"Capacity Building in Science, Engineering and Technology – a European Perspective"

C.L. Robertson Memorial Lecture

Zimbabwe Institution of Engineers ZIE 4th Congress, Victoria Falls, Zimbabwe

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1. Introduction

Capacity building, especially in science, engineering and technology is said to play the key role in the development of countries, independent whether they are developed, in the transition state or non-developed. Capacity building is one of the Millennium Development Goals and its global achievement is one of the highest targets. A number of globally, regionally and nationally acting associations and non-governmental groups are involved in the forthcoming of this process.

WFEO, the World Federation of Engineering Organisations, gives the global platform for all engineers, and since last year also the civil engineers have a global platform and, thus, support with the newly founded World Council of Civil Engineers (WCCE).

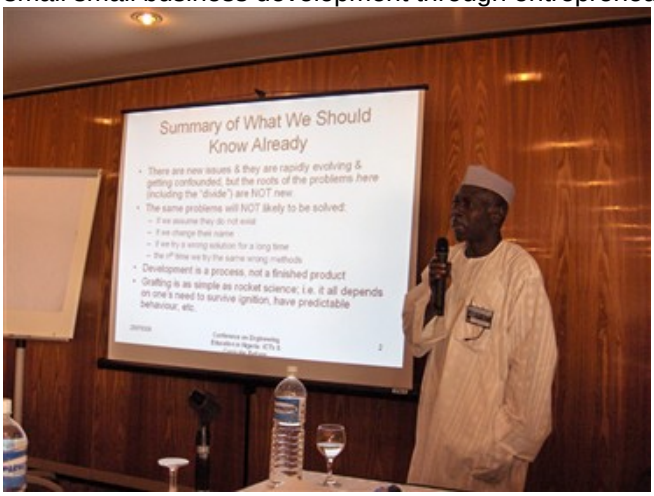
Due to the very urgent demands of the African nations and communities the capacity building process in science, engineering and technology is fostered e.g. by the International Council for Science (ICSU) but no longer the World Bank, and from Europe it is e.g. the European Investment Bank (EIB) and – a little bit apart - the Centre for Development of Enterprises (CDE).

More directed to actual engineering education and training help it is the African Network of Scientific and Technological Institutions (ANSTI), which fosters the process of postgraduate training e.g. by offering and organising fellowship grants from UNESCO and the German Academic Exchange Office (DAAD). A very strong and important input could and may come from the European Federation of National Engineering Associations (FEANI), and within the field of civil engineering it could become the European Council of Civil Engineers (ECCE).

As you all know, the given names are just a few out of the numerous active groups or organisations, which are active in capacity building in different fields. I do believe that you all are much better informed about these activities than me. In addition you know that help from outside does not always reach the respective persons, groups, countries and, thus, its target.

From 4 to 6 March 2007 the "Engineering Africa" initiative of WFEO Committee on Capacity Building conducted a pilot conference in Abuja, Nigeria. The conference brought together an invited group of educators, industry leaders, government officials and NGO's representatives to discuss how a multi-sector approach could be effective in enhancing engineering education in this most populous country in sub-Saharan Africa in order to develop an appropriate quality and quantity of engineering graduates

to attract direct foreign investment, address the technical needs of Nigerian economy, and stimulate small small business development through entrepreneurship (see picture 1).



Picture 1: WFEO Capacity Building, Nigeria, March 2007-05-20

Co-sponsors of the conference included the Hewlett-Packard Company, the Nigerian Society of Engineers, the African Engineering Education Association, and the UNESCO Regional Bureau for Science and Technology in Africa.

Help from outside does not always reach the respective addressees. So, it is much more important and on a longer range more successful to start sustainable development, not only but especially in capacity building in science, engineering and technology at home, based on own considerations, ideas, common understanding and own will. You may or will need some ignition from outside as well as continuous support. But it remains still your child, which you have to raise and grow up, and this on your responsibility, with all your force and knowledge that still exists.

As the keynote speaker today I like to help giving you a kind of ignition. For this I use help from the coming World Engineers' Convention (WEC) 2008 in Brazil. WFEO and the Brazilian engineering societies CONFEA and FEBRAE are inviting all of us engineers worldwide, you and me, to this great event, and for this they produced an invitation and initiating paper out of which I use some citations as follows always at the beginning of each chapter.

2. Networking

We need to create a network of information through which experiences and knowledge can be shared and enriched by studies and experiences. In this way we can make viable and effective decisions-making forums that discuss care for our greater good, the environment, and how to preserve it, use it, destroy it. These networks can help each one be aware of the importance of participating in these processes.

Networking is a powerful tool for all professionals worldwide. At the 4th Congress of the Zimbabwe Institution of Engineers (ZIE) in connection with the WCCE 2nd General Assembly we all demonstrated how necessary it is for all of us. Being in Victoria Falls we started to build up or strengthen such a network. You gathered here as representatives from different African engineering associations. It is a pity that the president of WFEO, Engineer

Kamel Ayadi, had to cancel his visit just a week ago, but you can be sure that he would appreciate much to be with us in this networking congregation.

