The Observatory

Status of engineering education for sustainable development in European higher education, 2006.

THE ALLIANCE FOR GLOBAL SUSTAINABILITY

The Observatory
EESD Report 2006

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The EESD Observatory (EESD, Engineering Education for Sustainable Development) is a partnership between Chalmers University of Technology, Technical University of Catalonia and Delft University of Technology. The EESD Observatory is produced as a report within the AGS (The AGS, The Alliance for Global Sustainability). The Observatory partners and the AGS universities are all Universities of Technology deeply committed to EESD.

The main mission of the EESD Observatory is to provide European Universities of Technology with a goal for change towards EESD, with clear and measurable indicators and criteria and to increase the recognition of the importance of EESD to universities, industry and society, underpinning the Barcelona Declaration on EESD.

THE AGS
www.globalsustainability.org

The AGS brings leading technical universities together with industry and government to confront some of the world´s greatest challanges. The AGS is an international partnership of four leading universities: The Swiss Federal Institute of Technology, Massachusetts Institute of Technology, Chalmers University of Technology and the University of Tokyo.

Introduction

The EESD Report 2006 identifies the extent that sustainability is embedded in European engineering education. This is the first progress report since the Declaration of Barcelona (2004), the latter being the definitive consensus document on EESD (Engineering Education for Sustainable Development). The EESD Report 2006 also provides support to the UNESCO Decade on ESD which has just commenced (2005-2014).

The report is supported by statements on EESD by leaders in industry, statements that clearly lay down the requirements of industry for a next generation of engineers with a holistic understanding of the three dimensions of sustainability; environmental, economic and social.

Jeroen van der Veer (Chief Executive, Royal Dutch Shell) makes it clear that engineers cannot work and exist in isolation – the best technical solution for a challenge is not necessarily the one most acceptable for the environment and society. He refers to the concept of re-engineering the engineers; modern engineers must have a holistic approach and be the agents of change for sustainable global development. Higher education has the responsibility to provide the premises for EESD.

Jan-Eric Sundgren (Senior Vice President for Public and Environmental Affairs, Volvo Group) is convinced that engineers will solve the pressing global challenges faced by the transport sector; challenges which include reducing greenhouse emissions and mobility in mega-cities. He identifies education as playing a key role in providing the basic knowledge for engineers who will work with sustainability as not just a technical issue, but also a question of providing quality with economy and safety for all humans.

Academic leaders from the US, Asia and Africa also make the case for EESD and demonstrate the global interest in promoting the area.

The main findings for the Observatory are a collation of the response of the 51 European Universities that chose to join the survey. Universities are scored on each learning activity and the final score provides a 0-10 scale. The following categories and scores were defined before the survey:

- Inspiration, score > 9
- Reaching targets, score 6-9
- Making progress, score 3-6
- Getting started, score < 3

To date there is no European University that shows sufficient progress in EESD to be considered an inspiration. The highest accolade would indicate a university that has made a dedicated effort in all areas of EESD and can be

expected to provide students with a dedicated learning environment for EESD. The premises for EESD in the Observatory include:

- Stated policy and action plans on engineering for sustainability in research, education and the campus environment
- Dedicated undergraduate courses in the area of sustainability for engineers. This includes both holistic overviews of ESD and specialized courses on specific aspects of sustainability.
- Identified postgraduate programs that provide a possibility for specialization or continuation for all engineering students.

The 16 universities that are identified as reaching targets achieve good scores on the full range of EESD premises. These universities provide satisfactory conditions for engineering students and many are poised to become an inspiration. In most cases a supportive core of academics can be identified within the university, champions who have worked hard to coordinate learning activities in EESD. However, reaching the highest category, becoming an inspiration for others, will require a dedicated effort from the university leadership, clear signals and economic resources on a university-wide basis.

The 23 universities that are now making progress on EESD have clearly recognized the importance of sustainability for engineers and are taking steps to embed sustainability in research, in education and in the university environment.

This report and the Declaration of Barcelona lay down the premises for EESD and provide guidance for continued efforts.

The remaining European universities that are getting started provide only limited premises for engineering students in the field of sustainability and will need a dedicated effort if they are to reach an acceptable level in the near-term future. Perhaps the Observatory will be the wake-up call for these universities.

European universities are mapped on a geographical basis. The highest rankings are dominated by universities in the North of Europe; Scandinavia, Germany, UK and the Netherlands.

Universities that chose to join the survey in the South and East of Europe were limited and were not as highly ranked, with a few notable exceptions. There would appear to be an urgent need to raise awareness on the importance of EESD in these areas of Europe.

The European mapping is benchmarked in the report against examples and statements from outside Europe. An outstanding example is at the University of Tokyo where the Japanese Government, in response to the needs of industry and society, has invested considerable resources in the IR3S (Integrated Research System for Sustainability Science) initiative.

The IR3S initiative provides the inspiration which is missing today in Europe. Awareness on EESD is growing in the world and European universities that wish to provide engineers with the skills in sustainability that industry requires and needs to remain globally competitive should not remain complacent.

This report has been prepared by Chalmers University of Technology, Technical University of Delft and Technical University of Catalonia in cooperation with the AGS.

Ranking

For this first Observatory report a self evaluation questionnaire was sent to institutes and universities across Europe. Those universities that chose to reply are featured in this first report, with the top 16 (in ranked order) presented below. All participating universities are presented at the end of the report.

