ON CONTEMPORARY ENGINEERING EDUCATION

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ARE YOU SATISFIED WITH THE PRESENT STATE OF ENGINEERING EDUCATION?
CURRENT ENGINEERING EDUCATION BASED ON:

- traditional system of KNOWLEDGE TRANSFER
  → more or less authoritative professor-student relationship
- significantly reduced ELITIZATION of knowledge
  → information is now available for anyone!
- use of more modern teaching TOOLS
  → presentations, multimedia sources etc.
- education mainly through specialist trainings
  → for example in CE divisions according to building materials
- generally there is no significant multidisciplinary or team-work
  → students rarely need to contact several professors for solving assignments
- the main principle:
  → one-size-fits-all education
‘LINEAR’ SYSTEM OF EDUCATION

Current level of Knowledge

- strongly STATIC process without too many ‘interruptions’
- in the focus ‘AMOUNT’ of knowledge that should be poured ‘into’ the students
- specialised knowledge without ‘DEPTH’ → to know everything about nothing
- ‘ANALOG’ transmission of sets of information → congestion, difficult linking
- formation of ISLANDS OF KNOWLEDGE → individuals operate separately
- showing what’s been learnt mostly by mere REPRODUCTION → low-level learning
IS THAT WHAT WE WANT?

SOCRATES:

‘Education is the kindling of a flame, not the filling of a vessel.’

A NEED TO CHANGE THE EXISTING PARADIGM OF ENGINEERING EDUCATION!

Strategic thinking:

WHAT → WHY → HOW → WHERE → WHO

EDUCATE AND TRAIN ENGINEER OF THE FUTURE CAPABLE TO SUCCESSFULLY DEAL WITH THE CONTEMPORARY AND FUTURE PROFESSIONAL CHALLENGES.
THE TRUTHS
(not so comforting, but good for us to be aware of in the beginning):

1. There is NO education system, no matter how sophisticated and comprehensive it may be, to fully prepare students for what is ahead of them once they finish studies and face their professional tasks

   → LEARN (yourself and the students) TO MAKE DECISIONS WHEN THERE IS NO ALL INFORMATION AVILABLE (Pareto principle – 80/20 Rule)

2. We have to put our attention to the fact that contemporary education market becomes more and more challenging, taking knowledge as a ‘product’ that has to meet the usual requirements that also apply to other products - for example:
   - a certain level of quality, functionality, usability, durability
   - it must have a ‘unit of measure’
   - it has to find its place on the market
   - its properties should be monitored, tested and approved (QA system)
   - It has to be sustainable and so on.

   → CONSIDERING THE PROBLEM THAT WAY MAKES IT EASIER TO CREATE OR MODIFY OUR STUDY PROGRAMMES AND LEARNING OUTCOMES
CONTEMPORARY ENGINEERING PROFESSION

- more demanding, complex, long lasting and comprehensive projects that have to be considered from various aspects – financial, social, environmental, economics, political etc.

- urge for using new/modified/improved materials, sustainability

- strong impact of ever-developing technology both in design process and application (construction..etc.)

- a growing need for remediation of consequences of modern capitalism – overcrowded cities, disfunctional traffic and utility infrastructure, large amounts of waste, lack of drinking water, forest devastation, drastic climate change and following disastrous events – earthquakes, flood, hurricanes, tidal waves etc.)

- overlapping and/or redefinition of the boundaries between professional fields

- a need for abilities and skills other than narrow professional ones

- complex and high-demanding modern professional design codes

- an accelerated need for upgrading and perfecting our personal knowledge and skills

- ability to adapt or re-invent the very nature of engineering field
HOW TO ACCOMPLISH OUR GOAL?

A. EINSTEIN: ‘Problems cannot be solved at the same level of awareness that created them.’

- GENERAL APPROACH
  - CHANGE THE PERSPECTIVE!

