New Models in Engineering Education

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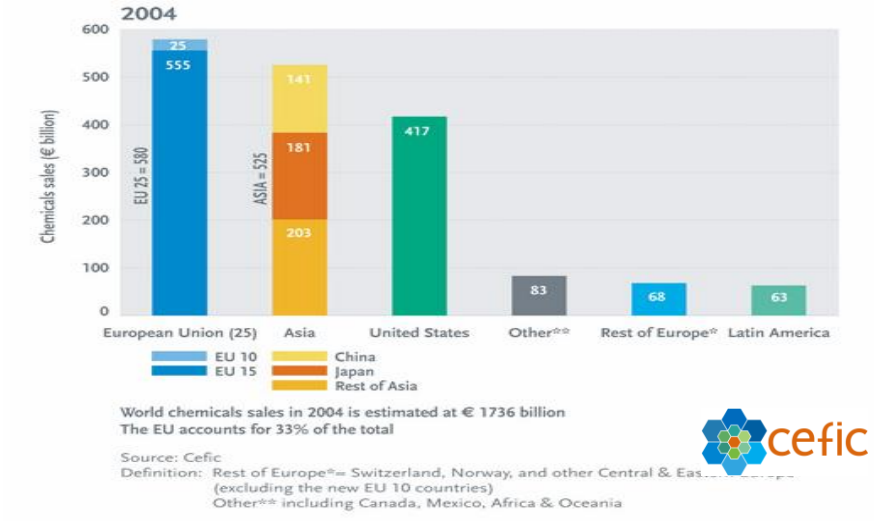
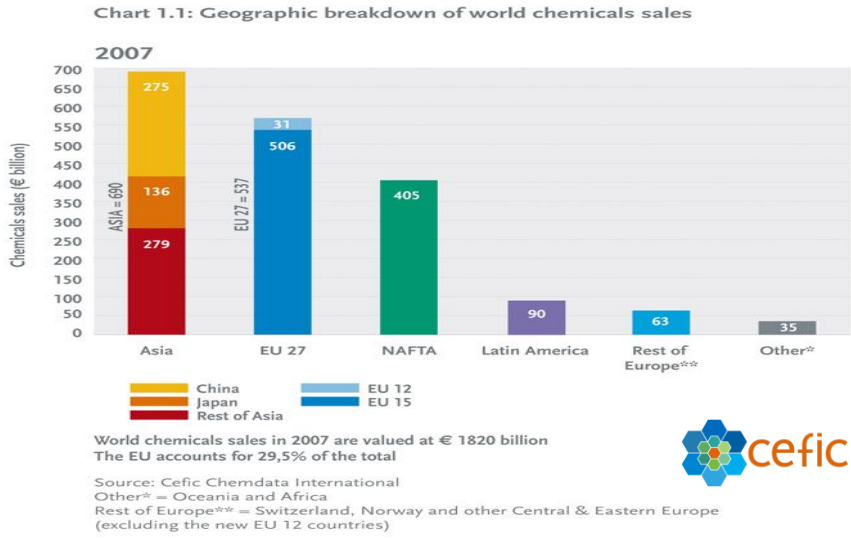
Outline

- Life Today - Educational goals and needs in a global world
- Structure of Education in Europe, post-Bologna
- The substance of chemical engineering education for the world
- Tools in the information age, in the era of communications
- A final thought – third paradigm of chemical engineering education, is it so?