The ranking assesses universities across five defined criteria drawn from the Barcelona Declaration:

- ESD policy: evaluates the commitment of the university on education, research and in-house activities for SD.
- Education – courses and specializations: measures the number of courses and specializations on SD offered by the university at the undergraduate level.
- Education – postgraduate programs on SD: measures the number of courses and specializations on SD offered by the university at the postgraduate level.
- Education - Embedding in the curricula: reflects the degree to which universities promote the embedding of SD in curricula
- In-house EMS; indicates the extent of adoption of an environmental management system.

Top 16 Universities Reaching Targets

Ranking	School	Country
1	Norwegian University of Science and Technology	Norway
2	Royal Institute of Technology	Sweden
3	Rostov State University of Civil Engineering	Russia
4	Technical University of Catalonia	Spain
5	Ion Mincu University (Arch. & Urban planning)	Rumania
6	TU Delft	The Netherlands
7	TU Dresden	Germany
8	Technische Universität München	Germany
9	Chalmers University of Technology	Sweden
10	University of Plymouth	UK
11	University of Strathclyde Engineering	UK
12	Blekinge Institute of Technology	Sweden
13	Eindhoven University of Technology	The Netherlands
14	Tampere University of Applied Sciences	Finland
15	University of Pannonia	Hungary
16	University of Växjö	Sweden

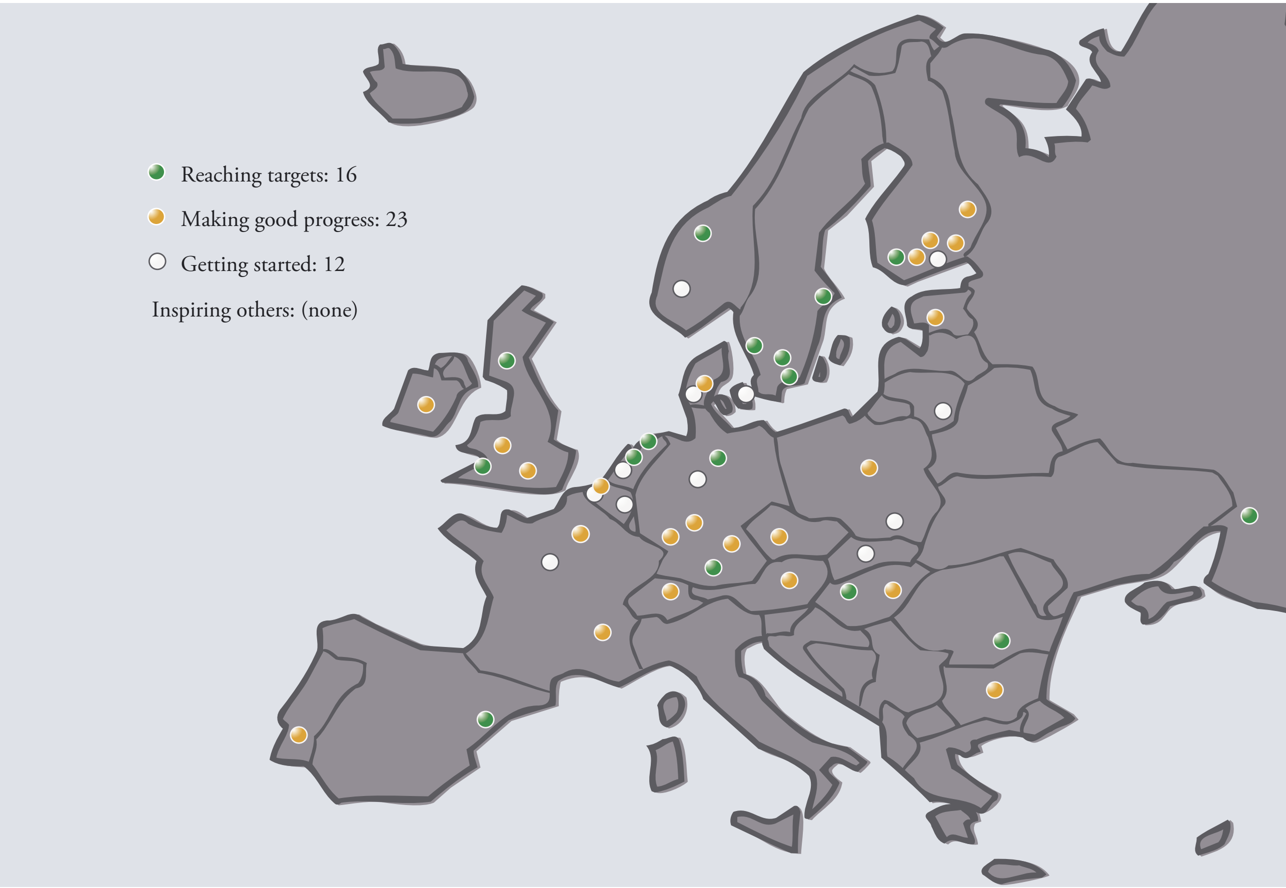
The final score provides a 0-10 scale. The following categories were defined before the survey:

- Inspiration, score > 9
- Reaching targets, score 6-9
- Making progress, score 3-6
- Getting started, score < 3

To date there is no European University that shows sufficient progress in EESD to be considered an inspiration. The highest accolade would indicate a university that has made a dedicated effort in all areas of EESD and can be expected to provide students with a dedicated learning environment for EESD. The business and academic leaders interviewed in the next section, all applaud efforts to promote EESD in higher education and identify the skills implied in EESD as essential for solving sustainability issues.

