

Furniture finishing: the Canadian approach

Phil Evans, from the Department of Wood Science in the Faculty of Forestry at University of British Columbia in Vancouver, Canada, explains the development of a new suite of courses aimed at the wood finishing industry.

The furniture industry uses significant quantities of wood, which is invariably finished to enhance its appearance and protect from damage and dirt. But finishing can influence consumer perceptions of furniture quality – either positively or negatively.

The cost of finishing can be significant because multiple steps are involved in applying even the simplest finish, and finishing is difficult to automate. Expense and complexity are further increased by the demand in some market segments for furniture that is finished using environmentally friendly methods (low VOC or water-based). Furniture manufacturers need to respond accordingly by developing environmentally compliant, cost-effective ways of finishing that enhance product quality.

However, the industry in Asia, Europe and North America mainly consists of small-to-medium sized enterprises that often lack in-house technical expertise in wood finishing. As a result, it isn't surprising that many companies are looking externally for knowledge and training to help meet the finishing challenge.

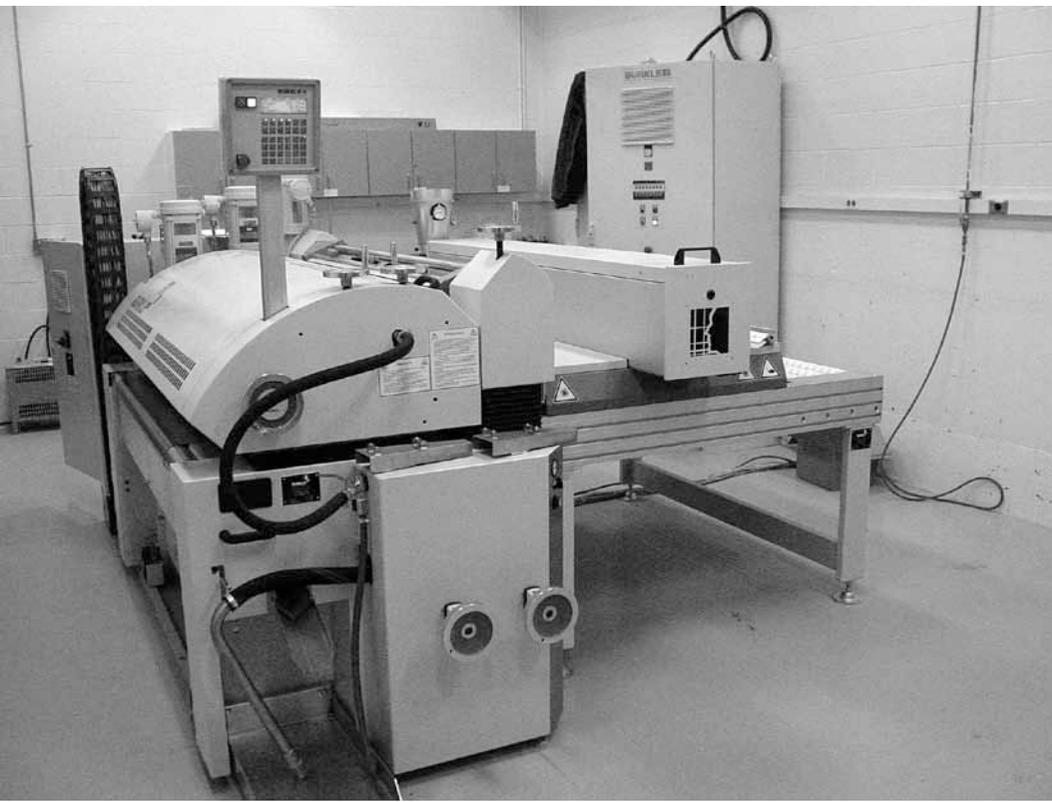
Formal training on wood finishing is hard to find, and the training that is available is often taught by vendors of coating materials or industrial machinery, who naturally enough focus on their areas of expertise rather than providing comprehensive instruction.

