

DEVELOPMENTS IN UNDERGRADUATE WOOD SCIENCE EDUCATION AT STELLENBOSCH UNIVERSITY, SOUTH AFRICA♣

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ABSTRACT

In South Africa, Stellenbosch University (SU) is the designated provider of Bachelor, Master and Doctorate level qualifications in Forestry and Wood Products Science. SU provides educational programs to both mechanical (sawmilling, preservation, composite products, furniture, etc.) and the chemical (pulp & paper) processing sectors. To ensure academic quality, SU regularly has her academic programs assessed externally. In 2000, several changes to the then existing 4 year B.Sc. Wood Science program were recommended. A restructured SU undergraduate program, similar to the B.Sc. Wood Products Processing program at the University of British Columbia (UBC), Vancouver, Canada, was consequently introduced in 2003. That same year, to provide more support to this effort, a partnership between UBC, SU and the Nelson Mandela Metropolitan University, the SA institution responsible for the National Diploma and Bachelor of Technology degrees in similar subjects, was established. The objective was to develop and deliver successful tertiary programs in value-added wood product processing education for South Africa and later, for other African countries as well. A Wood Products Processing Education Project, implemented in 2004 and running until mid 2010, funded by the respective partner institutions and the Canadian International Development Agency (CIDA) through the University Partnership in Cooperation and Development Program, was established. In addition to curriculum developments based on the UBC model, module content was modified to address relevant South African conditions. To make modules accessible to part-time students and members of industry off-campus, conversion of several Wood Products Science modules into e-learning format was implemented.

A concise overview of Wood Science education at Stellenbosch University is given and the implementation and progress of the CIDA project at SU is briefly discussed. Solutions to the educational needs of the SA pulp & paper sector are also highlighted.

Keywords: Wood products science, education, undergraduate program, pulp and paper, South Africa

INTRODUCTION

The Faculty of AgriSciences of Stellenbosch University (SU) offers two fields of study in Forestry and Natural Resource Science i.e. *Forest and Resource Management and Wood Products Science*. To support the South African commercial (plantation) forestry industry and to address environmental and community (agroforestry) issues, the Forest and Resource Management program focuses on providing tertiary education in silviculture, forest management and forest engineering. Value adding to the locally grown and imported timber resource into a variety of quality products is covered by the Wood Products Science program. The SU is the designated provider of Bachelor, Honours, Masters and Doctorate level qualifications in these fields of study and has provided many graduates to government and industry. Of the enrolments in Wood Science, a relatively high number of students continued with further post graduate studies.

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Over the last 30-40 years, the Department of Wood Science (DWS) has been active in the wide field of wood science and technology. Its educational programs offered to the timber industry can be broadly classified as focusing on the mechanical processing (sawmilling, preservation, wood composites, secondary processing, etc.) and chemical manufacturing (pulp & paper) sectors. Over the years and with National Government (Department of Forestry) support, excellent infrastructure was established at the SU to offer these educational programs and to conduct much needed research for the SA forestry and forest products industries. Since the early 1990s, this dedicated Forestry Department's Grant-in-Aid was phased out.

As experienced worldwide, student numbers in Wood Science at the SU have, relative to other science, engineering and technology programs, always been low. In attempts to address the unique needs and priorities of the SA timber processing industry but at the same time striving to make the academic program economically viable, program changes were made regularly. In the late 70's and 80's, based mainly on the recommendations by the Malherbe Committee (Malherbe 1975), appointed to evaluate Forestry and Forest Products education in SA, the 4-year B.Sc. Wood Science undergraduate program had a strong science and engineering focus and offered electives that catered for the needs of both mechanical and chemical processing sectors. Following recommendations from the Grant-in-Aid Control Board and the Industry Advisory Board, the pulp & paper training was made an elective in the undergraduate chemical engineering program. Full time, one year, post graduate diploma programs in either chemical or mechanical wood processing, in which only wood science and pulp & paper science modules were lectured, were also offered to students who completed suitable courses at other faculties such as engineering (industrial, chemical, mechanical) and natural science (chemistry, physics, biology). Although undergraduate training in pulp & paper was phased out in 1996, post graduate training in this direction continued. Later, to address the essential business skills required in mechanical, primary processing of timber, the B.Sc. program was again adjusted. At the same time, the SU went through a restructuring process in which faculties and departments were amalgamated to become more cost effective entities. These changes also impacted on the curricula.

