DECORATIVE SURFACE CONFERENCE

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Conference Proceedings

Edited by

Kurt Fischer

Technical Conference Management
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² University of Innsbruck, Institute of General, Inorganic and Theoretical Chemistry
Together we made a lot happen in FY13

“Wherever I’ve been, from China to Austria, Russia or Sweden, I’ve been really proud to see the great commitment and deep knowledge throughout our organisation and value chain.”

Peter Agnefjäll
President and CEO, IKEA Group

FY13 — a good year and consumer spending is recovering in many markets

Sales:
+3.1% to €27.9 billion

Net income:
+3.1% to €3.3 billion

Strong growth in China, Russia and the USA

Gained market share in almost all markets

Profits give us resources to grow

• Cost focus contributed to a positive result
• Profits re-invested in sustainable growth

FY13: €1.9 billion re-invested
• Stores, factories, shopping centres
• Renewable energy
The year in brief — A few snapshots

- Opening five new stores and e-commerce in 3 new countries
- IKEA cooks up a new kitchen: METOD
- Launch of STOCKHOLM
- A bright, sustainable future with LEDs
- Expanding in China: stores and new factory in Nantong
- Application approved for IKEA retail in India

The year in brief — People & Planet Positive

- LED bulbs sold saved €86 million on our customers’ electricity bills
- 2/3 of our cotton from more sustainable sources
- 1/3 of all wood from more sustainable sources
- We have now invested in 137 wind turbines & installed 550 000 solar panels
- All home furnishing suppliers IWAY approved
### The year in brief — IKEA Foundation

- The IKEA Foundation donated €101 million (+ 21%)
- Testing IKEA inspired shelters in UNHCR camps
- More than 100 million children will benefit from current IKEA Foundation-funded programmes by 2015

### Retail, distribution, production: operations in 43 countries

<table>
<thead>
<tr>
<th>Region</th>
<th>Stores</th>
<th>3% Purchasing value</th>
<th>Distribution centres</th>
<th>Trading service offices</th>
<th>IKEA Industry Production units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NORTH AMERICA</strong></td>
<td>50</td>
<td></td>
<td>6</td>
<td>1</td>
<td>1 IKEA Industry Production unit</td>
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<tr>
<td><strong>EUROPE</strong></td>
<td>215</td>
<td>60%</td>
<td>19</td>
<td>11</td>
<td>36 IKEA Industry Production units</td>
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<td><strong>SOUTH AMERICA</strong></td>
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<td><strong>RUSSIA</strong></td>
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<td><strong>ASIA</strong></td>
<td>19</td>
<td>33%</td>
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<td>36 IKEA Industry Production units</td>
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<tr>
<td><strong>AUSTRALIA</strong></td>
<td>5</td>
<td></td>
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</tr>
</tbody>
</table>

- **303** IKEA Group stores located in 26 countries
- **684** Million visitors to the IKEA Group stores
- **60%** of production takes place in Europe
- **1,046** Home furnishing suppliers to 52 countries

- **RUSSIA**: 14 Stores, 3% Purchasing value, 1 Distribution centre, 3 Trading service offices, 5 IKEA Industry Production units
- **ASIA**: 19 Stores, 33% Purchasing value, 5 Distribution centres, 12 Trading service offices, 2 IKEA Industry Production units
- **AUSTRALIA**: 5 Stores, 1 Distribution centre
Material Area FLATLINE

Purchase Value

- Worktop
- Laminated flooring
- Board veneer and pigment
- Foil on Board
Segmentation FOB (Foil On Board)

<table>
<thead>
<tr>
<th>FOIL EDGE</th>
<th>MFC</th>
<th>LAMINATES</th>
<th>WRAP PANELS</th>
<th>WRAP PROFILES</th>
<th>PLASTIC FOILS</th>
<th>PRINT LACQ EDGE</th>
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<table>
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<th>100</th>
<th>100</th>
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<td>137</td>
<td>140</td>
<td>135</td>
<td>154</td>
<td>140</td>
<td>115</td>
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<td>FY20 index</td>
<td>119</td>
<td>164</td>
<td>160</td>
<td>163</td>
<td>186</td>
<td>166</td>
<td>131</td>
</tr>
</tbody>
</table>

The IKEA Group

INGKA Holding B.V. is the parent company of IKEA Group of companies. Its purpose is to support and manage the IKEA Group.

IKEA of Sweden

Range Strategy & Product Development Supply Chain

The IKEA Group of companies

INGKA Holding B.V.

IKEA Group Industry

IKEA Group Staff functions

IKEA Group Retail

Ex Swedwood etc
IKEA Industry

was established in September 2011 to optimize the industrial operation with more integrated ways of working together inside IKEA.

1991 **Swedwood was founded**, IKEA acquires its own sawmills and production plants and establishes the industrial group Swedwood to produce wood-based furniture and wooden components.

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**The Role of IKEA Industry**

1. To create **outstanding customer value** in terms of price and quality.
2. To create **capacity for growth** in strategic important categories where capacity is hard to find or there is a monopoly/oligopoly situation.
3. To add **production competence** to IKEA and suppliers.

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**IKEA Industry 2013**

- **Operates in 11 countries**: China, France, Hungary, Latvia, Lithuania, Poland, Portugal, Russia, Slovakia, Sweden, and the US.
- **43 production units** in 11 countries.
- **Turnover** of 1.9 billion Euro in FY13.
- **19,000 co-workers**
- **Top 3 production countries**
  - Furniture products
  - Poland: 53%
  - Sweden: 13%
  - Slovakia: 8%
Four Divisions

1) Division Flatline
2) Division Solid Wood
3) Division Boards
4) Division Purchase

Division Flatline

- The division operates 13 production units in 8 countries.

