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Effective methods and tools for training engineers and technologists: regional trends

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ABSTRACT: The important thing in any training is to offer knowledge in a motivating way – and to ensure long-term retention. Learning engineering concepts should be unified by doing and an interactive learning system with a whole new dimension of functionality is preferred. Trainees should discover technology and the functions of real components through practical exercises. The practical training is to shape skills and cement experience. An engineering training method should analyse and correct or supply approaches to finding the correct solution. New technologies have played a big role towards the achievement of this new engineering training concept. In developed nations, the roles of a lecturer and new technologies in training engineers are complementary, whereas in developing countries, the scheme followed is still overly dependent on the lecturer. This article presents a discussion on the latest methods and tools available and currently used worldwide to solve issues related to the training of engineers and technologists. A comparison of engineering training in developed and developing countries is also presented. It is concluded that, in order to produce technology innovators, developing countries should adopt suitable policies and use effective methods and tools to train engineers.

INTRODUCTION

The technical advances of the 19th Century and the rapid changing demands of the socio-economic development in the 20th Century greatly broadened the field of engineering and introduced a large number of engineering specialities. Today, the main branches of engineering are: chemical, civil, electrical and electronic, geological and mining, mechanical, military, marine, nuclear, safety and sanitary engineering. Combinations of most of these engineering disciplines are essential for any nation's industrial development. Therefore, engineering education plays a very important role in the social and economic development of a nation.

Without engineers, design, construction and control of machines, public services like roads, bridges, electrical apparatus and systems, chemical plants and production processes in various industries cannot be realised. Since engineers rank high among any country's human resources, their training comprises an integral component of the development strategy of a nation.

Worldwide, higher technical institutions contribute to national and regional development through the training of high-level human resources. In their attempt to accomplish this mission, universities have to continuously develop innovative approaches to education delivery and training. Stakeholders' partnership in academic and professional fields is fundamental in the search for solutions to this process.

THE CHANGING DEMANDS OF TRAINING IN ENGINEERING EDUCATION: A GLOBAL PERSPECTIVE

In developed nations, investment in science and technology has given rise to new technologies and a new range of technical labour, which has created entirely new products and a whole range of industries. These trends have increased the role of technology in the world economy and must be reflected in the education and training of engineers and technologists.

With the emergence of the world economy, there is a real need to develop a global awareness in the minds of today's engineering students. Educating students for the global economy can range from simple awareness of other cultures to foreign language competency, mastering the complexities of national regulations, treaties, legal requirements and demands of international agencies. Somewhere along the continuum, engineering education must draw a line and start the global awareness education process. According to Kuhnke, global players need internationalised engineers and pioneering strategies are required to train engineers [1]. He further states that universities can make a powerful impact in their approach to the training of their students by incorporating the necessary ingredients that would make an engineering graduate suitable for the global market – engineers of an international standard.

Developing excellence in technical skills must still be the primary focus of universities. However, for those students that proceed to non-traditional careers, technical skills will be a ticket for entry, but other skills will be needed for success. Course work in business, marketing, finance, or manufacturing would enhance the graduate's value to potential private sector employers, and many employers point to the need for better communication and interpersonal skills in the scientific and technical workforce.

Engineering students need to recognise that they must have the skills to defend and sell technical ideas to management and their peers. Being bright, technically sound and motivated is not enough. They will need excellent oral and written communication skills for a successful career. Every class report, every test and every mentoring or counselling session is an opportunity to impact on students' communication skills. The ability to communicate effectively is essential if they wish to be *winners*. A lack of sufficient communication skills serves only to undermine the image of an engineer, but engaging features of emotional intelligence in the education of engineers can help to tackle this problem [2]. The majority of engineering students in developing countries use English as a second language. To enhance effective communication skills among engineering students, those universities in developing nations could develop strategies to achieve this goal. One of the many strategies available is to make English language training a compulsory course unit taught and examinable throughout the entire engineering training programme.

