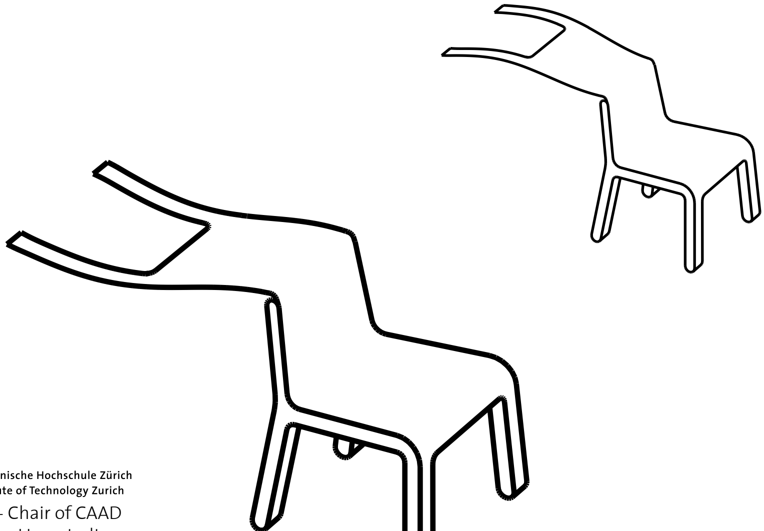
SkinChair

If Ebnöther NDS CAAD 2004 indiviual thesis



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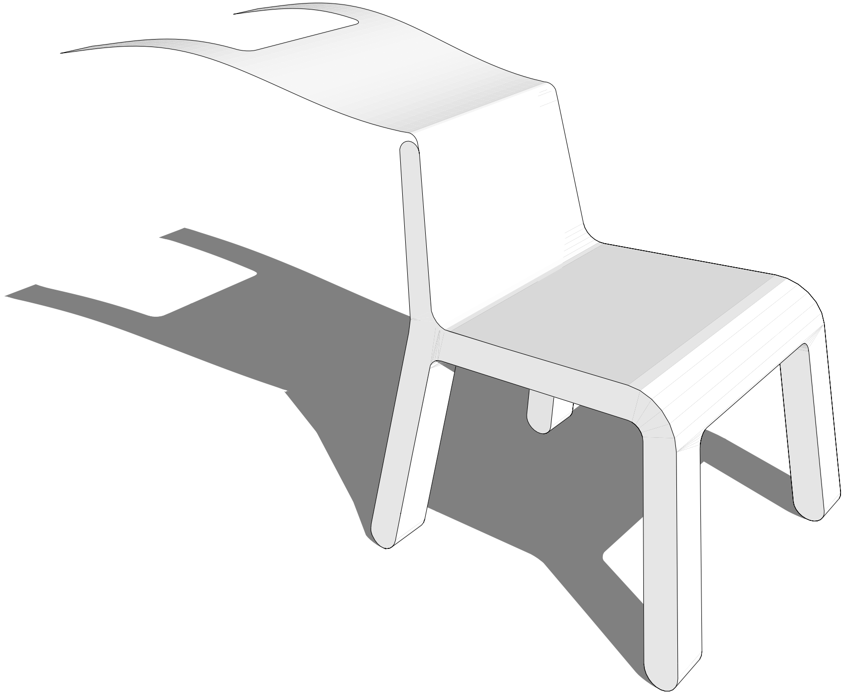


Content

Fig. 02a,b: “expo.ch-chair”

Fig. 01: Stacking Chair “Fred”,
Design Hannes Wettstein / zed. ,
2001, trunz.collection

1. Introduction

1.1. Setting

This thesis documents the work for the indidual thesis at the NDS CAAD ETH. It was produced alongside the work on the group diploma 2004 project, the “Untitled” pavillon.

The SkinChair project is an exploration of some of the possibilities CNC technologies offer for designers (and makers). At the center of attention was fast (rapid) prototyping to quickly develop the design on a 1:1 scale.

The project makes use of specific tools available at ETH Hönggerberg: Flash for a web-based frontend, SolidWorks for automated parts generation, Surfcam to produce G-Code and the Precix 3-axis mill to produce a 1:1 scale prototype.

In many ways the SkinChair project is a continuation of the work done for my BA diploma 1998, the conceptual “expo.ch chair” (Fig.02). Imagine a stand at the Expo 2001 where visitors can have a chair made to their size. The parts of that chair are manufactured within minutes on the stand. The visitor assembles the personalised chair which bears his or her name. All the chairs are left on a piece of grass outside the stand to build up a living memory of the people who have visited the Expo.

