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Internationalisation in Retrospect: The Engineering College of Copenhagen and Undergraduate Education

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The article deals with the history and different aspects of internationalisation of the engineering colleges in Denmark, and highlights various milestones, such as the FEANI accreditation in 1971 and the European Union programme ERASMUS from 1987, which supports the exchange of students and teachers and which subsequently led to the Bologna Declaration in 1999. The engineering colleges' approach is to encourage an evenly proportioned flow of students based upon bilateral agreements and this is exemplified through the BSc course in Electronics and Computer Engineering and the European Project Semester, both conducted in the English language, at the Engineering College of Copenhagen (ECC), Copenhagen, Denmark.

INTRODUCTION

Internationalisation has become a general theme in the majority of Danish college and university programmes [1]. This development started some 15 years ago and it is beyond doubt that Information Technology (IT), which spread like rings in the water at the time, has been a contributing factor to an increased interest in, and the need for, communication across national borders and continents.

People were suddenly online with universities and colleges all over the world and individuals had instant access to R&D results through the Internet when, previously, a great deal of time was spent trying to get hold of this information. The world moved into laboratories and classrooms and profoundly affected the method of acquiring knowledge and professional competences. At the same time, Information Technology has set new standards for teaching methods, as well as the planning of curricula.

HARMONY AND CREDITS

Another vital factor in the wave of internationalisation that swept Europe in the mid-1980s was the European Union's (EU) signing of the the Single European Act in 1986. For the first time, the university world saw a collective European vision for cross-border cooperation.

The idea was, and still is, to foster continuity in the construction of European education and exchange. The educational systems had to be coordinated and harmonised in order to ensure transparency and comparability. The objective was to make the transfer system more flexible, as well as to simplify academic credits for those students who wanted to take elements of their education abroad.

This move also promoted confidence in the educational systems of the individual countries. It effectively established an instrument for quality assurance and the quality development of European university programmes simply by virtue of the control function that arose when individual countries viewed each other's systems and compared educational structures in order to establish a coordinated credit system.

At the same time, increased cross-border movement in education supported the concept of labour market mobility, which was one of the great ideas of the EU from its soft start in the 1950s.

Internationalisation in Education

There is a marked and special need to establish and develop collaboration across national and cultural boundaries when it comes to internationalisation in the educational sphere.

The Engineering College of Copenhagen (ECC), Copenhagen, Denmark, belongs to an international programme called *Undergraduates* that, due to its initial structure, does not automatically nurture

international research contacts, and this can generate problems. Furthermore, the resources available do not cover the funding and labour necessary to join EU projects that could enhance professional and scientific expertise.

The Engineering College of Copenhagen has taken part in such projects on several occassions and, each time, has required considerable co-financing and comprehensive use of available resources.

1987 - A CENTRAL YEAR

Recent history of internationalisation is quite brief. It began in 1987 with the launch of a joint EU exchange and grant programme called Erasmus and was later expanded to include Socrates, which specifically addresses higher education.

The focus on internationalisation was further emphasised when Bertel Haarder, Denmark's former Minister of Education, resolutely introduced a central pool, called the *Quality Improvement* pool, which was aimed at financing internationalisation in Danish study programmes. The result was the establishment of several international offices, which were based at universities and other institutions of higher education.

The Engineering College of Copenhagen received a portion of these funds and established an international office in 1987. The international office was, and still is, responsible for maintaining continuity in the College's international work. This office handles collaboration agreements with technical universities and other institutions in Europe, provides information about travel and grant facilities and oversees the process whereby students can gain foreign examinations credited in Denmark.

This initial period was characterised by enthusiasm and the spirit of *learning-by-doing*. It was a new and exciting era and those people involved keenly and quickly identified new focus areas. Supported by the Ministry of Education, the College established courses for foreigners in the Danish language and culture, and a growing number of engineering courses were offered in foreign languages (primarily English) for exchange students in Denmark. At the same time, the College organised housing for these foreign students.

In the beginning, at least, the shortage of suitable student housing was a barrier in attracting foreign students to Denmark. However, since 1992, the Engineering College of Copenhagen operates its own efficient student-housing agency, which provides housing for about 130 foreign students at the College annually.