Ethics is another very important topic in engineering training because, as young engineers assume positions of increasing managerial importance, they will face decisions requiring judgements based on ethical reasoning. When this point of decision-making occurs, they should find comfort in a personal memory bank established during their student years – if not earlier – with guidelines for ethical personal conduct. Ethics should be an educational priority. Engineers of the future will have to be very comfortable working in a multicultural society. They must be sensitive to diversity issues or they simply will not succeed.

Everyone who teaches and counsels future scientists and engineers must consider the many profound changes in career paths in these fields and in the economy and workforce generally. As such, faculties should seek to develop in students a new set of expectations beyond cocooning in academia. They must emphasise that jobs in business units, manufacturing, service industries, small business and other non-academic settings make for exciting, hands-on, rewarding careers and convey the sense of satisfaction in taking what you know, applying it to real-world situations and seeing the results.

Given the kind of environment that engineers of the future will be working in, engineering training institutions should therefore adopt effective methods and tools with respect to the kind of training that an engineer of the future must have. The present engineering students must be trained to meet the demands of a modern workplace.

METHODS USED FOR TRAINING ENGINEERS AND TECHNOLOGISTS

The main objective for the development of various methods and tools for training engineers has been to increase teaching and learning efficiency. Greater training efficiency is achieved when students develop the ability for self-learning. There are a number of teaching methods or approaches to a learning process. Each is related to different levels of learning. The most common are didactic, practical, experiential and heuristic ways of teaching.

Effective training or teaching methods for engineering graduates describe the instructional process, that is, not only how information gets from the trainer to the learner but also how the learner uses it, interacts with it, receives guidance and is given feedback [3]. Teaching involves two-way communication, so the trainer should encourage dialogue and active participation by students or trainees. Eight teaching/training methods commonly used in universities and their characteristics are summarised in Table 1 [4].

Outcomes of a Workshop on Effective Teaching Methods

In August 2002, the Faculty of Engineering at *Jomo Kenyatta* University of Agriculture and Technology, Nairobi, Kenya, organised a two-day workshop for its teaching staff under the theme of effective teaching/instructional methods in engineering education. The aim of this workshop was to standardise teaching methods in the Faculty. Among the many tasks discussed during the workshop was the selection of teaching methods.

The 20 participants who attended were divided into two groups and tasks given as follows. The continuum, shown in Figure 1, includes the following teaching methods: lecture, project, case study, problem-solving, laboratory work, buzz group, field trips, tutorial and simulation. These were to be ranked in the continuum in order of most to least teacher and student-orientated. One group was given the task of ranking the various teaching methods on a continuum, going from most to least teacher-orientated methods. The other group was to perform the same task but use a student-orientated continuum. In addition, both groups were asked to state reasons for placing of each method in a particular position on the continuum. Results from the discussions of both groups indicated that it is not easy to rank many of the teaching methods on both continuums because of the several factors that influence the way a particular method is used.

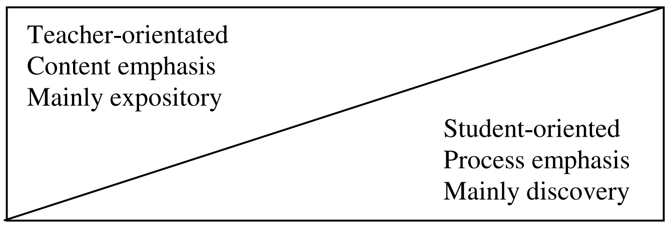

Figure 1: Continuum of teaching methods [5].

Educational research has shown that learning is enhanced if students are more active and independent, with the lecturer adopting less of an expository role and more of a facilitating and guiding one. Not everyone accepts this, as yet, but teaching developments indicate a recent and significant shift towards more student-centred learning with an increase in active participation by students. The result is more variety, flexibility and integration of teaching methods.

