural district with over 10 500 inhabitants. With commuter train from Stockholm in one hour.

The area Frösjö strand is collaboration between Gnesta Kommun, Gnestahem and Peab all responsible for different parts of the area.
Gnestahem and Peab will build 140 homes in the area. Gnesta Kommun plan to create a park and a bath area withe a beach, boat dock, playground, barbecue area, Cafe, out door gym, dressing room, shower and toilet. A bridge is needed and planned to be built to connect the two footpaths over the wetland withe high and low water.
At the top: picture taken from Gnesta Kommun. http://www.gnesta.se/byggabomiljo/planeradebyggnationerinnomkommunen/markanvisningstavlingfrosjostrand.4.69c6fa0b14ae160590a2cf7.html
Bottom: picture taken from this point, overlooking the lake.
CREATING A BRIDGE - growing into the landscape

The length between the two footpaths becomes the exact dimensions of the systems body.

The body is mirroring this space.
CREATING A BRIDGE - growing into the landscape

The base struktur

Linking the body parts together
by connecting the curves on the spiral
the body parts creates a pattern.
continuity within continuity a tunnel of time.
The pattern is the base and the structure of the bridge.
CREATING A BRIDGE - growing into the landscape

The base structure

To place the base of the bridge on this land I follow the lines of the system body, Dividing the plan into sections and proportions. The composition is a rhythm, describing the bridge's personality.
CREATING A BRIDGE - growing into the landscape

The base structure

I'm using the curve on the body parts to make a mark on the land.
The curve being a fragment of the eternal spiral turns the bridge towards land.
CREATING A BRIDGE - growing into the landscape

The body structure

Connecting the body parts so they create the growth of the branches on a tree forms a pattern. This pattern helps the mind to understand the connection between the body parts on this bridge. It provides the detail in this space and illustrates the link between the whole construction of the bridge and the small parts.
CREATING A BRIDGE - growing into the landscape

The body structure

There is one color for each body part, the color tone will change in shade by the change of the scale creating depth connecting the same parts through color, rising or decreasing in size.
CREATING A BRIDGE - growing into the landscape

The body structure

The rhythm creates a grid. This grid gives me boundaries and controls the outgrowth of the body parts on the bridge.
CREATING A BRIDGE - growing into the landscape

Composing movement

The body parts are growing on this grid. The grid helps me to visualize the pattern of the movement through the bridge. It gives the composition of the body parts rhythm and diraction.
CREATING A BRIDGE - growing into the landscape

Composing movement

Allowing the body parts to move freely within the grid. Connecting the body parts horizontally and vertically into different spatial units.
CREATING A BRIDGE - growing into the landscape

Composing movement

With the help of the rhythm, I’m placing the units on the bridge base. This creates a sequence, providing different scenes through movement on the bridge.
CREATING A BRIDGE - growing into the landscape

The sequence creates different scenes

Units pact together into a small and narrow passage

Opening up letting the air in

Units rising slowly with space in between

An extended pause with wide opening allowing sight

Units tightening up with height

Air

Clustering units ending the passage

The silhouette of the bridge is taking shape.
CREATING A BRIDGE - growing into the landscape

Tipping down the silhouette
the sequence on the plan
creates a sound wave.
The bridge is singing.
CREATING THIS SPACE – transformation

Walking toward the bridge, the walls with bright colours appear through the branches and the leaves, a body has to squeeze and turn to get through the entrees. The collars of the walls reflecting on the body. Only one body at a time can move through this entree. Seeing throng the gaps, informing the brain of the direction to the other side.

Feel the damp of the water on the walls, smell and hear the sound of the water. Well through the small entrees, the glittering water makes the ayes peek. In the open, the body opens up, feels the breeze and fills out.
CREATING THIS SPACE - transformation

The fragrant of the newly planted herbs awakens the curiosity, the rectangular vessel carry soil and tools. Passing the gardeners and going in to the gateway, black and high walls making the body feel the urge to hurry throng. The sounds mute for a minute living the mind quiet.
CREATING THIS SPACE - transformation

The splashing children welcome the hart to enjoy the sound of their laughter. Searching for sticks and stones, in the water, their back reflects the sunlight, under the watching eye of their mother sitting on a bench. Their white clean towels waiting for them in the wall locker getting warm in the sun, the small room where they have changed their clothes.
CREATING THIS SPACE - Transformation

The wind brings the smell off fresh coffee, making the eye look for the sores. People finding a place to rest on the bridge. The graffiti on the walls disturbs the self indulgent, breaking the rule.

A solid rectangles through a frame rectangle, rectangles withe colour, patterns off rectangles, it's a language the body doesn't speck but understand though the colour ton.

This bridge is making the body avers of its steps, the lower levels brings the feet's closer to water. Walking out on the floating deck, towards the deep water, passing through a frame, the entrance to the moving parts of the bridge.

Every step on the dock makes small waves splashing in under the bridge making a clucking sound. The body feeling it's weight on the dock, it's balancing.

