

# Curriculum Innovations in Design and Technology at the University of Botswana, Southern Africa

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## Abstract

The paper describes the rationale, methodology, and outcome of several innovations in developing the curriculum in design and technology for teacher education at the University of Botswana. The rationale for the development was to bring the curriculum up-to-date in the face of developments in design and technology in Botswana, and other parts of the world. The university's decision to semesterise all programmes of study commencing 2002-03 accelerated the process of curriculum development. The exercise involved a number of formally constituted bodies consisting of stakeholders from academia, government and industry. The final programme structure incorporating the new curriculum and regulations have been approved by the Departmental Board, Departmental Advisory Board, Faculty Executive, Faculty Advisory Board, the University Academic Policy Review and Planning Committee as well as the Senate.

The new curriculum has a number of distinctive and innovative features, which transform the programme from the Bachelor's Degree of Education (design and technology) into Bachelor's Degree of Design (design and technology education). It commences with building a science-based foundation followed by basic engineering principles. Courses in the area of education are offered alongside courses in design and technology as professional studies, culminating in projects in the areas of design and technology and education. The emphasis on 'design' is comparable with the emphasis on the 'hardware and software of technology'. Finally, it permits flexibility in terms of student-determined choices through a number of optional, elective and general education courses.

## Introduction

The Department of Technology and Educational Studies (DTES) in the Faculty of Engineering and Technology (FET) at the University of Botswana (UB) is the only place in Africa which has been offering a programme of study leading to a Bachelor's Degree of Education (BEd) (design and technology) since 1993. The programme has been going on without any significant change in the curriculum, which was drafted by a British team in 1980. It is surprising that this should be the case in the face of changing technology and philosophy of design and technology in different parts of the world. As a matter of fact, the DTES proposed to change the curriculum two years ago, but the same was postponed awaiting the introduction of a

semesterised system at university level. The department has been aware of the shortcomings in the existing curriculum including the following:

- total absence of basic courses in science and mathematics in the programme and hence a weak scientific basis of the programme
- lack of courses in design, i.e. graphic design, processes of designing, cultural influences on design, environmental issues, human factors in design, economic influences on design, contemporary design issues, etc.
- lack of courses in analytical skills and technology, i.e. mechanics, structures, mechanisms, control systems, etc.
- lack of flexibility in terms of student-determined choices
- too much emphasis on acquiring craft knowledge and skills i.e. wood work metal work, technical drawing, etc.
- over-emphasis on project work in relation to course and tutorial work
- too early exposure to courses on education and teaching methods, i.e., as early as in the first year of the 5-year programme
- lack of emphasis on research methodology in education and in designing
- too prescriptive in terms of assignments and assessment.

On top of the above shortcomings, the existing curriculum lacks emphasis on creativity. Kimbell (2000) has highlighted the need to foster creativity in teacher education for design and technology, quoting research conducted for the Design Council and regretting the absence of even a mention of creativity in the '65-statement acceptable level of performance of teachers' formulated by the UK's Teacher Training Agency. There is a lack of risk-taking and creative endeavours through critiques of existing products, design case studies, self-initiated projects and research tasks in the existing curriculum.

The University announced its plans to semesterise all academic programmes with effect from the year 2002. The Department entered into critical thinking and greater interaction across the globe and took the opportunity of reviewing the entire design and technology curriculum while bringing it into the semesterised format. Design and technology programmes in the UK, Canada and Australia were studied in detail. It was agreed to incorporate several new features including making it science-based while