In 2000, as part of the university's academic quality control system, the DWS was subjected to its first external departmental evaluation. The panel, consisting of Prof Xavier Deglise (from the École Nationale Supérieure des Technologies et Industries du Bois (ENSTIB) in Epinal, France, Prof Robert Kennedy (Faculty of Forestry, University of British Columbia (UBC), Vancouver, Canada and Mr. John Mortimer, Executive Director of the South African Lumber Millers Association (SALMA), held interviews with faculty, staff and students. In their report to the University, their two main recommendations were:

- establish a restructured (mechanical processing) undergraduate program with an emphasis on wood products (not only on the science of wood material and the conversion technologies).
- the re-establishment of research and education in pulp & paper, preferably at post graduate level.

Although the shift in emphasis suggested was towards wood products (their properties and performance), the importance of knowledge of the raw material, wood, as well as the conditions during processing (the technologies) was not reduced. The "wood products" description is not restricted to the primary products i.e. the beneficiated materials/products such as sawn boards, laminated beams, board composites, preservative treated poles, etc. End products such as joinery, furniture, civil constructions, etc. (i.e. wood products present in the so called "built environment"), would obviously be included as well. With a products emphasis the student is brought closer to the needs of the customers along and finally, the consumer at the end of the value chain. Over the years, several undergraduate pulp & paper modules were taught and research was undertaken at the DWS. Valuable and dedicated equipment such as an industrial wood chipper, chemical digester, thermomechanical pulper, mechanical pulper, laboratory paper machine, paper testing equipment and a small scale paper tensile strength tester was acquired. In the past, compared to the mechanical processing focused program, a relatively high number of post graduate

students had continued their studies in pulp & paper. As suggested by the second recommendation from the departmental evaluation report, a continuation to address the educational and research needs of the pulp & paper industry seemed logical.

The implementation of these two strategically important recommendations of the departmental evaluation report formed the action plans for the DWS. As the SU has always regarded education and research in forestry and forest products of strategic importance, considerable financial support from the university's strategic funds was made available. Since 2003 and after the amalgamation of the two faculties, Forestry and Agricultural Sciences, into the Faculty of AgriSciences, and the merger of the departments Forest Science and Wood Science into the Department of Forest and Wood Science (DFWS), efforts continued to achieve these objectives. On the staff side, these changes coincided with new appointments as some faculty members reached their retirement age.

Developments in Mechanical Processing

In 2000, the first three years of the four undergraduate programs offered by the then existing Forestry Faculty (consisting of the departments of Forestry, Wood Science and Nature Conservation) provided a general scientific education. Specialisation in Wood Science, Forest Science, Nature Conservation or Community Forestry occurred in the fourth year of study. A breakdown of the contribution of the different entities to the content of the B.Sc. Wood Science program offered in 2000 and 2010 respectively, is given in table 1.

Table 1. Comparison between module input (expressed as a percentage of the total credit value of the program) from various entities to the B.Sc. Wood Science/Wood Products Science programs in 2000 and 2010.

Year	Natural Sciences Faculty	Agricultural Sciences Faculty	Business Sciences Faculty	Engineering Faculty	DF or Forestry section of DFWS	DWS or Wood Science section of DFWS	Language Centre
2000	23	7	8	0	34	28	0
2010	10	0	0	46	5	37	2

The 2000 program received a considerable input (23% of the total credits) from natural sciences (biology, chemistry, physics and mathematics) and forestry (34%, made up by silviculture, forest management, forest engineering) and business management (8%). The Wood Science and Technology contribution of 28% was comparatively low and no engineering focus existed.

Following the departmental evaluation and subsequent proposals submitted to the SU administration by the DWS to bring back more wood science and engineering into the undergraduate program, a round table discussion with a large group of industry members was held where Prof Phil Evans was invited to present the B.Sc. Wood Products Processing program offered at his University of British Columbia (UBC), Vancouver, Canada. The results of the needs analyses performed for the Canadian timber industry (Barrett and Cohen 1996), the educational objectives identified and the applicability of UBC program content to the SA mechanical timber processing industry were discussed. This led to the formation of a Consultative Forum, chaired by and representing members from different sectors of the industry. A mandate was given to the DWS to obtain approval from SU administration and National Government to develop and implement a program similar to the UBC-model. The re-structured SU undergraduate

program was consequently introduced in 2003. Since then, modifications of the content to optimise the academic and practical relevance of modules received constant attention. The Consultative Forum met regularly to monitor progress and give guidance. Since inception of the restructured program, industry, government and SU have financially supported the program by making bursaries and funding for recruitment available.

