Preparing Next Generation of Software Engineers for Future Societal Challenges and Opportunities

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Facing grand challenges & opportunities

“The global community is facing Grand Challenges. The European Knowledge Society must tackle these through the best analysis, powerful actions and increased resources. Challenges must turn into sustainable solutions (...)” The Lund Declaration, 2009 [1]

Natural challenges:
Global warming, Insufficient supplies of energy, water and food, Ageing societies,
Public health, pandemics, Security, Environmental degradation

Unintended consequences of technology (together with opportunities come challenges):
AGI (artificial general intelligence), Nano-technology, Biotechnology/Bioinformatics, Autonomous machinery and control: Big data, Internet of things – internet of everything, Intelligent cities, Autonomous cars, Autonomous intelligent software as control physical systems, information systems etc.
...

Education of new generations of engineers often focus on training abstract skills without careful consideration of the role of embeddedness of technology into context.
Responsible research and innovation (RRI)

Global challenges and opportunities prompted Responsible Research and Innovation (RRI), [2-4], defined as:

“a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).”

Von Schomberg [2]

Education of future engineers should follow!
The university of the future

The transformation of “ivory tower” context-independent to socially-aware paradigm in increasingly information-rich knowledge-based societies.

The triple helix model connects:

- ACADEMIC
- BUSINESS
- GOVERMENT

Inspired by biology: THE TRIPLE HELIX
Gene, Organism, and Environment by Richard Lewontin
Science with and for society work programme

Societal challenges for the 2020 are formulated in the Science with and for Society work programme, meant to

“help build effective cooperation between science and society, to recruit new talent for science and to pair scientific excellence with social awareness and responsibility”

Science with and for Society Work Programme 2014-2015

All stakeholders (involved citizens, researchers, business, policy makers, etc.) interact throughout the research and innovation process to coordinate and align with societal values and needs: sustainability, safety, privacy, equity, diversity, etc.
Organizational adaptation in the era of complexity and continuous Change

A necessity of defining social/organizational responsibility in addition to customary personal responsibility [7].

We should take into account both intended and unintended consequences of research and technology in a preferably anticipatory and learning process that will in the first place prevent incidents and accidents and in the worst case mitigate their consequences, [8-13].
Organizational adaptation in the era of complexity and continuous Change

Contemporary global society is organized in networks of networks of interacting agents. Each individual belongs to a variety of networks, which define their different roles as stakeholders in various aspects of research and technology. In this context complexity and trans-disciplinarity /inter-disciplinarity comes as an important aspect of research and development.

Values, priorities, actions are negotiated by stakeholders, globally.
STAKEHOLDERS IN AN INDUSTRIAL PROJECT

Inspired by ETHICS IN ENGINEERING
Mike Martin, Roland Schinzinger
McGraw Hill, 1997
STAKEHOLDERS IN A RESEARCH PROJECT

- Research Communities
- International Academic research community
- Professional Organizations Societies
- Financing bodies
- Society at Large
- Academia
- PhD Student
- Research group
- PhD Advisors

Inspired by ETHICS IN ENGINEERING
Mike Martin, Roland Schinzinger
McGraw Hill, 1997
The uniqueness debate and engineers teaching ethics

Insight about necessity of teaching and discussing ethics in education leads to new questions.

Is ethics in engineering unique or is it a direct application of existing classical ethical theories?

Should experienced engineering professionals or philosophers teach ethics to engineers?
Educating engineers for the future

We are educating engineers that will solve future problems.

Future is already at our doors.

Choices are made all the time in the design and engineering.
MDH PROFESSIONAL ETHICS COURSE
http://www.idt.mdh.se/kurser/cd5590/

Chalmers University of Technology
RESEARCH ETHICS AND SUSTAINABLE DEVELOPMENT COURSE
https://www.chalmersprofessional.se/sv/utbildningar?tags=generic_skills&id=4409#.VLBc0ye0cgN
What is Research Ethics?

“The beauty of math, of course, is that we don’t need an ethicist.”
You will recognize this domain-based view in the analysis of many different types of problems – organization of society, sustainability of cities, ecology, economics, ethical aspects etc.
CONCLUSIONS

As response to global challenges and opportunities, we need a new kind of engineer, a “T-shaped” engineer.

“With respect to system thinking, a T-shaped person is one who has technical depth in at least one aspect of the system’s content, and a workable level of understanding of a fair number of the other system aspects. Many pure computer science graduates are strongly I-shaped, with a great deal of depth in software technology, but little understanding of the other disciplines involved in such areas as business, medicine, transportation, or Internet of Things. This leaves them poorly prepared to participate in the increasing numbers of projects involving multi-discipline system thinking.”

Boehm and Koolmanojwong Mobasser, ICSE 2015
CONCLUSIONS

We need research and innovation process and products that will contribute to the advancement of humanity and avert catastrophic events, or in the worst case mitigate their consequences.

This necessitates education of engineers with developed sensitivity to social aspects of engineering, which is including courses on research and engineering ethics and sustainable development.
CONCLUSIONS

Our experiences with teaching ethics are positive in terms of student engagement and results (articles, presentations) in the two courses

Professional Ethics course @Mälardalen University
http://www.idt.mdh.se/kurser/cd5590/

Research Ethics and Sustainable Development
@Chalmers University of Technology
https://www.chalmersprofessional.se/sv/utbildningar?tags=generic_skills&id=4409#.VLBc0ye0cgN
REFERENCES


SWEDISH RESEARCH ETHICS RESOURCES

http://www.vr.se/inenglish/ethics.4.69f66a93108e85f68d48000116.html  Research Ethics from Research Council

http://www.vr.se/inenglish/ethics.4.69f66a93108e85f68d48000116.html  Swedish Research Council
http://www.epn.se/sv/start/startsida/  Expert Group For Ethics
RESEARCH ETHICS RESOURCES

http://www.nap.edu/catalog.php?record_id=12192

http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2010_11_19/careedit.a1000111
Responsible Conduct of Research for Junior Researchers (Science, November 2010)
RESEARCH ETHICS RESOURCES

http://www.esf.org/fileadmin/Public_documents/Publications/Code_Conduct_ResearchIntegrity.pdf The European Code of Conduct for Research Integrity

http://www.zim.mpg.de/openaccess-berlin/berlin_declaration.pdf Berlin Declaration on Open Access to Knowledge

http://www.icmje.org/urm_main.html Uniform Requirements for Manuscripts

http://www.codex.vr.se/