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# Innovation in Surveying Education

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The article presents some key international trends in surveying education. In response to these trends, the surveying programme at Aalborg University, Aalborg, Denmark, has utilised a Problem-Based Learning (PBL) approach in a Project Organised Learning (POL) environment for some time. Flexibility and adaptability are keys words in this regard: the educational base must be flexible in order to meet the constant change evident in professional areas and the graduates must be able to adapt so that they can deal with the rapidly changing working areas. An important consideration is that professional and technical skills can be acquired and updated later in a career, while skills for theoretical problem-solving and *learning to learn* can only be achieved through flexible and up-to-date academic training. There is a need to change the focus in surveying education from predominantly an engineering focus to a more managerial and interdisciplinary approach that addresses issues and problems in their real-life context. The basic principles of this educational model are described and a case put forward for designing a future educational profile in surveying.

## INTRODUCTION

The evolution of modern land administration systems is seen as major challenge to the surveying profession. The institutional impact is significant: governments recognise the importance of spatial information to economic development and environmental management, and government institutions, as well as private sector companies, continue to evolve.

The spatial information revolution has also had a profound influence on educational and professional structures. Professions such as surveying are being re-engineered and re-invented to accommodate the spatial information revolution while endeavouring to maintain traditional services at the same time. At the university level, the impact on surveying has been significant: the focus is on spatial information management as a core discipline to combine the traditional areas of measurement science and land management. The challenge of the future will be to implement a new interdisciplinary IT approach in the traditional educational programmes of surveying and engineering.

## INTERNATIONAL TRENDS IN SURVEYING EDUCATION

There are several trends apparent in surveying education.

### Management Skills versus Specialist Skills

Changes in the surveying profession and practice, especially in the development of new push button technologies, have emphasised the need for the inclusion of the core discipline of management as a basic element in today's surveying education. Traditional specialist skills are no longer sufficient or adequate to serve the client base. Surveyors need to have the skill to plan and manage diverse projects that include not only technical skills, but those of other professions as well. In short, *the modern surveyor has to be capable not only of managing within change but managing the change itself* [1].

Technological developments have taken the skill out of measurement and the processing of data. Almost any individual can press buttons to create survey information and process this information in automated systems. In the same way, technological developments make Geographic Information Systems (GIS) a tool available to almost any individual. The skill of the future lies in the interpretation and management of the data in such a way as to meet the needs of customers, institutions and communities. Therefore, management skills will be a key demand in the future surveying world.

### Project-organised Education versus Subject-based Education

An alternative to traditional subject-based education can be found in the project-organised model where traditionally taught courses, assisted by actual practice, are replaced by project work assisted by courses. The aim of the project work is *learning by doing* or *action learning*. This project work is problem-based, and the aim is to broaden understanding and the ability to deal with new and unknown problems.

In general, the focus of university education should be more on *learning to learn*. The traditional focus on the acquisition of professional and technical skills (knowing how) often implies an *add-on* approach to curriculum development, ie for each new innovation one or more lecture courses must be added to the curriculum to address a new technique. It is argued that this traditional subject-based approach should be modified by giving increased attention to entrepreneurial and managerial skills and to the process of problem solving on a scientific basis (knowing why).

### Virtual Academy versus Classroom Lecture Courses

There is no doubt that traditional classroom lecturing will be supported by – or even replaced by – virtual media. The use of distance learning and the World Wide Web (WWW) will increasingly become integrated tools for course delivery, which may lead to the establishment of the *virtual classroom*, even at the global level. This trend will challenge the traditional role of the universities. The traditional focus on on-campus activities will change into a more open role of serving the profession and society.

The computer cannot replace the teacher and the learning process cannot be automated. Nevertheless, it is certain that the concept of the virtual academy represents new opportunities, especially in facilitating the process of learning and understanding, and for widening the role of universities. Furthermore, Web techniques used for course delivery on a distant learning basis represent a key technological engine, especially in the area of life-long learning programmes.

### Life-long Learning versus Vocational Training

There once was a time when one qualification was sufficient for life. However, today, we must qualify constantly just to keep up with change. The idea of *learning for life* is replaced by the concept of life-long learning. Consequently, the concept of life-long learning or Continuing Professional Development (CPD) has gained increasing attention [2]. CPD includes the continuous review of personal capabilities and the development of a structured action plan to enhance existing skills and acquire new ones. In this context, university graduation is only the first step in a life-long educational process.