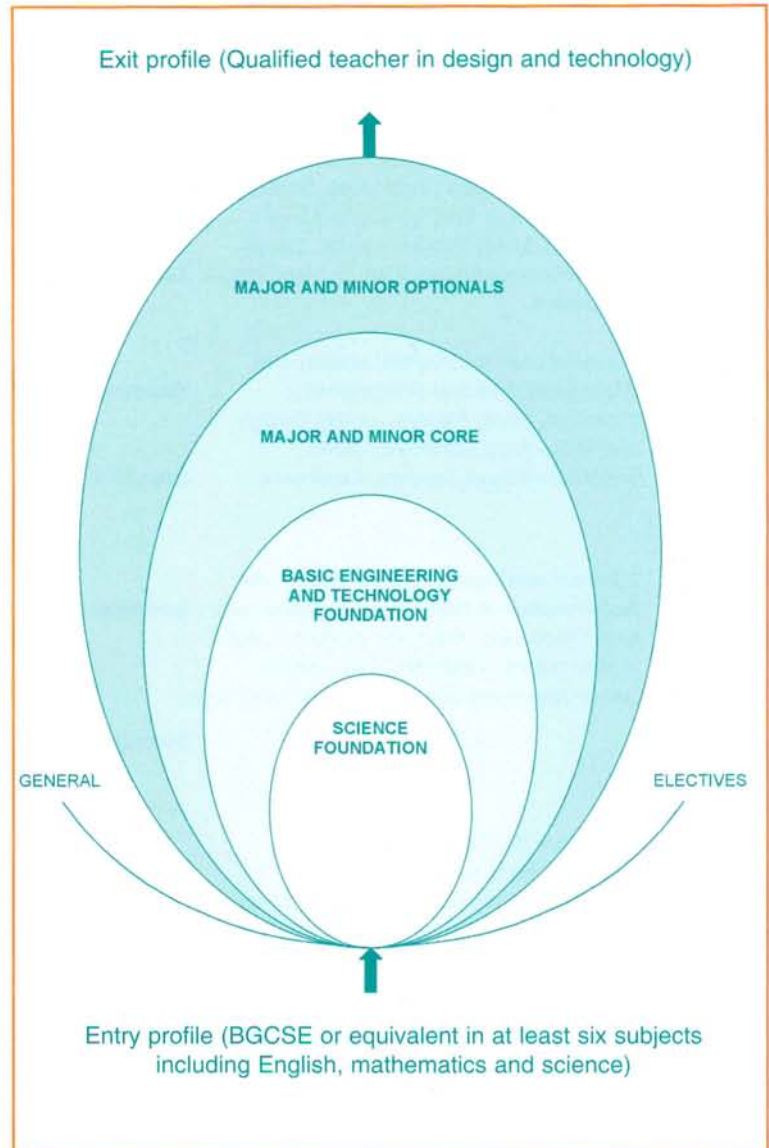


updating the curriculum into a Bachelor's Degree of Design (design and technology education).

#### Rationale of the new curriculum

It was considered prudent to lay down some overarching and philosophical guidelines before getting into details of the programme. Over the years, design has come to be recognised as a new discipline just as science, engineering and social sciences. Firstly, principles of design, history of design, theories of design, ergonomics, and aesthetics are well documented to be taught in the classroom. Secondly, it is now understood that developing design sense in students is instilled by way of considerable cognitive input together with related hands-on design experience. It is also recognised that a set of hands-on experiences and some experiments are necessary for all students to gain confidence before they are assigned projects. Teaching methods have also changed over the years. Case studies and project methods of teaching with emphasis on critical thinking result in mastery learning and development of the affective domain. It is well known that curricula are influenced by the environmental factors. It is particularly true for design and technology in relation to its content and emphasis because the programme is offered in different faculties, e.g. Education, Technology or Design. Being located in the FET in a developing country, we proposed that the students of design and technology should have a better background in physical sciences and mathematics as prescribed for science and engineering students. We have also decided that there should be some further common courses with the engineering students at the second year level. All the same, we believe that the introduction to design must commence early in the programme, unlike that in engineering disciplines. It was also agreed that the students of design and technology would share all the facilities in the common work areas for all Departments in the Faculty. A schematic of the programme structure drawn with the above rationale in mind is shown in Figure 1. The programme of study aims at producing prospective schoolteachers in the subject of design and technology. The intended exit profile of a graduate includes the following abilities:

- plan, prepare and teach courses in design and technology through lectures, demonstrations, supervised projects and other creative activities
- plan and provide project based learning experiences to individual students through guided discovery and strategic teaching-learning techniques



- review and update the prescribed curricula and motivate students to opt for careers in the area of industrial design and technology.

In view of the above and in a bid to overcome all the major problems with the existing programme, the courses have been drafted for the new programme and the same are tabulated alongside the courses in the existing programme, UB Calendar (2000-2001), as shown in Table 1.

#### Semesterisation at the University

The University spelt out the semester system of study in detail and all faculties were asked to commence their semesterised programmes in the year 2002. A semester is defined as one of the two annual 14-week periods of teaching. A course is a basic building block of teaching and learning activities with content designed to meet the prescribed aims and objectives, standing on its own. The

Figure 1: Programme Structure: BDes (design and technology Education) Major in design and technology; Minor in Education



Table 1: Comparison of current and new programmes.

