

Furniture Industry Has to Reconsider all Products – Call it Customization Design

J. Gros

C-LAB / Department of Design

Hochschule fuer Gestaltung / Academy of Art and Design, Offenbach, Germany

Abstract

Introducing mass customization to the furniture industry has one definitive bottleneck: nearly all of our traditional and modern furniture was either designed for handicraft or industrial technologies. It was not, of course, designed for the Computer Numeric Controlled technologies like CNC-milling or laser cutting – which predate mass customization. So we have to develop a full range of new products and consequently replace the concept of industrial design with the concept of customization design.

The first step to customization design is the CNC-suitable form, aimed from the very beginning at a proper and cost effective use of the new CNC-technologies. This requires at least a redesign of nearly all products. Four examples of furniture design will illustrate that in detail. Then we will need a lot of research and experimental design in order to incorporate completely new possibilities like, for example, innovative joinery. At the end, customization design becomes “virtual furniture,” but only if the product is produced completely via digital technologies. Then, mass customization opens up further visions and models like decentralized manufacturing, technofactories or product publishers.

Keywords: Customization Design, CNC-suitable Form, Technofactory

1 INTRODUCTION

This paper is based on the work of C-LAB for customization design at the Academy of Art and Design in Offenbach, Germany. Furniture designs of C-LAB are produced and distributed by an association of medium-size manufacturers under the brand name Newcraft.

Given the background of the current change to our production technologies and systems – i.e., of our entire production style – the following article at first tries to clarify the concept of customization design with the example of four furniture designs in details. The core issue is the question about a design that is production-friendly in a new way.

Since all of the furniture shown here has to be entirely produced with Computer Numeric Controlled (CNC) technology, various visions and scenarios can be put form on this basis. One attempt is to transfer the term “virtual product” to the furniture industry. The future of the furniture factory and the changing design processes due to mass customization will be a special focus.

Additionally, C-LAB has been dealing with the development of digital wood joints since 1995 and is currently working on a joinery project with regard to the subject of C-furniture that is sponsored by the Federal Ministry for Education and Research (BMBF). The point of this project is mainly two goals: the further development of CNC-compatible furniture forms and the development of a comprehensive solution for the customer-specific furniture production in a processing center called technofactory.

2 CHANGE OF STYLE

Craft – industry – customization. Everything points at the fact that we’re currently experiencing a fundamental change of our production technologies and systems. This change in production style will most likely also change the style of our products. We can find proof for

this direct connection between production technology and design in the terminology alone: arts and crafts – industrial design – and now: customization design.

Customization design is first of all defined by the fact that it no longer presumes industrial mass production but instead is oriented towards the conditions and possibilities of digital production – as a necessary precondition for individualization and personalization.

Form follows production method

No matter what future is predicted for mass customization, the fact remains: the trends in industrial mass production are reversing and in many aspects again remind us of the customer-specific production that exists in handicraft. This means that in a way the peculiarity of the new production style seems to be post-industrial and neo-handicraft at the same time.

What are the conclusions with regard to design? Post-industrial industrial design would be a contradiction in itself. It is therefore no question at all that as a consequence of mass customization the design concept will change in its core. Or, with other words: where the reference point of design is no longer called industry but customization, the past principles, models and business plans of industrial design also lose their traditional foundation. They at least have to be reconsidered.

One principle of design, however, applies to all forms of design – and in times of technological change it does so on a special scale. According to this principle the form of all objects of daily life should first of all follow the appropriate production method. It should be conceived in a producible and production-compliant way from the beginning and at the same time aesthetically reflect the schools of thinking that pertain to a specific production style. After all, industrial design became one of the most important forms of expression of our industrial culture. Its theory exclusively follows the historic transition from handicraft to industry.

Production method follows form

In the practice of design the conditions often have an opposite effect. Here, it seems, a new production method experiences a breakthrough only when we also develop new products. For example, the design of Michael Thonet is considered a necessary precondition for the first industrial production of chairs and almost all classics of industrial design make new materials and technologies accessible to the industrial production process – take, for example, Marcel Breuer, Charles Eames or Verner Panton.