Division Solid Wood

- Part of the entire value chain from the management and operation of forests on long-term contracts to sawmills, board and furniture manufacturing.
- 24 production units at 13 sites.

Division Boards

- Ensures long-term supply of raw material for IKEA flatline furniture business at competitive prices.
- Produces, durable, lightweight and sustainable wood-based boards and panels with a special focus on Lightweight boards and HDF.
- Operates six production units in six countries (France, Lithuania, Poland, Russia, Slovakia and Sweden).

Division Purchase

Centralised Purchase in Categories

- Common ways of working
- Bundle the volumes
- Alignment with IKEA Purchase, IMS and IKEA Components
4 Focus areas

- SPEED x2
  - To manage the growth and be first choice on the market
  - Faster to the market, decreased development time.

- Light weight carrier is an integrated part of the segments and supplier base.

- Innovation -> New Techniques / Materials
  - Explore all opportunities to create the "Övertag" in the market

- Customer experienced quality CEPQ
  - Humidity secured production for all regions and environment in the home
  - Structures and Natural touch

Focus areas

IKEA Basics
- good, basic home furnishings

4 style groups
- Scandinavium Modern
- Modern Popular
- Scandinavium Traditional
- Popular Traditional
- BASIC & VITALITY
Next Generation Product Development

How to work, lead and organize for the next generation product development in IKEA

Goals for the Develop the Product Offer Process

Happier people!

- Increase co-worker work satisfaction by 50%.

Better products at lower price!

- Improve customer perception of the range by 50%.
- Improve customer perception of our quality 4-5 times.
- Increase sustainability by 100%.
- Enable a dramatic decrease of prices and achieve price levels according to the “house model”.
- Increase news contribution to growth by 20%.

Faster and more flexibel time-to-market!

- Speed up time to market with 50%.
- 100% precision at sales start.
Development of factory floor – Development on factory floor

- Home furniture solutions
- Products, vitality, expressions
- Store solutions
- Supply chain set up

We are on a journey, where we shape the future product development together!

- Platform
- Components & Standards
- Assembly solutions
- Material & Technique Concepts
- Production concepts

2020:
Better products!
Shorter TTM!
Higher motivation!

Common way of working,
leading and organizing product development (Dec 2014)

Large scale roll-out
(Dec 13 – Dec 14)

Pilots
Learnings!

Diagnostic
Blueprint
**Functional adopted boards & lightweight**

- Focus in carrier materials

**Boboard**
- 2009
- 4 mills producing
- -100kg/m³

**BOBOARD definition**

Dual density particleboard is a three-layered, function adapted wood-based panel with defined high- and low density areas over the whole board area. The idea of dual density board is to adjust all necessary physical properties while spreading the materials individually on different parts of the panel.

**BOBOARD**

... saves material in areas without higher loads, stress or processing

... keeps the density on a suitable level in areas with higher loads

... reduces costs due to usage of less raw materials

... has to be specially adapted to every application

... is functionally adapted

**Call for new demands**

- Surfaces to look equal
- Edge processing
- Supply chain
- LPL for light boards
- Fittings
- Tests
- Standards

**Customer benefit**

- Less material
  - Capacity plant
- Less chemicals
  - Emission
- Low weight
  - Transport
  - Swelling
  - Handling
- Less cost
Focus areas

• Structures and natural touch
  – Laminate - plates/release papers
  – Foils - chemical emb.
  – Plastic - mechanical emb.
  – Veneer - brushing techn.
  – Powders - smooth.

• And how to control and define this in a multi sourcing setup?

Structures

With combination of Scanner and RA-measurment we can both create a quality system and full documentation of structured surfaces.
New Techniques / Materials

- New materials is always an interest
- Digital print
- OPP / Gorilla glass etc
- Powder pressing
- New Veneer processing
- Carrier development
New climate chamber test
Publication 2013w19

2 Test procedures
A complete humidity test cycle includes in the following order:
- 1 week conditioning at 23°C and 50%,
- 3 weeks in 85% RH and 28°C,
- 2 weeks in 25% RH 28°C.
- For storage furniture with movable parts, test after 1 week of conditioning at 23°C and 50%

Evaluation criteria:
- Safety (red light)
- Function (red light)
- Appearance (yellow light)
- Dimensions (green light)
### Table 2.1.B

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Test method</th>
<th>Class</th>
<th>P1</th>
<th>R0</th>
<th>R1</th>
<th>R2</th>
<th>R4</th>
<th>R6</th>
<th>R7</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R0</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>Home office &amp; Public Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td>Kitchen environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>R7</td>
<td>Horizontal surfaces &amp; Bathroom</td>
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<td>R8</td>
<td>Storage surfaces</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R7</td>
<td>Back panels and un-coated surfaces</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example: **R2 A, B & K**

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### Table 2.1.C: Coated/covered wood and wood-based substrates