BILATERAL AGREEMENTS

The Engineering College of Copenhagen is a frequent user of the various exchange programmes established in the late 1980s, which were created with the aim to make the Danish curricula more international and global in orientation. The main programmes are Erasmus/Socrates, Tempus and Nordplus. Today, the number of students who are sent out and the number of foreign students attending the Engineering College of Copenhagen is fairly well balanced and approximates 120 students in either direction.

In addition to the permanent EU exchange programmes, the Engineering College of Copenhagen has succeeded in establishing a number of bilateral exchange agreements with universities and colleges outside the EU. The College currently has bilateral agreements with three universities in the USA, three in Chile and, inside the EU, with one university in Scotland, UK. The objective of these bilateral agreements is to provide study experience outside Europe for students at the Engineering College in Copenhagen and to give students from non-EU countries an opportunity to study in Denmark.

PAST VISIONS OF THE ENGINEERING COLLEGE OF COPENHAGEN

The Engineering College of Copenhagen dates back to 1879. The history books state that the first engineering graduate from the College was registered as a member of the Engineering Society as far back as 1881.

In 1905, the name *Teknikum* was imported from Germany, and the College adopted the German model for the structure in engineering education. This could be loosely interpreted as one of the first attempts to internationalise the engineering sector.

The next step took a long time to eventuate. It was not until 1965 that attention was again turned towards the international scene. In 1965, the administration of the Engineering College in Copenhagen decided that English language textbooks should be used so that the students in the various programmes could acquire a level of familiarity with an international context.

At the same time, the introduction of non-Danish textbooks was an acknowledgment of the fact that, if Denmark was to keep its position in Europe as an innovative and creative country, international inspiration was a requirement. This is particularly important in technology because the resources allocated to research and development abroad are far greater than those afforded by a small country like Denmark. The entry of foreign textbooks also signalled that the quality of education was taken more seriously.

New Admission Level

Shortly after the introduction of English language textbooks, the admission level for the engineering programmes was raised. In 1967, a reform made an admission course prior to the proper programme a compulsory part of the study. The admission course was, and still is, an equivalent to the Danish upper secondary school leaving certificate. In addition to the necessary qualifications in mathematics and physics, the course also includes two foreign languages and philosophy.

In 1971, the Danish engineering colleges, including the Engineering College of Copenhagen, became a member of the European Federation of National Engineering Associations (FEANI), which looks after the interests of engineers both inside and outside Europe. Generally speaking, the role of FEANI is to affirm the professional identity of the engineers of Europe. This would be achieved by:

- Ensuring that the professional qualifications of engineers of member countries are recognisable in Europe and worldwide.
- Asserting the status, role and responsibility of engineers in society.
- Safeguarding and promoting the professional interests of engineers.
- Facilitating the free movement of engineers within Europe and worldwide [3].

At the same time, FEANI strives for a single voice for the engineering profession in Europe, whilst also acknowledging its diversity in developing working cooperation with other international organisations concerned with engineering matters. Furthermore, FEANI seeks to represent the engineers of Europe in international organisations and other decision-making bodies. The full membership of FEANI has meant that it has become easier for Danish engineers to obtain jobs outside the country than it was before Denmark joined FEANI's Group I in 1971.

Figure 1 shows the current position of the Engineering College of Copenhagen in a ministerial and organisational context.

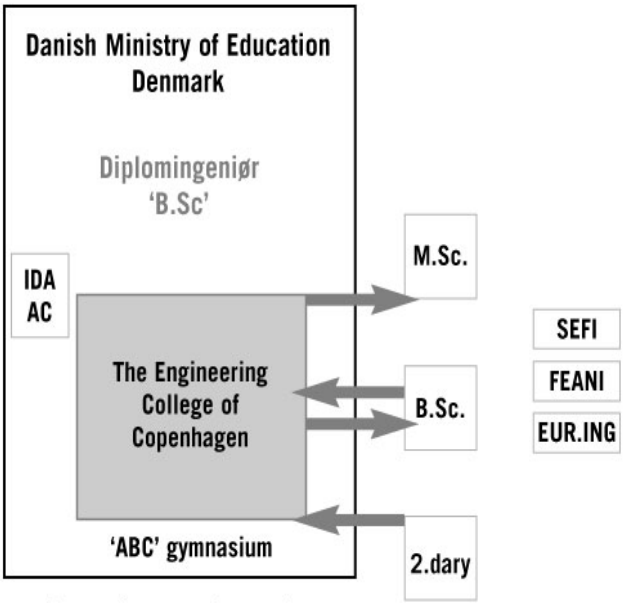

Figure 1: The ministerial and organisational context of the Engineering College of Copenhagen.