Now, we can have the analogous presumption that mass customization will not have its real breakthrough without new specially designed products that are production-compliant in a new way – at least not as far as furniture production is concerned.

Only in the beginning of mass customization was design not an issue. There's a simple reason for this: in the case of custom-tailored jeans, for example, the first successes were based on two-dimensional patterns that can be cut very easily with CNC technology. As soon as we enter into the area of more complicated production processes, such as for furniture, we recognize immediately that the new production method also presumes new products and fundamentally new designs.

Given the fact that all furniture in the past was designed and optimized for the handicraft or industrial production these designs are either entirely unsuitable or not optimally suitable for mass customization. With respect to customer-specific production, they have to be seen in a new light, need to go through a redesign or be replaced with new designs.

3 FURNITURE CUSTOMIZATION

Design for customer-specific furniture production begins with the replacement of characteristic elements that have thus far been developed for the handicrafts or industrial production with CNC-compatible design. In this process – as the term of the joiner lets us presume – the joinery plays a key role.

Digital Woodjoints

In a basic study of C-LAB for customization design, digital wood joints have been developed and tested since 1995. One interesting experience was that we were able to reproduce the most complex joints in the history of handicrafts in a new way with a 3-axle CNC mill – figure 2.

Fifty other digital wood joints, including more every-day joints and completely new types – figure 1 –, are available on CD ROM with German and English text [1].

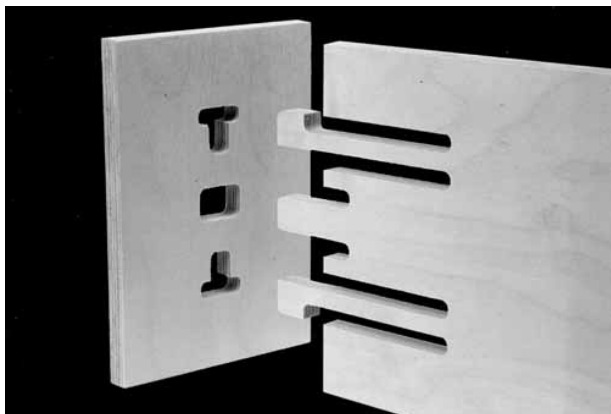


Figure 1: New type of woodjoints.

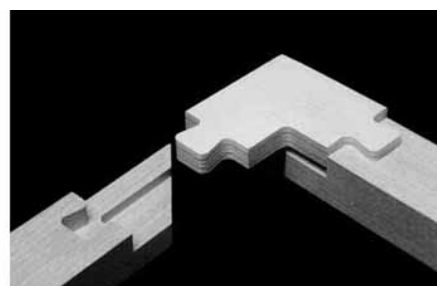
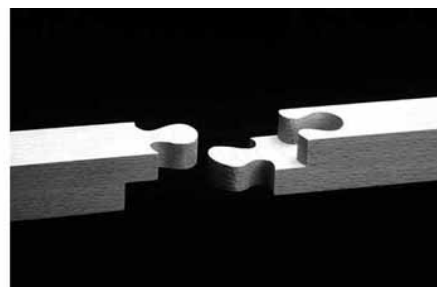
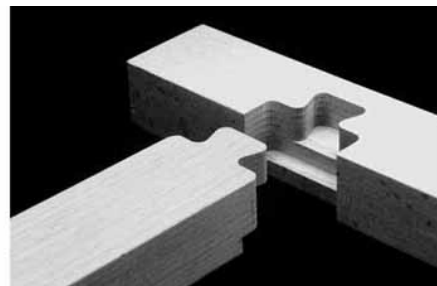
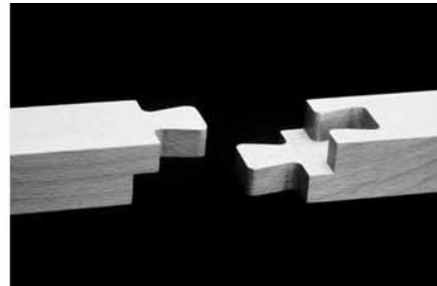
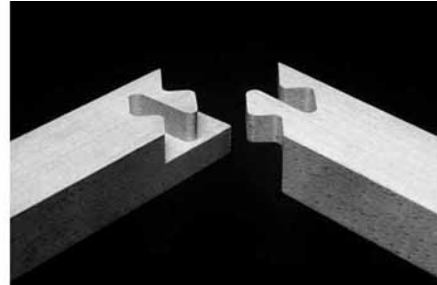
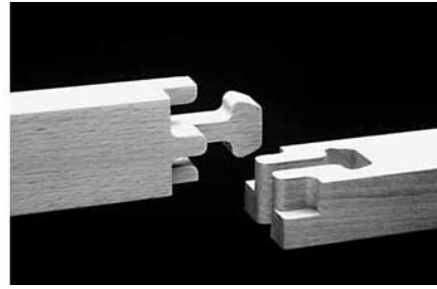