- STUDY PROGRAMMES
  - PROVIDE THE FRAMEWORK FOR THE NEW PERSPECTIVE

- KNOWLEDGE TRANSFER METHODS
  - ADAPT, IMPROVE AND MODERNIZE

- RELATION BETWEEN STUDENTS AND TEACHERS
  - RECONSIDER, CLARIFY AND THEN RESPECT!
GENERAL APPROACH
(valid for all levels)

- **BUILD ‘BRIDGES’** – keep defining links for various elements to become parts of a larger whole → openness, cooperation, team-work, synergy

- **ADOPT AN INTEGRAL APPROACH** - consider a person as the whole

- **THINK INTERDISCIPLINARY** – approach the problem from various aspects

- **ASSURE SUSTAINABILITY** – consider life-long cycles, recognize the long-term impacts that are being achieved

- **OFFER** as many OPPORTUNITIES as it is possible **TO CONNECT HIGHER EDUCATION, SCIENTIFIC AND PRACTICAL KNOWLEDGE**

- **ESTABLISH THE MECHANISM OF FEEDBACK COLLECTING** – monitor, collect and analyse data → QA system → keep reshaping the system
STUDY PROGRAMMES

- PRECISE definition of learning outcomes in terms of knowledge, skills and competence within The national qualifications framework taking into account comparability to the similar national and international higher educational institutions

- LEARNING OUTCOMES as ‘units of measure’/‘building blocks’ that can be easily connected into a larger meaningful whole
Enable EQUALIZATION of using ‘Bologna tools’ – ECTS system, diploma supplement and qualifications framework → remove obstacles for mobility
Rather than BE OCCUPIED with AMOUNT OF KNOWLEDGE allow FLEXIBILITY in courses:

- provide ENOUGH TIME for the students to discuss, connect and review the lecture content
- apart from obligatory tasks support opportunities for assignments created according to PERSONAL INTEREST and PREFERENCE
- encourage JOINT COURSES/PROGRAMMES/DEGREES
- ASSURE DIVERSITY in presenting the lecture content that will help to keep students’ interest in course (workshops, guest teachers, students’ presentations, multimedia time, fieldwork etc.)
- try ‘DIGITAL’ transmission of data: present quantitatively less but qualitatively more TARGETED information
ANTICIPATE OPPORTUNITIES for LINKING education process more closely to the BUSINESS sector as well as SCIENTIFIC research

- give students opportunity TO APPLY acquired theoretical knowledge in real circumstances and constrains
- provide possibilities for STUDENT’S PARTICIPATION in laboratory testing, numerical modelling or other parts of scientific research
- collect VALUABLE FEEDBACK information about actually realized learning outcomes
...and the most important, ULTIMATE GOAL:
TEACH STUDENTS TO LEARN!

- National Academy of Engineering, Washington, DC: The Engineer of 2020: ‘ENGINEERS ARE GOING TO HAVE TO ACCEPT RESPONSIBILITY FOR THEIR OWN CONTINUAL REEDUCATION, AND ENGINEERS SCHOOLS ARE GOING TO HAVE TO PREPARE ENGINEERS TO DO SO BY TEACHING THEM TO LEARN.

Give a man a fish, he’ll eat for a day. Teach a man to fish, he’ll eat for life.

Lao Tzu
4716 pupils, all 109 primary schools in Zagreb were included into research
KNOWLEDGE TRANSFER

- TECHNOLOGY ALONE IS NOT ENOUGH ➔ significant improvement in knowledge transfer process requires a deep understanding of HUMAN BEHAVIOUR
  - Approach based on considering a student as the ‘whole’ person rather than mainly focusing on intellectual level

Try to provoke full reflection on problems!
pave the way for awakening of ‘WILLING FACTOR’ instead of dwelling on ‘WANT FACTOR’ – nurture students’ self-motivation, determination and consistency so that they create integral learning frame and sense of RESPONSIBILITY for their own work

P. Salovey: *Emotional intelligence is the subset of social intelligence that involves the ability to monitor one’s own and others’ feelings and emotions, to discriminate among them and to use this information to guide one’s THINKING AND ACTIONS.*

→ along with professional skills help students to develop meta-competencies (‘soft’, ‘lateral’ skills) required of twenty-first-century engineer:

- ABILITY TO MANAGE INFORMATION
- ABILITY TO MANAGE THINKING
- ABILITY TO MANAGE COLLABORATION
- ABILITY TO MANAGE ATTITUDE

Peggy Klaus: ‘Soft Skills get little respect, but will make or break your career’.
PROVOKE higher cognition activities:
- ability to challenge and question
- ability to associate and connect
- ability to evaluate and express
ACCOUNT for changing behavioural patterns in younger generation

- American National Institutes for Health: *College students are one of the most sleep-deprived populations*
  - Game-driven generation
  - Strong dependance on social networks (‘it hasn’t really happened until it has been posted on...’)
  - Lack of attention...