	Current programme		New programme
	<b>BEd (design and technology)</b>		<b>BDes (design and technology education)</b>
Year 1	Introduction to Schools and Learning, Communication and Study Skills, Design and Technology, Practical Competence 1 (Graphics, Metal, Plastics, Wood), Design and Technology Foundations, Primary School Experience.	<b>Semester 1</b>	Communication and Study Skills, Computer and Information Skills, Mathematics 1. Plus at least two from: Biology 1, Chemistry 1, Physics 1.
		<b>Semester 2</b>	Communication and Study Skills, Computer and Information Skills, Mathematics 2. Plus at least two from: Biology 2, Chemistry 2, Physics 2.
Year 2	Pupils as Learners, Communication and Study Skills, Practical Competence 2 (Graphics, Metal, Plastics, Wood), Design and Technology, Community Junior Secondary School Teaching Experience.	<b>Semester 3</b>	Elements of Design, Workshop Technology 1, Engineering Drawing, Engineering Materials, Statics, Electrical Principles 1
		<b>Semester 4</b>	Designing Artefacts, Workshop Technology 2, Manual and Computer Aided Drafting, Dynamics, Strength of Materials, Analogue Electronics.
Year 3	Teachers and Teaching, Organisation and Administration of Education, Information and Data Processing, Electronic Product Design, Human Needs, Aesthetics, Ergonomics, Senior Secondary School Teaching Experience.	<b>Semester 5</b>	Design, and Technology and Society, Aesthetics, Ergonomics, Materials Processing, Principles of Learning. Plus at least two options from: Internet for Designers, Food Technology, Textiles and Leather Technology.
		<b>Semester 6</b>	Graphics, Digital Electronics, Pneumatic Controls, Product Analysis, Teaching Methodology, Industrial Training for Design.
Year 4	Curriculum Studies, Computer Control, Education for Industry and Industrial Placement, Design for Production, Student Initiated Project, Senior Secondary School Teaching Experience.	<b>Semester 7</b>	Computer Aided Design, Hydraulic Controls, Product Design 1, Educational Technology, School Teaching Practice. Plus at least two options from: Special Human Needs, School design and technology Projects, Design for Sustainable Rural Development, Interior Design.
		<b>Semester 8</b>	Product Design 2, Minor 'Design and Make Project'. Plus at least two options from: Educational Testing and Evaluation, Curriculum Studies, Philosophy of Education. Plus at least one option from: Ceramics Glass and Stone Technology, Applied Thermodynamics, Safety and First Aid Certification.
Year 5	Contemporary Issues in Education, Major Project. Plus one option from: Education Policy and Management, Introduction to Guidance and Counselling, Educational Measurement and Statistics.	<b>Semester 9</b>	Major Design Project, Research Project in design and technology Education. Plus at least two options from: School Organisation and Management, design and technology School Curriculum Innovations, Product Design 3, Industrial Product Design, Microcomputer Controls
		<b>Semester 10</b>	Major Make-and-Evaluate Project. Plus at least two options from: Case Studies in Designing, Computer Based Manufacture, Environmental Factors in Design. Plus at least two options from: Guidance and Counselling, Education Policy and Management, Educational Measurement and Statistics.



University prescribed that all programmes should be classified as single majors, major-minors, etc. and be structured into core, general education, elective and optional courses. Accordingly, the new Programme was proposed to be a major-minor programme with major in design and technology and minor in education. It was, therefore, designated as BDes (design and technology education).

The process of reviewing a programme at the University is long and complicated, but the bureaucratic process turned out to be a blessing in disguise because it gave us several opportunities to revise and modify the new programme from different perspectives and to come up with some innovations. The entire process commenced with a draft by the Head of the DTES, which was considered by the Departmental Board in its several meetings. It was discussed threadbare. The new programme structure and regulations were then considered by the Departmental Advisory Board (DAB). The role of the DAB was to act in an advisory capacity on the new programme. Chaired by the Head of the Department, the DAB consisted of representatives of various stakeholders and the Faculty and selected members of staff of the Department. The new programme structure and regulations incorporating recommendations of the DAB were then submitted to the Faculty Executive, which advised the Department on the Programme structure and regulations. Its membership consisted of the Dean, Heads of Departments, tutors and faculty representatives. The new programme structure and regulations incorporating the recommendations were then submitted to the Faculty Advisory Board (FAB) for their consideration. The role of the FAB was to act in an advisory capacity on all the revised and new programmes. Chaired by an eminent industrialist of the rank of a former Permanent Secretary, its membership included senior representatives of various stakeholders, Dean FET and the Heads of Departments. The new programme structure and regulations incorporating the FAB recommendations were then fine tuned and submitted to the University Academic Policy Review and Planning Committee and the Senate. The programme has thus been considered and approved by a number of formally constituted bodies.