Concerning the civil engineers under us they shall feel strongly supported making up a networking platform here in Victoria Falls. The World Council of Civil Engineers (WCCE) is here as the global voice for all civil engineers and its president, Prof. Jose Medem, is with us. The networking has also a continentally aspect because the European Council of Civil Engineers (ECCE) is present through me as the Senior Vice-president of this organisation.

Please, include also the European Federation of National Engineering Associations (FEANI), which is representing nearly all engineers within Europe and with which ECCE and I personally co-operate closely (see also chapter 6.).

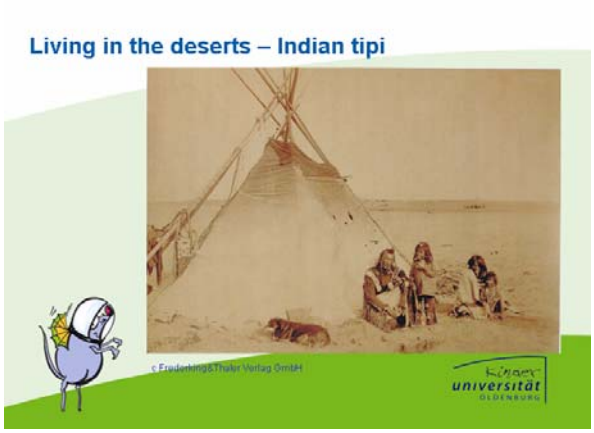
3. Culture and Globalisation

In Brazil as in other countries, the plastic languages of buildings, hotels, shopping centres and homes are increasingly homogenized, and the loss to the culture is violent. As Indian ecologist Vandana Shiva said, we are building a "monoculture of the mind". To be aware of our values, roots and the social, economic, environmental conditions of our field of intervention is also an ecologically correct attitude. It is important to know the "Ecological Footprint" of the different interventions and specific realities where we are acting.

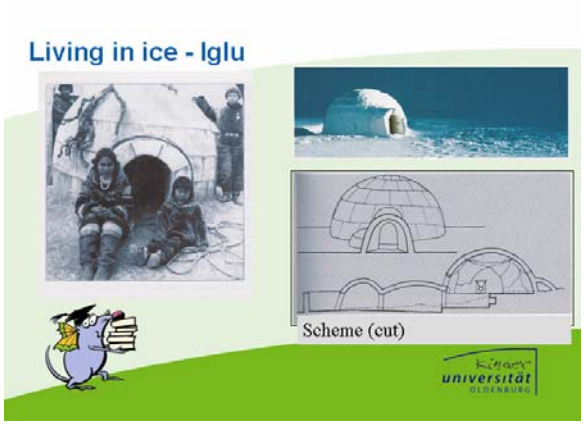
Networking and thus sharing professional knowledge shall by no means result in such uniformities. For me it is always a bad feeling to see MacDonalds, Starbucks, Gucci, Nike etc. in nearly each bigger city. This appearance is always closely linked with always the same "outfit" of the houses. But I know a number of people including students at home who feel "more home" when they find such establishments also in their host cities.

I would appreciate if this monoculture of mind respectively of building would no longer exist as the sign of being a global player, a globally open minded mayor of a capital, a universe architect etc. A nation should be proud to live, to show, to push forward its own footprints.

Such wishes, of course, do not target the very simple natural housings as can seen below (Picture 2 and 3). On the other hands these are very sustainable works, all material is from the direct nature, and the house is fit against all destroying attacks of just this nature. They protect the inhabitants against outer climate perils connected with dust, sun, storm and desert or cold, wind and animals. They really show national foot prints.