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Test method</th>
<th>Class</th>
<th>P1</th>
<th>R0</th>
<th>R1</th>
<th>R2</th>
<th>R4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat on scratches</td>
<td>ISO-7M-0002, section 2</td>
<td></td>
<td>2 N + 24 hours</td>
<td>3 N + 24 hours</td>
<td>3 N + 24 hours</td>
<td>2 N + 24 hours</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- The specified surfaces are only examples; the technical description specifies the applicable requirements and tests.
- Table 2.1.B applies to coated substrates of wood and wood-based materials, except for coated substrates of solid softwood and softwood veneers.
- Acceptable width of a scratch is maximum 0.3 mm. Penetration through the coating film is not acceptable. Result shall be 24 on the assessment scale 1-5.
- If the spreading of fat is not possible to observe, the requirement criteria for penetration are not applicable.
**Specification**

**Surface coatings and coverings**

**General requirements**

Table 2.1.K Coated/covered wood and wood-based substrates

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Test method</th>
<th>Class</th>
<th>P1</th>
<th>R0</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact on surface</td>
<td>ISO 4211-4*</td>
<td>50 mm</td>
<td>50 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result ≥ 4 on the assessment scale 1-5, including an impact mark of maximum 5 mm.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micro-scratching</td>
<td>ISO-TM-0002, section 20</td>
<td>&quot;SB 7447+&quot; 6 N, 160 rubs</td>
<td>&quot;SB 7447+&quot; 6 N, 160 rubs</td>
<td>&quot;SB 7447+&quot; 6 N, 160 rubs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result ≥ 3 on the assessment scale 1-5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adhesion</td>
<td>ISO-TM-0002, section 19</td>
<td>20 N</td>
<td>20 N</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Apparatus for impact on surface
The parameters are as follows:

- **Scrub material:** Scotch Brite (SB 7447+)
- **Speed factor:** 1 (47.5 rubs/min)
- **Number of cycles:** 160 (= 10 Lissajous movement)
- **Load:** 6 N

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### 19.5 Assessment

Carefully examine the test area for damages such as "white cracks" (which are the most evident for transparent coatings), or scraping of the surface finish partly or completely at a minimum total length of 2-3 mm. Example of partly scraping is when a top layer is separated from a basecoat, and completely scraping is when the entire coating/covering film is scraped off and the wood material is exposed.

Not considered as damages:

- Any damages that only occur during the first 20-30 mm of the test trace
- Dents or changes in gloss that occurs without the formation of white cracks or scraping

The assessment shall be performed in an evenly diffused artificial daylight giving an illumination on the test surface of 1200 ±400 lux.
Our great Business Idea

We shall offer a wide range of well-designed, functional home furnishing products at prices so low that as many people as possible will be able to afford them.
1. Introduction

Süddekor is one of the largest printing facilities in Europe and since December 2013 a member of the Surteco paper division.

Table 1: Süddekor within the Surteco paper division

With the acquisition of Süddekor, the Surteco group became not only one of the leading decorative printers in the world, but also a major player in the lacquered surface market. With five electron-beam and thirteen acid lacquering machines within our group, we offer a wide range of possibilities to create the surface of tomorrow. As Surteco we do understand the craving demand of the industry to offer unique selling propositions to their customers, creating a stronger bond between them. The times of high demand and short supply are long gone. In almost every market worldwide, companies are fighting with almost identical
weapons to catch the attention of their important customers. As everyone will certainly understand, this is not to be done with only a new design or a stunning new press plate. We all will have to look further then that, to impress our dear customers in the future.

In trend research we talk about tipping points, which describes the need of each industrial leader to recognize these trends before they become obvious. Once a trend becomes obvious, you are already too late. There are numerous examples in other industries where a industry leader missed a trend and was swept out of its market. Best example is Nokia, holding a 70% market share in 2007 in the smart phone sector before the iPhone was introduced. Only six years later the whole mobile phone sector of Nokia had to be sold to a competitor. It is very often the case that a company is so occupied with its own problems that they are not able to react to a turning market and take the appropriate actions.

The latest big tipping point in our industry has been the luxury vinyl tiles, which started in 2004 with a total volume of 3 Mio. m² of annual sales in Germany. Within a 9-year period the sales rose to a whopping 18 Mio. m² in 2013, leaving every other flooring cover in its dust.
Table 2: Comparison chart from 2004 until 2013

2. Basic product

Last year my colleague Dr. Haller presented to you our D.Fin Polytop®. This year we will take it one step further and introduce our latest development Polytop complete. But before we start, let us recapitulate what Polytop was all about.

We introduced a synthetic polymer carrier with an acrylic EBC-coating. The carrier foil needs to be thermostabilized and bidirectional forged to generate a good foundation for the bonding. All this would not be enough and therefore an additional chemical treatment of the carrier foil is needed to create an optimal bonding to the melamine film as to the acrylic coating on top. The fundamental properties are:

- Low shrinkage: < 0.5%
- Surface tension: +/- 60dyn/cm
- Heat stable: to around 230°C contact temperature

The advantage of such acrylic coatings is the possibility to fix additives and therefore functions on the top of the surface, where they are needed. On any melamine pressing, the industry always faced the problem of uncontrolled flow behaviour of anything added to the melamine resin. Additionally to this problem the additives had to be added in a very high concentration to reach the desired results. The Polytop started with, according to our
customers, one of the most anticipated features in the market, the Anti-Fingerprint-Effect on matt surfaces.

**Table 3:** Polytop buildup

This is possible by using the excimer technology, which is shrinking the surface and therefore changing the topography on top.