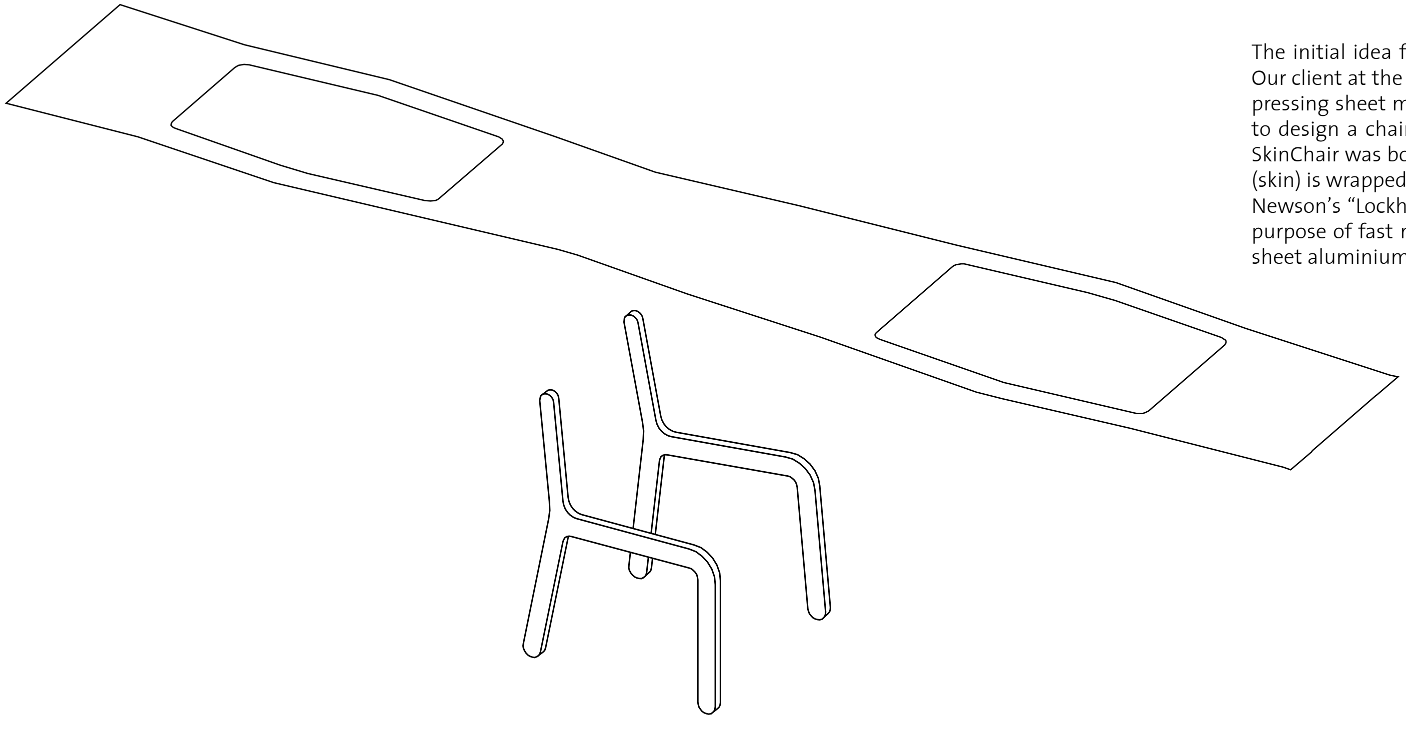


Fig. 03 Two ribs and a skin...

1.2. Idea

The initial idea for the SkinChair project was born while working on a real-life chair project. Our client at the time experienced how difficult (and expensive) it can be to make a mould for pressing sheet metal into the form of a seat shell (Fig. 1, p. 4). Surely, it would be a good thing to design a chair which does not need tooling that is so expensive. And so the idea for the SkinChair was born. Two ribs on either side of the chair define the basic shape, a thin material (skin) is wrapped around them - here goes the chair (Fig.03, 04). The first idea, inspired by Mark Newson's "Lockheed" Lounge Chair concerning materialisation, was sheet aluminium. For the purpose of fast modelmaking with available processes, this was soon changed (until recently sheet aluminium could not be cut on ETH's laser).

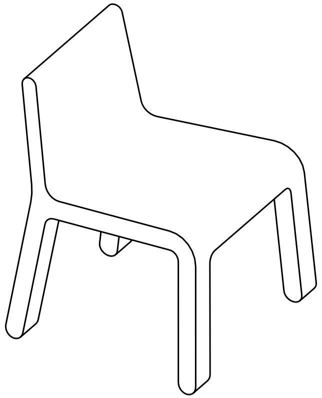


Fig. 04 ...make a chair.

1.3. A Look around

Fig. 05: "Lockheed" Lounge Chair
> A skin very sculputral "skin" chair

Fig. 06: "La Legerra" Chair, Aeroply filled with PU-foam
> It is more stable filled with foam, but recyclingwise...