#### **Proposed programme structure**

The programme is designed for 10 semesters of study over a period of five years. The programme structure is shown in Table 2.

In Semesters 1 and 2, design and technology students attend courses of the Bachelor's

Degree of Science (BSc) Programme, together with engineering students, offered by the Faculty of Science. In both semesters, the students shall take courses in mathematics and at least two other subjects from biology, chemistry and physics.

In Semesters 3 and 4, the design and technology degree programme students will attend most of the common core courses meant for all degree students of the FETL together with introductory design courses.

In Semesters 5 to 10, the design and technology degree students will attend the professional and associated courses in the area of design and technology offered by the DTES and in the area of education offered by the Department of Educational Foundations.

A student shall be awarded a qualification only after completing a minimum of 150 credits in the BDes (design and technology education) programme where at least two thirds of the total credits must come from core and optional courses prescribed in the programme, and the total number of credits from electives and general education courses must not exceed one third of the total credits.

General education courses can be selected from the following:

Area 1: Communication and Study Skills

Area 2: Computer and Information Skills

Area 3: Modes of Inquiry and Critical Thinking

Area 4: Physical Education, Health and Awareness

Area 5: Science and Technology

Area 6: World Civilisation

Area 7: World Economy and Business Skills.

All undergraduate students must, during their first two semesters, take general education courses (at least four credits) in each of Areas 1 and 2. In addition, students must take courses, selected from Area 3 (at least two credits), and from at least two areas out of Areas 4, 5, 6 and 7 (at least 10 credits) before completing their programme of study.

#### **Explanatory notes in respect of the above programme structure:**

- The academic year shall comprise of two semesters, each consisting of 14 teaching weeks, a 1-week mid-semester break, a 1-week study/revision period and a 1-week examination period.



Table 2: BDes (design and technology education) programme structure.

Level 100	Semester 1	As specified for the B.Sc. Programme in the Faculty of Science, which consists of courses in Mathematics and at least two other subjects from Biology, Chemistry and Physics.
	Semester 2	
Level 200	Semester 3	DTB 210 Elements of Design (3 Credits, Core) DTB 211 Workshop Technology I (2 Credits, Core) MMB 211 Engineering Drawing (2 Credits, Core) CCB 211 Engineering Materials (2 Credits, Core) CCB 212 Statics (2 Credits, Core) EEB 211 Electrical Principles I (2 Credits, Core)
	Semester 4	DTB 220 Designing Artefacts (3 Credits, Core, Pre-requisite DTB 210) DTB 221 Workshop Technology II (2 Credits, Core, Pre-requisite DTB 211) MMB 221 Manual and Computer Aided Drafting (2 Credits, Core, Pre-requisite MMB211) MMB 222 Dynamics (2 Credits, Core) CCB 221 Strength of Materials (2 Credits, Core) EEB 323 Analogue Electronics, (3 Credits, Core) 1
Level 300	Semester 5	DTB 311 Design, Technology and Society (2 Credits, Core) DTB 312 Aesthetics (2 Credits, Core) DTB 313 Ergonomics (2 Credits, Core) DTB 314 Materials Processing (3 Credits, Core) EDT 311 Principles of Learning (2 Credits, Core)  <i>In addition, all students shall select at least two of the following optional courses:</i>  DTB 315 Internet for Designers (2 Credits, Option) DTB 316 Food Technology (2 Credits, Option) DTB 317 Textiles and Leather Technology (2 Credits, Option)
	Semester 6	DTB 321 Graphics (3 Credits, Core) EEB 322 Digital Electronics (3 Credits, Core) DTB 323 Pneumatic Controls (2 Credits, Core) DTB 324 Product Analysis (3 Credits, Core) EDT 321 Teaching Methodology (2 Credits, Core) DTB 300 Industrial Training for Design [Vacation, 4 weeks] (2 Credits, Core)
Level 400	Semester 7	DTB 410 Computer Aided Design (3 Credits, Core) DTB 411 Hydraulic Controls (2 Credits, Core) DTB 412 Product Design I (3 Credits, Core) EDT 411 Educational Technology (2 Credits, Core)  <i>In addition, all students shall select at least two of the following optional courses:</i>  DTB 413 Special Human Needs (2 Credits, Option) DTB 414 School D&T Projects (2 Credits, Option) DTB 415 Design for Sustainable Rural Development (2 Credits, Option) DTB 416 Interior Design (2 Credits, Option, Pre-requisite DTB 312) EDT 400 School Teaching Practice [Vacation, 6 weeks] (3 Credits, Core)
	Semester 8	DTB 422 Product Design II (2 Credits, Core) DTB 423 Minor 'Design and Make Project' (2 Credits, Core)  <i>In addition, all students shall select at least two of the following optional courses:</i>  EDT 421 Educational Testing and Evaluation (2 Credits, Option) EDT 422 Curriculum Studies (2 Credits, Option) EDT 423 Philosophy of Education (2 Credits, Option)  <i>In addition, all students shall select at least one of the following optional courses:</i>  DTB 421 Ceramics, Glass and Stone Technology (2 Credits, Option) MMB 420 Applied Thermodynamics (2 Credits, Option) DTB 424 Safety and First Aid Certification (2 Credits, Option)