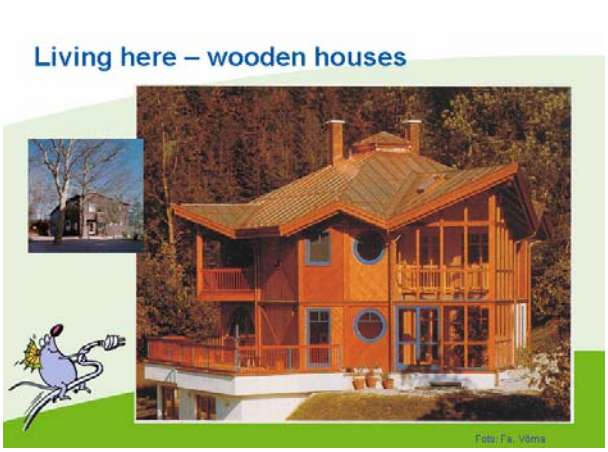


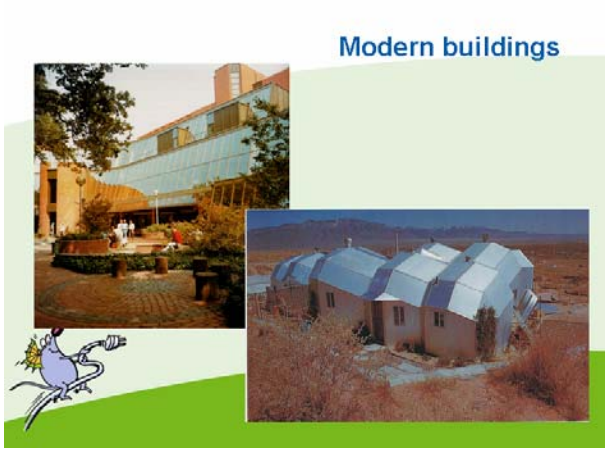
Picture 2: Indian tipi



Picture 3: Ice-Igloo

What I mean by national foot prints and nevertheless being at the peak of modern architecture and sustainability is shown in pictures 3 and 4. On the left one can see private low energy houses, made of natural materials, and on the right low energy public buildings like the Oldenburg University and row dwellings.





Picture 3: Low energy private houses

Pictures 4: Low energy public buildings

Indeed, this is sustainability on a high scaled platform, but existing and from the point of architecture showing up-to date design and national foot prints.

4. Sustainability

Our challenges will be to seek solutions that receive a commitment of respect for ecosystems, leaving behind the anthropocentric perspective that has characterized our interventions in the use of land and in the management of the earth. A sustainable society perceives the entire web of life on which depends our own survival. "The sustainable community is composed in such a way that its way of life, its business, its economy, its physical structure and its technologies do not oppose the intrinsic capacity of nature to sustain life". Thus it is necessary to apply our knowledge of ecology to a reformulation of technologies, in order to overcome the gap that separates us from ecologically sustainable systems.

Sustainability is very often shortened to the question how long do the reserves of fossil energy remain. Even if this is a small extract only of the meaning of sustainability it seems to be the most important objective. Engineers whether they are mechanical, electrical, agricultural, chemical, civil or nuclear engineers etc. have to use energy for their products. So, they realize during their daily work that the energy prices rise constantly and rapidly to a high degree, which makes their products more expensive and thus less competitive on the international market.

So, for a great number of people, including engineers, sustainability is often just a word. Sustainable production and behaviour then is often rejected because

- it is too expensive and thus only for rich nations;
- is not really feasible and
- is bringing no forthcoming but will drive us back etc.

I like to state here and today that this thinking and behaviour is not really “sustainable”, it may be correct only for this very moment, but even not for the next 5 to 10 year’s period. Of course, richer countries can start earlier and on a higher level to think and then realise e.g. buildings in a sustainable way (see chapter 3).

On the other hand there are a lot of sustainable projects that neatly fit into the demands of a number of African and other developing nations. These cannot be huge and cost extensive industrial projects, but more self consistent working plants (stand alone plants) in city districts, rural regions, congestions of dwellings etc.

When you look at the agenda of the ZIE-congress you will find the topics

- Education and Capacity Building in Engineering and Technology;
- Renewable Energy;
- Research and Development;
- Irrigation and Agriculture Mechanizations;
- Water and Sanitation.

Within these fields of engineering activities you will find a lot of insular solving plants (stand alone plants), which target not only one but more of the above topics. Some examples are given below and can be subsumed under renewable energy with specific other tasks:

- Power – Heat – Cooling coupling systems
  (using bio-gas, bio-fuel, wood pellets, stray etc.);
- Solar process energy for cooking, baking and drying;
- Solar cooling systems for facades of business buildings;
- Photovoltaic systems.
- Wind energy small grid electrical power stations (see pictures 4 + 5, figures 1 + 2);
- Wind energy powered heating and cooling systems;
- Wind energy driven salt water desalination and water purification systems;
- Wind energy driven water pumping systems;
- Energy autonomous insular supply and waste-treating systems;

Picture 4: Wind energy plant

Picture 5: Details of (transparent) machine room

The German company ENERCON has developed all relevant system components including the main control system (Power Management System) and can thus even supply a complete power station (based on wind energy) to provide consumers with power at locations where no energy supply has been available so far or where old diesel engines have to be replaced.