It has been estimated that the professional knowledge gained in a vocational degree course has an average life span of about four years. While this will vary according to the discipline, it does nevertheless highlight the increasing need to maintain an active interest in keeping up-to-date with changing technology and new legal regulations and procedures. The need to acquire new skills and knowledge is even more acute if, at the same time, professionals have expectations of increased managerial responsibility [3].

## A MANAGERIAL AND INTERDISCIPLINARY APPROACH

Surveying has traditionally leaned strongly towards the technical engineering disciplines. There is now a need for a shift towards teaching management skills that are applicable to interdisciplinary work situations.

Surveying and mapping are clearly technical disciplines (within natural and technical science), while cadastre, land management and spatial planning are legal or managerial disciplines (within social science). The identity of the surveying profession and its educational base should be in the management of spatial data, yet also maintaining links to the technical and social sciences.

Land administration infrastructures have moved away from being *provider* driven to becoming more *user* driven. Land administration is interdisciplinary by nature, requiring strong skills for management and problem-solving. The ability to access, interact with and contribute to, a wide range of public and private databases at a distance will become the norm in many areas of surveying. In fact, new demands on the profession will change the skills base of the surveying workforce, especially those surveyors holding managerial responsibilities.

## THE EDUCATIONAL PROFILE OF THE FUTURE

Universities should act as the main facilitator within the process of forming and promoting the future identity of the surveying profession. Here, the area of managing geographical and spatial information should be the core component of the identity. As such, this responsibility or duty of the universities should be

carried out in close cooperation with industry and professional institutions.

One of the main challenges of the future will be to implement the new IT-paradigm and the new interdisciplinary approach in traditional surveying and engineering educational programmes. A future educational profile in this area should cover the areas of measurement science and land administration, as well as be supported by and embed a broad interdisciplinary paradigm in geographic information management. Figure 1 illustrates such a profile [4].

This future profile was developed through a seminar held jointly by the International Federation of Surveyors (FIG) and the European Council of Geodetic Surveyors (CLGE), which was held at Delft University of Technology, Delft, the Netherlands, in November 2000 [5]. The seminar also concluded that a better understanding of different educational and competence models can establish a general improvement in the educational base and enhance professional competence in the broad surveying discipline throughout Europe, as well as on a more global scale [6].

## THE ONLY CONSTANT IS CHANGE

A recent survey of the surveying profession in Denmark can be used to illustrate this constant change [7]. The professional profile of the Danish surveyor combines technical, legal and design areas. Thus, the profile is a mix of an engineer, a lawyer and an architect who deals with surveying and mapping, cadastre and land management and spatial planning.

Cadastral tasks are the monopoly of licensed surveyors in private practice and the role of this private surveyor has traditionally epitomised the Danish surveyor. However, the profile of the Danish surveyor, as well as the surveying profession, has been turned upside down over the last two decades.

Since the late 1960s, the Danish Association of Chartered Surveyors has carried out a survey of the surveying profession every 10 years, starting in 1967. The changes during these past 30 years, especially over the last two decades, are quite remarkable.

In 1967, the number of surveyors working in private surveying firms accounted for about two thirds of the total profession, while surveyors employed in the public sector or in other private businesses accounted for only one third. In 1997, the situation has been reversed: two thirds of the profession are employed outside private surveying firms.

Furthermore, over the survey's 30-year period, the number of active surveyors has approximately doubled. This means that growth is located within the surveyors employed in the public sector or other private businesses, while the number of surveyors working in private surveying forms has been more or less steady during the last 30 years.

At the same time, the professional profile has changed completely. In 1967 and still in 1977, the cadastral area dominated the profile of the Danish surveyor, while in 1997, it accounts for only 20% of working hours. In 1997, the distribution was as follows:

- Planning and land management 23%;
- Cadastral work 20%;
- Mapping and engineering surveys 26%;
- Other areas 31%.

Changes in the working areas of the Danish surveyor over the last 30 years can be seen in Figure 2. Next to the decrease of the cadastral area, it is remarkable that the biggest area in 1997 is outside the traditional working areas. These *other areas* include management, IT-development and other business developments.