Other Engineering Teaching Methods

Other methods have been developed to ensure that learning engineering is never boring: solutions are found through trial-and-error exercises, systematic approaches or simulations. Interactive learning can be an interesting journey using various learning worlds – and can be a lot of fun. The learner goes through the exercises at his/her own speed: fast, thoroughly, sporadically, intensively, slowly and exactly. Interactive learning programs let the student train where he/she wants and how he/she wants it. The student determines how to achieve the training aims. There is also customised training where instructors know the individual strengths and weaknesses of their students. Such learning programmes allow the teacher to set the sequence that the students are to work through. The instructor decides the order and the aids and in this way can challenge any individual as required.

Table 1: Key characteristics of some of the main instructional methods [4].

Method	Strengths	Weaknesses
Directed study of material in textbooks	• Effective method to teach basic facts. • Allows learner to work at own pace. • Needs no specialised facilities.	• Requires careful planning and structuring. • Dependent on suitable text being available in sufficient numbers for the class size. • Not suitable for achieving many higher cognitive and non-cognitive objectives.
Programmed text	• Same basic advantages as directed study of books. • Allow learners to interact with the material.	• Preparing suitable material is very time-consuming. • Not suitable for achieving many higher cognitive and non-cognitive objectives.
Self-instruction using audio/visual media and computer	• Enables a wide range of educational objectives to be achieved (especially lower cognitive). • Allows learner to work at own pace. • Can save teachers from having to carry out repetitive and time consuming work. • Allows interaction between the learner and instructional programme and can be highly stimulating.	• Ideal ready-made courseware seldom available. • Preparation can be time consuming, expensive and requires specialist skills. • Not suitable for achieving many higher cognitive and non-cognitive objectives. • Cannot be used unless suitable hardware is available, which can be expensive.
Lectures and similar expository techniques, such as demonstration	• Cost effective in terms of staff/student ratio. • Strong in achieving lower cognitive objectives. • Generally popular with students and staff. • Ideal for introductory or overview process.	• Strongly dependent on the skills of lecturer. • Weak in achieving most higher cognitive and effective objectives. • Not suitable for achieving psychomotor objectives or developing communication or interpersonal skills. • Student involvement low or non-existent. • Pace controlled by teacher. • Most lectures are too long for the concentration span of students.
Buzz sessions and similar short small group exercises	• Excellent method of introducing variety into a lecture, thus helping to maintain student attention. • Can achieve a wide range of objectives, both cognitive and non-cognitive. • Students are actively involved in the lesson. • Permits feedback to take place.	• Only useful in a supportive role as a part of a larger lesson. • Requires a skilled facilitator.
Class discussions, seminars and tutorials	• Same basic advantages as buzz sessions. • In addition, the greater length allows a wider range of objectives to be achieved, often of a high level. • Enables relevant topics to be examined in depth.	• Danger that not all the class takes an active part. • Can cause timetabling problems if a class has to split up. • Danger of the tutor dominating discussions.
Participative exercise of games/simulation/case study type	• Can be used to achieve a wide range of objectives, both cognitive and non-cognitive, often of a high level. • High student involvement. • Stimulating and motivating if properly designed. • Ideal for cross-disciplinary work.	• Only useful in a supportive or illustrative role. • Can be difficult to fit in, especially with long exercises. • Must be relevant to be of educational value. • Requires briefing and debriefing skills.
Group projects	• Suitable for developing a wide range of objectives, both cognitive and non-cognitive, often of a high level. • Ideal for developing interpersonal skills. • Ideal for cross-disciplinary work.	• Danger that not all members will pull their weight. • Assessment of contribution made by individual student may be problematic.

Problem-based teaching encourages a student to seek a new approach to a particular problem and gives rise to his/her creative mental activities [6]. Indeed, problem-orientated teaching targets the development of a more creative mentality and facilitates the progression of a logical way of professional thinking.

Selection of Effective Instructional Methods for Training Engineers and Technologists

The variety and complexity of many resources available on how to improve teaching and learning of engineering education may cause confusion among engineering educators. A further problem is that the environment in which teaching operates has changed or keeps on changing. Therefore, there is need to identify the changes and influencing factors that operate so that engineering educators can come to terms with such forces. For example, a recent critical issue in developing countries has been how to effectively handle large engineering classes with the limited academic resources available.