Table 2: BDes (design and technology education) programme structure (continued).

Level 500	Semester 9	DTB 511 Major Design Project (3 Credits, Core) EDT 511 Research. Project in D&T Education (3 Credits, Core)  <i>In addition, all students shall select at least two of the following optional courses:</i>  EDT 512 School Organisation and Management (2 Credits, Option) DTB 512 D&T School Curriculum Innovations (2 Credits, Option) DTB 513 Product Design III (2 Credits, Option) DTB 514 Industrial Product Design (2 Credits, Option) DTB 515 Microcomputer Controls (2 Credits, Option)
	Semester 10	DTB 521 Major Make-and-Evaluate Project, (3 Credits, Core)  <i>In addition, all students shall select at least two of the following optional courses:</i>  DTB 522 Case Studies in Designing (2 Credits, Option) DTB 523 Computer Based Manufacture (2 Credits, Option) DTB 524 Environmental Factors in Design, (2 Credits, Option)  <i>In addition, all students shall select at least two of the following optional courses:</i>  EFM 560 Guidance and Counselling (3 Credits, Core) EFS 411 Education Policy and Management (3 Credits, Option) EFP 562 Educational Measurement and Statistics, (3 Credits, Option).

- The number of credits is assigned to a course in relation to the work required.
- Core courses are those which must be taken in order to meet the requirements of an award, that is, they are compulsory or mandatory.
- Optional courses are those courses which may be selected from a list of courses within a subject of study and which count towards the requirements of an award.
- Elective courses are those courses which may be selected from a list of courses outside a subject of study and which count towards the requirements of an award.
- General Education courses are those courses which enhance university education so that it is broadly based, promotes critical thinking, intellectual growth, broader perspective in analysis of issues, and general skills for life-long learning.

#### Plus points of the new curriculum

The new programme has a number of merits over the old programme, some of which are as follows:

- improved student development in terms of knowledge in science, technology and design as well as skills in designing, making and evaluating artefacts
- improved student determined choices for general education, elective and optional courses and their timing

- greater flexibility in terms of accumulating credits to complete the programme
- improved student preparation for teaching in the school sector.

#### The new curriculum and design and technology education in schools

Botswana is the only country in the region where design and technology is taught as a core subject in junior secondary schools and as an optional subject in senior secondary schools. Likewise, Botswana is the only country in the region where a design and technology programme to prepare teachers for schools exists at the University level. It is, therefore, important to examine the synergy between the new design and technology programme at the University and the latest review of the design and technology curricula at the junior and senior school levels.

The Western Cape Education Department in South Africa (2001) has proposed the subject of technology in Curriculum 2005 to be offered as *Intermediate* and *Senior* phase knowledge. Interestingly, their definition of 'Technology and Technological Capability' includes a great deal of 'Design Capability' making the course description similar to the design and technology course description as taught in Botswana.

#### Design and technology education at the 3-year Junior Certificate Level: Botswana

It is interesting to analyse the design and technology curriculum of the 3-year Junior Certificate Programme and examine its



correlation with the new design and technology degree programme. The Junior Certificate design and technology curriculum, revised by the Curriculum Development Division, Ministry of Education (1996), is based upon the following perceived goals:

- develop sound knowledge, skills, values and attitudes, as students manufacture useful artefacts
- stimulate creativity and imagination in students as they solve real-life problems in their communities
- provide flexibility to allow for varied interpretation of the syllabus according to local context of each community
- equip students with entrepreneurial skills to enable them to market their products effectively
- enable students to communicate through a variety of media while solving real-life problems
- enable students to apply scientific and technological knowledge and principles, knowledge from other subjects and other relevant sources, in problem solving activities related to their communities
- make students aware of the economic potential in their communities
- develop in students, an appreciation of their environment and to enable them to perceive problems in their communities as a challenge and a potential source of income
- enable students to incorporate indigenous materials and technologies into their design and technology activities
- give students satisfaction and a sense of pride, as they see their products being useful to their communities
- enable students to contribute to the economic, social and environmental development of their immediate communities and their country when they leave school.