These changes are significant and must, of course,

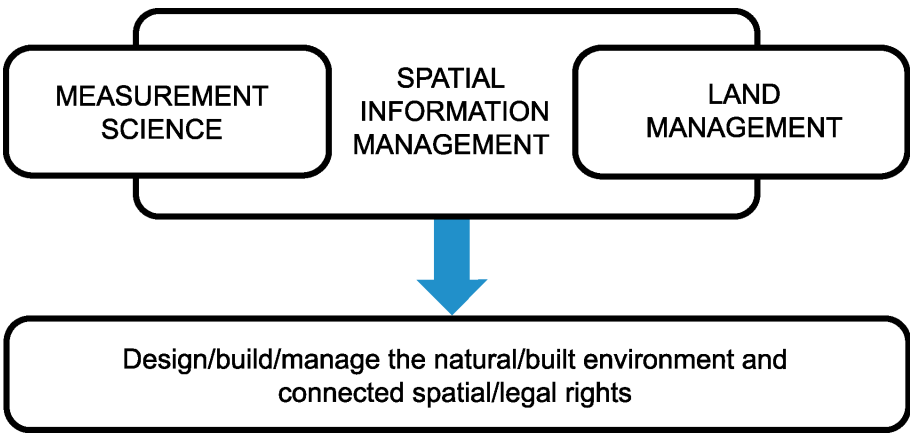


Figure 1: The surveying education profile of the future [4].

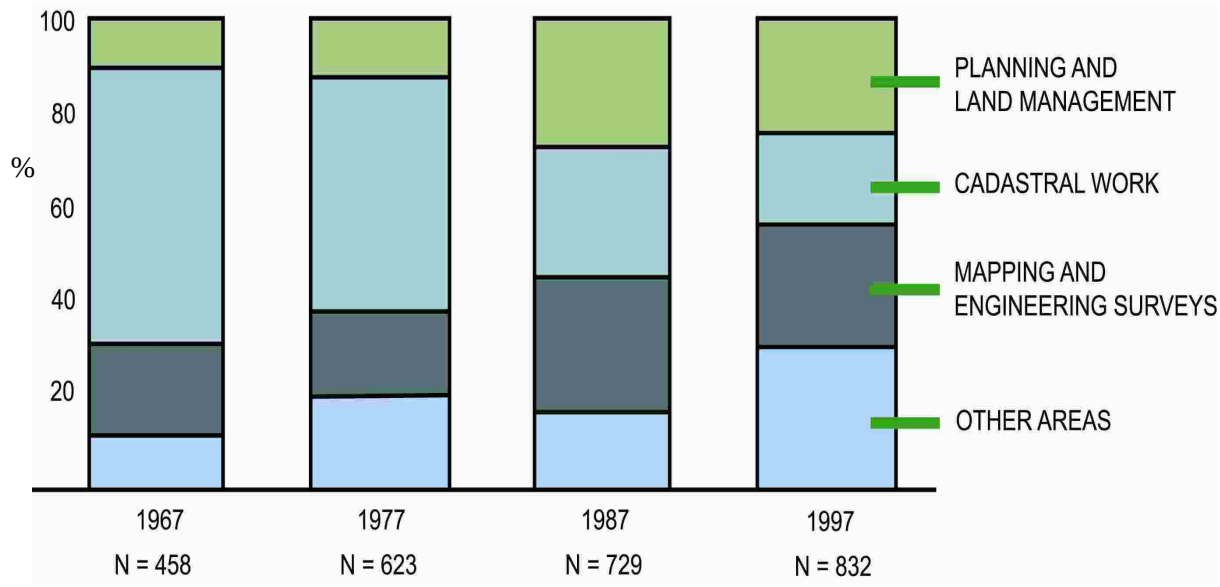


Figure 2: Evolution of the professional profile of the Danish surveyor [7].

be reflected in the content and structure of the educational base. The profession has, in fact, coped quite well with these changes, also with regard to the labour market. It would be fair to assume that this is due to the flexible and project organised educational model introduced in 1974, when the surveying programme was moved from the Royal Veterinary and Agricultural Academy in Copenhagen to the new university in Aalborg. It is also safe to say that, without a flexible educational base, the surveying profession would have faced some serious problems.

## LEARNING TO LEARN

In order to deal with this constant change, the educational base must be flexible. Graduates must possess skills to adapt to a rapidly changing labour market and be able to deal with unknown problems in the future. Professional and technical skills can be acquired and updated at a later stage in one's career; skills for theoretical problem solving and skills for *learning to learn* can only be achieved through academic training at universities.

Recent studies have confirmed that students retain only 10% of what they read and only 20% of what they hear [8]. However, if a problem is simulated, then up to 90% of the lessons learned may be retained. This finding lies behind the shift towards the pedagogical doctrine of project work and Problem-Based Learning (PBL). It emphasises learning instead of teaching. Learning is not like pouring water into a glass; learning is an active process of investigation and creation based on the learner's interest, curiosity and experience and should result in expanded insights, knowledge and skills [9].