The top 16 ranked universities, shown in the table are within the reaching targets category and are considered to be within reach of being an inspiration to others, if sufficient resources and emphasis are placed on EESD in the time through to the next Observatory report (2008).

Sustainability in European engineering education



The importance and need for EESD

The second part of the Observatory report is a global assessment of the needs for EESD through interviews with leaders in business and academia.

"SUSTAINABILITY FACILITATES NEW TECHNICAL SOLUTIONS"

Jan-Eric Sundgren
Senior Vice President for Public and Environmental Affairs, Volvo Group

The transport sector has a number of pressing global challenges which need to be met in the near future, including reducing greenhouse emissions and mobility in megacities.

I am convinced that engineers can solve these challenges, but they will need to have specialist knowledge and skills combined with a holistic understanding of global issues of sustainability.

I believe that the transport industry faces a number of global issues in sustainability and education has a key role to play. Volvo will have a future need to recruit engineering graduates who have both a specialist education and a holistic view of sustainability. Knowledge on sustainability is an important competence for our engineers and the foundations for this competence should be provided in higher education.

Engineers should have a basic under-standing of the three dimensions of sustainability; environmental, economic and social. A clear synergy can be seen with the corporate values for Volvo; environment, safety and quality. Sustainability for Volvo is therefore not just a technical issue, but also a question of providing quality with economy and safety for all humans.

The challenges that sustainability implies facilitates new technical solutions, new products and new ways of producing. This is not just my opinion, it is clearly stated in a report of the European Commission the "Environment Technology Action Plan". One major challenge we face at Volvo is the heavy reliance on oil of the transport sector, with 2/3 of total world use. A challenge for the engineers that we recruit from higher education today will be to find new solutions as oil becomes limiting tomorrow. As alternative fuels are increasingly introduced, consumers will need to accept and understand why it is critical to use them.

Education has a key role in providing the basis for engineers to be able to create new solutions for the whole chain from well or field to wheels.

Jan-Eric Sundgren

"RE-ENGINEERING THE ENGINEERS"

The first question presented to me by the editors of this Report reads: 'Why is engineering important for sustainable development?'

My counter question would be: 'Why is the sun important for life?' In my opinion scientists and engineers are the be-all and end-all of technological development and thereby of human progress. An arrogant claim? Not as long as engineers realise that they cannot exist in isolation and that their work interacts with society and the environment.

Sustainable development can be seen as a state of mind, but remains empty phraseology unless it is supported by technological innovations. Take for instance the energy sector: energy production from

Jeroen van der Veer
Chief Executive
Royal Dutch Shell

unconventional resources, development of sustainable energy sources, improved emission performances, clean fuels, carbon capture and storage, new materials, gasification and conversion techniques – it's all the domain of engineers, and critical for the sustainable development of future energy supplies for the benefit of mankind.

Modern engineers must have a holistic approach, so they can not only use their expertise in a scientific or technological context but are also sensitive to social, environmental and political needs. The best technical solution of a challenge is not always the one most acceptable to society. Therefore engineers must also be skilled communicators, able to translate challenges and possible solutions between society and science.

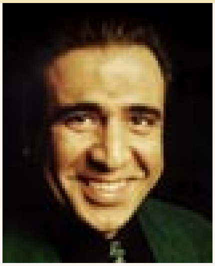
'Re-engineering the engineers' is a challenge to the engineers themselves, to the companies they work for and to their educators. 'Higher education institutions should not restrict themselves to generating disciplinary knowledge and developing skills' according to the EESD 'Declaration of Barcelona' in 2004, and I fully agree.

Universities and colleges of technology should supply tomorrow's technical professionals with a broad mindset about their role in society. Like all education it's about the integration of knowledge, skills, attitudes, values and diversity. Plus essentials for engineers like creative and critical thinking, and being able to work in multidisciplinary teams in globalised organisations.

Those re-engineered engineers can be the change agents for sustainable global development. Can there be anything more important than that?

Jeroen van der Veer

"FORGING FORWARD LOOKING CURRICULA"



Said Irandoust
President, Asian Institute of Technology

At this juncture of human development, it is clear that the world cannot go on a consumption agenda. There is increasing emphasis on sustainable development by international organizations, national governments, business houses (e.g. World Business Council for Sustainable Development) as reflected in regional and international agreements, Agenda 21, UN Millennium Development Goals and national development policies. Formulation and implementation of sustainable development policies at international, national and local levels require a new breed of:

- policymakers and planners, who can prepare and execute sustainable development policies; and
- technical experts working in various sectors, who can develop and disseminate environmentally and socio-economically sustainable technologies.

These individuals and organizations should have a holistic approach on the three pillars of sustainable development – economy, environment and society, but a cross-cutting theme would be the human dimension (self). We are at the start of the decade of Education for Sustainable Development (2005), and the following are some of the questions that require some reflection:

Do our current teaching methods foster such an holistic approach? Don't we need specialists? What do they need to know to become responsible members of future society? Should this be initiated at the university level or in primary schools? How many such initiatives are there? What are the indicators of sustainable development?