The curriculum commences with Safety Precautions and First Aid in year 1. It deals with materials, e.g. timber, boards, metals, plastics, adhesives, abrasives etc. and moves to graphics communication. It dwells on practical skills of marking out, wasting techniques, joining, forming, deforming and finishing methods. Hand tools and power tools are introduced. In year 2, the curriculum expands on materials and communication and introduces the design process. Structures, mechanisms and basic electricity are

introduced. Practice is provided on the practical skills introduced earlier. In year 3, additional materials are introduced and a major design project is spelt out. There is also some further coverage on communication, technology, practical skills, tools and equipment.

It is noticed that all the goals laid down for the Junior Certificate programme design and technology curriculum are adequately covered in the new design and technology education curriculum at the University. Further, design and technology teachers are prepared through courses such as Elements of Design, Workshop Technology 1 and 2, Engineering Drawing, Engineering Materials, Electrical Principles 1, Designing Artefacts, Manual and Computer Aided Drafting, Strength of Materials, Analogue Electronics, and several other courses in the area of design and technology. In fact, the new design and technology education programme prepares the teachers far more in theory and on practical skills than that required for teaching at the Junior Certificate level.

#### **Design and technology education at the 2-Year Senior Secondary Level: Botswana**

It is also interesting to analyse the design and technology curriculum of the two-year Senior Secondary programme and examine its correlation with the new design and technology Education degree Programme. The Senior Secondary design and technology curriculum revised by the Curriculum Development Division, Ministry of Education (2000), is designed to build on knowledge and skills acquired in the Junior Secondary education in order to prepare young male and female Batswana for the demands of the technological world of the 21st century. It is, therefore, intended to equip the students with a variety of knowledge, skills and attitudes that not only prepare them for further training and employment but for life in general.

The programme seeks to instil a sense of appreciation of technology to make sure that learners can adapt and cope with changing situations. It provides learners with broader design and technology concepts and principles that would allow them to expand their thinking capacity to tackle practical and real-life design problems in the community. Design and technology would also expose learners to a range of manufacturing knowledge, skills and processes. Hence, learners would have an opportunity to develop manipulative skills through the making, evaluating and improving the products designed by them.



Table 3: Areas and Topics of the Senior Secondary design and technology Programme.