The present content of this four year, multidisciplinary program for the mechanical processing of wood, is shown in Table 2. The program still focuses on “traditional” timber processing such as sawmilling, preservation and composites manufacture, but has been expanded to address the “built environment” (joinery and furniture). The program receives input from other departments/faculties on the Stellenbosch campus – see Table 1. The largest input (46% of the total credits of the program) is provided by the Faculty of Engineering, the 42% contributed by the DFWS is shared between Wood Science (37%) and Forest Science (5%), and 10% is provided by the Faculty of Science. After early necessary exposure to the basic natural sciences (chemistry and maths), the student learns about the unique characteristics (anatomical, physical and chemical) of the lignocellulosic, renewable material (wood), its behaviour during various value-adding processes and the properties and performance of wood and wood-based products. A description of the content of each module can be obtained on p112 and 113 of the Faculty of AgriSciences 2010 Yearbook.

The Industrial Engineering component of the program focuses on people and technological systems used in the timber industry with the aim of making timber based processing enterprises efficient and thus more competitive. This enables graduates to optimise design, implementation, operation, improvement and management of technological systems, which usually consist of people, equipment, information, capital, processes and procedures.

The science and engineering content of the program provides sufficient generic knowledge and skills to competitively process a renewable, biomaterial into useful, high quality, value added products.

Table 2. Module content and credit loading (in brackets) of the 4-year undergraduate B.Sc. program in Wood Products Science offered at Stellenbosch University.

(A 16 credit module typically consists of three 50 minute lectures and an afternoon (2-5pm) practical per week for 14 weeks.

Year	Language Centre (2%)	Science Faculty (10%)	Engineering Faculty (46%)	Forest & Wood Science Dept (42%)
1		2 x Chemistry (32)	2 x Engineering Maths (30)	Introduction to Wood Prod. Science (16)
		Applied Maths (15)	Strength of Materials (14)	Wood Anatomy & Identification (16)
		Computer Literacy (4)		Wood Chemistry & Preservation (16)
2	Professional Communication (12)		Engineering Drawing (14)	Wood Physics & Drying (16)
			Engineering Maths (15)	Introduction to Forest Science (11)
			Industrial Programming (15)	Mechanics of Wood Products (16)
			Production Management (15)	Adhesives & Composite products (16)
3			Engineering Economics (8)	Principles of Cutting & Tooling (16)
			Engineering Statistics (15)	
			Industrial Management (15)	Forest Finance & Economics (16)
			2 x Operational Research (30)	
			Quality Assurance (16)	
4			Enterprise Design (15)	Wood Products Manufacturing I (16)
			Environmental Engineering (8)	Design & Construction of Wooden Products (16)
			Industrial Ergonomics (15)	Wood Products Manufacturing II (16)
			Quality Management (15)	Forest Products Value Chain (16)
				Industrial Wood Finishing (16)

The program offers no electives, and like other SA engineering programs, runs for four years. In addition to the practical sessions for each module, all students taking the Wood Products Science programme must complete four periods of practical vacation work and submit satisfactory reports to the Department before the degree can be awarded. The description and scheduling of the compulsory practical work is given in table 3.

Table 3. Practical module content and schedule of the 4-year undergraduate B.Sc. program in Wood Products Science offered at Stellenbosch University.

Practical module	Description
Wood Products Science 211	Three weeks of practical work at Furntech, Cape Town, (one of six government supported industry training centres) in the December/January holidays (end of the 1st year or beginning of 2nd year)
Wood Products Science 241	One week chainsaw course in the September holiday of the 2nd year.
Wood Products Science 341	Three weeks of practical work in industry or on a research project in the Department in the December/January holiday (end of the 2nd year or beginning of 3rd year) and/or the June/July holiday of the 3rd year*.
Wood Products Science 441	Three weeks of practical work in industry or on a research project in the Department in the December/January holiday (end of the 3rd year and beginning of 4th year) and/or the June/July holiday of the 4th year*.