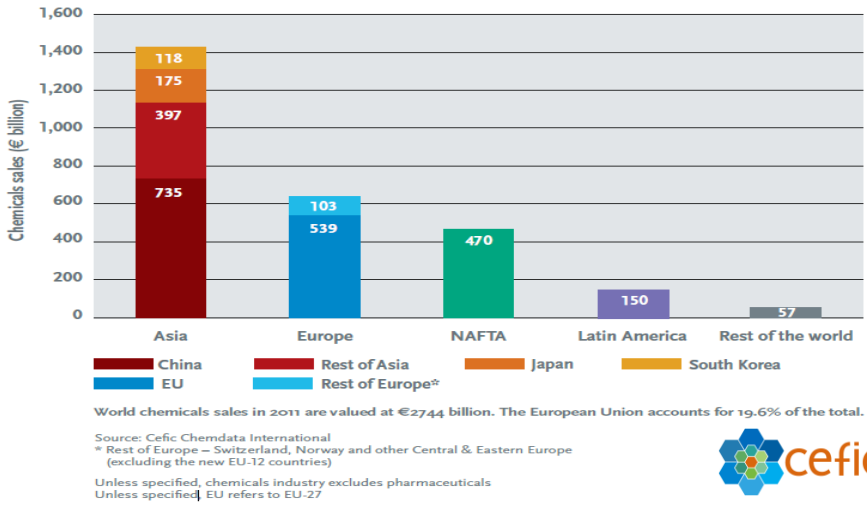
LIFE TODAY - PRODUCTION MOVES EAST
GEOGRAPHIC BREAKDOWN OF WORLD CHEMICALS SALES - 2004



LIFE TODAY - PRODUCTION MOVES EAST
GEOGRAPHIC BREAKDOWN OF WORLD CHEMICALS SALES - 2007



LIFE TODAY - PRODUCTION MOVES EAST
GEOGRAPHIC BREAKDOWN OF WORLD CHEMICALS SALES - 2011



World chemicals sales in 2011 are valued at €2744 billion. The European Union accounts for 19.6% of the total.

Source: Cefic Chemdata International
* Rest of Europe – Switzerland, Norway and other Central & Eastern Europe (excluding the new EU-12 countries)

Unless specified, chemicals industry excludes pharmaceuticals
Unless specified, EU refers to EU-27

LIFE TODAY
A MIX OF CHALLENGES, THREATS AND OPPORTUNITIES

- **The computer and communications era - dramatic changes of the concepts of time and space - globalisation**
- **The global market economy - driving today's Societies**
  - **Sharp increase in standards and competition Worldwide**
  - **Volatility of jobs**
  - **Job market and opportunities - wider than ever**
- **The increase of Expectation of Life vs. Social sustainability – work longer years**
- **The decrease of knowledge half-time – back to School**
- **Significant change in the concepts of individual career management, mainly for Young People**

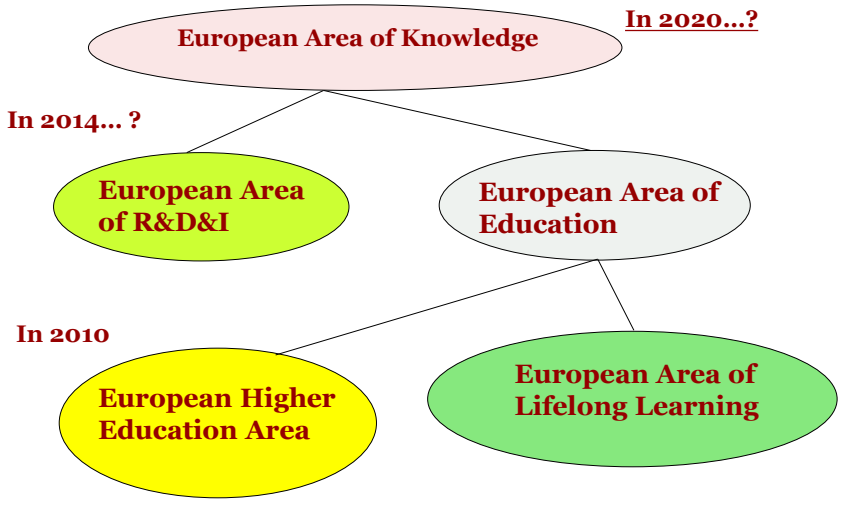
LIFE TODAY
ESSENTIAL INSTRUMENTS AND POLICIES FOR THE FUTURE

- **A global World living in and with a new paradigm of coexistence**
  - ✓ **COOPETITION = COOPERATION + COMPETITION**
- **That requires**
  - **New management and transnational cooperation policies**
  - **A new cultural paradigm of Education - Lifelong Learning**
  - **Mobility of students and professionals**
- **Which in turn requires**
  - **Policies and Instruments for recognition of academic and professional qualifications**
  - **POLITICAL WILL**