Figure 2: Digital woodjoints.

C-Stool

Next, let us look at the transition from the digital wood joints to CNC-compatible furniture design. One of the first examples is the C-stool designed in 1995 – a redesign of the traditional 3-board stool. This furniture style was already produced with dovetail joints in handicraft; slum inhabitants nailed it together with a cross-strip and in Max Bill's version it became an icon of industrial design.

In this place, the C-stool – figure 4 – illustrated the basic idea of customization design. On one hand, this case also confirms that even simple furniture cannot be produced without production-compliant modifications suitable with CNC technology such as computer-controlled milling. On the other hand, we can understand especially easily how the CNC-compatible redesign develops from a digital wood joint. The C-stool is thus first of all based on a transformation of dovetail joints into fingertip joints – figure 3.

As a consequence, we can produce the stool in a single pass from a plywood board via computer controls. In its second version it can then also be programmed and varied in the sense of mass customization via a mouseclick as a bench, base or desk – figure 5.

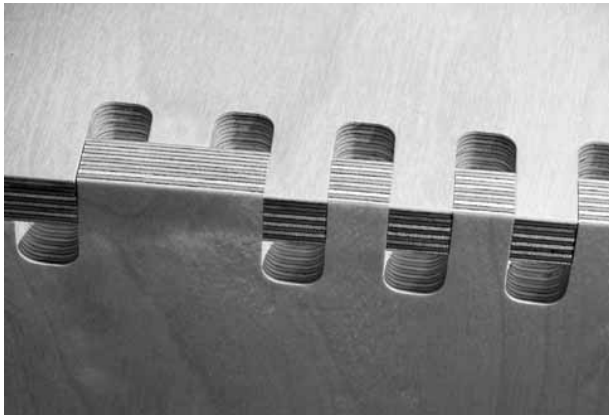


Figure 3: Fingertip joints.