Developing highly qualified and committed professionals who will play a leading role in the sustainable development of the region and its integration into the global economy is a mission that is more relevant today than at any time. Yet because of the very integration of the different regions into the global economy that we all are currently witnessing, keeping pace with this integration requires an educational and research concept that is able to adapt its methods.

While traditionally it may have been the role of a university to take a didactic role in development, telling society what is right and what is wrong and providing science and technology based upon research done within the ivory tower, that role is changing. Society, with its ever increasing number of knowledge centers, has begun to talk back. Therefore, higher education is undergoing fundamental changes. More and more, universities are becoming neutral platforms on which to build collaboration between the public and private sectors and between those who conduct research and those who use it. Universities are becoming the facilitators of dialogue and technology transfer. Therefore, we need to forge forward-looking curricula that tear down the walls of traditional disciplines.

For years, AIT has done this as part of its mission to support sustainable development in Asia. As the demands of the region are evolving, however, AIT is poised to integrate this concept into all of its academic programs, research projects and outside partnerships. AIT is currently formulating a sustainable development program at the Master's level, beginning in August 2007 in order to train policy-makers from national and local governments to consider a holistic approach. It will include topics such as cultural and ecological foundations of sustainable development, ecological, economic and social dimensions of sustainable development, sustainable consumption and gender-responsive sustainable development. Discussions are also under way with like-minded universities and organizations that would like to partner in this initiative.

Said Irandoust

"ENGINEERS CAN PROVIDE A NEW PROSPERITY IN AFRICA"

Kwesi Andam
Former Vice-Chancellor, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

Our immediate challenge is to educate a new generation of African engineers who are aware of global issues in sustainability and with cutting-edge skills in solving those issues. We look to these engineers to provide a new prosperity, in balance with ecosystems, in Africa.

I recently finished my term as Vice-Chancellor of a leading West African University of Technology and I look back to a time of realization, enlightenment and the establishment of new platforms for EESD. The first platform was the formation of the African Alliance for Sustainability which has the introduction of ESD into higher education as a cornerstone activity. This activity will develop to promote ESD for all engineering students.

The second platform has involved commitment to international courses and activities in sustainable development. African engineering students are now making a significant contribution in helping students in developed countries understand the economic, social and environmental challenges that sustainability implies for Africa.

The third platform is the establishment of courses on ESD in engineering studies at the university. This will require continued commitment from the leadership of the university as engineering degrees are known for their stringency and already heavy curriculum.

While it is tempting to look back on past progress, I must also look forward and lay out the immense challenge that EESD still poses for African higher education and society. The premises for EESD in Africa can be seen as somewhat different from those in Europe, where many of the societal infrastructures, such as water and energy systems, are already in place. In Africa we have the possibility for technology leap-frog as the infrastructures are built, providing significant possibilities for innovation and new thinking. A clear example of leap-frog has been the very rapid introduction of mobile phones – many Africans will never use a stationary phone. African universities therefore need to provide a new type of engineer; an engineer with a deep understanding of the latest technological developments and at the same time a global perspective of sustainability.

Kwesi Andam

Jorge A. Vanegas
Director, Center for Housing and Urban Development
Texas A&M University

EESD requires a systemic perspective – a new type of engineer is in the making.

Sustainable development is about satisfaction of needs and aspirations today and tomorrow, and both Science and Engineering play a critical role in achieving this goal. However, while science focuses on generating the fundamental knowledge required to help us understand and interpret in general the world we live in, engineering focuses on the application of that knowledge, combined with empirical experience and technology, to solve specific problems we face in this world, and to deliver these solutions within a diverse set of constraints. Consequently, engineering is crucial for the development, demonstration, and deployment of solutions to the social, environmental, and economic challenges and problems posed by sustainable development.

As the bridge between Science and Society, Engineering plays a critical role within each of the three dimensions of Sustainability, social, environmental, and economic, which can be both negative and positive. When the technical and technological solutions to problems that engineering develops and delivers focus primarily on achieving economic goals, without taking also into account social and environmental goals, the potential to adversely affect or impact people and the environment is high. Conversely, when engineering is driven by the triple bottom line of social, environmental, and economic goals, it can enable a higher quality of life for individuals, their families, and the communities in which they live, ensuring the environmental integrity and quality of air, water, soil, and biota, while achieving economic development goals.

The traditional linear industrial development process begins with the extraction and use of primary renewable and non-renewable natural resources, and the production and use of energy, as inputs to processing and manufacturing processes, with technologies, systems, products, and materials as outputs, which then are commercialized, transported, and used and consumed by society, until they reach the end of their service life. Each stage of this industrial development process consumes energy, depletes and degrades the resource base, generates and accumulates waste, and negatively impacts and degrades the environment. To overcome these negative impacts and achieve sustainability, engineering needs to move industrial development toward a sustainable system that operates as a closed cyclical system framed within a context defined by specific social, cultural, political, and regulatory, the economic and financial, and the ecological and environmental systems. In this sustainable system, intra- and intergenerational satisfaction of human needs and aspirations are an integral part of the desired outcomes of the development process, and natural resource use is managed proactively through monitoring and control of the extraction of resources from the biosphere in a way that ensures that the supply will always exceed the demand, and of the extraction of non-renewable natural resources from the lithosphere to prevent their total depletion. In addition, sustainable strategies and technologies are used proactively within every element of the system to promote the development, and to enable the use, of environmentally conscious alternatives and substitutes to current resources and energy sources used; to prevent or mitigate environmental impacts before any damage to the environment occurs, such as preservation, pollution prevention, avoidance, monitoring, and technologies for assessment and control; and to correct environmental impacts when some damage to the environment already has been done, such as remediation or restoration technologies. Finally, recovery of selected resources and products is actively pursued within every element of the system, through direct reuse of reusable components, remanufacture of reusable elements, reprocessing of recycled materials, and monomer/raw material generation.