ENGINEERING REFORM AND THE BOLOGNA DECLARATION

The engineering reform of 1993 marked a new turning point in the international work of the entire Danish engineering sector. In the reform, several engineering degrees were merged into one: the diploma engineer. As a result, there are currently two engineering degrees in Denmark: civil engineer (MSc) and diploma engineer (BSc).

The diploma engineering degree is fixed at 3½ years, including six months of practice in a Danish or foreign company. The degree is the same whether it is obtained at a university or an engineering college. This fact has set new standards for international cooperation since the parallelism between the colleges and universities has been firmly established. This means that engineering colleges are a natural step in the 3-2-3 model, which was finally established at the signing of the Bologna Declaration in 1999 [5].

The most important objectives of the Bologna Declaration are that the individual countries should promote:

- Transparency and comparability in the documentation of completed studies.
- More uniform structures with the introduction of steps in higher education.
- A system of credits.
- Mobility by overcoming obstacles to the free movement of students and teachers.
- Cooperation in evaluation and quality assurance.
- European dimensions in higher education.

In 1999, Denmark already had a stepped educational system and the 3-2-3 model for higher education, which was in use for several years. Nevertheless, it is certain that the Bologna Declaration will have increasing importance for Danish students who wish to study abroad, as well as for foreign students who seek to study in Denmark.

One of the instruments intended to enhance student mobility and encourage an international outlook is the European Credit Transfer System (ECTS). ECTS makes it much easier to transfer credits from completed courses under the system of one country to the systems of other countries, since the achieved qualifications can be weighed against objectively determined criteria.

SEFI AND DANISH ENGINEERING PROGRAMMES

The Engineering College of Copenhagen has been a member of the European Society for Engineering Education (SEFI) for the past 25 years and has been active at all levels: on the Board, in workgroups, in SEFI-sponsored EU projects and as participants at SEFI events.

The involvement in SEFI culminated at the SEFI 2001 Conference, when the Engineering College of Copenhagen, in cooperation with the Technical University of Denmark, Copenhagen, planned and organised the annual conference under the heading *New Engineering Competences – Changing the Paradigm.* This Conference highlighted the importance of internationalisation for those schools that do not automatically have the same professional research networks as universities.

All engineering schools in Denmark are members of SEFI. However, there is a tendency that Bachelor-level programmes are more focused on practical work, primarily because they have the greatest need for a professional forum in the discussion of developments in engineering education and for the creation of international contacts that cover institutional as well as personal issues.

The Need for Communication

The 2001 SEFI Conference was attended by 70 Danish teachers and principals, and many contributed with papers and as moderators in the workshops. While the number of Danish participants was naturally higher than at any previous conference held abroad, a number of participants indicated that there was major interest in communicating with colleagues and counterparts from other countries.

Many SEFI events have been held in Denmark over the years. In 1993, for example, the Engineering College of Copenhagen organised a successful and well-attended seminar on project and group work for 130 teachers and principals. At that time, the development of Danish engineering programmes was at the forefront internationally, with regard to both the contents and educational level. One of the reasons for this was the major reform occurring at the time, which redefined Danish engineering education and resulted in the implementation of the new diploma engineering degree.

The Competitors

Apart from SEFI, two other European organisations for engineering education exist. They are the International Gesellschaft für Ingeniörpädagogik (IGIP) and the Conference of European Schools for Advanced Engineering Education and Research (Cesaer). It is a fact that both organisations will not play any role in the future.

IGIP is largely a one-man show; the President has chaired the organisation for 30 years and will soon retire. IGIP is based in Austria, is a German-language organisation and has carried certain weight in relation to the former Eastern Bloc.

Cesaer began in 1990, and it is the *A* in the acronym that matters, which stands for Advanced; it is a club that only accepts members on recommendation. The only Danish member is the Technical University of Denmark, which was also one of the founders. Cesaer has lacked sufficient labour to do the practical work thus far because the researchers in the network have their own circles and priorities.

However, by virtue of its good academic and management relations, Cesaer has played a role in H3E, an EU-financed programme entitled Higher Engineering Education for Europe. The project has been replaced by E4, which stands for Enhancing Engineering Education in Europe [4]. It is still uncertain what level of importance this programme will have in the future. However, since the author is involved, it is the author's hope that the networks being created will be used to actively support the quality development of educational principles as a natural part of modern engineering education, as well as benefit the internationalisation of education.