**Table 4:** Microscopic picture of the Ultramatt surface
3. Polytop® complete

Today we are introducing the next step in the evolution of this product category. Polytop® complete will be a surface product which offers the following features:

- Using the same top layer, the product will offer all the advantages of an acrylic EBC coating
- It will combine a functional layer with a decorative one
- Can be delivered in rolls or sheets
- Available in widths from 1.200mm to 2.160mm
- Gloss grade will be fixed by EBC-coating and cannot be changed
- Ultramatt gloss will be delivered with anti-fingerprint-effect
- Product can be structured with press plates or by the use of release papers
- It is designed to work in LPL/ HPL and laminating processes
- Furniture and flooring product available
- Flooring resistance until AC6 standard
- Waterproof
- High resistance against chemicals

Table 5: Polytop® complete build-up
Polytop® complete can also be a solution for flooring producers who are looking for an alternative to the LVT products. With a soft underlay we are able to transform any base carrier (HDF, PP, and others) into a PVC and plasticizer-free flooring product.

3. The added value of functions
Additional functions will transform any product into a new category of surfaces. These functions can be added to almost any LPL, CPL, HPL and laminating product in the industry. We will start with a new category of antimicrobial surfaces which will work differently than any other surface in the woodworking industry before. Usually the Antimicrobial properties have been accomplished by adding additives to the resin like Triclosan (Microban) and Nano Silver. Unlike the products mentioned, our technology is not based on nanoparticles which can cross the blood-brain barrier to enter the brain. Especially Triclosan is highly controversial because it has been found in mother’s milk and various animal products, which has been proven by University of Minnesota and Greenpeace.

Our product is working strictly on the basis of an electrostatic interaction of the surface charge. The great advantage of this mode of operation is that nothing will migrate out of the product because the function is strictly physical. A special additive modifies the surface tension and as a consequence of this, the colonization of microorganisms will be prevented.

Table 6: Way of function
The graph below does show how the added microorganisms have not been able to survive on this surface and died of natural course within 180 minutes.

![Graph showing microorganism survival](image)

**Table 7:** Analysis of the specimen

4. Summary

There is a very interesting book, which is called “The Long Tail” from Chris Anderson. The book explains the future of companies and the change of all markets in the demand of diversity. In the perspective of our old marketplace the limiting factor was exhibition space in the shops. The problem was that only the best-selling 200 furniture systems made it to the stores because space was limited. Now with the availability of infinite space in the Internet, the tail does not need to be cut off. Nowadays nearly any available furniture can be offered and searched instantly by a click. This presumption is supported by the eCommerce growth rates of more than 20% each year. The same eCommerce growth rates have been observed in music, film, clothing and electronics and all of these industries have faced a tipping point which turned the markets completely over. The result was a much “Lower Head” curve (less mass products) and an endless “Long Tail” (more specific and custom-built products). We can find many indicators in our market which are leading us to the assumption that our industry will face a similar tipping point in the near future.
Table 8: The new market place explanation

The rotogravure printing machinery has been designed for a constant growth in volume and Pareto’s 80-20 principle is still valid for the furniture industry. 80% of their sales come from 20% of their products.

As a decorative printer we have been forced by the market to introduce 50 new designs each year. This caused the average order volume to collapse, driving production costs and machine downtimes to an all-time high.

For many markets the future often lies in selling less of a more valuable product. Unique selling point and functions will be the new battleground for the industry in the years to come. We may already have the first answers to the demand of the market and would be delighted to share our visions with you.
The Dawn of a New „Functional Décor“ Industry

Robert Massen and Thomas Franz

Baumer Inspection GmbH
Lohnerhof 6, D-78467 Konstanz, Germany
www.baumerinspection.com

ABSTRACT

Drop-on-Demand (ink-jet) technologies will transform the traditional décor printing industry for furniture, for in-house and exterior panels in a much more profound way as commonly stated in the specific magazines. We show how the combination of decorative and functional inks lead the path to a completely new “décor“ industry: an industry which produces on the basically same DoD production line both the decoration of raw panels with decorative inks AND a multitude of physical features like sensing, illumination, display etc.. We foresee a new panel industry arising which produces aesthetic physical systems instead of just nicely coloured wood boards.

1. The Drop-on-Demand tsunami hits the décor industry

We have discussed on last year’s TCM Decorative Surfaces Conference 2013 in Berlin how the actual traditional “analog” décor printing industry will be wiped away in the coming 5 to 8 years by a 100% “digital” decoration industry based on Drop-on-Demand, by “ink-jet“ technologies.

The arguments which speak for a rather fulminant progression of DoD printing technologies for the production of decorated panels are confirmed today:

1. DoD is a non-contact production which simplifies greatly the mechanical processes
2. DoD décor production capacity is easy to upgrade by parallelizing printing units, lowering the financial entry burden for new-comers
3. Storage of production masters is extremely simplified: a hard-disk instead of voluminous and delicate to handle gravure cylinders
4. DoD leads to an almost perfect implementation of the “Digital Factory” concept: everything under computer control
5. And beyond aesthetic decoration we foresee the DoD production of physical functions with functional inks on a basically same production line

One of my rather merciless arguments last year was just to look at stock-exchange prices of “analog” printing equipment companies such as Heidelberger Druck and Bopst Group compared to the producers of DoD technology such as Xaar. With a year having passed since, the picture hasn’t changed: the stock-exchange price of Heidelberger Druck is still creeping low whereas shares of its competitor Koenig&Bauer jumped up since K&B announced its move towards an own DoD technology.
The first move towards DoD technology through a partnership with Kodak was a pure fiasco for Heidelberger Druck, as Kodak itself went bust on the way.

The new partnership with Fujifilm has not yet convinced the markets: Heidelberger Druck is perceived as a company which does not really understand and giving the right weight to the technological DoD tsunami on the way.