*A satisfactory written report must be submitted to the Department within two weeks after completion of the work, followed by an oral presentation of the report.

That same year (2003), to provide more support to this effort, a partnership between UBC, SU and the Nelson Mandela Metropolitan University, the SA University responsible for the National Diploma and Bachelor of Technology degrees in similar wood related subjects, was established. The objective was to develop and deliver successful tertiary programs in value-added wood product processing education for South Africa and later, to extend this to other African countries as well. A Wood Products Processing Education Project, implemented in 2004 and running until September 2010, funded by the respective partner institutions and the Canadian International Development Agency (CIDA) through the University Partnership in Cooperation and Development Program, was established between the three universities. In addition to providing content for new modules, the CIDA sponsored re-structuring and development of the B.Sc. program at SU included conversion of several Wood Products Science modules into a digital (e-learning) format. As seen in table 4, five modules in the SU Wood Products Science program are being offered electronically via the internet or university intranet and efforts are under way to obtain funding for the conversion of the remaining five blended learning modules. The learning material of these modules is presently only available in digital and paper media and/or prescribed text book format.

Table 4. Distance Learning Status and Module Implementation

Year	Semester (2010)	Modules	Electronic or Blended Distance learning	Lecturer
1	1	Introduction to Wood Prod. Science		M. Meincken
	2	Wood Anatomy & Identification	Blended	L. Tyhoda/T. Rypstra
2	1	Chemistry & Preservation	Blended	L. Tyhoda/T. Rypstra
	2	Wood Physics & Drying	Blended	M. Meincken
	2	Introduction to Forest Science		Forest Science
	2	Mechanics of Wood Products	Blended	B. Wessels
3	1	Adhesives & Composite Products	Blended	T. Rypstra / M. Meincken
	1	Forest Finance & Economics		Forest Science Section
	2	Principles of Cutting & Tooling	Electronic	B. Wessels
	2	Forest Finance & Economics		Forest Science Section
4	1	Products Manufacturing I	Electronic	B. Wessels
	1	Design & Construction (Wooden Products)	Electronic	B. Lötter
	2	Products Manufacturing II	Electronic	B. Lötter
	2	Forest Products Value Chain		Forest and Wood Science
	2	Industrial Wood Finishing	Electronic	B. Lötter

2010

2011

With the restructured program and teaching improvements (e.g. e-learning conversions), the SU can now begin to address the tertiary level, Wood Products Science education needs of industry members by means of part-time/distance learning. From 2010, five WPS modules are offered on a distance learning basis with five more being available in 2011.

Developments in Chemical Processing

Strong ties with PAMSA, the SA industry association representing the pulp & paper (P&P) companies, and close cooperation with the SU departments of Process (Chemical) Engineering and Microbiology exist. To stimulate innovation in the P&P sector, and attract and retain highly skilled manpower, PAMSA has embarked on a long term project to sponsor nine new M.Sc. Engineering students and their projects at the five SA universities offering chemical engineering, annually for the following nine years. Each sponsorship consists of a R80 000 bursary/year for two years and R 100 000 towards the running costs of the masters project. Additional funding for each project is generated from National Government through programs such as the Technology and Human Resources for Industry Program (THRIP). During and after the study, a mentor is appointed from the P&P company with whom the student has signed an employment contract. Another important condition of the masters study is that each PAMSA sponsored student must successfully complete two basic Wood Products Science modules (Wood Chemistry and Wood Anatomy) offered by SU. Although only six were approved for 2010, three of the PAMSA sponsored M.Sc.Eng projects were awarded to SU. The involvement of and collaboration between the three faculties and their

departments i.e. AgriSciences (Forest and Wood Science), Engineering (Process Engineering) and Natural Science (Microbiology) have created a very strong initiative to make SU a logical tertiary knowledge partner for the P&P industry. Through this close collaboration, Process Engineering has invested close to R 150 000 in upgrading the Wood Science laboratory this year.

Practicals, tests and examinations

Full time students (on campus) attend scheduled lectures and practical sessions. To accommodate non-residing campus students, part-time/distance learning students must at the end of each semester also attend the practical sessions of each WPS module on the SU campus. Two one week practical sessions (in June and November) have been arranged.