Sustainability requires a systemic perspective, which encompasses the complex interdependence of social, cultural, political, and economic activities and the biosphere. In addition, engineers are making sustainable development a high priority in engineering and business, and as a result, they are promoting policy changes, codes of practice, and education programs that foster environmentally sound and sustainable practices. Furthermore, the hard lines between the traditional engineering disciplines are being erased as engineers join forces with ecologists, biologists, chemists, meteorologists, economists, architects, planners, political scientists, ethicists and community leaders in leading society on a quest for a sustainable future. As a result, engineers face inevitable changes to their conventional paradigms and ways of thinking, to their values, and to the way they make decisions, select among alternatives, and take actions. Thus, it is crucial that engineering education respond to these changes, in both the content and the context of learning, by increasing formally and explicitly the awareness of sustainability within engineering curricula, and by providing students the knowledge, the skills and abilities, the tools, and the values they will need as professionals, to develop, manage, and influence the public or private sector organizations and institutions where they will work, in a sustainable way.

Sustainable development requires a new type of engineer. First, sustainability requires engineers who are whole systems thinkers, and who promote integrated multi-stakeholder involvement, multi-objective goal setting, and multidisciplinary collaboration, in every engineering project. Second, sustainability requires engineers who are able to recognize the interrelationships and interdependences: (1) in general, among People (individuals, families, communities, and organizations), the natural environment (air, water, soil, biota), the Built Environment (facilities and civil infrastructure systems), the Industrial Base (production systems for goods, products, and services), and the Resource Base (social, natural, built, industrial, and economic capital); and (2) more specifically, among population, consumption, culture, social equity, health, and the environment. Third, sustainability requires engineers who have a deep understanding of disciplinary technical issues and processes, combined with a broad understanding of social, political, environmental, and economic issues and processes, and who have the knowledge, the skills and abilities, and the tools to understand the effects of the decisions they make, the alternatives they select, and the actions they take in all phases of the life cycle of an engineering project, on natural systems and habitats, their boundaries, and the resource and energy flows within them. Finally, sustainability requires engineers who have an understanding of technical, design, scientific, and institutional strategies and techniques that foster sustainable development; promote energy, water, and other natural resources efficiency and conservation; mirror natural system cycles and resource use; remediate and correct environmental problems and damage; and preserve the integrity of biological diversity.

Jorge A. Vanegas

"A SHIFT IN PARADIGM"

Domingo Jiménez Beltran, Member of the Sustainability Observatory Scientific Comitee

Engineering is a key for development, but for sustainable development I believe that we need a shift in paradigm for engineering education to meet this challenge. Rethinking the way we do things means rethinking engineering.

Sustainable development is about development based in knowledge and innovation with a purpose, oriented towards SD goals. In the same way that we wish to assure that the market economy works for sustainability, and not the opposite, we should make sure that engineering works for sustainability. After all, engineers are behind most of the unsustainable projects. In fact sustainability implies good and sound engineering for the interest of society.

Sustainable Development is a matter of social concern and political purpose. We do have the knowledge and the technologies and Engineering capacities to cope with this. Engineering can play a significant role in showing society and politicians that which is feasible in technological and economic terms.

Engineering can enhance the pathways to sustainable industrial transformation by including sustainability as a main reference/quality whenever acting professionally. Sustainability parameters, checklists and assessments should be a must when comparing alternatives of the response of engineering to demands. Further engineers should not participate in unsustainable projects or programmes, where engineering is required

Finally, engineers should bring sustainability as a quality feature, an added value to projects and rethinking all the activities. Reengineering engineering is indeed a good expression.

Engineers must be good, well formed and trained in all the basic tools and capacities required for dealing with sustainable development. Engineers should then orient all these capacities to serve the sustainability paradigm, in fact to deliver good projects and plans. These should serve the triple purpose of contributing to economic prosperity, social demands and a rational use on natural resources and enhancing environmental quality. Engineers should be aware of the need to improve the quality of life while reducing the use of resources and environmental degradation.

And for all that, and while society builds up the required frames to make sustainable engineering a must, the ethical and moral compromise is key. Engineers should subscribe to a "code of conduct", including the values at the very heart of sustainable development, a kind of professional ethical code on sustainability.

EESD is a question of improved aptitudes and a deep change in attitudes.

Domingo Jimenez Beltran

Special features

Significant efforts are being made in Europe and elsewhere to bring sustainability into engineering education. These efforts may be of a pedagogical nature by individual faculty, or may be policy decisions at a university or national level that enhance the implementation of sustainability into engineering education. In EESD 2006 we provide reports from Sweden, Japan, the UK and Spain.