Figure 4: C-stool, 1995

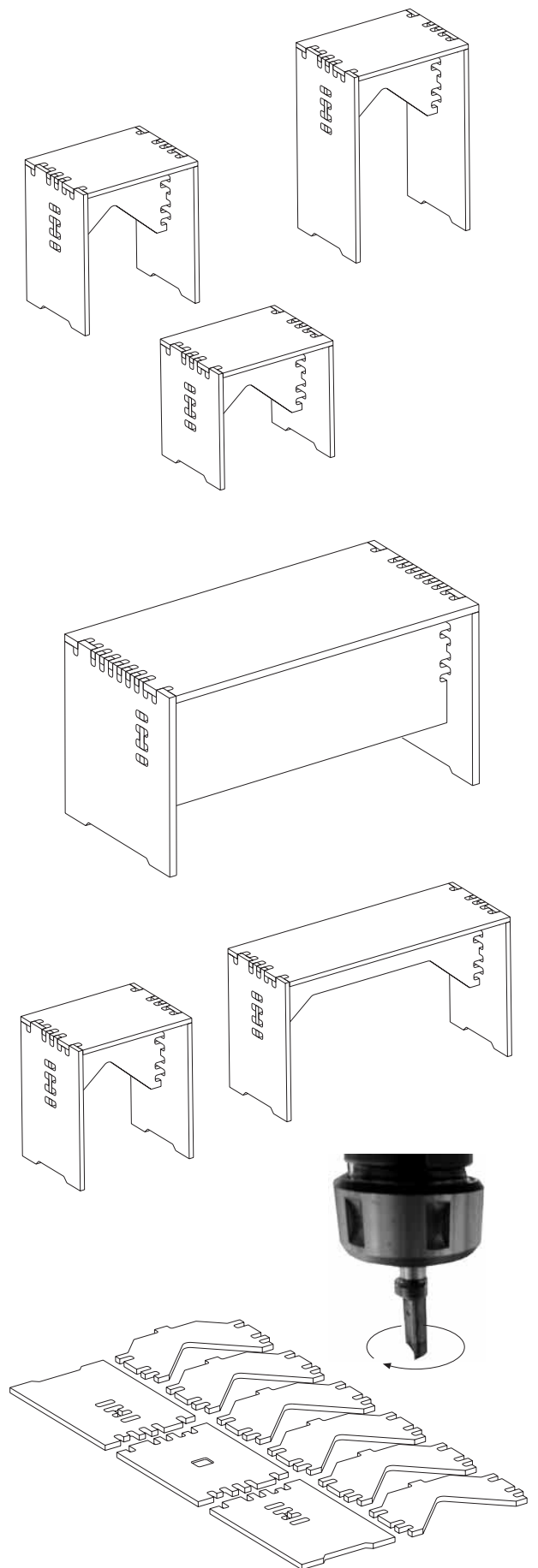


Figure 5: C2-stool, bench, desk, parts and milling tool.

Post-IKEA Design

IKEA, the furniture brand, embodies an outstanding success story of industrial design. And although the rise of this Swedish enterprise is certainly due to many factors, its design follows primarily one simple principle: IKEA develops cost-efficient self-assembled furniture.

In the context of industrial production sophisticated joints, special screws, angle irons or crossbeams are used – and delivered with more or less understandable assembly instructions. However, the IKEA design is neither intended nor suitable for mass customization.

The question, therefore, is how would comparable and CNC-compatible furniture be designed for mass customization?

Again wood joints integrated into the furniture design that we can change via software in any size and from case to case would seem appropriate.

Here the demo example is a double hook that enables especially simple and cost-efficient plug joints. Among others, a desk was designed with it that basically consists of nothing but the "intelligent cutting" of a panel material. The assembly is self-explanatory in a way that IKEA clients can only dream of.

However, such furniture will be presented in the future not only with pictures and in exhibitions but also in virtual reality, as VR objects – figures 6 and 7.

Such representations can be transferred via the Internet starting 2003 in a better quality, as well.

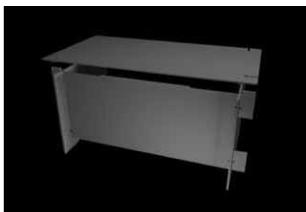
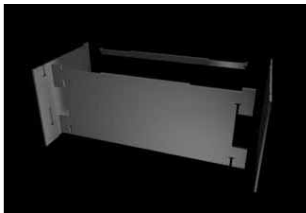
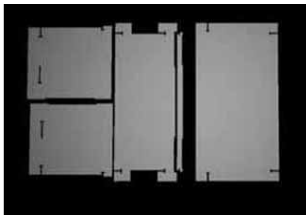


Figure 6: Post-IKEA desk, assembly.