Most attempts to improve instructional methods have concentrated on presentation skills, style or aspects of planning. These help the new lecturer, in particular, to acquire the basic skills of teaching. Another more recent approach, that of augmentation, attempts to update staff in those aspects of teaching that promote more active and participative learning, make use of dialogue, feedback and reflection and utilise a greater variety of methods and media. This calls for more facilitative skills and many of the tactics used in small group teaching and experiential learning. This approach emphasises the need for student engagement, helping the student to find structure and meaning by wrestling with concepts and sharing learning tasks with others. Aspects of such measures are especially useful with very large classes, which commonly feature today but require careful planning and high facilitative skills.

It is important to choose the right method for the right situation. Using the right method is important because the quality of student learning is dependent on the effectiveness of the approach used. In the selection of the method to be used, the teacher or trainer should consider the objectives of learning, group size, local constraints, the students' abilities and his/her own preferences. However, no one method is suitable all of the time or for every situation; many variables and constraints may affect the learning process. The type and level of learning, the time available, the facilities and size of class are some of the factors that need to be considered [7].

EFFECTIVE TOOLS USED FOR TRAINING ENGINEERS AND TECHNOLOGISTS

Advances in computing and Information Technology (IT) have seen the emergence of effective tools for training in engineering education. Improved information storage technology, advanced graphics and publishing tools, enhanced information processing and availability all exist as a consequence of IT developments.

The Computer as an Engineering Design Tool

Today, computer drafting has found widespread use in industry and technical institutions of higher learning where it has helped improve the teaching of design courses. In industry, it has enabled the automation of the production of detailed working drawings by which the finished design is communicated for manufacture. In this area, the central activities of design, those of synthesis and analysis, remain essentially unaffected, although it is possible that designers themselves might use a drafting system in the later stages of the design process proper.

The next step in Computer-Aided Design (CAD) has been the development of a great variety of separate computer programs or packages for carrying out analyses of performance. Packages have been produced for structural analysis, thermal analysis, kinematics analysis, the drawing of perspective images and many other applications. Other programs allow the behaviour of designs to be simulated, such as the simulation of electronic circuits, the simulation of robot manipulator arms moving in their workspaces and the modelling of the movement of lifts in high-rise buildings. Where the constraints on design can be formally stated, it may be possible to use mathematical methods to optimise the design with respect to that objective.

Integrated Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) is an area that has emphasised the use of computers in industry and learning institutions. The concept underlying CAD/CAM is that the description of the design is transferred electronically to the production processes. This has been achieved in areas of design, such as in the machining of a component utilising *NC Tools*; in the preparation of photographic masks for fabricating printed circuits and microchips, and in the direct production of printing plates in the newspaper and publishing industries. There are linkages between CAD and the programming of robots to carry out assembly operations. This process of automation has taken place in industries worldwide and universities use the same concepts to train engineers and technologists.

Given that images on a computer screen can be changed and manipulated much more easily than those on paper, the use of CAD techniques has been a major breakthrough in the teaching of engineering design processes. The use of computers and specialised software assists in many manufacturing processes, not only in the physical processes involved, but also in planning, scheduling and tooling. Indeed, IT has become the in-thing in modern industry. Therefore, there is a need for more investment in training in IT to enable engineering students and technologists to make appropriate use of the technology.

Virtual Reality

Virtual reality is a subject that studies evolutional mechanisms, that is all those processes (either purely physical or focused on humans). Which, through interactions between the real and virtual, produce changes in both spaces [8]. Virtual reality, with its extension of televirtuality, has revolutionised engineering education training. It offers users the possibility to create a representation of their educational models and to move about within virtual space. The 3D visualisation created with the help of virtual reality can provide a picture, which is both comprehensible and accessible for a non-specialist user.

Virtual Reality Modelling Language (VRML) allows for virtual space definitions independent from hardware platforms. VRML is a language for describing multi-participant interactive simulations via the global Internet and hyperlinked with the World Wide Web (WWW).