EDUCATIONAL NEEDS IN A GLOBAL WORLD

- **Universities should widen the students' "scope of thinking"… to the dimension of the Earth… and beyond…**
- **The need to understand other cultures and backgrounds**
- **Namely in large global companies, the need to think global – 24/7 – when Asia goes to sleep we start our work, when we go to sleep America start their work**
- **The need to promote mobility and cooperation, by promoting TRUST**
  - **Develop comparable qualifications frameworks**
  - **Apply quality assurance procedures that are recognised and accepted by all stakeholders**

THE EUROPEAN AREA OF… KNOWLEDGE… OFFICIALLY LAUNCHED ON 11-12 MARCH 2010, IN BUDAPEST-VIENNA - STILL UNDER CONSTRUCTION… TILL 2020…



FROM BOLOGNA TO BUDAPEST-VIENNA… AND BEYOND CHARACTERIZING THE PROCESS TODAY

- **Policy areas**
  - **Including great concern with the threat of 'Education without Boundaries'**
- **The Structure - organization issues**
- **The Substance – academic issues**

From Bologna to Budapest-Vienna … and beyond
The Structure - action lines and instruments for action

- ✓ **Degree Structure –**
  - **Based on recognised QUALIFICATIONS FRAMEWORKS**
- ✓ **A System to measure work and OUTCOMES**
  - **The ECTS credit and accumulation system**
- ✓ **A way of documenting qualifications**
  - **The DIPLOMA SUPPLEMENT**
- ✓ **A System to guarantee transparence**
  - **Building accepted QUALITY ASSURANCE procedures**
- ✓ **A System for recognition of qualifications**
  - **OVERCOMING DIFFICULTIES posed by the diversity of 'recognition cultures'**

From Bologna to Leuven/Louvain-La-Neuve… and beyond
The Substance - the latecomer in the Bologna Process…

- ➢ **Changes in slow progress…**
  - **New contents… closer to more immediate Societal concerns**
  - **New programme structures, linked to a concept of lifelong Learning**
  - **New Methods – change from**
    - ✓ **Teacher-Centred to Student-Centred methodologies**
    - ✓ **Teaching based on Teacher Inputs to Learning Centred in well defined objectives – Learning Outcomes**
    - ✓ **Digital repository support systems to Digital Collaborative and Cooperative Systems**
- ➢ **The third wave – Pedagogical qualification of 'Faculty'**
- ➢ **New tools for distance and cooperative learning**

QUALIFICATIONS FRAMEWORKS
THE DIFFERENT LAYERS – WHO DOES WHAT…

- **High level descriptors – Meta Frameworks**
  - **Characterized at institutional level of governments and stakeholders**
  - **They represent the 'legal crust' and the basis for National Qualifications Frameworks**
- **Complemented by Sectoral descriptors**
  - **By area and specialty**
  - **In close cooperation with higher education institutions and professional associations**
  - **In transnational cooperation**
  - **They represent Bologna in practice**
- **Complemented by descriptors at branch level**
  - **Typically developed in Education Working parties and Academic Consortia, at European Level, or within regulatory bodies at national level**
  - **They are the basis for credibility of the whole system**

EQF-LLL - THE EUROPEAN QUALIFICATIONS FRAMEWORK FOR LIFELONG LEARNING

- **Approved by the Parliament and the Council of the European Union on April 23, 2008**
- **Adopts 8 levels of qualifications characterized in terms of**
  - ***Knowledge***
  - ***Skills***
  - ***Competences***
- **Establishes a link of compatibility with the Framework for Qualifications of the European Higher Education Area**

Relevance of Sectoral and/or Curriculum Frameworks Taken from the Leuven/Louvain-la-Neuve Communique 29 April 2009

"…

Curricular reform will thus be an ongoing process leading to high quality, flexible and more individually tailored education paths.