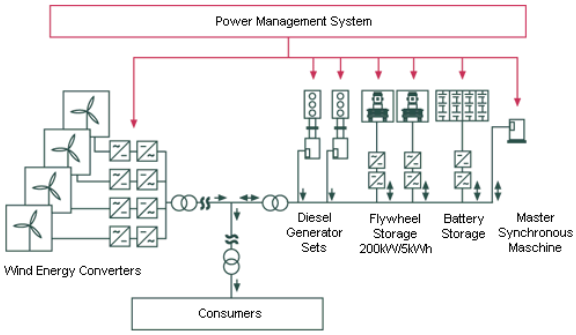


Figure 1: Stand-Alone power management system

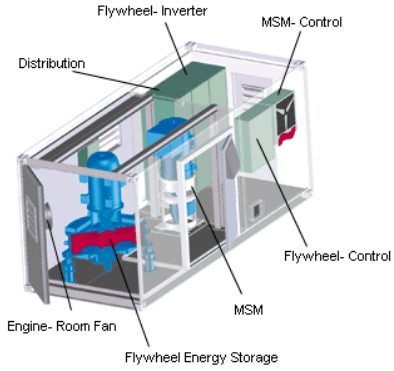


Figure 2: Container instalment

All these projects do not apply to great industrial plants, but they realise up-to-date projects, which are payable, sustainable, long-lasting, energy-efficient, economically reasonable, can be maintained by national technicians, involve a number of maintaining national personal, support self responsibility etc. For all such projects a great variety of investment plans, and refinancing, leasing and financially supporting models exist. One of these normally fits into the respective local needs.

5. Academic Training and Capacity Building for Academicians

We will have to restore the balance between objectivity and subjectivity in academic training. Linear thinking should give way to the recognition of the subjacent complexity of all things, and to do so, there should be training in "psychic and ecological literacy" in our schools. Ethics would be a fundamental curricular element, as well as pragmatic evaluations of the cost benefit ratio of our projects and buildings. The Venice declaration of 1990, which spoke of a new education, presented the Letter of Transdisciplinarity. To support a new education for the next millennium the letter proposed four pillars of its construction: science, philosophy, art and tradition, which are needed to care for reasons, sensibility, sensation and intuition of humans. We are thus speaking of a new epistemology. It is important to remember that the biggest enemy of sustainability is ignorance.

Even if this is a very generally formulated objective Europe has given a direct and actual answer, which could be of high interest also for the African education and training community.

You all know that nearly every European nation is member of the powerful European Union; now the EU consists of 25 Member States. With respect to its economic power and its economically guided behaviour you may have – and you seem to be right to have it – a number of concerns upon market regulations, especially in agricultural products and their trade.

With respect to education and capacity building the EU now is another attractive political being. The implementation of the European Higher Education Area (EHEA) has started and it was targeted towards an increase of harmonisation and mutual trust and acknowledgment between the European institutions of higher education. Due to the former existing variety of education systems and study programmes (from 3 to 6 years of education time) there was a

strong political and educational need for that. For the universities there was a very strong effort to make it easier and more automatically to gain academic recognition and, thus, to become mobile to study abroad and also to teach abroad.

The **Bologna Process** shall lead to the **European Higher Education Area (EHEA)** and got the biggest impetus on 19 June 1999, when 29 European Ministers in charge of higher education signed in Bologna the Declaration on establishing the European Area of higher education by 2010 and promoting the European System of higher education world-wide. The Ministers affirmed in the Bologna Declaration their intention to:

- adopt a system of easily readable and comparable degrees
- adopt a system with two main cycles (undergraduate/graduate)
- establish a system of credits (such as ECTS)
- promote mobility by overcoming obstacles
- promote European co-operation in quality assurance
- promote European dimensions in higher education

Later in Prague, Czech Republic, Berlin, Germany, and Bergen, Norway, three additional topics where added as

- lifelong learning
- involvement of students
- doctor's degree in a third education cycle
- enhancing the attractiveness and competitiveness of the European Higher Education Area to other parts of the world (including the aspect of trans-national education).

Today the Bologna Region consists of 45 members, including e.g. Russia and Turkey that are no EU-member states.

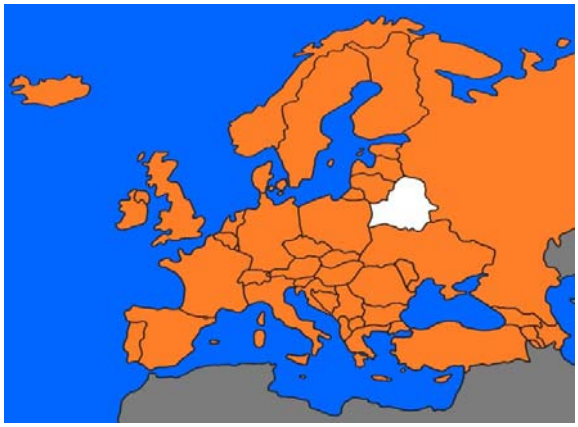


Figure 3: Bologna Member States

The actual education system now is a two-tier system. The First Cycle leads to a Bachelor degree and has to be attested as entrance to the professional market; the wording is employability. The Second Cycle leads to a Master degree and can be studied after having achieved a first cycle degree in an appropriate study program. The second cycle program can be a more professionally oriented program or a more academically oriented program. Both degrees together normally shall not be longer than 5 years.