One consequence of this shift from teaching to learning is that the task of the teacher is altered from transferring knowledge to facilitating learning. Project work also fulfils an important pedagogical objective in that students must be able to explain the results of their studies and investigations to other students in the group. This skill appears to be vital to professional and theoretical cognition: *knowledge is only established for real when one is able to explain this knowledge to others.* In traditional education the students take on knowledge presented by the teacher. When the project organised model is utilised, knowledge is established through investigation and discussion between the student members of the project group, mainly without the presence of the teacher.

## PROJECT-ORGANISED AND PROBLEM-BASED LEARNING

*Project-organised* means that traditionally taught courses and labs are replaced by project work assisted by lecture courses. The project-organised concept shifts the perspective from description and analysis to synthesis and assessment. The concept is based on a dialectic interaction between the subjects taught in the lecture courses and the problems dealt with in the project work. In principle, each term has a basic structure containing an equal distribution of lecture courses and project work. However, study time is dominated by lecture courses at the beginning of the term and by project work at the end. The project work is carried out by groups of four to six students with a teacher appointed as their supervisor.

*Problem-based* means that traditional textbook-knowledge is replaced by the knowledge necessary

to solve theoretical problems. The problem-based concept moves the context from understanding common knowledge to the ability to develop new knowledge.

The aim of the project work is *learning by doing* or *action learning*. The project work may be organised by using a *know-how* approach for training professional functions, or it may be organised by using a *know-why* approach for training methodological skills of problem analysis and application. The difference between traditional subject-oriented education and the project-oriented educational model may be expressed in short by an old Chinese proverb:

*Tell me and I will forget*
*Show me and I will remember*
*Involve me and I will understand*
*Step back and I will act*

## THE CURRICULUM

The curriculum has to be organised into general subjects or *themes* normally covering a full semester in order to incorporate project work as a basic educational element. The themes chosen in a programme must be generalised in such a way so that the themes in total will constitute the general aim or professional profile of the curriculum. The themes should provide for the study of core elements of the subjects included (through the lecture courses given), as well as exploring (through the project work) the application of the subjects in professional practice. Figure 3 provides one such example.

The *first* phase, that is a one-year programme (ie semesters 1 and 2), includes basic studies within engineering science. Courses on fundamentals, such as mathematics and computer science, are included in the syllabus together with some introductory courses to the professional areas in surveying. The first year of studies also aims to train the basic skills for carrying out problem-based project work.

The *second* phase, the undergraduate studies from the 3rd to 6th semesters, is comprised of two years of studies in the main professional areas for surveyors.