Academics, in close cooperation with student and employer representatives, will continue to develop learning outcomes and international reference points for a growing number of subject areas

…"

The EUR-ACE Sectoral Framework and Accreditation System

- **European Project that aimed at establishing an European System for Qualification of Engineering Education programes**
- **Programme Outcomes that must be satisfied**
  - **6 areas of competences are defined**
    - ✓ **Knowledge and Understanding**
    - ✓ **Engineering Analysis**
    - ✓ **Engineering Design**
    - ✓ **Investigations**
    - ✓ **Engineering Practice**
    - ✓ **Transferable (personal) Skills**
  - **For each category, the EUR-ACE Framework Standards list the expected Programme Outcomes of First Cycle and Second Cycle Studies**

EUR-ACE IMPLEMENTATION

- **The EUR-ACE project has lead to the creation in 8 February 2006 of an European Association**
  - ✓ **The ENAEE – European Network for Accreditation of Engineering Education – www.enaee.eu**
- **The ENAEE is responsible for maintaining and awarding the EUR-ACE label**

DESCRIPTORS AT BRANCH/PROGRAMME LEVEL

- **The Recommendations of the WPE-EFCE – Working Party on Education – European Federation of Chemical Engineering (2010)**
- **The VDI-GVC Recommendation for Chemical and Processing Engineering (2008)**
- **The CHEMPASS Project (2006-2009) – that aimed at identifying relevant general and specific Learning Outcomes for Chemical Engineering Programmes**

DESCRIPTORS AT BRANCH/PROGRAMME LEVEL RECOMMENDATIONS OF THE WPE-EFCE (I)

- **WPE-EFCE – Working Party on Education – European Federation of Chemical Engineering**
  - ✓ **Currently with associations from 23 Countries**
  - ✓ **Developed and published in 2010 a set of recommendations of core curriculum for chemical engineering – contents and methodologies**
  - ✓ **See EFCE Site and Bologna Recommendations (2010) at**

    http://www.efce.info/Bologna_Recommendation.html

DESCRIPTORS AT BRANCH/PROGRAMME LEVEL RECOMMENDATIONS OF THE WPE-EFCE (II)

- **These recommendations cover**
  - **Learning outcomes**
    - ✓ **Adopting the EUR-ACE Framework Standards for Accreditation of Engineering Education**
  - **Achieving the learning outcomes**
    - ✓ **Core curriculum**
    - ✓ **Teaching and learning**
    - ✓ **Industrial experience**
    - ✓ **Review of the educational process**
    - ✓ **Student assessment**

DESCRIPTORS AT PROGRAMME LEVEL RECOMMENDATIONS OF THE WPE-EFCE (III)

- **Using as reference accumulated knowledge, competences and skills after a Second Cycle in Chemical Engineering**

- **A minimum dimension is proposed to**
  - ✓ **Basic sciences, enlarged with life sciences**
  - ✓ **Chemical engineering sciences**
  - ✓ **Chemical engineering core**
    - **With engineering design,**
    - **With a dissertation for training R&D&I,**
    - **With diverse profiles through electives and external training.**

CHEMICAL ENGINEERING EDUCATION IN AND FOR THE FUTURE CONTRIBUTIONS IN THE XXI CENTURY

- **Chemical Product Design (E. Cussler and G. Moggeridge,2001)**
- **Chemical Engineering, Visions of the World (R. Darton et al., 2003)**
- **New Frontiers for ChE Education (R. Armstrong,2003)**
- **Beyond the Molecular Frontier. Challenges for Chemistry and Chemical Engineering, US NRC Report (2003)**
- **The proposals of TUNING-E4 Thematic Network (2003)**
- **The Recommendations of WPE-EFCE (2005, 2010)**
- **The CHEMEPASS Project (2007-2009)**
- **The VDI-GVC qualifications frameworks for degree course for Process Engineering, Chemical Engineering and Biomolecular or Bioprocess Engineering (2008)**

NEW DIRECTIONS FOR CHEMICAL ENGINEERING EDUCATION (I) – GENERAL GUIDELINES ON HOW TO PROCEED (I)

- **Revisit and modernize the programme**
  - **Bring in new topics – raise the awareness of new topics**
  - **Incorporate new Knowledge, Skills and Competences**
- **Bring in new methods for learning – adapted to the available tools and to the cultural evolution of society**
- **Develop within the institution an International Dimension (not only European) and Culture of Quality through mobility and academic cooperation and interchange**
  - **Prepare programmes for cooperation – Joint Degrees**
- **Prepare programmes to attract new publics – Lifelong Learning**