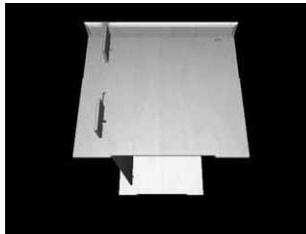
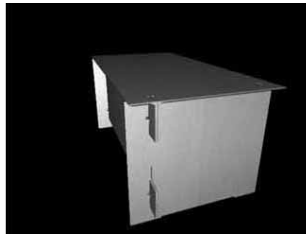
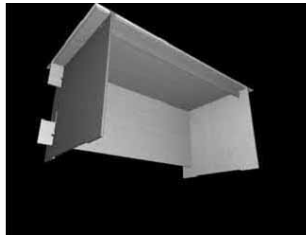
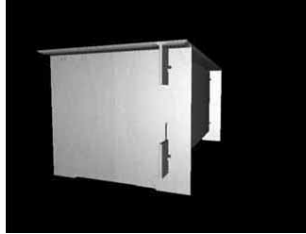


Figure 7: Post-IKEA desk, VR-Movie.

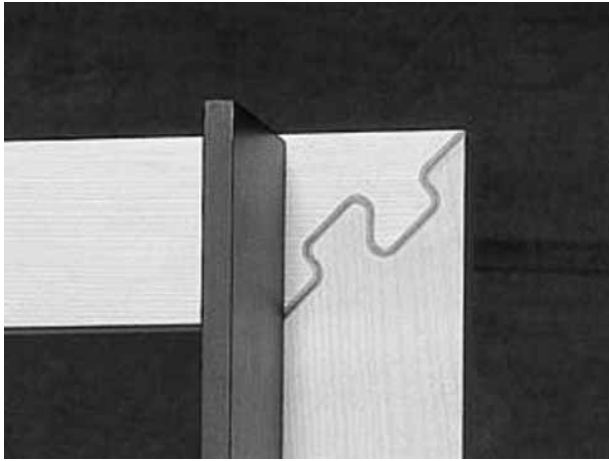


Figure 8: Frame shelf, 1998.

New Conditions and New Possibilities

The shelf in figure 8 at first also follows the conditions of CNC-compatible design: it is based on the use of digital plug joints and can be entirely produced with a CNC mill. To assemble it, the plug joints are locked by the slit side parts and the shelves spread and fix the latter.

Customization design should not only comply with the new conditions but also exhaust the new possibilities step by step: for example, in the field of cutting forms without waste and material conserving constructions.

Design light

When we assemble the shelf in figure 9 from angular forms we not only save two corner joints but the angles that interlock can now also be milled out of one of the various panel materials with minimal waste.

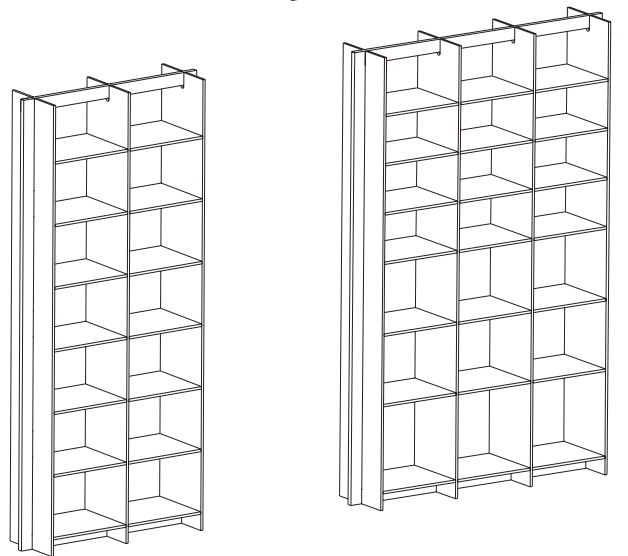
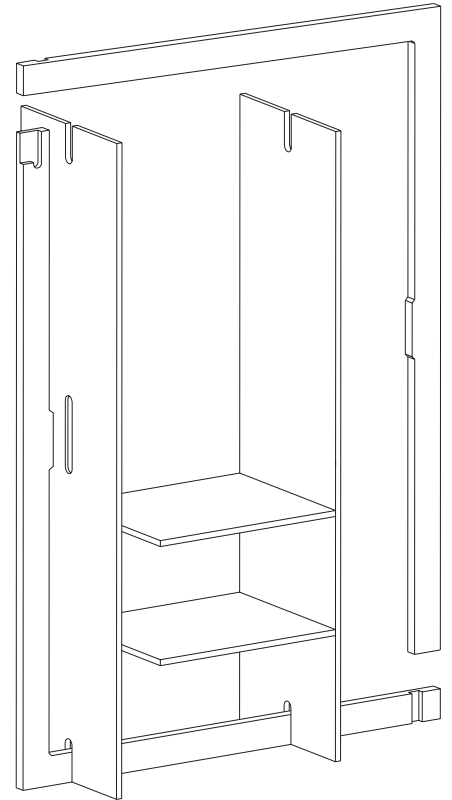