Multimedia

Multimedia is a combination of audio and visual materials. It is used to enhance communication and enrich presentation [9]. In multimedia, subject matter and exercises are selected according to an optimised concept or put together in an ad hoc way by the trainer specifically to achieve a given training objective.

Those who wish can use available information in different formats, such as images, text, animation and videos. Those who place great demands on their own creativity can start immediately with exercises.

Teaching and Learning with the Internet (E-learning)

In developed countries, electronic learning (e-learning) is being infused rapidly into the learning process and infrastructure of engineering education as a result of the spectacular improvements in computing power, communications capability, ease of use and declining costs. It also offers unique pedagogical opportunities to enhance student learning; it promotes exploratory and interactive modes of inquiry, supports and facilitates team-orientated collaborations and expands the ease of access to engineering education across institutional, geographical and cultural boundaries, among others. With e-learning, class notes and materials are posted on the Internet and students can access the sites from anywhere in the world. Unlike distance learning, where a student is given course materials and reads solely on his/her own until examination time, e-learning is interactive. The software allows the student to communicate, not only with the lecturer, but also with fellow classmates. It enriches and supplements the classroom experience by engaging the Web.

Web-based Engineering Experiments

One vital aspect of engineering is the laboratory and practical work necessary to give engineering students a taste of real situations, measurement and instrumentation, with all the attendant problems. The concept of Web-based experiments has revolutionised engineering laboratory and practical work. The idea is for students to be able to perform real experiments in real time on real equipment, but over the Internet.

Internet-based learning facilities have been developed to demonstrate all aspects of engineering teaching. One such development is a remote-controlled laboratory-using client-server developed by Ewald and Page [10]. The general structure of a client-server remotely controlled laboratory is displayed in Figure 2.

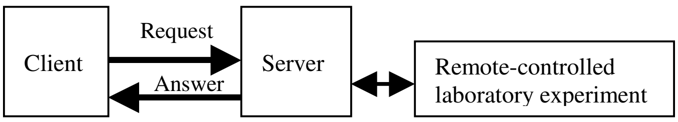

Figure 2: General structure of a remote-controlled laboratory using client-server architecture [10].

An attractive consequence of this development is that resources are saved because both partners need not cater for the whole spectrum of possible (and mostly expensive) experiments, which also have to be updated and maintained.

Microsoft and the Massachusetts Institute of Technology (MIT) have also developed remote-controlled, Web-based experimental teaching equipment: the HT30X Heat Exchanger Bench. MIT developed the software and Armfield, the world's leading supplier of engineering teaching equipment, supplied the hardware. Microsoft and MIT have made use of a USB interface to communicate with the heat exchanger system [11].

Modular Engineering Teaching Equipment

Maybury describes how modular, computer compatible equipment makes teaching of many aspects of chemical engineering theory and practice easier for professors and students [12]. He made reference to two pieces of equipment that he designed: the CEU Catalytic Reactors and the UOP12 Filtration Unit. Both are small, modular and computer friendly. Armfield has also developed a wide range of modular engineering equipment, some of which have an optional data-logging accessory that permit real-time recording of data to a personal computer [11].

DIFFERENCES IN ENGINEERING EDUCATION AND TRAINING IN DEVELOPED AND DEVELOPING NATIONS

Innovation and novelty arise from particular attitudes of mind and there are ways in which these attitudes can be encouraged – or rather that students can be encouraged to think and explore novel solutions to problems. Regularly placing students in situations that are entirely new to them, in which they have limited experience, requires them to *innovate*, that is, to take actions beyond their present state of experience. This might be termed relative innovation rather than absolute but it does lead to attitudes that question accepted solutions and which encourage the exploration of new ones, thereby generating confidence in attempting to innovate.

