Energy Engineering Education in the 21st Century:
Perhaps one possible pathway?

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Energy Education 21st Century?

- Energy Teaching / Learning: Where are we and how did we get there?
- Why do we need energy engineers?
  - Teachers are found in “developed” world
  - Students in “emerging / not-yet-emerging economies”
  - Physical mobility is good, but in no way enough. *Virtual mobility* a must
- Thus *world-wide e-energy* education needed: How is it today?
- Vision energy *e-learning*
- The KTH “Sustainable Energy Engineering World” attempt
  - “Computerized Education in Heat and Power Technology” learning *platform*
  - *Mobility* within the platform
  - Two year MSc program: *SEE World*
- *Where will universities be when the persons born today will join?*
- Closing remarks
Concluding remarks – 1(2)

• Very expensive to develop interactive learning material

• How to get teachers ”on-board”?
  ▪ Do teachers want to work together or are we to “NIH”?

• No “educational revolution” on its way:
  ▪ Computers are today used in very simple ways for education
  ▪ Very ”linear” teaching/learning
  ▪ What is ”complete e-learning”?

• Students interest very difficult to keep. Games needed?
  ▪ Is “collecting points” enough?
  ▪ Do we need “attacking and defending a power station”?
  ▪ Strategy games?

• Screen sizes significant limiting factor for fully electronic Mobile learning
  ▪ Foldable tabloid format the key?
• Research/development fragmented: It is EITHER technology OR social behavior OR content, but seldom the three together.
  ▪ Development of content seems to be lagging behind the available technology.

• How to get socializing, “Problem-Based Learning”, entrepreneurship and innovation between far-away students working fully?
  ▪ How can 2nd (and 3rd?) life, and www 2, 3, 4, … help?

• Important that platform work on different media: PC, Pocket PC, TV, Media computers, Mobile phones(?), ..

• “E-learning technology” (foldable screens, virtual keyboards, 3D vision, …) will soon be available.
  ▪ But what about “E-learning content?”

• Will the 2030 student really be an “on-campus student”?

“21st Century World Virtual Energy University”
Anyone interested?
Do we take off or do we stay on the ground?
Teaching from stone-age to previous?

- Transfer of knowledge in the stone-age: Oral and cave drawings
- Dissemination in the form of books from 7th to 15th century: Hand-copy
- 1452: Gutenberg and the printing machine
- ??: Blackboard

Back in the ”old days” (1999 [= 2008?]):

What was the difference between:
- Cave drawings and Blackboard? The Eraser?
- Monks in monasteries hand-copying books in the 14th century and students hand-copying from blackboards in the 21st century?

- Industry collaborated in a global environment
  - So did universities in research: educational, engineering, development of ICT-technology
  - What about “content development”? What was “pre-competitive”?
- Did universities consider teaching / learning to be a merit in an academic career?
- How was energy education performed in the last century?
Transfer of knowledge in the stone-age?

Story telling on individual basis and ->
Dissemination up to 1452: Handcopy
Energy education in the last century

• “Teacher centred” education.
  ▪ No change in pedagogical approaches, apart from some “problem-based learning”.
  ▪ Traditional text books, blackboard, power points, students copied

• Animations, “see the teacher speak” videos or simulations developed by many teachers in isolation
  ▪ Could anyone else than the developer use the simulations?

• How often did teachers exchange learning & teaching material?

• Teachers spent 80% (?) of time on repetitive questions?
  ▪ Was the priority on “quality time” or “quantity time”?
  ▪ Did teachers want to have it differently?

• Mainly “On campus” degree from one university only

• Could computers be used for learning? Revolution was expected!
  ▪ Had not happened

• Which visions did university leadership have for 2030?
Why do we need more engineers in energy?

• By 2030 the need for electricity will have increased 60% towards today
  ▪ The share of fossil fuels will remain well above 80%
  ▪ Oil prices not low presently. When will they rise again?

• CO2 concentration has increased dramatically over the last years

• 25% (1.6 billion) of the world’s population does not have access to electricity, 800 million more have only sporadic access,
  ▪ 2/3 of commercial energy used in developed countries
  ▪ 90% of all electricity comes from fluid machinery

• Some (not all) technologies exist, need to be implemented

• What will the consequences be if the energy problem is not solved?

=> Energy engineers needed worldwide

Where do we find them? And the teachers?
Energy challenge: Forecast 2030
Climate challenge

- Temperature in degrees centigrade (compared with 1960-1990 baseline)
- Atmospheric carbon dioxide (CO2 in parts per million)
How is the energy education performed today?