Figure 9: Frame shelf, design light.

Added is a construction where the frames interlock with the grooved side parts with a small tongue on the left and right side thus providing two elements with the structural stability of a T-beam. The result: clearly reduced material thicknesses.

This small detail is illustrative of a big opportunity of computer-controlled production, the so-called design light. Its principle consists of designing in a material-conserving way with more complex forms.

Finally, the next steps of mass customization can be easily imagined with the example of this shelf: versions are generated digitally via a product configurator, and if the shelf exceeds a certain width, for example, the configurator automatically adds a central element.

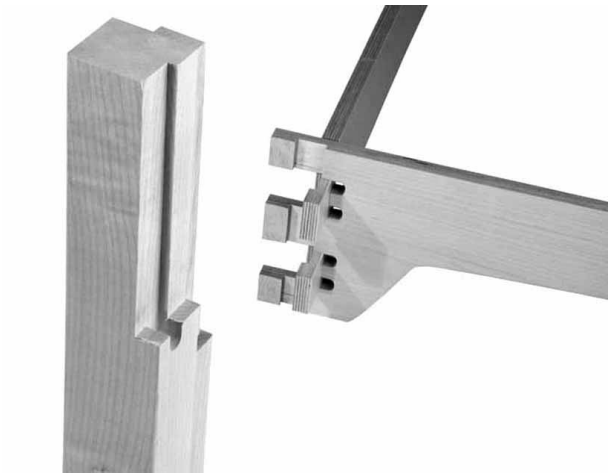
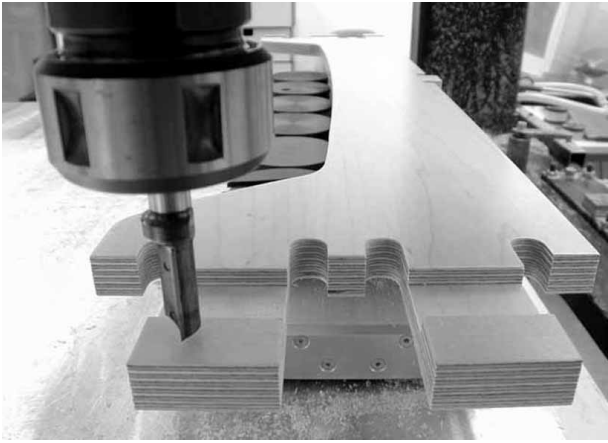


Figure 10: Table with Newcraft image.

Different Images

CNC-compatible design – for example in the case of the table in figure 10 – gains an almost neo-handicraft image with even more complex joints and fine woods, but with new high-tech characteristics.

This table only illustrates one of the many development paths on which customization design could differentiate and individualize. With CNC-compatible technologies that will be even more advanced in the future and growing experiences in CNC-compatible design, these stylistic differentiations will develop especially higher quality forms that, for example, with a new design come to the level of the former arts and crafts. Added is the expansion of our design possibilities through the use of various materials.

4 FURTHER VISIONS

Certainly, customization design is still in its early beginnings. But the fundamental technological and economic dynamics starts to unfold only on many levels. And the further we go, the clearer it becomes. The digital media is followed by the digitization of products.

If this is correct only in part then the cultural revolution initiated by the new media will soon ignite its second phase. Based on the beginnings of mass customization we could then imagine visions and scenarios of the digital revolution that go much further. However, we will restrict ourselves here to two questions: the future of the factory and the design processes.

