APPLIED RESEARCH AND DEVELOPMENT FOR THE BENEFIT OF THE WOOD PROCESSING INDUSTRY

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ABSTRACT:

During the past 20 years, the Bern University of Applied Sciences, Architecture, Wood and Civil Engineering (BFH) was able to establish a strong and internationally recognized applied research and development department (aR&D) with focus on wood research. In order to satisfy the market requirements the about 120 employees of the aR&D department are organized in specialised research units. A main challenge of the units is to remain flexible and to adapt quickly their thematic competence like material sciences, product development, application test etc. to the changing market needs. The article in hand presents some selected aR&D projects of our institution.

1. INTRODUCTION

From Today's Facts to Tomorrow's Prospects – under this maxim the Swiss wood industry defines their needs related to aR&D.
The Bern University of Applied Sciences reacted to this needs with the establishment of applied R&D resources focused on innovative furniture products, windows and doors and wood construction and with a strong orientation to problem solving. Thereby BFH was able to become a well-recognized partner for different stakeholders of the national and international wood Industry.

Summarized BFH is providing following services to clients:

- Applied research and development
- Contract services
- Knowledge and technology transfer

In order to offer competent, flexible and market oriented solutions the aR&D department is organized in the following competence centres and research units:

Competence center "Wood Technology and Composite Construction"

- Research unit Materials and Wood Technology
- Research unit Facades, Finishing and Furniture
- Research unit Timber and Composite Construction

Competence center "Planning, Building and Manufacturing Processes"

- Research unit Architectural Processes
- Research unit Management and Building Processes
- Research unit Production and Logistics

Competence center Natural Phenomena and Geotechnics

It has to be stated that such a comprehensive "package of competences" is unique for Switzerland and Europe.

2. A SHORT OVERVIEW OF IN THE RESEARCH UNITS REALISED PROJECTS

2.1. Research unit Materials and Wood Technology

The unit focusses its attention on wood, a raw material, working material and building material. It develops and optimises wood based products as well as new multifunctional wood and wood composite materials. In adhesives and joining technology, they are leaders in welding of wood – both with and without adhesives. They also develop new, environmentally friendly adhesives systems for the wood sector. Developing new coatings and coating systems for wood and wood composites is a core competency in the field of research. At the same time the newly established competence of measuring and evaluating volatile organic compounds (VOC) emitted by materials and in ambient air is becoming more and more important.

2.1.1. Project: Ducta - Development of a 3-dimensional, flexible solid wood and wood based panel

The project contented the material development, the definition of geometry and the product development, including special applications (f. e. sound protection, interior finishings, furniture).

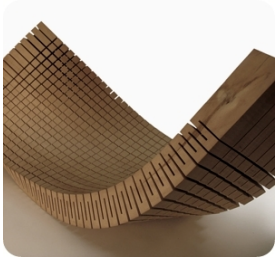

Figure 1: Example of DUCTA panel

In a second project step was developed the technology to use CNC-machinery for manufacturing the panels.

2.1.2. Project: Formable thin tannin- and long fibre based panels

For several years, the Research Unit has been working with a bio-sourced tannin- based resin extracted from tree bark. In collaboration with a design firm, it has produced thin panels made of long

natural fibres bound together with tannin-based resin. The fibres spread out in order to form a homogenous mat. This is then pressed under heat in order to give it the desired thickness of around 1mm. These panels can be post-formed when wet, with relatively small radii of curvature. After drying, the new form is retained. The resin is highly reactive, so pressing cycles can be short.

Figure 2: The long fibres and the phenolic glue are pressed under heat to form homogenous panels and can easily be put into the required form

There are many potential applications for such a process. The forming technique and the original aesthetics of the material give designers plenty of scope in terms of the forms and properties they are looking for. The ecological aspect is also important, since all the materials are based on natural and non-fossil materials

2.1.3. Project: welding for wood

The project contented the development and investigation on the thermo-hygro-mechanical behaviour of wood during and after a welding process and computer modelling of welding process.

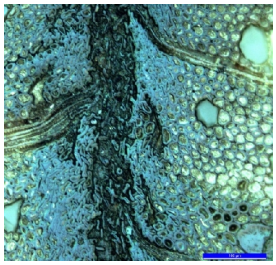

Figure 3: Microstructure of welded wood

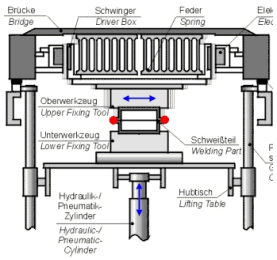

Figure 4: A type of wood welding machinery

2.2. Research unit Facades, Finishing and Furniture

As part of research projects and services to the industry, the unit develops and optimises products and processes in the areas of transparent facades, windows, construction elements, interior finishing and furniture. They take all aspects of development into account, from the requirements of building physics up to the characteristics and the processing of materials, from fabrication to logistics processes. In an internationally accredited laboratory can be tested the characteristics of construction elements and products for their suitability and safety in use. Besides, the unit works actively on standardisation issues within national and international committees and specialist groups.

2.2.1. Project: glued wood-glass assembly

The motivation of the project is based on the development of a construction for low-energy houses. In this context the question arose how to protect window wood frames better against weathering by reducing the cross-section of the frame and the manufacturing costs.