Wood finishing involves numerous practical skills and knowledge of a great diversity of subjects, including the material science of wood, physics (colour theory), chemistry (coating formulation and curing), engineering (design and operation of various application and curing equipment), economics and environmental science. There are few, if any, textbooks on the subject, especially ones that are suitable for higher level courses, and a lack of rigorous information on wood finishing in technical and scientific literature. The diversity of subject matter and skills involved in wood finishing, as well as the lack of relevant texts, are a formidable challenge to the development of comprehensive courses on wood finishing that meet the needs of educators and industry.

Meeting the training challenge

Phil Evans took on the challenge of developing a university course on wood finishing and also an industry certificate on the same subject when he joined the University of British Columbia in 2001 in Vancouver, Canada. University students taking the course in wood finishing as part of a Bachelors degree in wood products processing are based in Vancouver. In contrast, industry learners taking the certificate on wood finishing are drawn from across Asia, Europe and North America. Because the two groups of learners are geographically





Above

Pilot scale roller coater donated to the laboratory

Opposite left and right

Undergraduate students with furniture they have refinished as a part of their course on Wood Finishing

separated, a decision was made when developing the two courses to deliver information to both university and industry learners electronically using professional e-learning software (a course management system called Web-CT, now known as Blackboard). During the course, both groups work their way through 10 modules of online content covering every aspect of wood finishing at the rate of approximately one module per week.

University students apply the theoretical knowledge from the modules in practical exercises that are held every week for the duration of the course. They take three written exams to assess their theoretical knowledge of wood finishing and each student works as part of a group on a project to finish a piece of furniture. The project places students in a semi-realistic situation and gives them a good idea of the difficulty of finishing wooden furniture to a professional standard, as well as honing their practical skills.

Professional learners from industry complete and electronically submit a weekly quiz to test their theoretical knowledge using the Blackboard quiz tool. They also complete a written assignment where they relate course material to their own professional situation. Industry learners travel to Vancouver at the end of the university term to attend a week-long

practical training program. This program includes most of the laboratory exercises university students take during their course, as well as talks by guest speakers (for example, case studies and technology updates), demonstrations by vendors of new finishes and application technologies and factory visits.

University students and industry learners are brought together during the courses by a series of online discussions that involve answering open-ended questions on wood finishing. These encourage learners to relate their own practical experiences, pre-existing knowledge and opinions to the course subject matter. Both groups are asked to post at least one substantive original message and critique the postings of at least two other learners for each discussion. The involvement of both groups of learners in joint discussions prompts a richer exchange of knowledge and ideas than is possible with any single group. Participation in these e-discussions forms part of the assessed work of both groups.

Outcomes

University students have responded favourably to the novel format of the course, and the twinning of the course with an industry certificate. Many of the students have indicated that opportunities to relate theoretical content to the real world have helped them to gain a deeper understanding and better recall of the theoretical concepts introduced in the course. This is achieved by frequent



laboratory practicals, industry visits and exchanges with industry professionals in the e-discussions. Most e-students state that through the online discussions with industry learners they learned how the concepts introduced in the course could be applied to real industrial issues, thereby gaining an enhanced awareness of the contextual relevance of the subject matter. As a result, the undergraduate course in wood finishing is now one of the most highly ranked courses offered by the Faculty of Forestry at the University of British Columbia.

The response of industry learners to the course has also been very positive. They remark that they have benefited greatly from their online interactions with other industry participants, comment that they have substantially increased their knowledge of the field and applied the knowledge to make substantial improvements to the finishing operations of the companies they work for.

In addition to the benefits for course participants, the approach of educating university students and industry learners together has yielded additional benefits to the university. Firstly, the involvement of industry learners in the course has yielded valuable insights for the authors on what subject matter is most relevant to the world students will enter when they graduate, and this feedback has allowed us to make significant improvements to the course. Secondly, the involvement of industry learners has encouraged industrial equipment manufacturers to donate equipment to the teaching

laboratories of the university and provide guest speakers that have strengthened both courses. For example, one company donated a pilot scale roller coater to the Centre's laboratory after learning about the certificate program and the participation of learners drawn from several countries. The value of this single piece of equipment was greater than the entire annual capital budget for the laboratory.