## Senior Secondary design and technology programme subject content

1. Health and Safety.	<b>Safety Precautions.</b> <b>First Aid.</b>
2. Materials.	<p><b>Timber:</b> South African pine, jelutong, meranti, mukwa, oak, mukusi, iroko, teak, sapele, spruce, douglas fir.</p> <p><b>Manufactured boards:</b> blockboard, chipboard, laminboard, hardboard, battenboard, softboard, pegboard, plywood, medium density fibre.</p> <p><b>Metals:</b> high carbon steel, high speed steel, low carbon steel, stainless steel, tool steel, mild steel, wrought iron, cast iron, aluminium, copper, brass, lead, zinc, tin.</p> <p><b>Plastics:</b> polyamide (nylon), polymethyl methacrylate (acrylic), high density polythene, low density polythene, latex and rubber, rigid polystyrene, expanded polystyrene, polypropylene, polyester resin, polyvinyl chloride (PVC), urea formaldehyde, phenol formaldehyde, melamine formaldehyde, glass reinforced plastic (GRP), acrylonitrile butadiene styrene (ABS).</p> <p><b>Optional materials:</b> cane, cement, clay, glass, grass, leather, paper/cards, and soapstone.</p> <p><b>Adhesives:</b> hot plastic glue, polyvinyl acetate (PVA), urea formaldehyde (Cascamite), tensol cement (Types), contact adhesive, epoxy resin, super glue.</p> <p><b>Abrasives:</b> glass paper, emery cloth, wet and dry paper, garnet paper, steel wool, metal polish, aluminium oxide, buffing compound, rubbing compound, leather.</p> <p><b>Fixings:</b> nails, wood screws, self-tapping screws, machine screws, rivets, bolts, nuts, washers, threaded bars and studs, plugs, velcro.</p> <p><b>Fittings:</b> hinges, catches, latches, locks, stays, plates, knock down, handles/knobs, castors.</p> <p><b>Finishes:</b> sanding sealer, paint, stain, varnish, lacquer, wax, creosote, linseed oil, galvanising, bluing, enamelling, anodising, dip coating, electroplating, solvents.</p>
3. Communication.	<p><b>Graphics:</b> presentation techniques.</p> <p><b>Information Technology:</b> desktop publishing, computer control, CAD/CAM.</p>
4. Design.	<p><b>Design process.</b></p> <p><b>Marketing.</b></p> <p><b>Promotion.</b></p> <p><b>Costing and pricing production.</b></p>
5. Technology.	<p><b>Energy.</b></p> <p><b>Structures.</b></p> <p><b>Mechanisms.</b></p> <p><b>Electronics.</b></p> <p><b>Pneumatics.</b></p>
6. Tools and Processes.	<p><b>Measuring and marking out:</b> rule, squares, callipers, gauges, punches, micrometer, scribe, sliding bevel, spirit level, spring dividers, wing compasses, marking knife, surface plate, surface gauge, vee block, angle plate, engineer's blue, wet chalk, copper sulphate solution, wax crayon, felt pen.</p> <p><b>Saws and sawing:</b> abrafile saw, compass saw, coping saw, cross-cut saw, dovetail saw, gents saw, hacksaw, hole saw, jig saw, junior hacksaw, panel saw, pad saw, piercing saw, rip saw, saw set pliers, scroll saw, tenon saw.</p> <p><b>Planes and planing:</b> block plane, combination plane, jackplane, plough plane, rebate plane, router plane, smoothing plane, spoke shaves.</p> <p><b>Files and filing:</b> file card, flat file, flat surform, four-square file, half round file, hand file, needle files, rasp, round file, round surform, three-square file, warding file.</p> <p><b>Drills and drilling:</b> auger bit, awl, bradawl, breast drill, centre bit, centre drill, countersink drill, expansive bit, flat bit, forstner bit, hammer drill, hand drill, masonry drill, press drill, ratchet brace, twist drill.</p> <p><b>Chisel and chiselling:</b> bevel edge chisel, cross-cut cold chisel, diamond p. cold chisel, firmer chisel, firmer gouge, flat cold chisel, mortise chisel, paring gouge, paring chisel, round nose cold chisel.</p> <p><b>Shears and shearing:</b> bench shear, scissors, snips, guillotine.</p> <p><b>Forming, moulding and casting:</b> casting, cold casting, folding bars, line bender, pipe bender, vacuum former.</p> <p><b>Turning and milling:</b> wood lathe, centre lathe, milling machine.</p> <p><b>Joining and fabricating:</b> anvil, glue gun, hammers, mallets, pincers, pliers, revolving punch, riveting tools, screwdrivers, spanners, soldering iron, tap and die set, tongs, wrenches, welding.</p> <p><b>Holding and assembling tools:</b> woodworker's bench, woodworker's vice, engineer's bench, engineer's vice, hand vice, machine vice, G-cramp, sash cramp, mitre cramp, speed cramp, string cramp, toolmaker's clamp, vee block clamp, bench holdfast, bench hook, bench stop.</p> <p><b>Finishing materials.</b></p>



The programme would be implemented through problem-solving methodology, which is expected to make learners more resourceful and enterprising. At the end of the programme, learners should be dynamic, creative and multi-skilled and able to understand the environmental, social and economic implications of a variety of technologies. The syllabus is organised around broad content areas subdivided into topics as shown in Table 3.

It is noticed that all the goals laid down for the Senior Secondary design and technology programme are adequately covered in the new design and technology education programme. Further, design and technology teachers are prepared through several courses on Design, Technology and Society, Materials Processing, Internet for Designers, Food Technology, Textiles and Leather Technology, Digital Electronics, Pneumatic Controls, Product Analysis, Computer Aided Design, Hydraulic Controls, Product Design 1, 2 and 3, School design and technology Projects, Design for Sustainable Rural Development, Interior Design, Ceramics, Glass and Stone technology, Safety and First Aid Certification, Industrial Product Design, Microcomputer Controls, Case Studies in Designing, Computer Based Manufacture and Environmental Factors in Design. In fact, the design and technology teachers would be far more informed and competent in theory and on practical skills than that required for teaching at the Senior Secondary level.