ACTIVITY IS REWARDED

In a brief departure from the Danish context, and as an inspiration to the utilisation of international networks and contacts in the active process of generating funding, it is appropriate to take a look at Germany as a role model for undergraduate institutions.

Generally speaking, around the world, due to their international research collaborations and clearly stronger economy, universities are more advanced in the internationalisation process than institutions at the undergraduate level. However, in Germany, it appears

from the current debate that universities lag behind in this process. This is because they do not actively take part, but instead spend their energy in research networks that may be international, but which do not pay special attention to internationalisation.

The divide between universities and Fachhochschulen (universities of applied science) is larger than in Denmark. This is despite the fact that Fachhochschulen offer four-year programmes and are highly respected for their standards. This snobbishness is naturally a result of the struggle for funding. The Fachhochschulen are clearly more active and, like the Engineering College of Copenhagen, have established international contacts. But they also get their slice of the pie when funds are allocated to EU-financed projects.

OBJECTIVES OF THE ENGINEERING COLLEGE OF COPENHAGEN

Internationalisation is a general theme in all of the engineering programmes at the Engineering College of Copenhagen – irrespective of the speciality. Various types of language courses are offered in German, French and English, and some of the textbooks are in one of the international languages (primarily English).

Many engineering students choose to complete parts of their studies abroad, either at a university or as industrial practice, or as a combination of both. Thanks to various exchange and cooperation agreements with authorities and international departments at foreign universities, students at the Engineering College of Copenhagen can complete parts of their education abroad and gain credit for these studies at their home institution.

The internationalisation of education is a core challenge that carries a high priority at the Engineering College of Copenhagen. The target is to prepare students for international work by utilising curricula and study planning. The labour market places increasing emphasis on job applicants' international outlook and understanding, and employers prefer applicants to have a certain proficiency in the main European languages.

A degree in engineering opens many doors to an international career and this constitutes another reason for the Engineering College in Copenhagen to increase its focus on internationalisation. Similarly, technology and technology development are universal entities that cannot be halted by national boundaries. Many engineers have international jobs and have the whole world as their workplace. They can work as consultants in connection with planning and organisational development, as experts on specific construction projects, as researchers or scientists, or as bridgeheads or export managers for Danish or foreign companies [2].

Achieving Balance

One of the prime objectives of the Engineering College of Copenhagen's internationalisation work is to gain an even balance between the number of incoming and outgoing students. The balance is maintained through a large number of bilateral agreements, which also give the College a platform for comparing the quality of the College's programmes with the quality in the EU and the rest of the world. Such a platform helps to ensure a common understanding of the relationship between quality and content and, as such, is a vital instrument for establishing new standards and goals in teaching.

In 2001, the Engineering College of Copenhagen received 112 foreign students for a study period of between 3 and 12 months. The foreign students took courses, carried out practical work or studied for their final thesis. Conversely, the Engineering College of Copenhagen sent out 99 of its own students on the same conditions. This means that for 2001, the College had a *surplus* of 13 students. In 2002, the College expects to receive 140 students and send out about 100.

International Semesters

The increase in the number of exchange students is primarily the result of two new international semesters offered by the Engineering College of Copenhagen in the field of production and machinery [6]. These are two independent courses entitled *International Design Semester* and *International Business Semester.* The central idea of both courses is to prepare the students for engineering jobs after graduation.

The students have to solve real-life problems by working on projects and in teams. The courses involve wide cooperation with companies based on current problems that they need to solve.

Both semesters are for students who have completed at least two years of studies at a technical university or technical studies at another higher education institution. It is also a requirement that students must be signed up at a school participating in the EU framework programme Socrates. It should be noted that the objective of Socrates is to promote transnational cooperation in order to strengthen the European dimension and improve the quality of higher education.

Positive Development

The development of the internationalisation process at the Engineering College of Copenhagen can be seen in Figures 2 and 3. Much has happened since 1987 when the Danish Ministry of Education allocated funds for the establishment of international departments at institutions of higher education. In 1987, the Engineering College of Copenhagen sent out four students into the world and received the first two foreign students in 1990.