Technofactory

Developments that are – as one would have said in former times – on the drawing board can be most easily predicted. There is hardly any doubt that CNC technology – the foundation of mass customization – will still have a considerable development: with faster, more cost-efficient and much easier to operate 5-axle mills, with laser beam and water beam cutters with a much higher performance, with 3D plotters and entirely new machine concepts, for example the hexapods.

Then there is the combination of various CNC technologies in so-called processing centers. This combination could absolutely result in a developmental thrust that is similar to the combination of individual devices into an assembly line. Contrary to the assembly line, however, now flexible universal machines like the CNC mill and laser beam cutter are grouped into new processing centers. This is how the factory of the future is created with a fundamentally different technology, in a sense, as a high-tech system for the production of individual products – we call it technofactory.

This technofactory is about in the middle between the joiner's shop and the furniture factory. Since the production no longer is based on a multitude of devices for each individual working cycle but instead can do with just a few universal machines that each fulfill several working cycles, the new production unit should be considerably smaller than a comparable assembly line. Therefore, a medium-size company that decentralizes furniture production and in the end equals the model of print-on-demand is conceivable.

Pilot Projects

One of the first companies that tried to establish a chain of decentralized furniture factories was the Italian Op Top. The attempt, however, failed after a few years. The time was not ripe for the project in several respects. After all, Op Top was able to produce and deliver custom-tailored furniture within 48 hours in several decentralized facilities. Among the most serious problems was the restriction of the design to box-shaped furniture. The standard of an individualized furniture production therefore could not be communicated.

The German company InVIDO, which has been trying to introduce the procedures of mass customization into furniture production for a short time now, has thus far not gone beyond the stage of box-shaped furniture. InVIDO also discovered that Op Top had already anticipated: in the case of bulky products – like furniture – mass customization can be better produced in decentralized units that are close to the customers. Technological possibilities were already sounded out by Op Top. In its pilot projects the company had discovered that it would probably be best to operate only two computer controlled processing centers in various locations instead of gathering a multitude of identical processing centers beneath one roof. In the meantime, InVIDO is striving towards a cooperation with regional joiner's workshops.

However, it could also be possible to bridle the horse from the other end. Currently 15-20% of the German joiners are equipped with CNC processing centers, and it now becomes absolutely conceivable to develop the procedures of mass customization from the existing structures of the handicrafts – especially through cooperations.

Since 1998 ten joiner's workshops in North-Rhine Westphalia have joined forces and have been producing customer-specific furniture with CNC controlled machines under the brand name Newcraft since then. This model is still in the test phase, as well.

It seems remarkable, however, that a comprehensive discourse about the question of computer controlled furniture production has already developed in the professional trade magazines, and that a few joiner's associations have obviously come to the insight that the further development of customer-specific furniture production requires the broad development of CNC-compatible furniture design. This is shown, among others, in the design competition CNCconFORM that was first held in the year 2001.

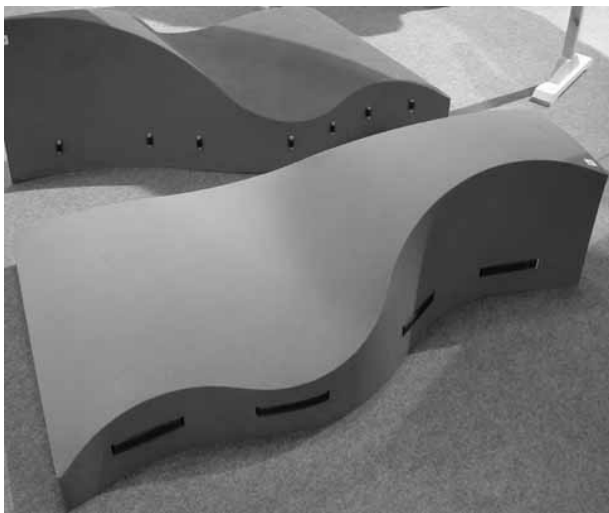


Figure 11: M. Schein, T. Herok, Chaise lounge, design competition CNC-conFORM 2001.