#### **Technology education: Western Cape, South Africa**

The subject of Technology proposed in the School Curriculum 2005 by the Western Cape Education Department (2001) encompasses Design Capability without being reflected in the title of the subject. This is because the role of a technologist is defined as that of 'designing, manufacturing and maintaining' systems and subsystems. Likewise, the subject has been divided into three components:

*Technological Capability  
Knowledge and Understanding  
Technology, Society and Environment.*

Technological capability refers to investigating, designing, realising and evaluating products and systems to meet peoples' needs and wants and to solve problems. The stages in the technological process are identified as Analyse the situation, Carry out research, Write a design brief, Write specifications, Work out possible solutions, Select the preferred solution, Prepare final drawings, Construct the prototype, Test and evaluate the design and Communicate the processes. Technological

Knowledge and Understanding covers different technologies and topics such as reliability, ergonomics, aesthetics, adaptation, modification and fitness for purpose. It also includes different practices in food, textile, architecture, medicine and engineering design. Emphasis is laid on methods of communicating, evaluating, promoting ideas and designing. Finally, the component on Technology, Society and Environment dwells on the values and attitudes aspects of technology and its interaction with society and the environment. It considers the complex balance of factors, which determine the decisions about technological innovations, newer designs and their impact on society.

Looking at the above extracts from the curriculum on technology, it is reasonable to state that the new design and technology education curriculum at UB would adequately prepare teachers to teach technology at schools in South Africa. They can certainly teach the subject better than those in possession of degrees in technology because technologists are not introduced to the philosophy and practice of design, as are design and technology teachers at UB.

#### **Comparison with design and technology curricula at overseas universities**

The design and technology programme at the UB has been designed for the setting in Botswana and in the South African Development Community region and it is by no means claimed to be an ideal programme in design and technology per se. It is pointed out that the UB is the only country in the region, which offers a degree programme in design and technology education. We are aware of teacher training programmes in design and technology at several universities in UK, including Brunel, Loughborough, Wolverhampton, Sheffield Hallam, Staffordshire, Coventry and also in some other countries, e.g., Australia, Canada, Netherlands, Italy and Norway. In an attempt to compare the Programme with those offered elsewhere, it is noticed that the intake into the University is based on passing *Form 5*, which is equivalent to *GCSE* level rather than the higher *A' Level*, which is the practice elsewhere. It is also observed that students are not adequately equipped with basic sciences and many students may not have taken design and technology at school. The students therefore, have to take mathematics and science courses in the Faculty of Science in their first year and also have to take most of the common engineering courses in their second year, leaving only three years for all professional studies. Even so, the structure of the Programme allows some further general education courses as extra-departmental



elective and optional courses in accordance with the university regulations. In doing so, it is not possible to permit students to specialise in different areas. This point has also been commented on in the external review by a senior design and technology professional from the UK that students would not be able to specialise in electronics, computer assisted design or the like. It may be added that the scenario in Botswana does not require specialisation at the first-degree level.

In view of the above, one cannot readily compare the new design and technology Programme at UB with similar programmes in other countries. For example, Loughborough University (2001), with which we have interacted a great deal during the development of our programme, has student intake with post-GCSE qualifications or equivalent experience. They have a 3-year degree programme because their students join with better knowledge in mathematics, science and design. During the three professional years, they cover the following subjects:

#### **Year 1**

*Design Practice, Design Contexts, Graphic Modelling, Materials Science and Processing, Foundation Technology, Ergonomics and Design.*

#### **Year 2**

*Design Practice, Design Studies, Presentation Techniques, Teaching design and technology, Computing for Designers, Materials Selection for Designers. Plus one option from: Mechanics for Designers, Electronic Systems, Product Analysis (Artefacts), Product Analysis (Systems and Environments), Materials, Sustainable Design.*

#### **Year 3**

*Design Project, Design Practice, Management and Marketing, Education Project. Plus one option from: Mechanics for Designers, Product Analysis (Systems and Environments), Inclusive Design, Issues in Design Education, Materials, Computer-Aided Modelling and Manufacture.*

It is noticed that they have less courses in the area of education in their Programme than we have in our design and technology Programme. This is because students who wish to become teachers there are expected to go on a one year Post Graduate Certificate of Education. We have no such requirement because our Programme is a Major-Minor Programme taking care of design and technology and Education components in the 70:30 ratio. On the whole, the new design and technology curriculum at the UB is comparable with that existing at the Loughborough University except that their

students can specialise in some area because they are required to spend an additional year for PGCE before becoming teachers. Comparison with design and technology curricula at other universities in UK, Australia and Canada shows the same general correspondence. All of them have 3-year degree programmes. It is satisfying to note that, in spite of the lower intake level, we have been able to come up with comparable exit profile of the graduate in design and technology education. This has been achieved by devoting the first year to learn basic sciences and mathematics and most of the second year to building a sound technology and design foundation for professional courses over the next three years. The nature and number of professional courses are comparable to the best in any institution in the world.

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