The analysis of Figures 2 and 3 demonstrates that the number of College students studying abroad has risen progressively and has levelled out at about 100 students per year. The progression of foreign students at the Engineering College of Copenhagen is different; there was a very slow start in 1990, but a quantum leap in 1998 when the number increased from13 to 66 in 1997. The increase in 1998 was primarily a result of the introduction of the European Project Semester in 1995 and the fact that the English language programme Electronics and Computer Engineering apparently did not actually gain popularity until the late 1990s.

Electronics and Computer Engineering

It should be mentioned that the international programme of Electronics and Computer Engineering is the flagship course of the Engineering College of Copenhagen. The first class began in 1992, so the course celebrates its 10th anniversary this year. The programme has been an acknowledged success and has a current annual capacity of 66 students. The students come from all over the world and represent many different continents, such as Asia, Africa, Latin and North America and Europe – including the Nordic countries.

The College has learnt a lot from its activities in Asia with regard to the implementation and development of the international programme in Electronics and Computer Engineering. The experience gained from the cooperation with China is particularly remarkable. So far, the Engineering College of Copenhagen has received 60 Chinese students and, since the

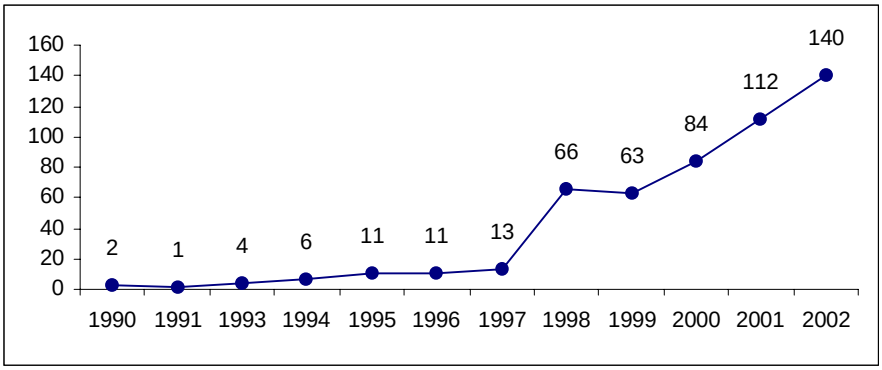

Figure 2: Foreign exchange students at the Engineering College of Copenhagen studying, undertaking practical work, or working on their final thesis, between 3 and 12 months, since 1990.
Note: No foreign students were registered before 1990 and the figure for 2002 is estimated.

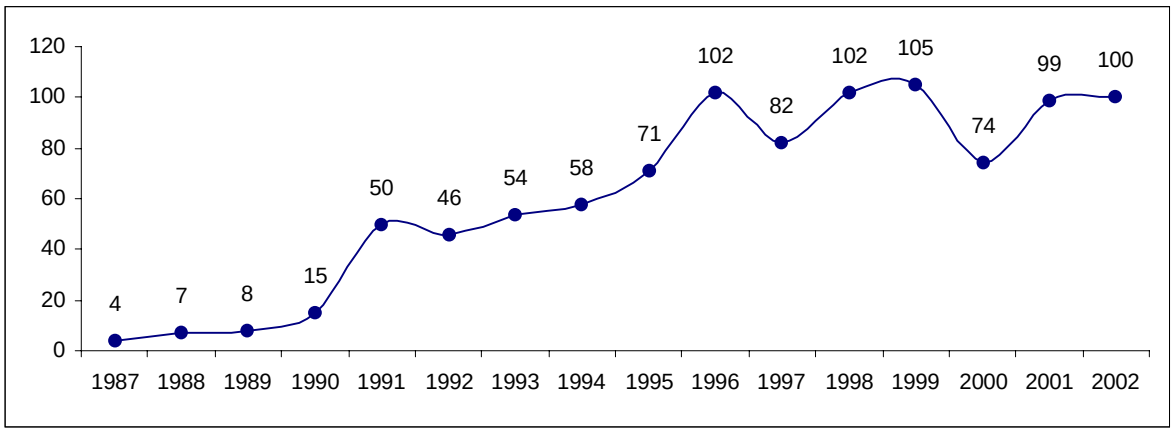

Figure 3: Full-time students at the Engineering College of Copenhagen studying, undertaking practical work, or working on their final thesis abroad, between 3 and 12 months, since 1987.
Note: no students were registered before 1987 and the figure for 2002 is estimated.