Such an improvement to laboratory infrastructure benefits not only the certificate program, but also the practical elements of the undergraduate wood finishing course and the research capabilities of our graduate program. Finally, tuition revenues from the industry certificate have enabled the university to hire an additional laboratory technician to provide technical support for both courses.

Long-term plans

The lack of scientific information on many aspects of wood finishing in the technical literature looms large as an impediment to increasing the quality of the courses that we can offer to industry and university students. As a result, we decided very early-on to embark on a long-term program of research and development to acquire information on wood finishing that can support our teaching programs. As a first step we acquired some key pieces of equipment: a confocal surface profilometer and a laser spray-droplet particle size analyser that allow us to assess the quality of surface finishes and atomised spray plumes, respectively. These

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Above

Effect of wood moisture content on the colour of veneer panels stained with a red solvent-borne stain. The panels are sub-divided into three areas:

1 (top) = conditioned to 20% moisture content

2 (centre) = conditioned to 12% moisture content

3 (bottom) = conditioned to 6% moisture content

The left-hand side of each panel was coated with clear lacquer.

pieces of equipment complement our well equipped coating application and testing laboratories in UBC's Centre for Advanced Wood Processing.

Several research projects have been completed or are underway with the support of a research scheme in Canada (Natural Resources Canada, Value-to-Wood) that is tailored to the needs of small-to-medium sized furniture manufacturing companies. These projects include:

- grain-raising caused by the application of water-borne coatings to wooden furniture
- influence of wood moisture content on the colour of wood finished with stains and dyes
- cracking of water-borne coatings on wooden substrates
- finishing of oriented strand board with UV-curing coatings
- atomisation of coatings
- development of methods to reduce variability in colour of wood finished with dyes and stains
- plasma modification to alter the colour of wood finished with water-based stains and dyes

These projects are generating some of the information we need to turn wood finishing from an art into a science, and elevate the subject to the level that is required for a university course. For example, we are examining the factors affecting the colour of wood finished with stain, as mentioned above. Staining is a key step in the finishing of wood furniture and can be used to give wood a more attractive and even colour that mimics the colour of more expensive woods. Once this has been achieved, the colour needs to be reproducible within and between stained pieces by carefully controlling the staining process. Reproducing exactly the same colour during the staining of wood, however, is difficult in practice. Therefore there is a need to better understand the factors affecting the staining of wood, which could lead to better control of the staining process and less variation in the colour of stained wood and also possibly lower manufacturing costs due to prevention of defects and re-staining. One piece of work examined the effect of wood moisture content and clear coating on the colour of stained North American furniture woods. Very briefly we found that hardwood panels stained with a

red/brown stain at higher wood moisture contents of 20% were either significantly redder or darker than panels stained at lower moisture contents of 12 or 6 %. Clear coating made panels darker and redder. The moisture content of air seasoned wood in the Pacific Northwest of North America can vary from 13 % in summer to 22 % in winter and much lower moisture contents of 4 to 6 % have been recorded for wood stored indoors. Moisture content differences of this magnitude in veneer panels are likely to influence the colour of the stained wood and produce seasonal variation in the colour of finished wooden furniture components. Hence, our results suggest that companies that require a high degree of reproducibility of colour between batches of furniture should take care to ensure that the moisture content of their wood components does not greatly exceed the recommended wood moisture content for staining. These findings were subject to rigorous peer review and published in a scientific journal, and it is our intention to do the same with all of the work that we do. This practice should, over time, generate a large body of knowledge on wood finishing that the university community and industry can draw and build upon.

Wood finishing is an important part of the complex process of manufacturing furniture, but training in the area is often unsatisfactory, and the research needed to transform wood finishing from an art into a science is lacking. The teaching and research programs on wood finishing developed at the University of British Columbia are seeking to rectify these deficiencies, and the outcomes so far have been very positive. The courses developed have been very well received by industry learners and undergraduate students alike, and the research programs are providing important insights into the finishing of wood that are being shared more widely via the scientific literature. The long-term challenge will be to maintain the momentum that has been generated to date and extend the reach of the programs by partnering with other institutions and drawing more industry participants from across Asia, Europe and North America. We hope to be able to report on our progress in these areas in future.

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► **Further information**

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