The performance of part-time/distance learning students is assessed in the same way as for full time students. Tests, official examinations, assignments, etc. are written at assigned locations or completed through the internet. A certificate stating modules successfully completed is issued to the student.

Admission requirements

As the WPS program consists of 46% engineering, the admission requirements for full time undergraduate WPS students are the same as for Engineering. A National Senior Certificate, Maths level 5, Physical Sciences level 5 and a Language level 4 are required from high school graduates. Part-time students enrolled for one or more WPS modules must have (an) appropriate qualification(s) as well as the National Senior Certificate with an average >50%, Maths and Physical Sciences. These students are registered as Special Students at SU and get full recognition as all modules completed are registered at the national Department of Higher Education. The qualifications of students from outside SA are evaluated by the university's International Office during enrolment.

Further graduate studies (i.e. Honours, Masters and Doctoral) are possible on successful completion of the B.Sc. program or of selected modules by students holding appropriate first degrees such as in engineering or the natural sciences.

Student numbers

Attracting students to enroll for wood science and technology or wood product programs has always been difficult. In SA specifically, the supply of high school graduates with the required qualifications in Maths and Science to enroll for Engineering (and Wood Products Science) is low (0.5% of all high school graduates). Much more general and specific information on careers in Engineering, Medicine, Science and Agriculture than in the timber processing industry is available to school leavers. With only 1.1% (1.3 Mha) of the total land area of SA covered by manmade forests and a building culture in which bricks and mortar are dominantly used, a wood products scientist is not a well known profession and dedicated marketing/recruitment strategies are required to attract school leavers and students. As seen in Table 5, attracting students has so far showed variable success. For the initial three years since 2003, the services of recruiting officers were obtained but as a result of frequent staff changes because of the employment contract not being permanent, continuity and follow-up, necessary to make these efforts successful, could not be maintained. However, it is envisaged that part-time/distance learning student numbers will now increase substantially. The part-time/distance learning opportunity offered by the DFWS can now provide the undergraduate student numbers required to make WPS modules economically viable for the department (and the university) and just as important, to increase post graduate numbers to get improvements in R&D in industry going.

Table 5. First year and Part-time/Distance learning student numbers

Year	Full-time	Part-time
2003	1	0
2004	9	2
2005	10	1
2006	5	2
2007	8	0
2008	8	0
2009	2	1
2010	11	9

The development of a marketing plan was also part of the CIDA project. Based on market research conducted, the following realistic objectives formulated for SU are

- to increase annual enrolment in WPS at SU to 10 new students with a minimum of 7 per year graduating with a B.Sc. in WPS by 2014
- to establish a continuing education program built around the e-learning modules that would mount five modules per year for 15 - 25 industry participants by 2011
- to get the message out to all stakeholders and the general public that the forest and wood products industries are sensibly and sustainably managed and have a significant positive environmental and economic impact on the country.
- to enrol two African universities in a business relationship whereby the e-learning modules are offered through their institutions on a negotiated basis by 2011-2012

Although the SU undergraduate program addresses the needs of the SA industry, the generic composition and content of various modules can provide a comprehensive knowledge base for timber industries in other African countries, irrespective of whether timber is grown locally in plantations or natural forests, or imported.

Future developments

In addition to necessary module and program maintenance, the following developments are envisaged:

- implementation of the Marketing Plan (including the appointment of a part-time, permanent recruiting officer)
- roll out of teaching the 10 WPS modules to part-time students
- discussions with two African universities
- application for funding to convert remaining (and other) modules to e-learning format (Both UBC and SU will be involved)
- establishment of a Centre of Competitiveness, funded by the national Department of Trade and Industry, for the furniture industry.

CONCLUDING REMARKS

It is envisaged that the educational developments at Stellenbosch will in the short to medium term make a positive impact on efforts to alleviate the acute technical skills shortage in the SA timber processing industry. By creating a sound undergraduate foundation in science and engineering, the possibilities to initiate and undertake innovation in R&D will be enhanced and make the SA timber industry involved in primary, secondary and further processing globally more competitive. Capabilities of the DFWS to network with industry, other departments on the SU campus and learning institutions within and outside SA, can make transfer and generation of knowledge much more cost effective.

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