Fig. 07: "Ply" Chair, Jasper Morrison
> minimal as can be:
a space between the seat and the structural rib allows for flexing

Fig. 05

Fig. 06

Fig. 07

Fig. 08: "Topos"-Chair, Mark Naden
> A beautifully smooth shape assembled from indiviual ribs (5-axis milling)

Fig. 09: "Puzzle"-Chair, David Kawecki, 1999
> Completely flat-pack chair featuring interesting detail for locking parts together.

Fig. 08

Fig. 09

Fig. 09

Fig. 09: "UntoThisLast", Website
> "UntoThisLast" is a shop in London which sells products directly from the mill. Olivier (the owner) of course has his own focus when working with CNC machines. He is interested in building up a database of proven designs, which can be manufactured fast without any postprocessing. His business is now running in the 4th year, it has provided a livelihood for four people for the last two years.

Fig. 10a-c: "mTable", Gramazio-Kohler Architekten
> Experimental project showing a new way of consuming furniture: Basic parameters of the table and position, size and shape of the protruding holes can be defined with a mobile phone. The configuration is saved (it can be checked on a website) and then manufactured and delivered. One of the problems encountered was that people do not spend several thousand CHF on an object they have never seen (or touched). Only one table so far has been sold directly - all other clients went to the shop (Zingg-Lamprecht, Zürich) first.

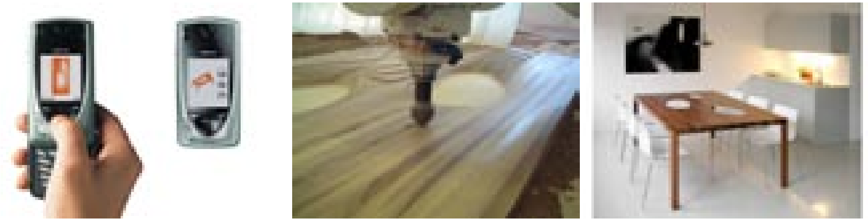


Fig. 10a-c

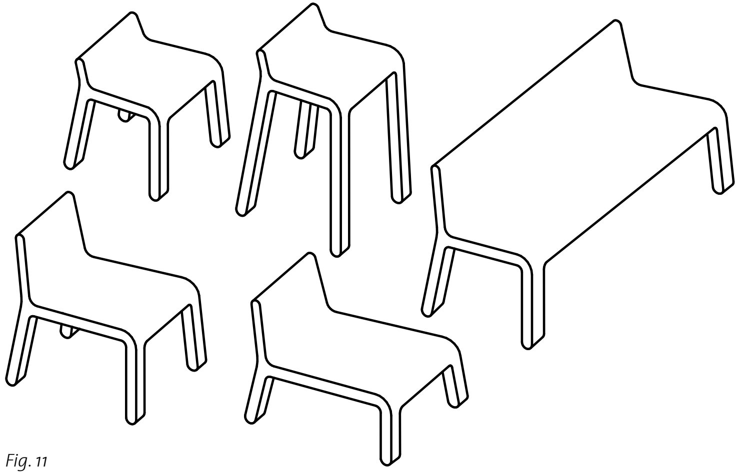


Fig. 11

2. The User Interface

2.1. First Prototype

The first prototype of an interface (Fig.12) was realised as part of the NDS Flash module. The different types of SkinChair (Fig.11) can be chosen with a drop-down menu, an animation shows the transformation from one type into another. The “?”-menu presents the underlying construction idea (two ribs + one skin = a skin chair). While this interface nicely shows some of the possibilities, it does not allow people to change a design, let alone save any changes made.

Fig. 12

2.2. Second Prototype

The second prototype is truly interactive.
It allows users to influence the shape of their chair in various ways:

Fig. 15: “free mode”: the control points can be dragged freely
Fig. 13, 16: “ergonomic control mode”: a certain geometrical relationship within the chair is maintained to assure some comfort (ergonomics)
Fig. 17: “maximum length mode”: the length of the unfolded skin can be defined, this is pracitcal when working with limited machining / material sizes
Fig. 18: automated construction: the number of stabilising ribs changes according to the seating depth (of course this can be done for the backrest also)
Fig. 14: “living mode”: all the points are continually shifted slightly, leading to unforeseen designs