Report from Sweden; political pressure on universities

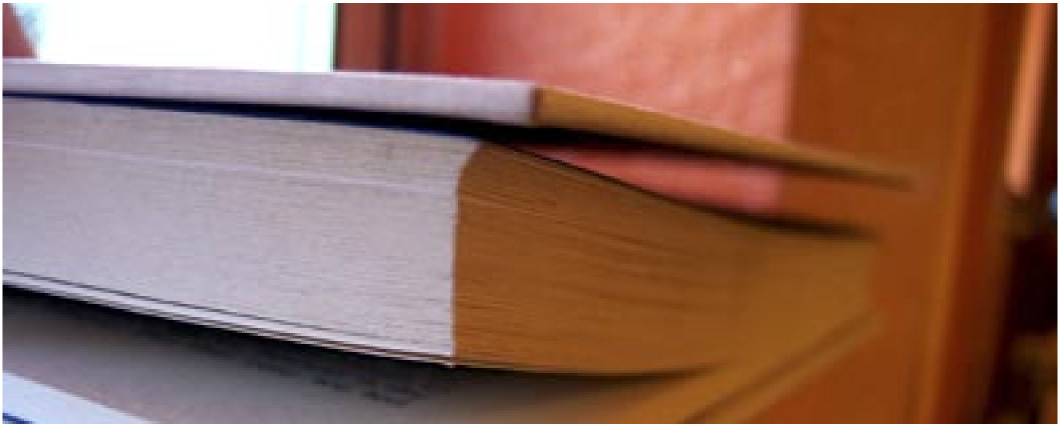
In an unprecedented action the Swedish Higher Education Act (1992: 1434) has been amended to provide for ESD; "universities will promote sustainable development through their educational activities, which means that present and future generations are guaranteed a good environment, good health, economic and social welfare and justice".

The Swedish Prime Minister announced a seminar on ESD at the 1992 Earth Summit in Johannesburg and this was held in Göteborg, Sweden in 1994 (International consultation on ESD – learning to change our world).

The change in the Higher Education Act is a direct consequence of recommendations made by the seminar committee and is seen as the Swedish response leading into the UN Decade on ESD (2005-2014).

The Swedish National Agency for Higher Education have been quick to respond and in their 2006 evaluation of civil engineering programs (at Swedish universities and institutions of higher education) state that "the Agency cannot be certain that the evaluated institutions ensure that the students actually learn sustainable applications of engineering".

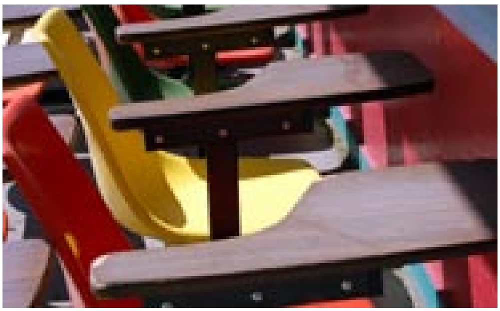
The Agency plans to check action taken in the 2009 follow-up of civil engineering programs.



Report from Asia; integration and sustainability science

Compared to other regions of the world, Asia has the potential for on the one hand rapid, sustainable development and on the other hand, social/economic and environmental destruction. The growth ratio of the Asian region is the most rapid in the world, especially in China and India. However, hidden behind this rapid economic growth lie problems of economic gaps between and within countries. Additionally, poverty and the problems of increasing urbanization are expanding. Moreover, black carbon production and environmental destruction are a serious concern in Asia. Sustainability in the Asian region is an important part of the challenge of a global sustainable development.

The University of Tokyo (UT) has approached sustainability education through both internal and international activities. In 1998, UT established The Graduate School of Frontier Sciences, which was initially designed as a graduate program for Masters and Doctoral students, one of the five divisions being the Institute of Environmental Studies. The school is based on the new framework of "transdisciplinary studies" whereby researchers not only from UT but also from the other research and education institute can join. By analysing the sustainability issues from the viewpoints of nature, culture and society, students are provided with the education and studies necessary to formulate policies and develop human-oriented technologies for the future.



Next, as a member of The Alliance for Global Sustainability (The AGS), UT has made an effort to create and implement an international sustainability education program. The UT-AIT Intensive Program on Sustainability (IPoS) was started in 2004 as a short-term intensive course in collaboration between the Asian Institute of Technology (AIT) and UT. The aim of this program is to provide an opportunity for students to think about sustainable development focused on the Asian region, this experiential learning approach includes workshops, field visits, lectures and discussions while cultivating friendship between different nationalities and academic backgrounds.

Based on the experiences of Frontier Science and the AGS (IPoS), UT launched, in 2005, the Integrated Research System for Sustainability Science (IR3S), an alliance comprised of the University of Tokyo, Kyoto University, Osaka University, Hokkaido University, Ibaraki University and other universities and research institutes, supported by Special Coordination Funds for Promoting Science and Technology from the Japanese Ministry of Education, Culture, Sports, Science and Technology. The five participating universities are now collaborating on inaugurating the Integrated Research for Sustainability Science Program, a master's program that nurtures specialists who can make an active contribution to the construction of a sustainable society on the global stage. The universities, providing instruction primarily in English, will educate postagraduates who thoroughly understand the diversity, internationality, and interdisciplinary of the concept of sustainability and who take action in order to promote the realization of sustainability through the practice of public activity. This program aims to become a benchmark and inspiration for sustainability education in the world's universities.