• In the traditional on-campus way!
  ▪ Thousands of general online courses exist
  ▪ Very few energy-related on-line courses
  ▪ Virtually no online energy degree programs (1?)

• How is the e-learning content presented today in engineering?
  ▪ Open University: Ex 1
  ▪ Stanford online Computer Science courses (no Stanford credits): Ex 1; 2
  ▪ MIT Open Course Ware: Ex 1; 2;
  ▪ 3 =>Impossible to keep everything updated

• But, there is light at the end of the tunnel!
  ▪ MIT I-labs: Ex 1;
  ▪ Duke university: Ex 1;
  ▪ MERLOT: Ex 1;
Energy E-learning Vision: One possibility?

Platform that is:

- Interactive and international
- Focuses on learning, not teaching.
  - Learning independent of specific Course and On/Off-Campus
  - In the classroom as well as for self-studies
  - All material “at home” exactly as in the classroom.
  - Allow for self-assessment and preparation
- As courses: Quality time instead of quantity time
- Under- and post-graduate level both at universities and industry
- Everything we today associate in ”real-life learning” and much more
- For 2030: Students put together their own degree programs?
  - Project based learning and social interaction all over the globe
  - Engineering ethics satisfied in a global environment
  - Universities and institutions accredit individual tracks
Much more

- Paper books
- E-books with guided messages & simulations
- Web & filmed lectures
- Virtual & remote & filmed lab exercises
- “Classical” & filmed & interactive calculation exercises
- Local & remote simulations
- Virtual & filmed study visits
- Sophisticated small & large-scale calculation programs
- Quizzes
- Self-assessment (quizzes, calculation exercises, open-ended questions, …)
- Strategy (& other) games
- Mobile
- Socially attractive and still “human”
- Foster entrepreneurial and innovative creativity in the students
- …
CompEduHPT Main Features

• Design: Share-ware Learning material (1995)
  ▪ Bookshelf interface
  ▪ Analogy with traditional paper books
  ▪ Chapters designed as e-pages (OH) with hyperlinks
• Videos and animations and quizzes
• Traditional / automatic / filmed calc. exercises
• Lecture series (example) and pages in languages
• Simulations with guided messages, lecture notes
• Remote simulations, glossary, dictionary, e-book
• Virtual “field trips” and case studies
• Virtual, filmed with quizzes, and remote exp.
• Calculation programs
• Web CompEdu: Used in various places
• Example of teacher use
• Further work
CompEdu: 100 last users on May 12, 2008
Challenge and further work for CompEdu

• Challenge: Faster, broader, deeper learning process with basic knowledge so that “just in time SPECIFIC knowledge” can be assimilated and put into practice.
  ▪ How to avoid learning formulas “by heart”
  ▪ How get teachers and other “content providers” to work together?
  ▪ How sustain engineering ethics in “all modes of delivery”?
  ▪ Individualize the learning: How to satisfy the needs of “diverse learners”? 
  ▪ How get industry to valid distance education: For university and life-long?

• Feedback, Personal notes, Discussion forum, Social networking

• Comparison in results Stockholm vs other campuses

• Keep track on progress:
  ▪ Credits for knowledge, “trade” hints and ideas
  ▪ “Get an answer from the Professor when you reach 10’000 points”

• Games, 2nd (&3rd etc) life, web 2.0, 3.0 etc

• Accreditation of individual learning in a global environment
Mobile Learning: Pocket PC

19.3 Blade Vibrations

Although their shapes are often complex, turbomachine blades can as a first approximation be represented as a beam or a plate model.
KTH Sustainable Energy Engineering World

- MSc program since 1997, on-campus Stockholm
- On-line since 2004: **Goal: Educate where the most students are!**
  - Presently 12 different campuses (Sweden, and Partner Universities in Tanzania, Mozambique, Zambia, Sri Lanka, Ethiopia, Uganda, Mauritius, Mexico)
  - Intake 2008: 291 students, 50-60% probably drop out rate
  - 80 scholarships paid presently per year
  - **Student library** with books, 2 computers, projector, scanner, ... per campus
  - Project groups made up with students from different campuses
  - “Facilitator” workshop one week / year in Stockholm
  - One teacher one week per year to each campus
  - Lectures **beamed** & recorded every year
  - Prestige for partners: Transfer the complete program to their universities ASAP
- “Challenges”:
  - LMS, Suspected cheating, Bandwidth, Electricity breakdown, Students not used to “European study art”, Commitment, General skills, ID-check by “individual exams”, passivity, ...