The lesson is clear: Traditional producers of analog print equipment, be it for the décor industry or for the classical press market, will have to understand that embracing DoD technologies is not an option, but a must.

They will have to learn that this “digital” DoD technology will operate both with graphic, i.e. decorative inks and with the new “functional” inks.

We are watching the birth of a new, fascinating industry. We will illustrate in the following this new emerging functional décor industry on a few easy to understand examples.

2. Functional inks for a new “digital” panel industry

DoD printer for the decoration of panels make use of UV- curable or water solvable CMYK inks plus sometimes a few additional special décor inks such as silver or metallic.

The experienced printer tries its best to produce brilliant and sharp décors by playing with the degrees of freedom at hand: drop volumes, dot placement matrix etc.. In contrast to analog printing, all these settings are under a 100% computer control, supported by advanced RIP (raster-to-image) software. The rapid worldwide on-going development of printing head technologies, of ink chemistry, of redundant or fail-safe printing nozzle arrays, of camera-based in-line quality inspection drive the DoD technology in a very fast way, leaving the R&D on traditional rotograph and heliograph technologies looking like re-animating a dying species.
Fig.3  There is a very large number of “functional” inks available and imaginable for printing physical, electrical, optical, bio-technical, acoustical components using a basically same DoD technology as for decoration (by courtesy of Xennia Ltd)

We may group these “printed functions” into three families (see fig. 4):

a) **passive devices** needing no electrical power supply.
(special surface coatings, 3D structures, light conducting structures, antennas…)

b) **active devices** requiring electro-magnetic power supply.
(Organic Light Emitting Displays (Oleds), paper loudspeakers, bio-sensors…..)

c) **self-powering devices** which generate their own power supply (solar cell based radio frequency emitters, printed generators producing electricity from thermal energy, from mechanical micro-motions or vibrations…..)

It is evident that printed passive devices look particular simple and interesting for combining with the aesthetic panel decoration as they do not need any electrical connections and may hopefully reach the lifetime of a traditional decorated-only panel. We will show a few applications to trigger your imagination.

We will furthermore discuss that beyond technological feasibility the main challenge for these
future bi-valent aesthetic & functional panel products is to not fall into the pitfalls of gimmics and short-life play stuff. It is very serious business brainwork required to concentrate on those additional DoD printed functions which provide a clearly increased customer value without sacrificing the well founded trust of customers in traditional furniture, flooring and facade panels as long living products requiring very little servicing.

3. Decorated panels with integrated printed (passive) light piping

3.1 The illuminated wardrobe

We all know the typical “wardrobe nuisance” when in the early morning, only half waken up, in a dim illuminated sleeping room, we have to locate a particular dress inside a much too dark wardrobe (fig.5 left). Suppose we have no electrical power supply available at this particular place of the chamber; no fancy LED lamps can be fitted to allow a good visual perception of the clothes.

So why not ask my wardrobe producer to use panels with an integrated DoD printed passive light pipes to funnel the chamber’s ceiling illumination to the wardrobe back panel and thus increase the visibility of its content (fig.5 right)?

Fig. 6 shows a sketch of the system. The wardrobe top panel has a printed light piping system which collects and funnels the dim ceiling lamp light via the edge of the top panel’s line-piped printed coating towards the equally light conducting and emitting layer of the rear
panel. The wardrobe is thus diffusely illuminated from the back, increasing the visibility of the stored clothes.

This new kind of “functionally decorated” furniture panels thus combine classical DoD printed CMYK décoration with the new DoD printed physical function of light piping.

Fig. 5 The much too dark wardrobe  
Good perception due to the passively Illuminated back panel

Fig. 6 The wardrobe’s back panel is illuminated by the dim ceiling lamp light funneled via the light piped top panel to the equally light piping rear panel. The entirely passive system is DoD printed with functional inks onttop of the CMYK panel decoration.
The 3\textsuperscript{rd} age staircase

Staircase down stepping is one of the most dangerous activities for elderly people keeping to live at home. The poorer visual acuity, the wearing of bi-focus glasses makes it difficult to see the step front edge for the seniors and missing a step very often lead to serious home accidents with broken hips and knee disjunctions.

Thyssen Krupp Encasa has developed a motorized “Stairwalker” to help seniors using their staircase at home (Fig. 7), an interesting but rather complex and expensive motorized solution.

Making use of light piping functional inks to design laminated staircases with a passively illuminated front step edge may achieve the same goal at far lower costs.

Fig. 8a shows that a usual decorated laminate stair step has a very low visual contrast for the human eye when looking down during down stepping. The visual difference between succeeding steps is small and does not give to seniors the right Information of where to put the foot. Stumbling is frequent.

It just needs a bit of printed light piping with functional inks to collect ambient light from the staircase lateral face and to funnel it to the front step edge. The edge then becomes significantly brighter and produces a far better visual contrast to guide the senior’s save stepping down.

Fig. 7 Thyssen “Stairwalker”

Fig. 8 Piping light from the lateral staircase face to the step front edge increases the visibility of the steps for elderly people and thus prevents stumbling.
3.3. Flooding the dark city with sunlight

The rapidly increasing Mega-Cities for housing an exponentially increasing world population unavoidably leads to dense and high building, rather narrow streets and consequently poor daylight illumination. Let’s try decorated laminate façade panels with an integrated light piping system to collect sunlight at the roof level and then guide it to equally light piping façade panels. These panels brighten up the lower street with natural daylight in a very "green", zero carbon approach, an amazing and powerful tool for creative urban architects.