Seeing over to the other side, the high slop withe the small houses, behind the rails, remembering...the time! The train is coming!
CREATING THIS SPACE - transformation

Zigzag through the frame, back on the bridge, truing a curve, seeing the way out.
A child is crawling through the small opening, wishing the same, hurry the train is coming!
CREATING THIS SPACE - what could it become

An outdoor bathhouse, small and shallow swimming ponds for children.

Protected rooms to change clothes and rest. Deeper water for swimming.

A café with outdoor bar decorated with a pattern created by the system and a few resting places for thoughts.

A floating garden, vessels for planting vegetables.

A meeting place, a playing ground or just a bridge to pass through every day on the way to work.
CREATING THIS SPACE - engaging with the environment

With the low tide some parts of the bridge will follow out with the water and separate the bridge, making some parts not accessible. When the high tide comes some parts of the bridge will be flooded and the parts that was separated will come together.

This geometric system has the capacity of transformation. Like the growth of the lizards tail, who from its birth has certain characteristics and a sufficient autonomy, a basic structure that can integrate or resist the changes in life. This doesn't signify a loss of identity.
RESULT

This bridge I have created is the places where I have been, the courtyards where I have chase lizards, the small and narrow passages I climbed into, the odd spaces I have experienced, the gaps that I could not reach, shelters I rest under and inner corners that comfort me. My earliest emotional feelings of architecture. This bridge is my playing ground.

Every part is about experiencing the architectural space. The sequences crates the scenes in these rooms, getting new perspective, change of direction. This system, it self is the bridge from which I approach architecture with and it could be used for other architectural interpretation.

For example how would it feel to go through an avenue where the trees where planted in the sequence of this system, the rhythm 11235 53211 ... and so on. What other spaces could this system alter and how would the changes be experienced.

This system has helped me to simplify the abstraction of this bridge I have created. It has detaches me from the normative way of building architecture. Spatial architecture that are non normative is interesting to me, this are the architectural spaces that I want to discover.
REFLECTIONS

In this project I have been investigating and testing a set of rules against a particular sight and program. I had an inspiration and found a sight and applied my rules to the sight. I have created a system that can be sight and program specific, when I apply this system to this sight I get a composition and a certain asterisk, a set of rules that is about the aesthetics of proportion, composition and rhythm, the foundation of or field.

My system has provided me with tools that make the aesthetic decision meaningful by using a system. I have also made my system free for interpretations through breaking up the logarithmic spiral, which allows translating the system into a given place. It is a recursive and iterative approach to the dynamic modelling of an architectural space. This system is similar to a recipe that one would follow, performing the steps according to the instructions given. While without a certain scale or dimension it can be applied to any given situation, responding to any dimensions.

This system provides a way of approaching the complexity of designing an architectural space. It is a guide which helps through its system to evaluate, pay attention, and contribute to spatial qualities. It also articulates my subjective description of how I perceive movement through space and time.

Moving through time and space is for me an information seeking process, where any interruption in speed creates new paths of experience and associations that are both separate and coherent. Like little drops of water that role separate on a surface collide and make a bigger drop, the drops becoming a sea that flows in to a ocean and then evaporates into the air, making clouds that rain. In all stages the water is separated but is still a part of the same, living parallel life in different cycles of time. Repeating this process makes life.

In such an organic vision of reality, repetition is now reproduction, two words which in fact mean the same, a force that puts something in movement and information is perceived as it crosses through the temporal clocks, this creates new paths of experience and associations that are both separate and coherent. As if the mind were the lizard and the rupture in the tail is the constant update of the continuity of one’s perception of the room. Each rupture entails a new separation of the past and creates new lines of associations. Without this ruptures the constant flow of information would be meaningless, not making new paths of associations that make new patterns of information.
REFLECTIONS

I have applied my idea of breaking the continuity in space and time by using a system of proportions in the design of a bridge that becomes a meeting place, a place that can be adapted by its users and respond to the change in seasons.

What I have learned by creating and using this system is that it is possible to work with the broken up parts of a whole and create a construction that articulates integrity and still is adoptable and changing without losing its personality. By limiting me this system has taught me to make decisions that strengthen the bridge expressions and use.

I have been testing this system in different approach on how to use it. In some parts of the bridge I have been using the body parts separately arranged on a grid provided by the system and on other parts of the bridge I have created a rhythm keeping the parts together.

The qualities I found are that, this way of working with a system is a giving and taking process. Much like working with a client with its own limitations and desires. It allows me as an architect to control the outcome within the boundaries of the system. The potential in using this system to create an architectural space is that it makes me work with the detail and the whole simultaneously, I could illustrate the larger construction of the base on the bridge as well as the detail like colour and patterns. The limitations are that it takes time to test this system and understand how you would like to use it. But the potential of what you can achieve with this system is in my opinion endless, that's because of its capacity to adapt to different tasks. Like the tail on the lizard it adopts its body to the function it is required of it and grows out with its own expression.
Thanks

Ulrika Karlsson  Professor, Inredningsarkitektur & Möbeldesign
Anna Odlinge  Lektor, Inredningsarkitektur & Möbeldesign
Rochus Hinkel  Lektor, Inredningsarkitektur & Möbeldesign
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and

grateful thanks to my friends and family for all your support