Fig. 13

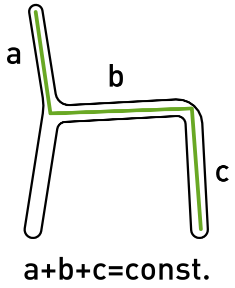


Fig. 14

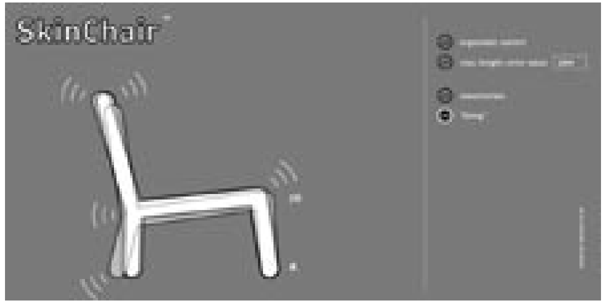


Fig. 15

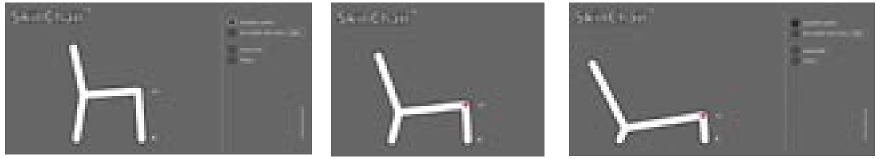


Fig. 16

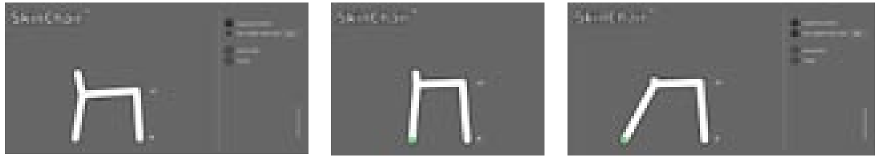


Fig. 17

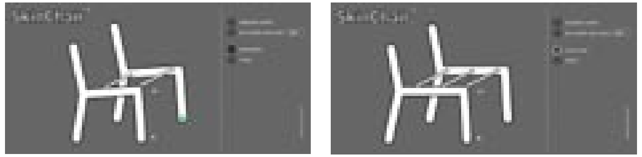


Fig. 18

2.3. Data Export

Once a good design has been defined, the relevant parameters which describe its appearance and construction are saved. There are various approaches to how this can be done technically, the idea here (Fig. 19) is that the values are written into a text file which in turn is being emailed to the manufacturer. A different concept is to write the data into a web-based database, something we tested on the NDS (Fig. 20). In this project, the export/import issue has not been prototyped, but its feasibility was acertained.

Fig. 19: data flow

Flash - Frontend | *A web-based interface (built with Flash MX) allows users to change the shape of their chair. Various functions support the finding of new forms. Information about the way the chair is constructed (depending on the size of the chair, more structural ribs are required) is generated.* ***Export*** | *All the relevant parameters are exported to a text file which can be emailed to the manufacturer.* ***SolidWorks - Automated parts generation*** | *The parameters are imported to SolidWorks, a mechanical engineering package, which automatically calculates the shape of all the parts needed to build a chair.* ***Export*** | *The finished parts geometries are exported for further processing.*

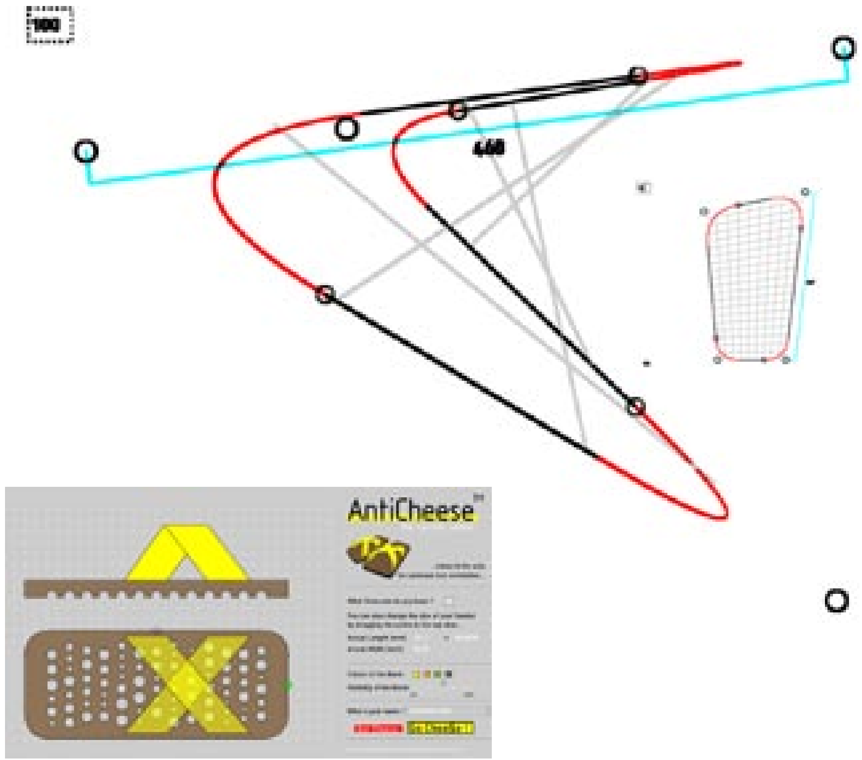
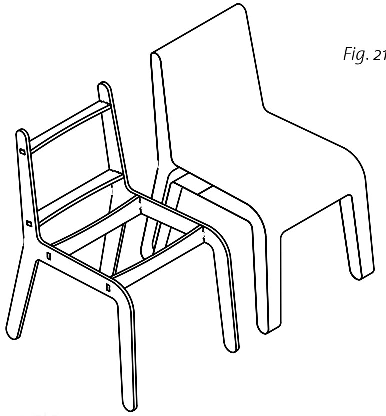
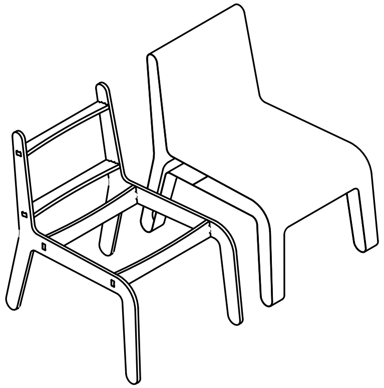