Report from the UK; a new sustainable futures center

The Centre for Sustainable Futures (CSF) at the University of Plymouth opened on 1 June 2005 following a successful bid by a group of academics representing several disciplines (architecture, biological science, civil engineering, education, environmental science, geography, and law) for a Centre in Excellence in Teaching and Learning: Education for Sustainable Development.

The goal of CSF is “to transform the University of Plymouth from an institution characterized by significant areas of excellence in Education for Sustainable Development (ESD) to an institution modelling university-wide excellence and, hence, able to make a major contribution to ESD regionally, nationally and internationally”

The University of Plymouth 2004-2009 Corporate Plan identifies research into “economic, social and environmental sustainability” as one of “four strategic priority areas” where “research investment will be strategically concentrated”. In line with this priority, CSF has a pedagogical and institutional research team that is researching processes of change under the curriculum, campus, community, and culture headings so that approaches, initiatives and strategies are, with cumulative effect, research-informed.

The nine identified research strands providing a framework for CSF research activities are:

- Starting and evolving perceptions of University academic and support staff;
- Threshold and evolving student attitudes and worldviews (including student narratives of engagement with sustainability);
- The dynamics and trajectory of CSF as a project;
- Curriculum impacts, including student actions projects on campus and in communities;
- Institutional change/transformation;
- Community partnerships and impacts;
- Wider (national and international) partnerships and impacts;
- Pedagogical research; and
- Theoretical research.

A CSF meta-research group meets half-yearly to review all research outputs, explore their change and development implications, and recommend how, in concrete terms, approaches toward the curriculum, campus, community and culture might be accordingly re-focused and steered in new directions.

Report from Spain; Evaluating the sustainability knowledge of students

A research project on EESD is being held by UPC (Sustainability, Technology and Humanism Group) in alliance with TU Delft (ODO Group). The project evaluates the knowledge that engineering students achieve in SD courses offered in Technological European Universities. Conceptual maps are used to estimate the knowledge acquired by the students. The outputs of the project will be to validate the course contents and to evaluate the best pedagogical strategy to be used so the student learns the full meaning of SD. The assessment has been carried out in several universities in The Netherlands, Spain, Sweden and UK; the investigation is still in progress.

The Barcelona Declaration

We live in an increasingly complex world and we are at a critical juncture at which humanity must make some serious choices about the future. Our current model of development poses significant challenges when it comes to achieving a more just society based on respect for nature and human rights, and demands a fairer economy and greater solidarity towards different cultures and future generations. Ignoring this reality when educating and informing future citizens, and therefore future professionals, could have severe consequences. It is undeniable that the world and its cultures need a different kind of engineer, one who has a long-term, systemic approach to decision-making, one who is guided by ethics, justice, equality and solidarity, and has a holistic understanding that goes beyond his or her own field of specialisation.

We declare that

Today's engineers must be able to:

- Understand how their work interacts with society and the environment, locally and globally, in order to identify potential challenges, risks and impacts.
- Understand the contribution of their work in different cultural, social and political contexts and take those differences into account.
- Work in multidisciplinary teams, in order to adapt current technology to the demands imposed by sustainable lifestyles, resource efficiency, pollution prevention and waste management.
- Apply a holistic and systemic approach to solving problems and the ability to move beyond the tradition of breaking reality down into disconnected parts.
- Participate actively in the discussion and definition of economic, social and technological policies, to help redirect society towards more sustainable development.
- Apply professional knowledge according to deontological principles and universal values and ethics.
- Listen closely to the demands of citizens and other stakeholders and let them have a say in the development of new technologies and infrastructures.

Engineering education, with the support of the university community as well as the wider engineering and science community, must:

- Have an integrated approach to knowledge, attitudes, skills and values in teaching
- Incorporate disciplines of the social sciences and humanities
- Promote multidisciplinary teamwork.
- Stimulate creativity and critical thinking.
- Foster reflection and self-learning
- Strengthen systemic thinking and a holistic approach
- Train people who are motivated to participate and who are able to take responsible decisions.
- Raise awareness for the challenges posed by globalisation.

Education supports a process of self-discovery and learning about the world, encourages personal development, and helps individuals find their roles in society. However, education is also a commitment to improving society by strengthening communities and stimulating social progress. This reality forces us to reconsider the purpose of our role as social actors, in particular as educators, and to construct a way of responding to these challenges.

Education, and particularly higher education, is a vital tool to be used for facing today's challenges and for building a better world. Higher education is essential if we are to achieve sustainable development and therefore social progress. It also serves to strengthen cultural identity, maintain social cohesion, reduce poverty and promote peace and understanding.

Higher education institutions must not restrict themselves to generating disciplinary knowledge and developing skills. As part of a larger cultural system, their role is also to teach, foster and develop the moral and ethical values required by society.

Universities need to prepare future professionals who should be able to use their expertise not only in a scientific or technological context, but equally for broader social, political and environmental needs. This is not simply a matter of adding another layer to the technical aspects of education, but rather addressing the whole educational process in a more holistic way, by considering how the student will interact with others in his or her professional life, directly or indirectly. Engineering has responded to the needs of society and without a doubt, today's society requires a new kind of engineers.