NEW DIRECTIONS FOR CHEMICAL ENGINEERING EDUCATION (I) – GENERAL GUIDELINES ON HOW TO PROCEED (II)

- **Make recognition of qualifications easy**
  - **Re-design curricula with reference to agreed reccomendations or descriptors of learning outcomes at high level, sectoral level and branch level**
  - **Perform internal quality assurance exercises, following agreed guidelines**
  - **Submit the programme to recognized external quality assurance agencies**

NEW DIRECTIONS FOR CHEMICAL ENGINEERING EDUCATION II – ADDRESS PROBLEMS, ANSWER DEMANDS…

- **New concerns on energy and environment problems and generally on sustainability**
- **Sharp demand for 'performance products' - specialties, food, personal care products…**
- **Functionalized materials….**
- **…….**
- **Process and product development times came down sharply (3 to 5 fold) - risk management…**
- **Technological and scientific developments - new paradigms on Unit Operations open for discussion - micro-systems, process intensification…**
- **…….**

NEW DIRECTIONS FOR CHEMICAL ENGINEERING EDUCATION III – TODAY AND FOR THE FUTURE, WE HAVE TO…

- **Speak of**
  - ✓ **Life sciences and of biology as one of the four basic sciences,**
  - ✓ **Environmental issues and sustainability**
  - ✓ **(Nano) structures and material science issues**
- **Speak of ENERGY and OPTIMAL Operation**
  - ✓ **An economy based on alternative energy resources**
  - ✓ **Systems engineering and knowledge based methods for optimised, safe, simple to operate systems**
- **Give an answer to the demand of Society for specificity and quality**
  - ✓ **New products – competencies in product design**

New Directions for Chemical Engineering Education IV - Guidelines... not a single degree structure... (I)

- A decision has to be made on appropriate dosage of depth and scale of phenomena analysis
  - **Molecular modelling and microscopic scale**
    - ✓ Polymer properties, microporous materials, vapour-liquid equilibria...
  - **Macrocospic scale**
    - ✓ Process modelling and process synthesis, full plant models for optimisation, computer-aided process operations
    - ✓ Modelling through knowledge integration

NEW DIRECTIONS FOR CHEMICAL ENGINEERING EDUCATION IV - GUIDELINES... NOT A SINGLE DEGREE STRUCTURE... (II)

- A core group of topics, concerning basics and engineering, and of skills and competencies, should be part of the programmes
- A complementary group of elective modules should lead the student to work on frontier topics of chemical engineering and/or new relevant issues
- Bring students nearer to the practice of chemical engineering:

  External training, more practical 'hands-on' training is required - give sufficient practical experience, both in the laboratory, pilot plant and industry in the core curriculum
- Promote holistic thinking through integrated case-studies and strengthening of horizontal issues
- **Lifelong learning is the key concept to have the edge**

NEW DIRECTIONS FOR CHEMICAL ENGINEERING EDUCATION V – INCORPORATE NEW KNOWLEDGE, COMPETENCES AND SKILLS

- **Programmes are of course directed to raise scientific and technical knowledge – fundamentals should never be put aside**