Fig. 20 AntiCheese sandal configurator with advanced geometry interface

Fig. 21a-b: relational assembly: all parts change together





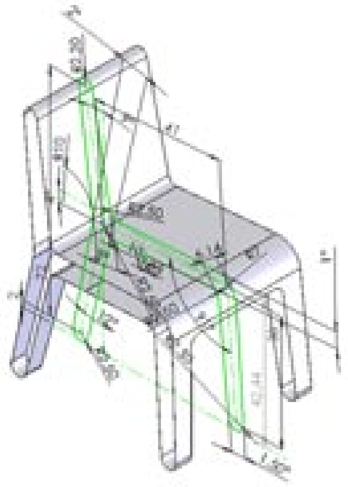


Fig. 22: fully parametric SolidWorks model

3. The SolidWorks Model

For the actual design development aswell as for producing the "real" geometry of the chair and its parts SolidWorks, a mechanical engineering CAD package, was chosen. SolidWorks (SW) offers many great features. Firstly, it is a fully parametric modeller (Fig.22) which allows changes to measurments at any time and comes with a comfortable sheet-metal function to unfold (Fig. 24) the skin of the chair (there is a similar feature in FormZ which is not quite as good).

Secondly, SW supports all sorts of relationships between measurments, parts and groups of parts (assmblies) (Fig.21). The following equation can be defined directly in SW:

D4@skin=0.8*D1@siderip

It simply means that the measurment "D4" of the part "skin" is always 80% of "D1@siderip". Like this the "ergonomic control function" from the user interface could easily be tested.

Thirdly, the dimesions can be assigned a variable name. The value of that variable can be loaded from an external (Excle-) file, thus a digitally integrated workflow is possible (Fig. 23).

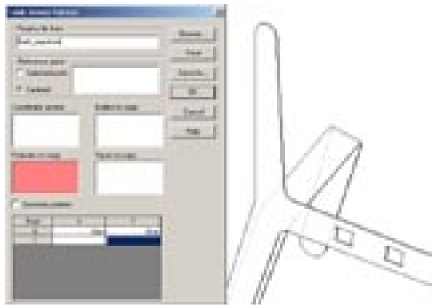


Fig. 23: table driven pattern: a spreadsheet defines number and coordinates of a hole in a component