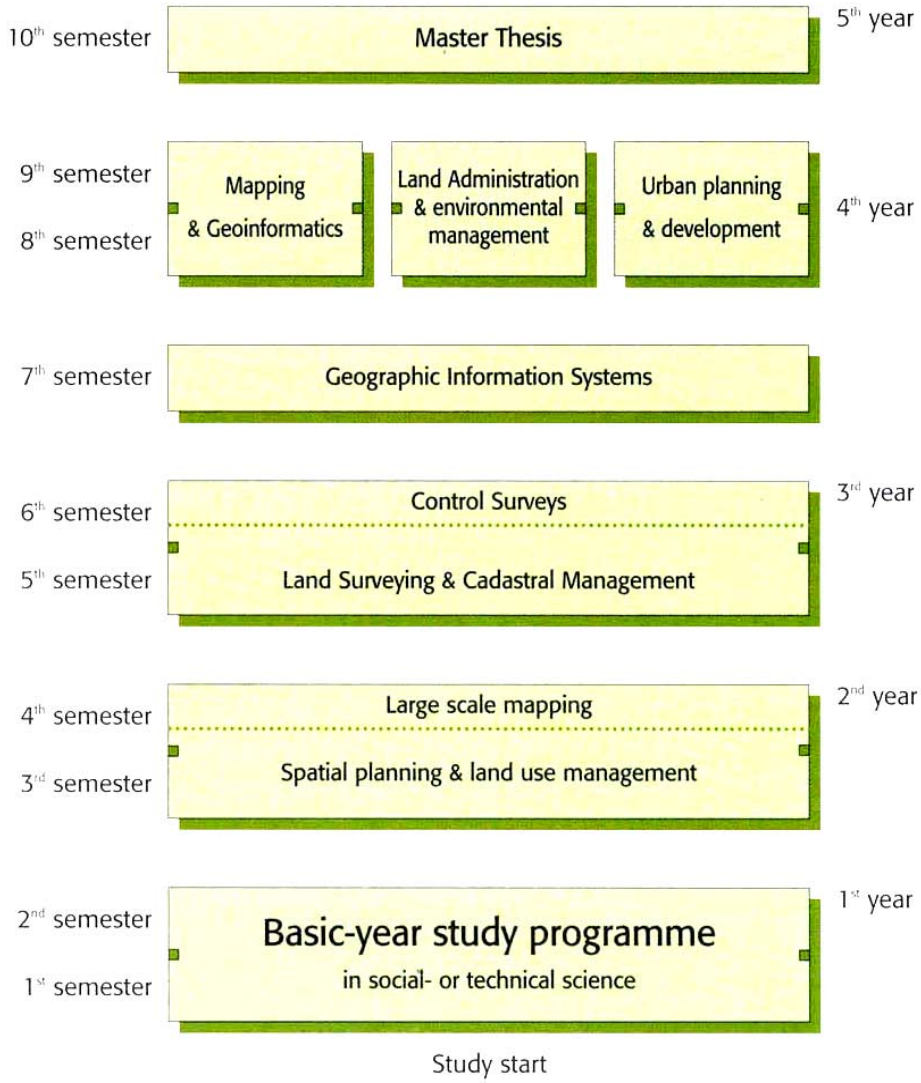


Figure 3: The curriculum for educating chartered surveyors at Aalborg University, Aalborg, Denmark.

The themes provide for teaching the necessary disciplines through lecture courses and for training the professional functions through the project work. Therefore, this phase is characterised by a *know-how* approach where the project work is focused on learning by doing.

The *third* phase covers advanced studies from 7th to 9th semesters and the curriculum provides for the opportunity to specialise. As such, this third phase of the curriculum has a more scientific approach that is based on *know-why*. The themes provide for teaching the necessary theories within specific professional areas, while the project work aims at training methodological skills in problem analysis and application.

The *fourth* phase, the 10th semester, is devoted to the preparation of a Masters thesis, which is carried out as project work and deals with a problem chosen by the student group. The purpose of the Masters thesis is to provide evidence of the student's professional insight, as well as theoretical and methodological skills.

## FLEXIBILITY AND ADAPTABILITY

The flexibility and adaptability of the project-organised educational model may be explained under three headings, as follows:

- The adaptability of the *individual theme*. This means that the focus on the subjects presented in the lecture courses and dealt with during the project work is easily updated or changed to reflect technical and professional development in society. Subjects and contents of the lecture courses are planned in advance before starting the semester to ensure that they include the most topical issues within professional practice.
- The adaptability of the *total curriculum*. This means that the focus of the themes in total can be easily adjusted or changed, according to the needs and development of professional practice, and are consistent with current technological developments.
- The adaptability of the *graduates*. Each graduate will possess specialised knowledge within one of the three main areas: mapping, land management or spatial planning. However, graduates will also possess the ability to understand and adapt interaction between the three main areas because of the basic knowledge that they have acquired during the second phase of the curriculum and the methodological skills established during the project work.

The consequences of this educational model are that the new graduates are less experienced in solving standard everyday problems, as they will appear in further employment. However, they are much better qualified to undertake large and complicated tasks, to combine insight from different fields, to analyse new problems and to acquaint themselves with new fields to which the problems of practice are related.

The aim is to engender a broad insight into, and understanding of, the links between different fields and skills that would enable graduates to function in a society that is becoming increasingly complicated. In principle, it can thus be ensured that graduates have obtained the skills and experience needed to solve unknown problems in the future [10].

## VIRTUAL ACADEMY AND KNOWLEDGE MANAGEMENT

University graduation must not be seen as an end in itself but rather the first step in a life-long educational process. In this regard, there will be a need to establish a new balance between universities and professional practice. This new balance should allow professionals to interact with universities and thereby gain access to a continual updating of their professional skills in a life-long learning perspective.

The role of universities will have to be reengineered based on the new IT-paradigm. The key term will be *knowledge management*. On-campus courses and distant learning courses will be integrated, even if the delivery may be shaped in different ways. Existing lecture courses should always be made available on the Web. Existing knowledge and research results should also be made accessible and packed in a way so that it is tailored for use in different areas of professional practice. All graduates will then have access to the latest knowledge throughout their professional life.