In addition all curricula have to be taught or learned in modules, which is a more "bit"-wise education compared to the former more "closed-circle" education. All modules as well as the

total curriculum have to be given a description of the study load of the "normal" student. This study load is at least the time, which is necessary for a "normal" student to fulfill the demands of the study program and, thus, successfully finishes his studies. The study load of one semester is 30 ECTS-credits, which are awarded to the successful student semester per semester. - ECTS stands for European Credit Transfer (and Accumulation) System. – The basis for a normal work load is very much comparable to the normal work time in any normal profession, which means 8 hours a day, 40 – 50 hours a week and about 1.600 hours a year or more. A number of more sophisticated descriptors of workload came up recently.

The student accumulates these semester credit points at any European university in an appropriate study program until he earned enough credits to be awarded the respective degree. Typically the two cycles have no sharply fixed duration. The EU-directive on Professional Qualification as well as the Bologna (Follow-up) Declarations now gives a small span of duration or credits for each cycle as follows:

Cycle	**EU-directive**	**Bologna**
First Cycle	Not less than 3, but not more than 4 years (which may be 3, 3 1/2 or 4 years)	180 – 240 ECTS-credits
Second Cycle	More than 4 years (but normally not than 5 years)	90 – 120 ECTS-credits with a minimum of 60 credits out of second cycle (300 ECTS all together in general)
Third Cycle (just for completion)	Not mentioned	(about 3 years) x ECTS-credits not specified

Table 1: Duration or ECTS-credits of cycles

Program Outcomes for Accreditation of Engineering Curricula (EUR-ACE)

EUR-ACE has been founded to describe the accreditation demands for engineering curricula. Its work has been finished now and overturned to the European Agency for Accreditation and Quality (ENQA). This agency does not work like the American ABET but as a qualification board consisting of all national accreditation organizations, which lay down general accreditation rules for the respective national organizations.

All study programs have to be (re-)designed to assess the curricula and the qualification of students by outcomes. This is the most crucial change in European teaching programs in higher education, because the normal education has been done by teaching and by giving input only by teachers.

There are six Program Outcomes of accredited engineering degree programs as follows:

- Knowledge and Understanding;
- Engineering Analysis;
- Engineering Design;
- Investigations;
- Engineering Practice;
- Transferable Skills.

Although all six of the Program Outcomes apply to both First Cycle and Second Cycle programs, there are important differences in the requirements at the two levels. These differences in the levels of First and Second Cycle accredited engineering programs should inform the interpretation of the Program Outcomes by Higher Education Institutions (HEI) and by accrediting panels. The differences are particularly relevant to those learning activities that contribute directly to the three Program Outcomes concerned with engineering applications, Engineering Analysis, Engineering Design, and Investigations.

Students entering an accredited Second Cycle program will normally have graduated from accredited First Cycle programs but the HEI should provide opportunities for students entering without such a qualification to demonstrate that they have satisfied the First Cycle Program Outcomes.

Integrated programs leading directly to a qualification equivalent to that of a Second Cycle qualification will need to include the Program Outcomes of both First and Second Cycle Programs. All students will receive a complete Diploma Supplement, which describes in a very detailed manner all learning input and outcomes of the student. It works like a personal education and training card.

The outcomes qualification descriptors are given as follows:

First cycle qualifications are awarded to students who:

- have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study;
- can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study;
- have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues;
- can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences;
- have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy.

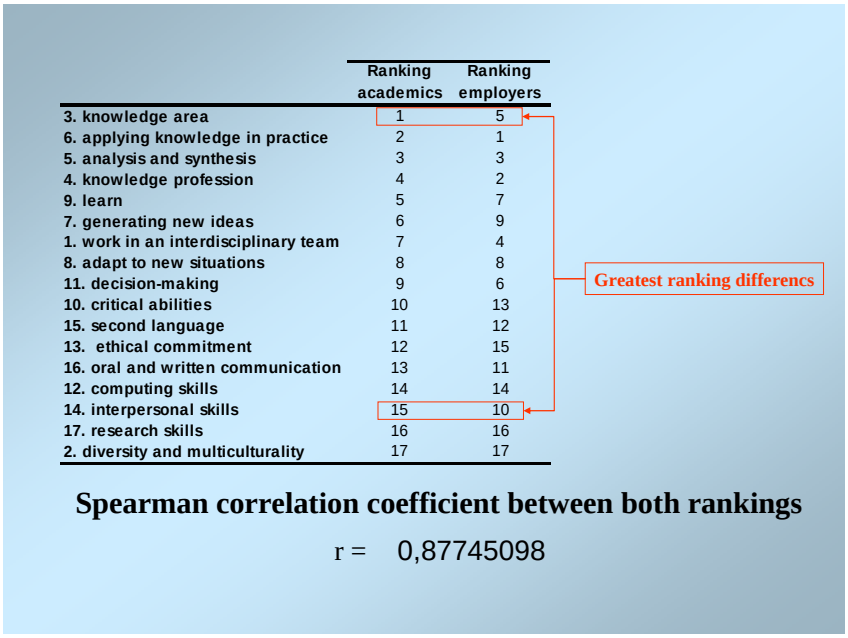
Second cycle qualifications are awarded to students who:

- have demonstrated knowledge and understanding that is founded upon and extends and/or enhances that typically associated with the first cycle, and that provides a basis or opportunity for originality in developing and/or applying ideas, often within a research context;
- can apply their knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study;
- have the ability to integrate knowledge and handle complexity, and formulate judgments with incomplete or limited information, but that include reflecting on

social and ethical responsibilities linked to the application of their knowledge and judgments;

- can communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences clearly and unambiguously;
- have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

The outcomes concern technical and professional skills as well as generic or so-called soft skills. The ranking of skills by academia and the professional world are crucial for implementing a new or refurbishing an old curriculum. Table 2 shows that the preferences of both these groups are not too far away from each other.



	Ranking academics	Ranking employers
3. knowledge area	1	5
6. applying knowledge in practice	2	1
5. analysis and synthesis	3	3
4. knowledge profession	4	2
9. learn	5	7
7. generating new ideas	6	9
1. work in an interdisciplinary team	7	4
8. adapt to new situations	8	8
11. decision-making	9	6
10. critical abilities	10	13
15. second language	11	12
13. ethical commitment	12	15
16. oral and written communication	13	11
12. computing skills	14	14
14. interpersonal skills	15	10
17. research skills	16	16
2. diversity and multiculturality	17	17

Table 2: Correlation between the rankings as given by academics and employers

The Bologna region is targeted to make the European Area of Higher Education successful, interesting to and attractive for the international education market. EAHE can and will be treated now as a competitor to the US and Asia-Pacific education market.

ERASMUS-MUNDUS

One of the biggest offers for capacity building in science, engineering and technology is the newly installed European ERASMUS-MUNDUS Programme. For African students and university staff this programme could be an objective of high appreciation and as kick-off for its own capacity building. The general ERASMUS programmes started in the beginning of the Nineties and has been one of the most powerful capacity building programmes.

The actual ERASMUS-MUNDUS Programme

- is put in force for the period 2004 - 2008
- with an investment capital of 230 Mio € (in 2008 it is accelerated to 98 Mio €)

The programme invites all universities of developing countries all over the world to participate. The main objectives or challenges of this programme are as follows (see also PPT):

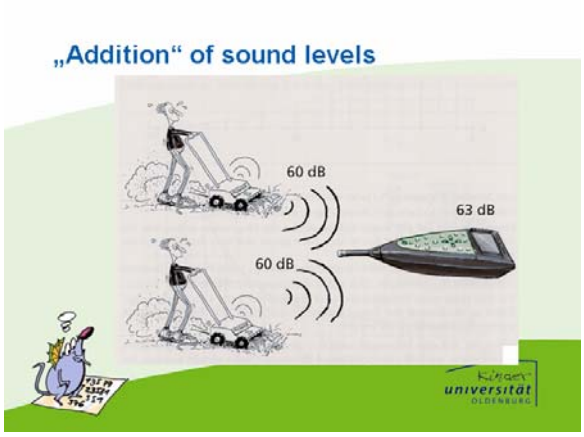
- communication on re-inforcing co-operation with third countries;
- preparation of citizens for the global society;
- goal to ensure world-wide recognition of European universities as centres of excellence;
- remaining at leading edge of developments;
- contribution to cultural understanding (intercultural dialogue as a new policy).

There are four actions:
- Action 1: ERASMUS MUNDUS Master Courses;
- Action 2: Scholarships;
- Action 3: Partnerships;
- Action 4: Enhancing Attractiveness.

The main outputs in 2004 – 2008 are:
- 115 Erasmus Mundus Master Courses;
- 6,000 grants for incoming third-country students;
- 1,000 grants for incoming third-country scholars;
- 100 partnerships;
- 4,000 grants for outgoing EU-students;
- 800 grants for outgoing EU-scholars:
- 50 attractiveness projects.

On the other hand in nearly all EU-member States we envisage a lack of capable engineers. In Germany e.g. we have about 20,000 industry vacancies for engineers of all kind since the beginning of 2007. Some effort thus has and will be undertaken in these countries to fill this gap and to attract young people for an engineering education, which in many cases is treated to be tough and intelligence demanding. In my home city Oldenburg we, like other universities, started a so-called Children-University with which we attract about 1,000 children of about 10 years of age in every lecture in our big assembly hall.

I was also giving a lecture, which by the way coasted me a lot of preparation time. The title was “Why do Houses need a Coat?”. To give you a short impression about the difficulty to make understood the “noise coat” and its measuring data together with modern visualizing acoustic measuring devices you may see figures 6 and 7.