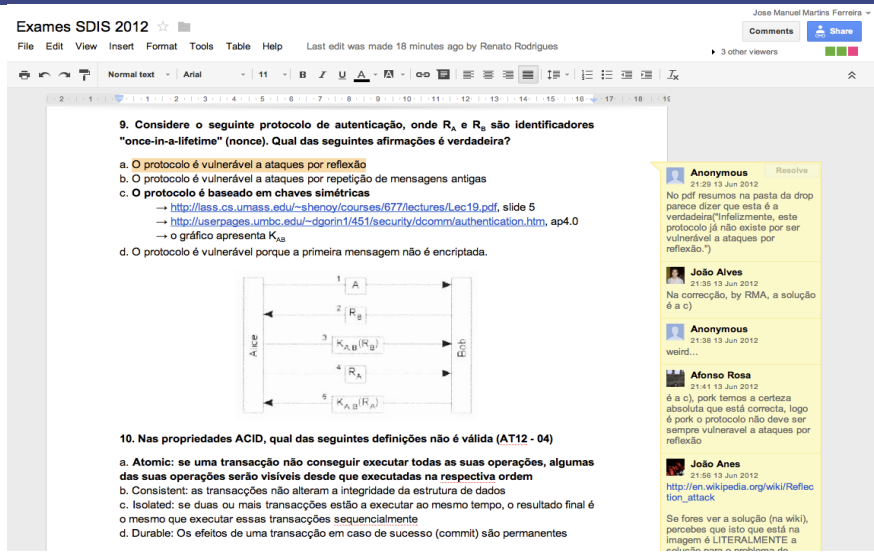
BUT

- **Must bring in the development of attitude, skills and competences valued by Industry and Society in general**
  - **Skills and competencies for innovation and entrepreneurship**
  - **Job related skills**
    - ✓ **Teamwork, Communication, Leadership**
  - **Competencies (How tasks are done)**
    - ✓ **Holistic thinking, self-management, achievement of objectives..**

TOOLS IN THE INFORMATION AGE, IN THE ERA OF COMMUNICATIONS

- **The 'good old days of Moodle' ?**
  - **Moodle is indeed and essentially a digital repository system with some capacity for interchange**
- **Google Apps for education?**
  - **Google Apps are indeed tools for collaborative study and learning**
  - **A growing number of universities are going 'Google Apps'**
- **MOOCs – Massive Open Online Courses – Coursera, EdX...**
  - **Tools and means for learning through cooperative learning**
  - **They challenge the educational model... the concept /paradigm of 'constant time - variable learning'**
  - **Indeed platforms for education without boundaries – a political issue**

TECHNOLOGIES X TRANSFORMATIVE LEARNING: VIA TOOLS (E.G. GOOGLE APPS)



Exames SDIS 2012

File Edit View Insert Format Tools Table Help — Last edit was made 18 minutes ago by Renato Rodrigues

Jose Manuel Martins Ferreira — Comments — Share — 3 other viewers

9. Considere o seguinte protocolo de autenticação, onde R_A e R_B são identificadores "once-in-a-lifetime" (nonce). Qual das seguintes afirmações é verdadeira?

a. O protocolo é vulnerável a ataques por reflexão
b. O protocolo é vulnerável a ataques por repetição de mensagens antigas
c. **O protocolo é baseado em chaves simétricas**
→ http://lass.cs.umass.edu/~shenoy/courses/677/lectures/Lec19.pdf, slide 5
→ http://userpages.umbc.edu/~dgorin1/451/security/dcomm/authentication.htm, ap4.0
→ o gráfico apresenta K_{AS}
d. O protocolo é vulnerável porque a primeira mensagem não é encriptada.

10. Nas propriedades ACID, qual das seguintes definições não é válida (AT12 - 04)

a. **Atomic: se uma transacção não conseguir executar todas as suas operações, algumas das suas operações serão visíveis desde que executadas na respectiva ordem**
b. Consistent: as transacções não alteram a integridade da estrutura de dados
c. Isolated: se duas ou mais transacções estão a executar ao mesmo tempo, o resultado final é o mesmo que executar essas transacções sequencialmente
d. Durable: Os efeitos de uma transacção em caso de sucesso (commit) são permanentes

Anonymous 21:29 13 Jun 2012
No pdf resumos na pasta da drop parece dizer que esta é a verdadeira("Infelizmente, este protocolo já não existe por ser vulnerável a ataques por reflexão.")

João Alves 21:35 13 Jun 2012
Na correcção, by RMA, a solução é a c)