College does not have explicit cooperation agreements with Chinese universities, the general cultural exchange agreement between Denmark and China has been utilised as a vehicle for student exchange.

In addition to the practical side of the agreement, which enables the College to receive Chinese students, the College is proud of its contribution to Denmark's intercultural communication with the world's most populous nation. Furthermore, China plays a much more important role in world trade and cooperation today than it was imagined ten years ago, when the international Bachelor programme was launched.

The success of the programme is also based on the fact that the Engineering College of Copenhagen is the only Danish institution of higher education to offer a full Bachelor degree in English in electronics and computer engineering. The course takes 3½ years and the students and teachers occupy and enliven the campus day after day, making the College an inspiring and international environment for engineers.

The project-organised orientation of the teaching method has an interdisciplinary focus. The continuing relevance and dynamism of the programme is maintained through sustained dialogue with industry and universities all over the world.

European Project Semester

The Engineering College of Copenhagen took yet another step onto the international scene in 1995 with the launch of an interdisciplinary and internationally focused European Project Semester (EPS) [7]. With close to 40 students commencing their studies every year from all over Europe, as well as Chile and the USA, the semester has been a great success. A total of 15 countries presently take part in the semester and the number of participating countries is increasing continuously. Similarly, the criteria for the content of the programme are under constant development. The establishment of thematic networks in a European context is the latest initiative.

Over recent years, the Engineering College of Copenhagen witnessed increasing competition from other countries that offer similar international semesters, which often resemble plagiarism. New thematic networks are envisgaed to be set up in order to counter this competition, as well as to ensure the quality of the programme. The network will comprise 31 universities and the objective is to define and implement the necessary quality parameters in the semester. The network actually has the opportunity to have the EPS module formulated as a genuine trademark, so that only those institutions in the network can offer the EPS.

EPS Objective

Many observers consider that the College's present model of an engineering graduate needs little adjustment in order to satisfy industry requirements [8]. Engineers must be capable of dealing with frequent and unexpected changes, and the College already provides students with a good level of basic knowledge in engineering, economics and management. However, they also require training in a broader range of disciplines, such as international communication, teamwork skills and languages. It is probable that there will be growth in the number of engineering consultants. Now that the EU is mature, it is likely that the mobility of labour will increase. Many engineers will work in more than one country, often on a short-term basis.

Working in a foreign country involves many skills. The EPS is specifically designed to train engineering students to work in international teams [7]. In an EPS, an international team of students work on a real-life project, which is carefully chosen to match their speciality and capabilities. The projects are supported by theoretical studies and English is the medium of communication. Supervisors from their students' home institution normally visit them once or twice during the term. Students obtain full credit upon successful completion of the course, according to the ECTS Qualitative Scale System.

CONCLUSIONS

In recognition of the fact that engineering education is an international phenomenon with competences that can be applied all over the world, one of the global challenges is to create a worldwide system of accreditation that is based on agreement and transparency.

In the USA, a joint accreditation system has been established called the Accreditation Board for Engineering and Technology (ABET). One could see the American system (K-12, BS, MS), as well as this accreditation system (ABET), as a result of exporting and integrating the European culture (over 50 million immigrants from 1880-1920).

One proposal could be to re-import the American system (the Bologna process) and the accreditation system back to Europe with the aim of implementing it at the European level. This would at least generate uniformity in the western world. Then Asia could come into the picture so that, within the foreseeable future, there may be a global accreditation system. This would benefit the engineering profession in general and also contribute to the future development in global communication and knowledge exchange.

One final point is that the author is convinced that, in the future, the number of international contacts that an institution has formulated will be an even more decisive competitive parameter in the ability to attract students than is the case today. This refers to students both from home and from abroad. The then intensified competition will primarily increase in step with the institutions' growing orientation towards internationalisation and global opportunities. Furthermore, the first to see and benefit from these new opportunities will be the younger generation: students.

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BIOGRAPHY

Prof. Flemming Krogh completed his BScEE at the Engineering College of Copenhagen (ECC) in 1973. From 1974 to 1980, he worked at the University Hospital in the field of computerised tomography. Since 1980, he has been lecturing at the ECC in telecommunications and microwaves. From 1986, he was elected the Head of Department of Electronics and IT. Prof. Krogh is currently Rector of the Engineering College of Copenhagen, a position he was appointed to in 1998.