Picture 6: Physical sound and sound level

Picture 7: Visible sound with sound camera

6. New Challenges for Engineering Professionals

Business in the era of knowledge, considering …, demand from the future engineering professionals to be close to both the products from this era and their management. ….
What is done today in terms of professional engineering activity is very different from what used to be done ten years ago. Unfortunately, at first and especially for those who do not recognize the society of knowledge, this revolution left out those people who perform routine work. The number of engineers working in the realm of information and ideas is increasingly growing. ….. In the new society of knowledge there is an explosion of vacancies for engineers of knowledge. …. The contents of knowledge of all the work has grown exponentially in all areas of activity, even in farming activities. The ability of the engineer is no longer only technical, but has become technical and managerial. The managerial component increasingly answers for job opportunities in the area of engineering.

Parallel to the implementation of the EHEA in the EU the political discussion took place how to mutually recognize the "training" and, thus, the quality and capability of professionals to give to them the possibility to settle down and to deliver services across the borders within the European Union (EU). The parliamentarian result was the new EU-directive 2005/36/EU of the European Parliament and the Council on the Recognition of Professional Qualifications dated 7. Sept. 2005. Within the discussion of it a number of pan-European professional associations were involved trying to achieve the best for their clients. ECCE was also very deeply involved in activities to make up a so-called "common platform for civil engineers".

Common European platform for engineering professionals

Up to now it is the normal procedure for any individual to personally apply for being accepted whether to a university or to a professional regulating body when going abroad to study or settle down as a professional (civil engineer). In most cases this individual application is connected with the fulfilment of a number of specific regulations and demands and by this to come up with compensation measures in the host (member) state.

The most convenient possibility by which this can be done in a relative clear, secure and quick way is by waiving of compensation measures and is set out in Title 1 General Provisions, Article 15. This article opens the possibility that "European professional organisations may establish common platforms at European level" providing adequate guarantees as regards the applicants level of competence. Again: By this the respective individually necessary compensation measures as described in Article 14 will be minimised.

A **common platform** is defined as a **set of criteria of professional qualifications** which are suitable for compensating for substantial differences which have been identified between the training requirements existing in the various Member States for a given profession.

These substantial differences shall be identified by comparison between the duration and contents of the training in **at least two thirds of the Member States**, **including all Member States which regulate** this profession. The differences in the contents of the training may result from substantial differences in the scope of the professional activities.

Common platforms may be submitted to the Commission by **Member States** or by **professional associations or organisations which are representative at national and European level.**

The Professional Formation Framework of Civil Engineers of ECCE, an example

The Professional Formation Framework of Civil Engineers of ECCE has been devised

- to be definite, transparent, directly applicable and objectively reviewed;
- to contain sufficient flexibility to meet the national requirements of the different Member States;
- to take into account the two different education/training levels at institutions of higher education as described in the directive;
- to follow the descriptors and educational demands within the Bologna process in the European Higher Education Area (EHEA);
- to apply criteria of professional education by outcomes and competencies instead of just education time;
- to be based on a combination of elements of education, training and professional experience;
- to define minimum conditions of professional postgraduate experience;
- to acknowledge rules of professional conduct
- and to being equivalent and/or comparable to other national/international (civil) engineering platforms.

ECCE has 22 national member associations, 20 of them are EU-members, too. Up to now it was impossible for ECCE to describe a common platform, which fulfils the demand of the EU and of our members.

Also FEANI that represents about 80 member associations in 30 European countries, and within these about 20 different engineering branches, tried to come up with a common platform. FEANI realised that it will be impossible to bring under one hat all the different and nationally coloured regulations of its member organisations. So, FEANI quit to go on with this work, but started a new initiative, which seems to be quite successful.

The new initiative now is to implement a **European Engineering Professional Card (ENGCARD).** The goal of ENGCARD is to design a committed professional qualification passport intending to play the role of a "Sesame" to facilitate mobility by reducing the major obstacles related to the recognition of the professional qualification of the engineering professionals and complying with the following assumption:

"Recognition of Qualifications requires Trust, and Trust requires Transparency"

Figure 4: Logo of ENGCARD, FEANI and EUROCADRES as another supporter

Up to now it is a European Commission funded project and started with an in-depth feasibility study to investigate and validate the added value of this proposed ENGCARD concept in term of enhancement of mobility and also to reach consensus between the main stakeholders in the

future usage of ENGCARD. – There are about 3.5 millions European engineering professionals, employers and contractors, national administrations in charge of recognition of professional qualifications and also national authorities regulating the engineering profession.

Figure 5: Information sheet (Cover page)

Figure 6: The ENGCARD concept organigram

The conceptual approach of ENGCARD is based and capitalises on the following legislations, best practices and standards:

- the Directive on Recognition of Professional Qualifications (DIR 2205/36);
- the Directive on Services in the Internal Market (DIR 2006/123, especially article 39 on "European Code of Conduct");
- the EUROPASS Single Community Framework for the transparency of qualifications and competences;
- the EQF-European Qualifications Framework for Lifelong Learning (COM 2006/479);
- the EUR-ACE standards for the accreditation of engineering education programmes;
- other legislations (data privacy, electronic signature) and standards.