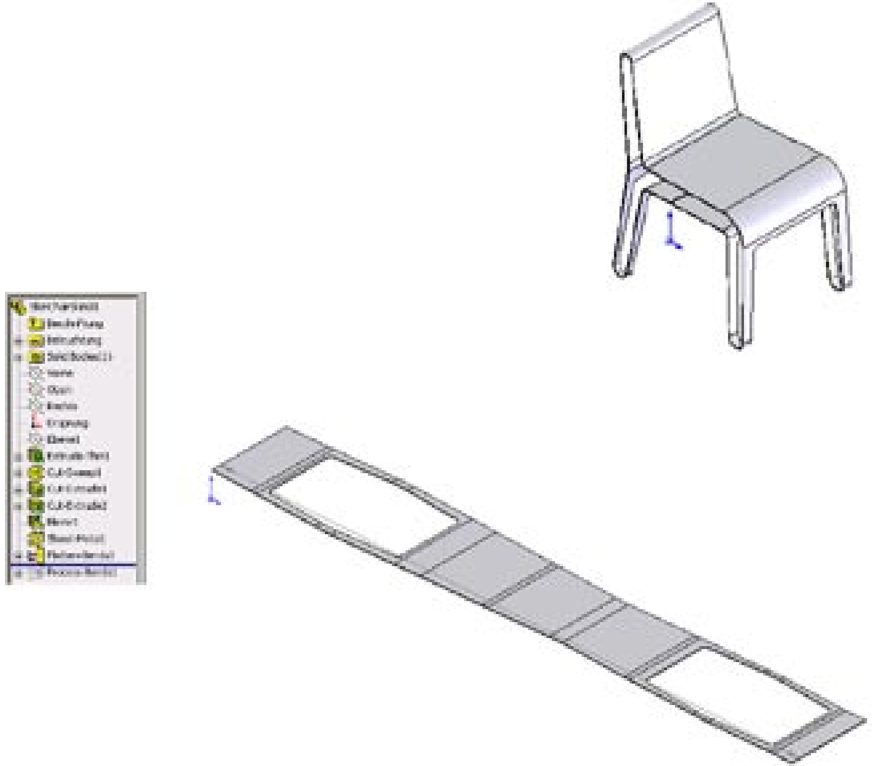


Fig. 23: folded and unfolded skin with the SW feature tree

Some of the advanced (?) features of SW are great fun to work with, especially the combination of "in-the-assembly-logic" with external data. For example, the number of stiffening ribs is calculated in the User Interface. The number of holes needed to anchor the ribs in the construction is defined in SW and taken directly from the number of ribs.
It is important to understand that even a fairly simple model with just a few defined relationships can produce unexpected results when measurments are changed. So working with equations only really makes sense for a.) really simple prototyping or b.) final models where everything is defined.

Most importantly: SW needs a fast computer to run on. A change in the chair model would take up to 20sec. to process (SW running on Turbinenbräu, Fig.39, p.32).

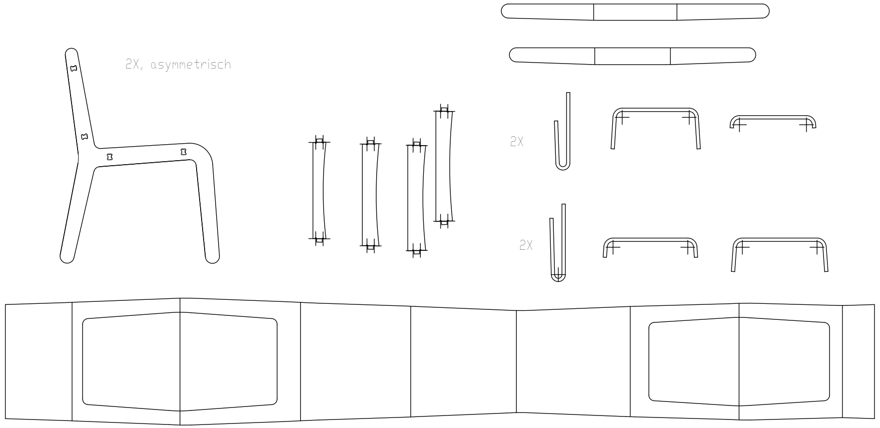


Fig. 24: cutting plan for the 1:1 model (p. 25). the plan is linked to the 3D model.
if any measurments change in the 3D model, they are automatically changed on the plan !

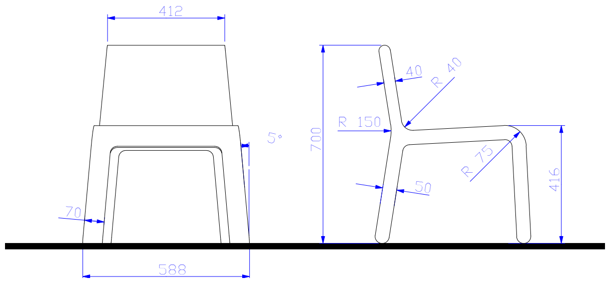


Fig. 25: basic plan

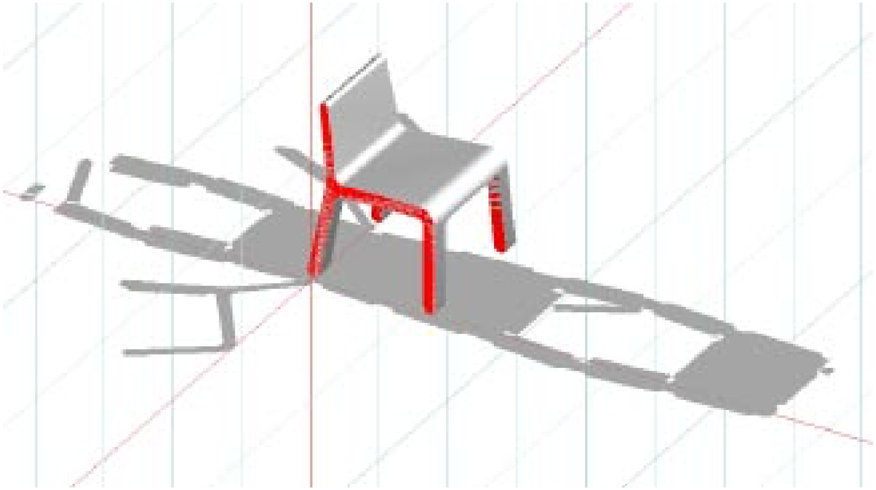


Fig. 26: unfolding (FormZ) for the aluminium model

4. Modelmaking

4.1. Design Development

CAD / CAM and CNC techniques were used at various stages and scales to produce prototypes and to develop the final design of the SkinChair.