Differences between developed and developing countries in the methods of training engineers are reflected in worldwide-patented engineering innovations. There is a contrast in the number of engineering innovations patented in developed and developing countries. In developing countries, engineering training emphasises the production of technology consumers: engineers who can adopt already existing technology, and to some extent, be maintainers of that technology rather than innovators. Yet why is this trend persistent in developing countries? Universities in developing countries still pursue traditional programmes that very much rely on didactic methods for the transfer of knowledge using lectures, tutorials, seminars and classical laboratories, which are all delivered on-campus. Such a system places priority on a huge volume of knowledge at the expense of developing learning abilities, creativity, innovation and understanding of the engineering profession and its present and future role in the global society [13].

Engineering Education and Training in Developing Countries: is the Future Promising or Bleak?

In the last 25 years, the world has witnessed profound changes while adopting a free market economy: political-economical revolutions, computers and communication, demographics, education (the number of students increasing), scientific revolutions (the GDP for education in leading industrialised countries increasing) [14]. However, in developing countries, universities and other institutions of higher learning are experiencing reduced levels of state funding due to economic problems.

Apart from the various challenges posed by the new global economy, developing countries face additional obstacles in their endeavours to provide quality engineering education and training using IT. Engineering graduates from developing countries are deficient in a number of areas, including leadership and communication skills, quantification skills, interpersonal relations and the ability to work in teams, the understanding needed to work with a diverse workforce at home and abroad, as well as the capacity to adapt to rapid change.

Other major problems include a lack of suitable telecommunications infrastructure, inadequate qualified human resources and finances to implement engineering training programmes. For example, the telephone sector in Africa is characterised by low network penetration rates, obsolete equipment and long waiting lists for telephone lines. In 1996, there were only two lines for 100 Africans. The average expected wait for obtaining a telephone in Africa was three years, the longest in the world [15]. Yet telecommunications infrastructure is a conduit to the Internet. Developing countries are therefore lagging behind their developed counterparts in engineering education training.

Lack of Policy in Modern Telecommunication Technology

The governments of developing countries have been slow in recognising the role played by modern telecommunications in a country's economic development. The majority of the governments of those nations have maintained virtual strangleholds over local access to Internet services. They control the airwaves and are reluctant to liberalise the telecommunication services. In addition, they charge exorbitant fees to Internet Service Providers (ISPs).

Studies have found that wide disparities exist between countries in Africa regarding Internet adoption. At the regional level, the share of sub-Saharan Africa rose from a meagre 0.1% in 1998 to 0.4% in 2000 [16]. Internet services cost seven times that of the USA, largely due to the monopolistic structure of Internet service in Africa [17]. The high costs for the local ISPs are inevitably passed on to the consumer, making Internet access the preserve of an upmarket clientele, while in other parts of the world it is almost free. The high cost of the Internet is a factor that inhibits the potential utilisation of the WWW as a vehicle for increased information dissemination on engineering education.

The adoption of modern telecommunication technologies, such as Very Small Aperture Terminals (VSATs) technology, which enables the quick transfer of large volumes of data, could result in major savings in engineering education and training and other sectors of the economy in developing countries. Unlimited access to VSATs technology is necessary if universities and industrial entities in developing countries are to advance and keep pace with the rest of the world. They cannot be shackled in their efforts to use information and communication technology.

Meanwhile, e-education is one of the most promising growth areas in global education today. Governments of developing nations should therefore take overt moves to ensure that their citizens get their piece of the action. Once governments create an enabling environment for the development of engineering education and training, networking and forming partnerships can address the various challenges facing these institutions. This means that new information and communication technologies must be harnessed by all nations, including developing countries, in order to enable expanded access to engineering education and training.

Mariasingam cites a mismatch between the skill needs of industry and the knowledge and skills of engineering graduates coming out of universities as a worldwide problem, but one that is more prominent in developing countries [18]. He further states that active involvement of the stakeholders (government, employers, engineering professional institutions and the universities) is vital in order to solve problems that affect the development of engineering education and training in developing countries.

Table 2 summarises the key differences between developed ad developing nations with regard to engineering education and training.

Table 2: Summary: comparison of differences in engineering education and training in developed and developing countries.