The first step towards this goal could be the establishment of Web-based platforms within different professional areas. The content of these platforms should be peer reviewed in terms of professional knowledge, just like the content of professional journals is reviewed. These platforms should be developed to include local, national and international approaches. The international approach could be developed based on agreements between leading universities throughout the world. These agreements would aim at providing knowledge adapted to the needs of the international community and international aid organisations, such as the United Nations and the World Bank.

Attempts to implement such a *virtual academy* concept at the School of Surveying and Planning are

currently underway. The development, maintenance and enhancement of professional competence should be seen as a total process facilitated through an efficient interaction between education, research and professional practice.

## CLOSING REMARKS

Even if the content of surveying curricula may vary between countries, some general trends can be identified. Clearly, there is a move towards an increased focus on managerial issues and the acquisition and application of interdisciplinary problem-solving skills. Regarding course delivery, there is a trend towards the increased use of project-based education, as well as skills for teamwork, cooperation and communication. Furthermore, Web-based learning is increasingly becoming an integrated tool for course delivery.

The challenge of the future will be to apply the new IT paradigm and a new interdisciplinary approach to surveying education. Further, it should be recognised that the only *constant* in the future is change. The educational base must be flexible in order to deal with such significant change. Graduates must possess skills to be able to adapt to a rapidly changing labour market and they must utilise their skills to deal with the unknown problems of the future.

Skills for *learning to learn* have become increasingly essential. In this sense, the project-oriented educational model at Aalborg University has proved to be very successful.

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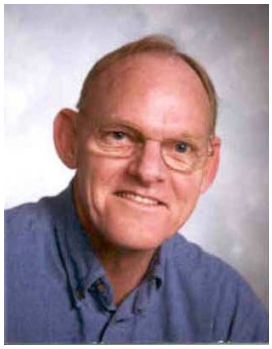

Prof. Stig Enemark is Head of the School of Surveying and Planning at Aalborg University, Aalborg, Denmark, where he is Reader in Land Management. He obtained his MSc in Surveying, Planning and Land Management in 1966 and, until 1980, he worked as a consultant surveyor in private practice. He is Vice-President of the Danish Association of Chartered Surveyors and an Invited Fellow of the Royal Institution of Chartered Surveyors, UK. He was awarded the Danish Real Estate Prize in 1991. From 1994 to 1998, he was Chairman of Commission 2 (Professional Education) in the International Federation of Surveyors (FIG). In 1999, he was appointed an Honorary Member of FIG. He was recently appointed a Deputy Director of the UICEE Centre for Problem-Based Learning (UCPBL).

His teaching and research interests are in the areas of land administration systems, land management and spatial planning. Another research area covers project-organised education and the interaction between education, research and professional practice. He has consulted and published widely within these topics and has presented invited papers at more than 40 international conferences.

## Conference Proceedings of the *5th UICEE Annual Conference on Engineering Education* under the theme: *Student-centred Engineering Education*

edited by Zenon J. Pudlowski

The *5th UICEE Annual Conference on Engineering Education*, under the theme of *Student-centred Engineering Education*, was organised by the UNESCO International Centre for Engineering Education (UICEE) and was held over the Internet and in person at Anna University, Chennai, India, between 6 and 9 February 2002. This volume of Proceedings includes papers submitted to the Conference and offers a manifold collection of almost 50 papers detailing various international approaches to engineering education and specific activities.

The Conference theme, *Student-centred Engineering Education*, was chosen to identify and present best projects, programmes and examples relevant to the main theme and to discuss their impact on the status and quality of global engineering education. Although the Conference s emphasis was on this theme, the papers included in these Proceedings present many aspects of engineering education and industrial training, addressing topics of vital importance to engineering education. These have been placed into various groups, namely:

- Innovation and alternatives in engineering education
- Important issues and challenges in engineering education
- New trends and approaches to engineering education
- Quality issues and improvements in engineering education
- Learning strategies and methods in engineering education
- Course development in engineering education
- International examples of engineering education and training
- Multimedia and the Internet in engineering education
- Case studies

Several papers in the Proceedings demonstrate research and development activities from within India and illustrate that the global debate on engineering education and the international expansion of interest in engineering education has grown and is having an increasing influence on the host nation.

In order to ensure their high quality and the value of the Proceedings for the future, all papers have undergone assessment by independent international peer referees.

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