Belenky at al., 2003
CONTINUOUSLY monitor and analyse education system functioning (QA)

- OPPORTUNITY to keep track of current efficiency and goal achievements as well as detecting problems

Example: FCE Osijek → phenomenon so-called ‘Backward studying’

Due to more relaxed entry into studying in the first year (low credit threshold), students struggle to catch up with their growing obligations afterwards and find themselves fully stucked in the third year.
Action undertaken: CREDIT TRESHOLD RAISED from 42 to 50 ECTS

De Koning et al.: ‘Impact of binding study...’
(2014): ‘Introduction of a credit threshold results in a positive change in study behavior’.
STUDENT-TEACHER RELATIONS

- Recently STRONG ACCENT on shifting the role of teachers/instructors to orchestrators/facilitators of learning and more extensive including students into courses’ planning
  
  → BE CAREFUL with ENGINEERING!

- We should strive for partnership and mutually respective relationship based on TAKING RESPONSIBILITY FOR THEIR OWN ACTION
  
  → It is unavoidable condition for SUSTAINABILITY.
  
  Anne Frank: ‘Our lives are fashioned by our choices. First we make our choices. Then our choices make us.’

- Five ‘Es’ of an excellent university teacher:
  
  → EDUCATION
  → EXPERIENCE
  → ENTHUSIASM
  → EASE
  → ECCENTRICITY
- We don’t need isolated poles but **advanced combination of**:
  - Knowledge and desire of knowledge
  - Experience and open-mindedness

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Le Corbusier (1887-1965) – relation between architects and engineers

Epictetus: ‘It is impossible for a man to learn what he thinks he already knows.’
So, WHAT we need is...

‘SPIRAL’ MODEL OF EDUCATION

- The SPIRAL symbolizes continuous growth through dynamic, self-evolving process → not ONLY replicate and evolve but also DESIGN THEIR OWN EVOLUTION by choosing and inventing the direction of their own development.

- The process should come back around the beginning point but at a HIGHER, different LEVEL (as a consequence of the new knowledge/experience/awareness), seeing everything IN A NEW PERSPECTIVE.
SOFT SKILLS EDUCATION PROCESS (shift an old paradigm as much as you can!)

CURRENT LEVEL OF KNOWLEDGE

KNOWLEDGE MODULES (as a function of desired learning outcomes)

DIVERSITY INTEGRAL APPROACH

TEAM WORK FLEXIBILITY

REALISTIC ENVIRONMENT PRACTICAL PROBLEMS

JOINT PROGRAMMES ECTS INTERDISCIPLINARITY

DIRECT SYSTEM FROM A NEW PERSPECTIVE (keep, modify, reshape, adapt, change, revoke...)

EDUCATION POLICY MAKING

FEEDBACK INFORMATION (QA: collect, analyze, understand and TASK!)

STAKEHOLDERS GOVERNMENT DEPARTMENTS COMMUNITY ALUMNI

BUSINESS & INDUSTRY SECTOR

BUILD BRIDGES! UNLOCK REGIONAL RESOURCES!
CONCLUDING REMARKS

- WE HAVE TO CHANGE OUR CURRENT PERSPECTIVE (=MIND-SET) ON ENGINEERING EDUCATION

- THE BEST WAY FOR DOING IT IS TO APPLY ‘STRATEGIC THINKING’ METHOD (What? Why? How?...). IT IS VALID AT ALL LEVELS (an idea, a person, a group. ... a system)

- UNDERSTANDING OF HUMAN BEHAVIOUR IS CRUCIAL FOR IMPROVING KNOWLEDGE TRANSFER PROCESS

- THE KEY TASK IS TO TEACH STUDENTS HOW TO LEARN AND TAKE RESPONSIBILITY FOR THEIR OWN CONTINUAL RE-EDUCATION (LLL)

- COMPLEMENTING KNOWLEDGE AND DESIRE OF KNOWLEDGE, EXPERIENCE AND OPEN-MINDEDNESS WILL BOOST DEVELOPMENT

- SELF-SUSTAINING AND SELF-IMPROVING ‘SPIRAL’ SYSTEM OF EDUCATION SHOULD BE RUN BY MOTIVATING FACTORS FOR ALL PARTIES

ENGINEERS HAVE CHANGED THE WORLD, BUT THE TIME HAS COME FOR THE WORLD TO CHANGE ENGINEERS
THANK YOU FOR YOUR ATTENTION!
REFERENCES