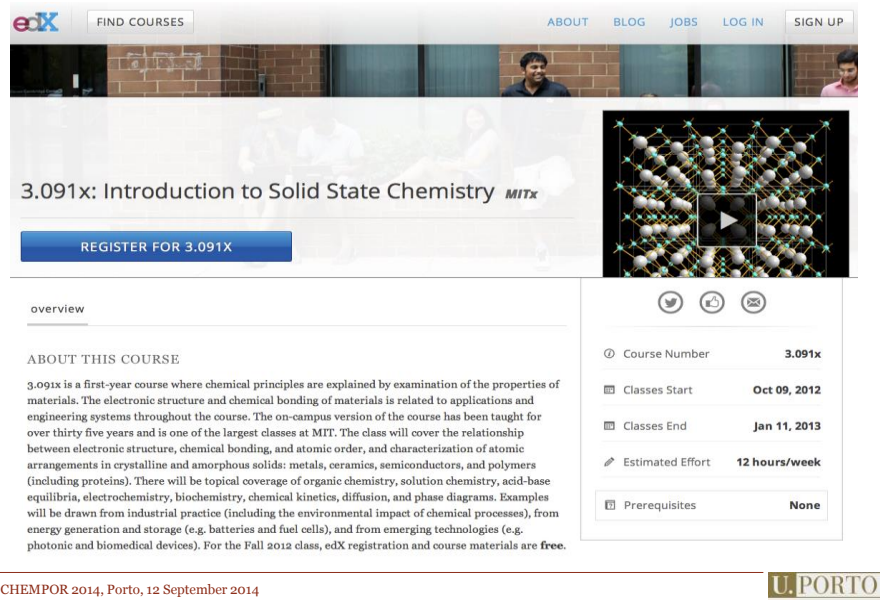
Anonymous 21:38 13 Jun 2012
weird...

Afonso Rosa 21:41 13 Jun 2012
é a c), pork temos a certeza absoluta que está correcta, logo é pork o protocolo não deve ser sempre vulnerável a ataques por reflexão

João Anes 21:56 13 Jun 2012
http://en.wikipedia.org/wiki/Reflection_attack

Se fores ver a solução (na wiki), percebes que isto que está na imagem é LITERALMENTE a

TECHNOLOGIES X TRANSFORMATIVE LEARNING: VIA CONTENTS (E.G. MOOCS)



edX FIND COURSES ABOUT BLOG JOBS LOG IN SIGN UP

3.091x: Introduction to Solid State Chemistry MITx

REGISTER FOR 3.091X

overview

ABOUT THIS COURSE

3.091x is a first-year course where chemical principles are explained by examination of the properties of materials. The electronic structure and chemical bonding of materials is related to applications and engineering systems throughout the course. The on-campus version of the course has been taught for over thirty five years and is one of the largest classes at MIT. The class will cover the relationship between electronic structure, chemical bonding, and atomic order, and characterization of atomic arrangements in crystalline and amorphous solids: metals, ceramics, semiconductors, and polymers (including proteins). There will be topical coverage of organic chemistry, solution chemistry, acid-base equilibria, electrochemistry, biochemistry, chemical kinetics, diffusion, and phase diagrams. Examples will be drawn from industrial practice (including the environmental impact of chemical processes), from energy generation and storage (e.g. batteries and fuel cells), and from emerging technologies (e.g. photonic and biomedical devices). For the Fall 2012 class, edX registration and course materials are **free**.

Course Number	3.091x
Classes Start	Oct 09, 2012
Classes End	Jan 11, 2013
Estimated Effort	12 hours/week
Prerequisites	None

AT THE END OF THE DAY… A PARADIGM SHIFT IN CHEMICAL ENGINEERING EDUCATION?

- **1st Paradigm(s)**
  - **In general terms - First quarter of the XX Century - Education close to industrial operations - Unit Operations**
- **2nd Paradigm(s)**
  - **In general terms – Third quarter of the XX Century – Education shift to Engineering Science**
- **3rd Paradigm ? ? ?**
  - **We are possibly at present on the process of developing a model and of conceptualizing the evolution for a new paradigm… which is not yet quite identified…**

INSPIRING WORDS ABOUT CHEMICAL ENGINEERING EDUCATION WE SHOULD NOT FORGET THE SINE WAVE OF LIFE…

- **The words of A.B. Newman, President AIChE, 1938**

  'Theoretical descriptions should be limited to illustrate the engineering fundamentals, because a manager does not hire a young engineer just because he is able to describe how a product is produced'.

- **Words of Ralph Landau, Stanford University, 1997*:**

  'I believe chemical engineering's third paradigm, if there is one, is to return the discipline closer to the practices in industry'

* **Landau, R. (1997), "Education: Moving from Chemistry to Chemical Engineering and Beyond," Chemical Engineering Progress, AIChE, pp. 52-65**