	Developed countries	Developing countries
1.	New technologies play a big role in knowledge transfer	Greater reliance on didactic methods of knowledge transfer. Little use of new technologies
2.	Extensive use of multimedia	Little use of multimedia
3.	Use of modular equipment in practical training	Little use of modular equipment in practical training due to financial constraints
4.	Human and financial resources available for the implementation of new programmes	Limited human and financial resources available for the implementation of new programmes
5.	Wide variety of specialised courses offered, with the implementation schedule being very flexible	Few specialised courses available and the implementation schedule not being flexible
6.	Developed telecommunication infrastructure allows engineering education and training to thrive	Telecommunication infrastructure is not well developed, mitigating growth of the engineering education profession
7.	Quality assurance standards are commonly utilised to ensure that the engineering training offered meets international standards	Most higher training institutions do not use any quality assurance standards, ie codes of best practices are hardly implemented

SUMMARY AND CONCLUSIONS

In the real world, we are often *attacked from behind*. A civil engineer may be confronted with a design problem in which the calculations do not *add up*, but the bridge in reality could stand. The engineering education training process should be concerned with motivating the student to read, conduct his/her own research, and understand (what he/she is learning) as opposed to mere rote learning. Thus, the intellect will develop and be perceptive to new ideas and experiences.

Learning, knowledge and education are the major themes of the 21st Century. Solutions are required for fast learning and the successful retention of knowledge for the wide range of engineering education professions. Expertise and experiences in these areas puts engineers in a key position in future markets. The demand for engineering training will continue to grow rapidly. As such, higher technical institutions need to set themselves the goal of making engineering training ever more efficient. This is a great challenge for engineering educators.

Engineering educators should use the many different instructional methods available and not just stick to what is familiar as no one method is perfect. A combination of main instructional methods is the most effective approach for the training of engineers and technologists.

Throughout the world, higher technical institutions should harness modern efficient IT systems in conjunction with improvements in staff training through continuing professional development. The use of effective methods and tools to train engineers and technologists requires skilled professionals for the efficient delivery of training programmes. These actions cannot be confined to one part of the world alone (developed nations), but should be also extended to developing nations through networking. Further, staff development programmes should aim at creating a modern progressive, human resource environment, which is the necessary ingredient for developing great staff who can effectively use modern training methods and tools to train engineering students for the global market.

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6th Baltic Region Seminar on Engineering Education: Seminar Proceedings

edited by Zenon J. Pudlowski & Norbert Grünwald

The very successful *6th Baltic Region Seminar on Engineering Education* was held between 23 and 25 September 2002 in Wismar, Germany, and was hosted by Hochschule Wismar – University of Technology, Business and Design (HSW).

The Baltic Seminar series has a strong set of resolute objectives: to bring together educators, primarily from the Baltic Region, to continue and expand on debates about common problems and challenges in engineering and technology education; to promote discussion on the need for innovation in engineering and technology education; and to foster the links, collaboration and friendships already established in the region.

There are 53 papers from senior academics, representing over 20 countries from around the globe, included in this set of Proceedings. Academics gathered at this Seminar to consider and debate the impact of globalisation on engineering and technology education, the rapidly changing technology and production processes and the status, quality and importance of engineering education in the context of the recent economic changes in the Baltic region. The papers included in these Proceedings reflect on this debate and are grouped under the following broad topics:

- New trends and recent developments in engineering education
- Case studies
- Specific engineering education programmes and future directions in engineering education
- International examples of engineering education and training
- Multimedia and the Internet in engineering education
- Learning strategies and methods in engineering education
- Important issues and challenges in engineering education
- Importance of science subjects in engineering education and recent developments in engineering education

As with all UICEE publications, the papers in this collection were subject to a formal peer review process. This should ensure the future value of these Proceedings, not just for the Baltic region, but internationally as well.

To purchase a copy of the Seminar Proceedings, a cheque for $A70 (+ $A10 for postage within Australia, and $A20 for overseas postage) should be made payable to Monash University - UICEE, and sent to: Administrative Officer, UICEE, Faculty of Engineering, Monash University, Clayton, Victoria 3800, Australia.
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