Fig. 27: 1:10 scale model in sheet aluminium

Fig. 28: 1:1 scale model, paper

Fig. 28: 1:1 scale model, mdf and plywood: the plywood has flutes milled into it to allow for the tight bending

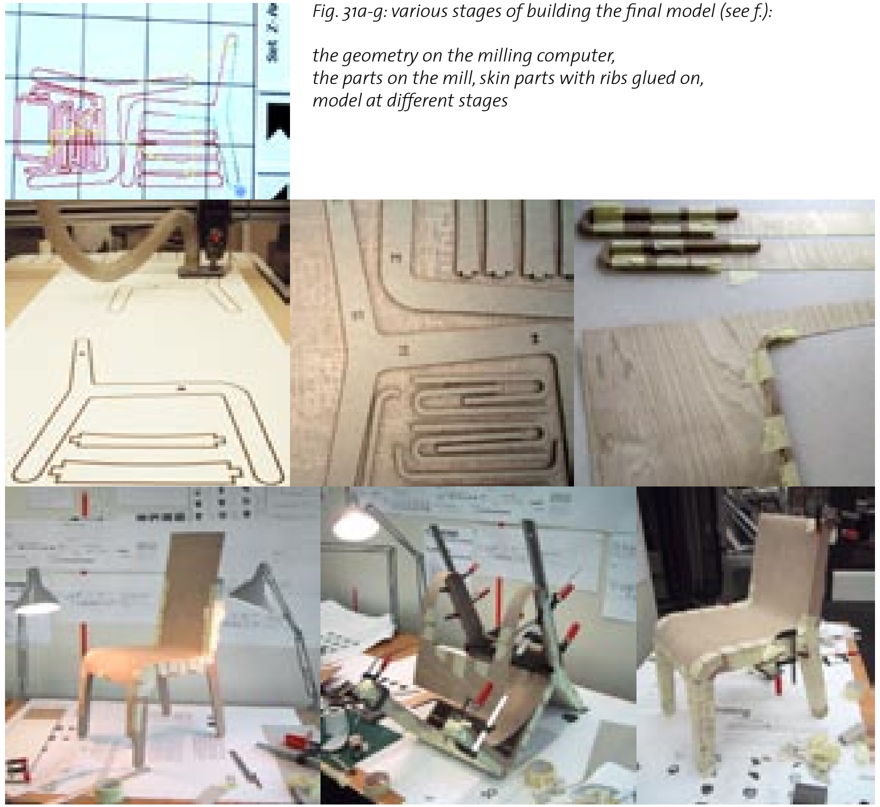


Fig. 31a-g: various stages of building the final model (see f.):

the geometry on the milling computer,
the parts on the mill, skin parts with ribs glued on,
model at different stages

4.2. Final Model

The final 1:1 scale model was realised using MDF for the side and connecting ribs and 0.6mm Aeroply for the skin. The resulting design prototype transports the aesthetic quality and the purity of the intial concept very nicely. It is, however, not to be used as a chair, the skin is too vulnerable against piercing by sharp objects (see Fig. 06, p. 8). The use of CNC equipment helped a great deal in the manufacturing of this object.