We can conclude that the race for the technofactory in furniture production is still open for the most part. Since we're dealing with a convergence model of the industry and trade, it can probably be tackled from both sides. The industry provides greater resources and the trade provides the home field advantage. If someone from the ranks of the industry starts off, they may establish a kind of McDonalds for furniture, and the joiner's trade could grow into the structures of a specialty restaurant. The winner is, at any rate, mass customization.

5 NEW DESIGN PROCESSES

Let us combine the perspective of customization design and the outlook on the technofactory into reference points for yet another question: in which way do not only the forms of the products but also the procedures, the organization and not least the creative processes of design change?

The Customer as a Co-Designer

When the customer determines the color, proportions and versions of a product, he already begins to take over tasks that the industrial designers generally rack their brains over for a long time. The customer becomes a co-designer in an even more obvious way when he adds his own ideas about forms, inscriptions or, for example, the

contour of a table top, to the production process – see figure 12.



Figure 12: Freehand drawing, table top.

Marketing experts now say that the customer is neither a motivated nor capable co-designer. This may apply to today and even tomorrow. But if we remember the do-it-yourself-movement and the fact that individuals are increasingly familiar with computers, then a design-it-yourself-movement could emerge in the near future whereby ideas are formulated in a CAD program, transferred online to the nearest technofactory and produced there.

"Fitting Form"

Theoretically, we can no longer even exclude the idea that the design profession that has emerged only with the age of industrialization may disappear along with industrial mass production. In fact, the design processes in the context of mass customization already resemble those of pre-industrial handicraft and the arts and crafts more than those of industrial design. The procedure that produced rather handsome furniture without a designer back then is described as "fitting form" in design theory. It is based on continuous feedback processes between producers and customers – both gain in design competence in this process.

Type Scouts

But what tasks then remain for the professional designer? First of all, new ground is broken. The changeover from industrial design to customization design is professional work. But after that furniture customization will develop in two directions according to its logic: as a reduction of the multitude of types and an explosion of the formation of versions.

The customer-specific product does not involve new inventions, nor new construction, nor independent design – it is a version. On one hand, it meets with our

need for differentiation in a much more individual way than does industrial design, and on the other hand, it allows a concentration of the various types – for example, a kitchen table – to sensitive, technologically mature and aesthetically striking solutions.

The development of such basic types remains the task of the designer. Their further development, differentiation and individualization hence only occur continuously with versatile interactions between the producer and customer – following the old model of the "fitting form."

Designer Consulting Hours

The customer often won't be able to do without professional help even in the case of the formation of versions. Especially as a co-designer he will need a trainer in the beginning, and in difficult cases, an advisor. Such design services, however, have to be organized in an entirely different way than in a design office – for example, as designer consulting hours or as a hotline.

Product Publishers

In the end, what might change the role of the designer most is the fact that he will no longer make designs but produce "virtual products." The design then not only includes the blueprint but also programs for the computer-aided manufacturing.

Wherever production is developed following the model of print-on-demand, the production is regionalized and the trade with virtual products is globalised. With respect to the furniture production, on one hand, furniture "publishers" could develop and distribute digital designs

like book publishers distribute texts. On the other hand, production companies or chains will develop that produce every globally offered design locally and modify them on site individually for their customers.

From Design to the Applied Arts

It remains to be seen how satisfying, lucrative and glamorous the different roles of design will become in the end as a result of mass customization. Much depends on whether we can only appreciate the ergonomically custom-tailored version of a product, or whether we truly exhaust the new technologies of individualization and personalization. May be to the point of creating a renaissance in the applied arts. Theoretically, quite a bit stands in favor of this. Just as the old connection between art and everyday objects was torn apart by mass production, it would have to be connected again today by overcoming mass production.

Only one thing is certain. If renewed forms of the applied arts indeed develop, they will no longer be produced with handicrafts but with the new technologies and procedures of mass customization – but that's a different story, call it art customization.

6 REFERENCES

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