In order to achieve the Barcelona declaration, the following aspects of the educational process must be reviewed:

- The links between all the different levels of the educational system.
- The content of courses.
- Teaching strategies in the classroom.
- Teaching and learning techniques.
- Research methods.
- Training of trainers.
- Evaluation and assessment techniques.
- The participation of external bodies in developing and evaluating the curriculum
- Quality control system

These aspects cannot be reviewed in isolation. They need to be supported by an institutional commitment and all decision makers, in the form of:

- A redefinition of institutions' and universities' missions, so that they are adapted to new requirements in which sustainability is a leading concern.
- An institutional commitment to quality.
- An institutional support for changing educational paradigms and objectives research funding.

Universities must redirect the teaching-learning process in order to become real change agents who are capable of making significant contributions by creating a new model for society.

Responding to change is a fundamental part of a university's role in society. There is evidence that sustainable development has already been incorporated in engineering education in a number of institutions around the world.

The United Nations Decade on Education for Sustainable Development (2005-2014) offers a great opportunity to consolidate and replicate this existing good practice across the international higher education community.

Universities now have the opportunity to re-orient the traditional functions of teaching and research, by generating alternative ideas and new knowledge.

They must also be committed to responding creatively and imaginatively to social problems and in this way educate towards sustainable development.

Complete ranking list

Ranking	School	Country	Score (1-10)	
1	Norwegian University of Science and Technology	Norway	8,50	Reaching Targets
2	Royal Institute of Technology	Sweden	8,30	
3	Rostov State University of Civil Engineering	Russia	7,98	
4	Technical University of Catalonia	Spain	7,90	
5	Ion Mincu University (Arch. & Urban planning)	Rumania	7,90	
6	Technical University of Delft	The Netherlands	7,90	
7	Technical University of Dresden	Germany	7,80	
8	Technical University of Munich	Germany	7,56	
9	Chalmers University of Technology	Sweden	7,50	
10	University of Plymouth	UK	7,30	
11	University of Strathclyde Engineering	UK	7,10	
12	Blekinge Institute of Technology	Sweden	6,84	
13	Eindhoven University of Technology	The Netherlands	6,67	
14	Tampere University of Applied Sciences	Finland	6,48	
15	University of Pannonia	Hungary	6,31	
16	University of Växjö	Sweden	6,26	
17	ETH Zurich	Switzerland	5,50	Making good progress
18	Technical University of Denmark	Denmark	5,46	
19	Graz University of Technology	Austria	5,40	
20	Furtwangen University	Germany	5,33	
21	Warsaw University	Poland	5,16	
22	University of Regensburg	Germany	4,91	
23	University College London	UK	4,90	
24	University of Kuopio	Finland	4,60	
25	Tallin University of Technology	Estonia	4,58	
26	Lyon School of Chemistry, Physics and electronic	France	4,57	
27	Laurea University of Applied Sciences	Finland	4,37	
28	University of Westminster	UK	4,24	
29	University of Karlsruhe	Germany	4,06	
30	Eutek University of Applied Sciences	Finland	4,01	
31	North East Wales Institute of Higher Education	UK	3,85	
32	Lahti University of Applied Sciences	Finland	3,60	
33	Lisbon Instituto Superior Tecnico	Portugal	3,55	
34	University of Limerick	Ireland	3,47	
35	Technical University of Gabrovo	Bulgaria	3,40	
36	Institut Superieur D´Architecture La Cambra	Belgium	3,26	
37	University of West Bohemia, Pilsen	Czeck Republic	3,22	
38	University of Miskolc	Hungary	3,06	
39	Ecole d´Architecture et de Paysage de Lille	France	3,03	
40	Agder University College	Norway	2,93	Getting started
41	Kaunas University of Technology	Lithuania	2,74	
42	Slovak University of Technology in Bratislava	Slovakia	2,67	
43	University of Bremen	Germany	2,46	
44	Ghent University	Belgium	2,42	
45	Helsinki University of Technology	Finland	2,09	
46	Krakow University of Technology	Poland	1,82	
47	Ecole Superieure d´Electricite (SUPELEC)	France	1,35	
48	University of Twente	The Netherlands	1,12	
49	Catholic University of Leuven	Belgium	0,94	
50	University of Southern Denmark	Denmark	0,00	
51	Danish University of Pharmaceutical Sciences	Denmark	0,00	

TUDelft
Delft University of Technology

CHALMERS

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The Observatory

Status of engineering education for sustainable development in European higher education, 2006.

The main mission of the EESD Observatory (EESD, Engineering Education for Sustainable Development) is to provide European Universities of Technology with a goal for change towards EESD, with clear and measurable indicators and criteria and to increase the recognition of the importance of EESD to universities, industry and society, underpinning the Barcelona Declaration on EESD.

One output of the Observatory is the EESD Report, a biennial survey and ranking of European Universities of Technology that lead the way in integrating Engineering Education for Sustainable Development into their policies, curricula and in-house activities.

The EESD Observatory is a partnership between Chalmers University of Technology, Technical University of Catalonia and Technical University of Delft. The EESD Observatory is produced as a report within the AGS (The AGS, Alliance for Global Sustainability). The Observatory partners and the AGS universities are all Universities of Technology deeply committed to EESD.

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