Fig. 32a-d: various views of the 1:1 scale final model

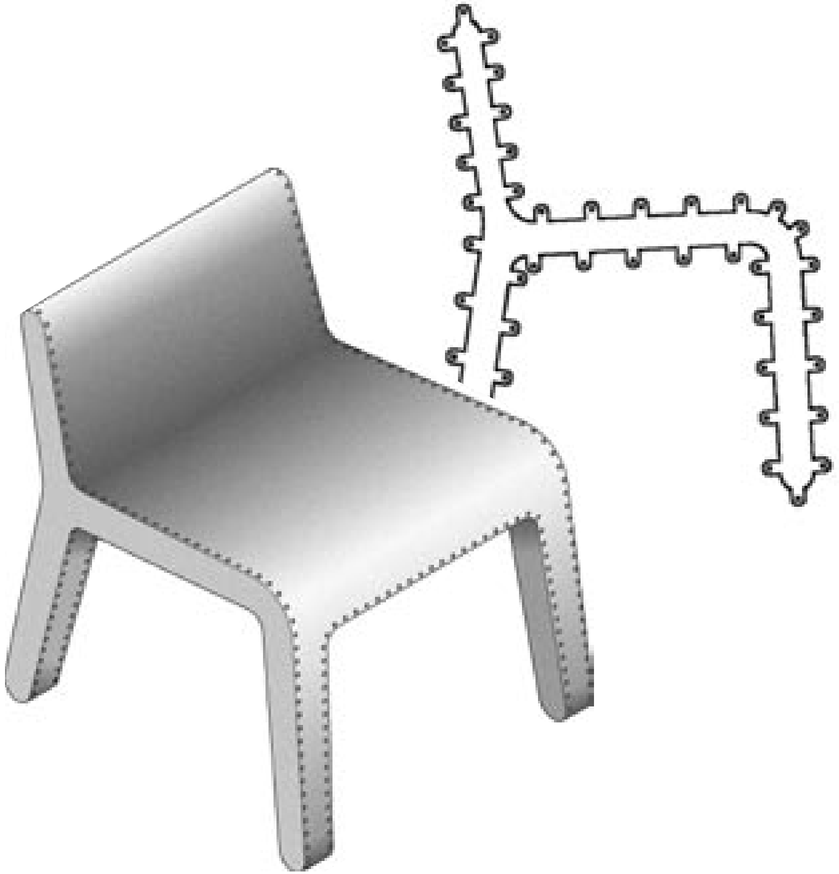


Fig. 33: SkinChair made from sheet metal

5. Beyond

5.1. Towards a CNC product

So far, CNC techiques have only been used for model making in this project. But it would be fantastic if the actual finished product could be manufactured directly. Here some ideas as to how such a design could work.

Fig. 34: SkinChair made from Polypropylene, various connecting details

5.2. More CNC !

The author's interest goes beyond using CNC techniques as a means of versatile manufacturing, but also as a source of inspiration for finding form. On the one hand there are of course machine and material specific aspects to be considered. But the capability of the machines to produce unique objects or variations of a type at a reasonable price makes you think what these variations could look like. Nowadays, the designs come from product configurators. Surely it would be much more exciting if there were an element of surprise in the design process, if maybe every form only existed once. All of this is already happening - behind the scenes, people are working on ground-breaking methods for developing forms.

Are the chairs of the future simply grown ?

Fig. 35 Computer Assisted Urban Design (CAUD), Markus Braach: the shape of the skyscraper is grown so that it does not shadow any of the neighbours for more than two hours.

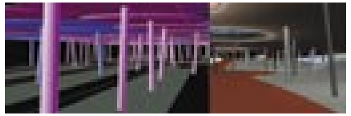


Fig. 36 The Groningen Twister, Fabian Scheurer: the positioning and dimensioning of the columns happens according to set criteria.

Fig. 37 Twig-Table, Salone Satellite 2004: Programming brings complexity back to aesthetics,

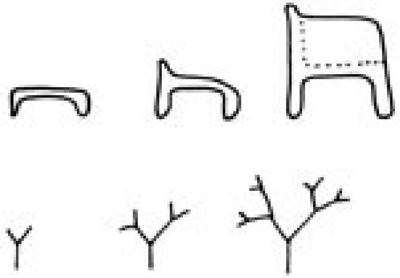


Fig. 38 ... a chair that evolves ...

6. Credits

6.1. Sources

Texts:
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- C_Moebel, 2003, Dagmar Steffen, ISBN 3-87038-355-0
- Im Stil des digitalen Handwerks, Jochen Gross, publiziert in dds 1/2001

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Internet:
- www.solidworks.com
- www.flashkit.com
- www.alias.it
- www.newcraft.de
- www.designboom.com

Downloads:
- http://wiki.arch.ethz.ch/twiki/bin/view/NDS/Nds0304IndividualTheses
> all the NDS' individual thesis
- http://edu.caad.hbt.arch.ethz.ch/nds2004/5
> my student hompage. digital playground.
- www.ebnoether.com
> some more serious stuff. soon.

Fig. 39 Turbinenbräu (Sony Vaio, x86, 261MB RAM, Win2k)

6.2. Acknowledgements

Many thanks to the following people without which this work would not have been possible:

Ludger Hovestadt and his crew for hosting the CAAD chair at ETH, in particular Odilo Schoch for getting me on the NDS course so decisively, Philipp Schaerer for keeping our course running smoothly, Russell Loveridge for showing us a trick or two on the old mill, Markus Braach and Fabian Scheurer for their nice programming, Kai Rüdenauder for some tips in VectorWorks, Karsten Droste for keeping it open source, Torsten Spindler for running things smoothly, Christoph Schindler for shared interests, Oskar Zieta for lasering with us. The students of the NDS 2003/04 for good times and tight discussions, in particular Alexander “Da Greek” Kapellos for keeping spirits up. Leonhard Fünfschilling of the IKEA Foundation Switzerland for the unexpected and much needed scholarship. Verena Egloff, Verena Ebnöther - Auf der Mauer, Giovanni Auf der Mauer and Daniel Ebnöther for their continued support over the years. Christian Dietrich for the friendly studio photography.

Many thanks to all of my friends (including 186rockers) for years of discussion - may the great spirit of CNC be with you !