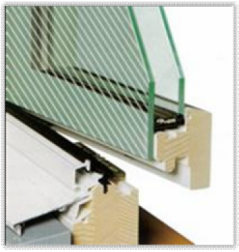

Figure 5: Example of a glued wood-glass construction for windows

The project contended the development of a new type of windows and the implementation of the manufacturing processes in several swiss companies. Today this type of products is established in the swiss market.

2.2.2. Project: Developing new composite materials for facades

The demands placed on building envelopes, in terms of building physics, present the manu-facturers of building materials with constant new challenges. Increasingly, opaque thin, facade elements in particular – such as parapet panels or cladding behind roller blind casings – fail to meet performance standards. Furthermore, the hygroscopic building materials used for these elements can no longer contend with the stresses imposed by modern, more compact, con-struction processes. In this context, the following issues are of particular concern: moisture absorption due to inappropriate storage on building sites, accelerated drying processes for buildings and overlapping construction phases. The project aimed to develop a new facade panel that would meet customers' greater requirements.

In January 2012, Tavapan SA, started production of the newly developed product Tavapet. The panels have very good building-physics characteristics, an attractive weight (core 80g/m3), are easy to use and can be employed in numerous areas.

Figure 6: Screening material cork

They stand out because: they are resistant to water and moisture, they are resistant to freezing water, they are resistant to alkaline water (concrete water), they have good thermic qualities U max= 0.45

W/m2K at a depth of 70mm), they have good mechanical qualities (pressure resistance, stability under load, resilience, ease of use with regard to screws, cutting and drilling) and they use recycled materials.

2.3. Research unit Production und Logistics

The unit explores automated finishing and logistics processes and the treatment of solid wood and timber-derived product surfaces, as well as the use of software for planning and controlling processes. The laboratories are equipped to a high technical level, enabling to contribute the scientific competences in practical and application-oriented ways to national and international research projects, or provide them as services directly to users. By employing modern CNC and robot technology, with the corresponding software, the researchers can simulate production processes from the data collection stage through to the end product. This allows them to appraise technical and commercial feasibility. The unit employees are pioneers in using RFID technology and apply this particularly to the construction of windows, wooden houses, kitchens and furniture.

2.3.1. Project: Clear Coat

Coating derived timber products with powder is a new and environmentally friendly technology for creating high-quality surfaces. Transparent powder varnishes are not being used yet on an industrial scale for wood or derived timber products. Based on the current lessons learned by powder manufacturers and coaters, was developed a technology that is likely to broaden considerably the range of applications for powder coatings on wood.

The potential for coating with clear varnishes provides mainstream furniture makers and wood processing concerns with a whole new range of possibilities. The powder coating makes it possible to manufacture substantially improved surfaces with characteristics that make them virtually scratch-resistant, make them emission-free during processing and use – there is no emission of VOCs – reduce wastage entirely or almost entirely during coating, facilitate good coating of edges and make them resistant to UV and chemicals.

The project aimed to determine the optimal process parameters for the pre-treatment, application, fusion and integration process for coating wood and veneer surfaces. There was built a semi-automatic, quasi-industrial test facility for powder-coating hanging construction elements.

Figure 8: Powder coating equipment

Figure 9: Variety of colours of powder coated MDF-surfaces

2.3.2. Project: Developing specific coatings for window tools

An important goal in the manufacturing of wooden window scantlings is achieving a level of milling quality that allows scantlings to be painted or varnished without sanding, or that, at least, reduces sanding to a minimum. In order to achieve this, the milling process needs to be optimised. The machines must operate with low vibration levels, while tools also play an important part in the quality of the scantlings' surfaces. One influential factor is the tools' cutting edge.

Together with industrial partners was developed a coating for tools that gives the cutting edges an operating life that is up to ten times longer than that of uncoated edges. Different types of nanostructured hard-material coating used in metal processing were combined and refined specifically with regard to processing and materials; the result was a coating that can be used in wood processing.

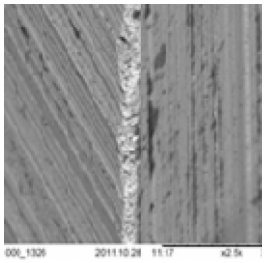

Figure 10: Microscope images of an unused coated cutting edge (left) and a used coated edge (right)

Figure 11: Coated milling tool

2.3.3. Project: RFID-based wood processing

A project to introduce radio frequency identification (or RFID-) technology in wood industry was realized in the last 2 years. This project contended the interface setup improvements and the economic impact in the wood industry.

Figure 12: Testing the RFID-technology in the manufacturing laboratory

After laboratory works the technology was implemented in several woodworking companies, f. e.

window makers and manufacturers of shop furniture.

3. CONCLUSION

Thanks to the close collaboration with the national and international wood industry the Bern University of Applied Sciences, Architecture, Wood and Civil Engineering was able to establish during the past 20 years a strong applied research and development department which contributes to the innovative and sustainable use of wood and wood based products.

The close link between material science, effective, economic and resource efficient manufacturing processes, the development of applicable solutions and new wood and wood-based products allowed BFH to become a unique institution in the wood sector.

Today the around 120 employees are dealing with a big number of mainly third party financed mandates, projects and services. Through the close collaboration with the different education departments (technicians, bachelor, master, further education etc.) the aR&D contributes to attractive conditions for the students and consequently to a well-educated cadre of the wood industry.

The article in hand shows only three examples out of the seven aR&D units but may show how and why the Bern University of Applied Sciences, Architecture, Wood and Civil Engineering became a leading aR&D institutions in Switzerland and Europe.

4. REFERENCES

More information you can find under **www.ahb.bfh.ch/research**