![Image](image-url)

Fig. 9  Dark façades create dark streets. Façade elements with surficial light piping collect sunlight at roof level to brighten up the darkness of narrow streets

4. A DoD printed decorated and functional kitchen top

The combination of DoD printed décors with active sensors and physical devices opens a Pandora’s box of novel printed decorated and functional furniture.

Fig. 10 shows a decorated laminate kitchen table with a number of passive and active printed functions:
- a water repellent zone around the washing basin for better cleaning (passive, 2D)
- a heat protection pan drop zone (passive, 3D structure preventing décor burning)
- a bio sensor measuring fat content, time to cook etc. for a steak (active, bio sensing)
- switches and displays (active sensors and Oleds)
- antennas and magnetic coils to communicate with smartphone while charging (active)

The number of inks and procedures to print sensor with DoD technologies is growing at a fascinating pace. There is huge interest of the pharmaceutical industry, of the security and viral identification chips, of printed sensors coupled to smartphones for home diabetes treatment etc. All this research should be carefully watched for possible application in the furniture industry.
5. No functional décor panel industry without inspiration and transpiration

The furniture industry which orders decorated panels from external producers is a traditional industry offering long living products which are rather well understood by the customer. Furniture and panel producers which want to ride the functional décor wave must be aware not to fall into the “smartphone trap”: a new product cycle every half year, much too complex to be handled by Mr. and Mrs. Everyday, with an abundance of features which are never used, at the critical mercy of urgently needed technical support…..

The traditional décor panel industry must be aware that the new functional panels are highly interdisciplinary products which have to be imagined, designed, produced and marketed by a complex grouping of specialists in the many different technologies involved.

Setting up such a team is demanding and possibly only achievable by starting from scratch. Resisting to technological fanciness, confining to panel products which fit to the brand of the furniture company is an absolute must.

Beyond all technological cleverness, the purpose, the advantage and the handling of the new products must be self-explaining to the customer. It must give an answer to an existing need, not to one invented by marketing people. All these difficulties require time, people, money.

There is no simpler way to succeed!
I. History and development of the manufacture of laminates in a continuous process

Laminate – or HPL – is relatively old material, which was developed and patented during the early 1930’s in Spremberg in Eastern Germany. It consists of several layers of resin-impregnated paper laminated together under heat and high pressure. The resins, generally phenol- and melamine formaldehyde resins – condense in the press, releasing water, and then harden. The finished product is a high-utility material which, since its invention, has been in use in the most varied applications in the area of surface coating: the surface is hard, smooth and extremely robust. The uppermost visible paper layer is decorative. Also, the surface of a laminate is waterproof, heat resistant and, being perfectly closed, extremely hygienic.

Traditionally, decorative laminates have been manufactured in large multi-daylight presses. In each daylight of the press several large laminate packages, separated by
structure plates, are pressed together under temperature of approx. 140 °C and cooled down before opening of the press.

Initially, the individual layers of resin-impregnated paper are positioned by hand, always alternatively with structure plates, and the intermediate layers, in order to separate the individual laminates. When the charging cage in front of the press has been filled with the necessary quantity of packages and the preceding press operation completed, the multi-daylight press is then unloaded in a single work stage, and then recharged. While the new laminate package is being slowly pressed, the completed laminate packages must be separated into laminate, structure plates and release films depending on the process. Edge trimming and sanding of the underside of the laminates are carried out in separate work stages at a different location.

From today’s point of view, it therefore appears logical to further develop the manufacture of laminates in a continuous process.

At a certain point of time (probably at the end of the 1960’s/early 1970’s) the idea of manufacturing laminates – like many other products – in a continuous process, was, so to speak, in the air. A practicable solution is provided by the isobaric pressure system, in which the necessary pressure is built up pneumatically. The material to be pressed is fed through the press by means of two endless steel belts, each travelling over two steel drums. In the centre of the press are pressure cushions, which are supplied with compressed air, one above and one below each steel belt. By means of a special gasket, each pressure cushion is sealed off from the steel belt in order to prevent pressure losses. Heating of the impregnated paper webs occurs directly from the steel belts which themselves are heated via the deflection pulleys in the entry and exit areas of the press. On demand post-heating of the press belts during contact with the impregnated paper webs is ensured by pre-heating of the compressed air to 220 °C.
The continuous manufacture of decorative laminates began in the late 1970's with the production of melamine edge-banding. From the very beginning, the economic advantages were unmistakable. Not only the production of the laminates is continuous, but all further stages in processing such as trimming, sanding, cutting in cross- and lengthwise direction are carried out in one single run. In the continuous process, changing the décor is possible “in flight” – at that time an unbelievable gain in flexibility. The personnel requirement fell from approx. 12 to 3 operators per production line and shift, while capacity increased.

The double-belt presses embarked upon their victory march in the early 1980's, when many laminate manufacturers went over to the continuous process. A further incentive to change over to the new process was the possibility of producing increasingly thin materials down to 0.2 mm. This had not been possible in multi-daylight presses with their trays, and the consequent non-uniform pressure distribution. The quality of continuous production laminates is more uniform and precisely controllable.