The ENGCARD architecture for consistency reasons is designed to become integrated in the EUROPASS framework as a new EUROPASS document, and will be linked to European and other employment search engines. It contains the following electronic files:

- the "EUROPASS-CV", which is a comprehensive standardized document containing GENERIC information;
- the "language Passport" to record language competences;
- the "Diploma Supplement" attached to a higher education diploma to understand the learning outcomes in terms of knowledge and competencies (third party certified);
- the "Mobility Training Certificates", which records the training and experience spent abroad (third party certified);
- the new ENGCARD-part, which gives the specific engineering-related information (qualifications, experiences, expertises, competences, professional titles, licences, code of conduct, penalties – and, of course, strongly third party certified);
- the optional electronic professional signature.

The ENGCARD benefits can be described as follows:

- the cardholder reached a universal quality label;
- the card will act as a qualifications transparency enhancer and recruitment facilitator tool;
- the card will act as recognition facilitator

and it will be the first card for international recognition of engineering professionals' qualifications.

7. Personal Behaviour and Capacity

In the beginning of the 21st century a new era is arising for humanity, an era based on knowledge and on relationship between people that will affect all aspects of our lives, both in the individual and organizational points of view. … On the other hand, the development of new information and communication technologies, the appearance of a generation of new, smart products and engineers of knowledge are turning knowledge engineering and management into a need that is part of any business. (Additionally see chapter5.)

Capacity building and personal behaviour of engineers in a new era of humanity can be described rather easily in general. But what does it mean in detail, and how can the single student and the engineer realize and learn to live in a business environment in the era of humanity? The ethical aspects, which engineers have to realize and very likely have to follow in this era of humanity are not always too obvious. All codes of conduct, which exist in all countries and which are part of the respective engineering societies and associations will fail if it is not clear to the single engineer that it is part of his or her education.

In Germany we try to involve this knowledge into our curriculum in a way, which is described by the regulation VDI 3780 as published by the German Association of Engineers (VDI, Verein Deutscher Ingenieure). In this regulation all the simple values in technical actions are described and connected with the correct behaviour of an engineer as part of his or her education and knowledge gaining. Seven values are introduced and described and finally the relationship between these values is discussed, see figure 1.

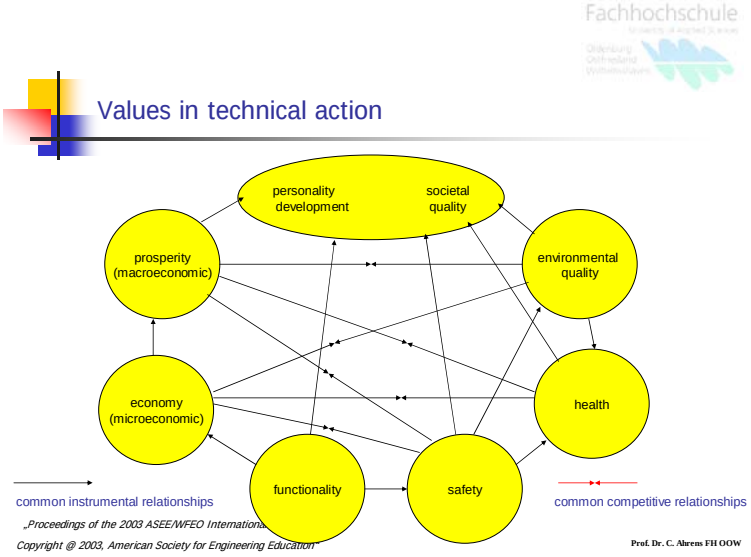


Figure 7: Values in Technical Action

This figure has been part of a paper, which I gave on the ASEE/WFEO conference 2003 in Nashville, USA. In this paper I described the work on and the results of a rather big and challenging SOCRATES Intensive Project called “Ethics in the Built Environment (EiBE)”. This project, which lasted three years, got a nice amount of money from the European Union and brought together more than 100 students from 13 different European partner universities for a period of about two weeks each of the three years.

The regulation cannot give any direct guide line to the single engineer or to the single student how to behave ethically and in the new era of humanity. But it was very interesting, surprising and at least pedagogically worth to realize the difficulties these European students with different socio-cultural background have had e.g. to just name and sum up civil engineering entities which describe the functionality e.g. of a bridge. They realised that they all have learned these functional entities, but did not treat them as specific civil engineering qualities and, thus, as part of ethical behaviour as an engineer.

Step by step they also learned the relations and much more the competitive or better contra-dictionary relations between technical values. And they learned to bring their thoughts on the point, as figure 2 shows it for one of these contradictions.

Figure 8: Contradiction between Safety and Micro Economy
(a student’s example)

8. Addresses of Interest

www.fh-oow.de
www.ecceengineers.eu (under construction)
www.wcce.net
www.feani.org
www.vdi.de
www.enercon.de
www.bologna-bergen.no
ec.europa.eu/education/programmes/mundus