Owing to simultaneous contact of all layers with the heat inside the press, the degree of condensation of the resins in all layers of the product can be exactly controlled. In contrast to the multi-daylight press, continuous production laminates undergo the same, fine-adjustable process parameters. As a result, the laminates feature extremely uniform characteristics, which is of great advantage during further processing. During the course of the years, the impregnating resins have become more and more closely adapted to the continuous process, so as to permit shorter press times at lower pressures. Especially the postformability of the laminates has been clearly improved, and the working width of the presses has been increased of up to 2.300 mm which can be supplied either in sheet form or in rolls.
In the early days of continuous laminate production there was an “experts debate” lasting for several years on the differences in quality between continuous and non-continuous laminates. Standards existing at the time determined not only material characteristics in terms of the usability of HPL, e.g. scratch resistance, stain-resistance, cigarette burn resistance and impact-, heat- and steam resistance, but also stipulated a pressure of 70 bars for manufacture. At that time, this pressure could not be reached in continuous presses. Admittedly laminates produced on double-belt presses fulfilled all the values of the standard in terms of usability. The debate finally died away of its own accord when more and more laminate manufacturers went over to continuous production of their laminates.

In general, owing to its many advantages, continuous production of decorative laminates on double belt presses has for a considerable time now asserted itself as the standard process.

Standard parameters of laminate production of double belt presses, the pressing operation is performed at pressures of up to 50 or up to 70 bars, depending on the product, at speeds of up to 30 m/min. for thinner laminates. The layer thicknesses produced on double belt presses range between 0.2 and 1.2 mm generally however between 0.4 and 0.8 mm.

For certain laminates and for laminates with a layer thickness in excess of 1.2 mm, the multi-daylight press is still the favoured choice even today. In addition, there still exist all over the world numerous older types of multi-daylight press which are still in
operation.
Nowadays, manufacturers who utilise both methods generally no longer distinguish between the two: the products are all sold under the designation HPL.

II. **Double Belt Press Technology**

*Example layout sketch*

![Diagram of Double Belt Press Technology]

1 – Paper unwinding  
2 – Double belt press  
3 – Cooling station  
4 – Structure paper winding  
5 – Sanding (back side)  
6 – Edge trimming  
7 – Laminate winding (for thin laminate)  
8 – Clipper (Laminates are cut to sheets)  
9 – Laminate stacking

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**Framework of the Press**

10 – upper frame  
20 – lower frame  
30 – Tie- rods  
40 – Supporting frame with hydraulic cylinders  
50 – 8 foundation plates
Fast steel belt change

Automatic opening of covers (10) by pneumatic cylinders for a quicker access to the steel belt which allows a faster exchange of the structured belt.

Temperature, viscosity, curing and pressure profile

Relations between temperature, viscosity, curing and pressure during processing by continuous running double belt press
Comparison CPL vs. HPL

The direct comparison of using CPL vs. HPL shows significant advantages of CPL

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>HPL</th>
<th>CPL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>*</td>
<td>N.a.</td>
</tr>
<tr>
<td>0.8</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>0.6</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td>0.4</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>0.15</td>
<td>***</td>
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</tr>
</tbody>
</table>

- Postforming
- Wear resistance of surface
- Sheet material available
- Sheet material in variable length, without waste of product
- Roll material available
- Roll material available slitted to customised width
- Line speed double belt press, 3 m pressure cushion (m/min)

III. New technical innovations

*SAD – Side sealing system*

for flexible production of various laminate widths of the HPL-Double belt press. Endless SAD belt, traveling continuously through the double belt press on the drive side, with return by the machine.
Sealing system – Pressure cushion

New sound-absorbing Sealing system

TBS – Turbo-System

Additional technology for cooling or heating the product under pressure in the double belt press.
Example: re-cooling of the laminate under pressure for the production of high gloss laminate.
The compressed air circulated by a pressure-resistant fan is cooled resp. heated by a heat exchanger.

IV. **Outlook and actual developments for continuously laminated HPL**

Hymmen’s Vario-Paper-Cut-System (VPC) in combination with structure paper for production of embossed in registered HPL

Digital printing technology for flexible production of high-quality HPL

Direct digital printing on modified parchment paper and continuous pressing with melamine treated overlay film for thinnest CPL (0.1 mm approx..) for special wrapping applications with smallest radii, e.g. for door industry.
1. Introduction

The powder coating of wood based panels has attracted increasing interest during the past years due to its economic and environmental advantages and the potential to create novel product types with unique surface properties [1-2]. While the technological problems in powder coating medium density fiberboards have recently been well studied and overcome to a large extent, the powder coating of solid wood based materials such as wood veneer or plywood to obtain high-quality surfaces represents still a major technological challenge. This is mainly due to the more inhomogeneous and porous structure of such materials. Wood veneer is frequently applied in the surface finishing of wood-based panels and, in contrast to paper-based decorative laminates still needs a subsequent coating step which is currently performed using solvent or water borne paintings. In the present study, a novel approach to apply powder coatings to wood veneer surfaces is described. Special low-temperature curing powder coatings that were optimized for application onto MDF are either cured in conventional ovens (convective heat transfer) or in infrared ovens (radiative heat transfer); attempts are made also to apply UV-curing powder coats. In contrast, in the present study, a completely different approach for the film formation and curing of the powder coating is pursued. Here, we describe how to create decorative surfaces on particle boards using wood veneers: maple, bamboo, beech, oak, walnut and wenge, whereby the veneer surface is finished by a powder coating and the curing of the powder coating is achieved by using a heated press. The results of this study have been recently published [3].
2. Materials and Methods

For the coating of particle boards six different types of wood veneers were used: Maple (Acer platanoides), Bamboo (Phyllostachys pubescens), Beech (Fagus sylvatica), Walnut (Juglans regia), Oak (Quercus robur) and Wenge (Millettia laurentii). Standard commercial particle boards with dimensions of 320 mm x 280 mm and a thickness of 18.7 mm were used. The previously sanded and temperature/humidity equilibrated veneer sheets were glued on top of commercial particle boards using an urea-formaldehyde resin glue by heat and pressure using a heated press at a temperature of 70 °C for 360 s and a pressure of 80 N/cm².

In the powder coating of veneered particle boards the highly reactive hybrid epoxy/polyester powder transparent Drylac 530 Series from TIGER Coatings GmbH & Co. KG, Wels, Austria was used. Curing is accelerated by a mixture of catalysts reaching curing times of 3 min at 150 °C or 5 min at 135 °C which allows for energy and time savings making Drylac Series 530 powder suitable for the coating of temperature-sensitive substrates such as MDF and wood. The powder was applied uniformly onto the veneered particle board surface using a laboratory powder coating spray unit with a manual spray gun with corona charging. The appealing glossy and mechanically resistant surfaces of the coated wood veneers were created by melting and curing of the electrostatically applied transparent powder layer at 130°C for 8 minutes in hot pressing.

3. Results

The types of wood veneers used in the present study were selected as to represent a wide range of different morphologies to gain a representative overview about the principle powder coatability of solid wood-based materials. Surface roughness of the coating substrate is very important and, in case of solid wood surfaces [4] can strongly be influenced by various factors such as cross grain, annual ring width, ratio of early wood and late wood, rays, knots, juvenile and mature wood and specific cell structures. The analysis of the surface topography by 3D microscopy was performed on the selected veneers and offered important information regarding the roughness, primary profile, waviness and porosity of the substrate before coating. Tight grained woods such as maple and beech have smoother surfaces and were expected to allow for an even finishing with powder coating films.

Since for powder deposition the electrical resistance is immediate importance, the influence of the moisture content on the electrical resistance has been investigated. Comparing the surface electrical resistance values at the optimal value of 25°C and 50% relative humidity for veneers before use and veneered particle boards (Figure 1) it can be observed that in general these values are higher for raw veneers as compared to the corresponding veneered particle boards.
The electrical resistance values are significantly higher for maple, beech and walnut raw veneers, around $10^{11}$ Ω, while for bamboo, oak, wenge, as well as for the veneered particle boards the values are around $10^{10}$ Ω, indicating optimal substrates for electrostatic powder application [5].

The powder was applied electrostatically on the veneered particle board surfaces and the melting and curing of the powder was done in the heated press, creating thus the transparent coating layer. Three different amounts of powder were used on each type of wood veneer in order to evaluate the efficiency of coating layer build-up in dependence on the used veneer type. The thicknesses and quality of the achieved coating films were used as an indicator for the powder coatability of the veneer: the coatability was judged as being the better the less powder had to be applied in order to achieve a defect-free, smooth surface film. The coating experiments resulted in largely varying coating thicknesses (Figure 2) for each veneer type.
Figure 2. Microscope photo: Different layer thicknesses on powder coated beech veneered particle board

In the powder coating process the veneer pores are filled by the powder coating, reducing to a minimum the variation of the surface texture parameter values, as smooth surfaces are obtained after powder coating and curing for all veneer types.

In the case of the one-coat low system for oak, walnut and especially wenge the finished surface was not completely homogenous and smooth. The powder coating layer used in the one-coat-low system was, indeed, too thin and the larger pores of these veneers still appeared as small valleys in the coating surface.

Figure 3. Coated veneered particle boards; 1) ...Maple; 2)...Bamboo; 3)...Beech; 4)...Oak; 5)...Walnut; 6)...Wenge
Gloss values were influenced by coating thickness. The two-coat tests resulted in coating thicknesses above 180μm – 200μm and a significantly reduced gloss for all six types of veneered particle boards. A foggy appearance was observed with all two-coat tests. The highest gloss (after press) was obtained with “one-coat high” systems that led to medium coating thickness in the range 100μm – 140μm, for all six veneer types (Figure 3). Glossy surfaces were obtained, with gloss values around 65 - 75 gloss units.

**Conclusion**

Powder coating was successfully carried out on veneered particle boards using six types of wood veneers: maple, bamboo, beech, oak, walnut and wenge. Moisture content of the wood substrates could be controlled using a climate chamber. It was found that the surface electrical resistance values are significantly higher for maple, beech and walnut raw veneers, around 10^{11} Ω, while for bamboo, oak and wenge the values are around 10^{10} Ω, indicating suitable substrates for electrostatic powder application. The appealing glossy and mechanically resistant surfaces on wood veneers were created by melting and curing of the electrostatically applied Drylac 530 transparent powder layer at 130°C and 8 minutes, in hot pressing. Veneer surface was thoroughly characterized by Alicona 3D microscopy. The different veneer types showed different topography characteristics regarding roughness, porosity and absorbability that were reflected in the powder coating results. Results show that glossy surfaces with gloss values measured at 20° in the range 65 - 75 gloss units can be achieved by powder coating of veneered particle board surfaces followed by hot press curing. The optimum amount of powder specific for each wood type in order to create glossy high quality surface was identified. Surface quality tests showed that optimal results were obtained with one coat and coating thickness around 100 - 140 μm, for all six veneer types. The present study demonstrates that the solid wood-based materials like wood veneers can successfully be powder coated to yield surfaces of satisfactory property profile.

**References**


