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“Engineering for Humanity, Sustainability and the SDGs”

Tony Marjoram, PhD, FIEAust, CPEng, MIEEE

Guest Prof, UNESCO Aalborg Centre, University of Aalborg, Denmark
Head of Engineering Sciences, Basic and Engineering Sciences, UNESCO, 2001-2011
Editor UNESCO Report, “Engineering: Issues, Challenges and Opportunities for Development”
Second UNESCO Report, “Engineering the SDGs: Putting Aspirations and Action into Practice”
Introduction

Reported shortages of engineers, shortages of the right engineers: need to attract young people, esp women, minorities, STEM

Part of bigger picture: young engineer under/un-employment over-supply - globalisation/outsourcing, under-supply - education

Australia: restructuring/un-employment, new engineers: 70% visa

Similar challenges other countries: need brain-train, less brain-drain

Need engineers, need the right engineers: to address UN Sustainable Development Goals (SDGs)

Need to attract and train young people for cleaner/greener engineering

Need better engineering information and statistics, policy and planning to train engineers for the SDGs, to put aspirations into practice
Appropriate engineering and technology for humanitarian development

Engineering underpins:
social progress, sustainability and humanitarian development
innovation, infrastructure, industry, employment, economic growth
post-disaster and post-conflict response and reconstruction
sustainable production and consumption, climate change response

Engineering vital to address UN SDGs

Need to promote engineering for sustainable development, eg:
Daimler-UNESCO Mondialogo Engineering Award, 2003-10
10,000 student engineers from over 100 countries, address MDGs
EWB Challenge, Engineers Without Borders Australia/UK, 2011-16
Ongoing EWB Challenges around the world

Young people concern about climate - need them in engineering
Daimler-UNESCO Mondialogo Engineering Award

Low cost bridge building: Rwanda-Germany

Mondialogo Engineering Award
Very popular with students
Some projects commercialised

Prosthetic foot – Colombia-USA
Engineering and sustainability

Key areas of sustainability are identified in the UN Global Goals for SD: *Transforming our world: the 2030 Agenda for Sustainable Development*

The United Nations Sustainable Development Goals (SDGs) 2016-30 consist of seventeen goals, 169 targets and 304 indicators.

The SDGs follow UN Millennium Development Goals (MDGs) 2000-15 MDGs – 8 goals, 18 quantifiable targets, 48 indicators

The SDGs are aspirational rather than actual (not engineering goals)

Only one specific reference to engineering, in education scholarships  
(No reference to engineering in the MDGs)

We need to get engineering on the sustainability/SDG agenda!
17 goals, 169 targets and 304 indicators
The SDGs and Engineering

**Poverty:** basic services, infrastructure, employment, humanitarian eng

**Hunger:** agriculture engineering, food production, processing

**Health:** clean water, air, food production, housing

**Education:** engineering education vital for sustainability

**Gender equality:** promote participation of women in engineering

**Water/sanitation:** depends on engineering and technology

**Energy:** renewables, sustainability, affordability, energy efficiency

**Work/econ dev:** employment, infrastructure, industry, innovation

**Production/consumption:** resource/ecosystem management, use

**Climate change:** mitigation/adaptation, energy, emissions

**Global partnerships:** in engineering for sustainable development

You need to be in it to win it – promote engineering for sustainability
Engineering and engineering education

Are as they are due to technical, social and educational factors
Developed through successive waves of innovation (Kondratiev waves)

1 Wave, 1785-1845: Ind Revolution, iron, water power, mechanisation
2 Wave, 1845-1900: steel, steam power and the railways
3 Wave, 1900-1950: electricity, chemicals, oil, heavy eng, i-c engine
4 Wave, 1950-1985: automobiles, petrochem, electronics, aerospace
5 Wave, 1985-2005: computers, ICT, info societies/economies
6 Wave, 2005-2025: new knowledge, ICTs, bio/nano/matls tec, robots

New technology, knowledge, new modes of knowledge production

Mode 1 traditional/disciplinary → Mode 2 modern/interdisciplinary
Increasingly shorter periods of change, from a lifetime < generation
Increasing emphasis: sustainability, climate change mitigation/adapt
Waves of innovation and change - Kondratiev waves

50 years, reducing, <generation? Accompanied by educational change
Engineering education

New technology, knowledge, new modes knowledge production
New modes of knowledge transmission and learning

1 Wave, 1785-1845: Ind Revolution, craft/activity based, on
2 Wave, 1845-1900: apprentice/trade uni/theory/practice, on/off
3 Wave, 1900-1950: engineering science, uni/theory/practice, off
4 Wave, 1950-1985: engineering science, uni/theory, off
5 Wave, 1985-2005: engineering science, uni/theory/practice, off
6 Wave, 2005-2025: changing models, modernise, eng ed, off/on

Engineering education evolved from craft/trades practical on to university theory/practical, ‘Humboldt Model’, Mother Uni”, 1810 to ‘engineering science’, university - theory, courses, off now to changing models – PBL, CDIO, flipped classrooms etc
Appropriate engineering education and Problem-Based Learning (PBL)

Problem-based learning is ideal for problem-solving engineering

- Problem orientation: guided problem analysis/solving
- Project organisation: projects guide problem analysis and learning
- Integration of theory and practice: link knowledge and application
- Participant direction: students define problem and project work
- Team-based approach: problem/project work in groups students
- Cooperation and feedback: peer/supervisor feedback important

PBL – student-centred, focus on student learning needs

- Link between theory and practice (eg Humboldt model)
  (1970 mech eng – never really understood thermo and fluids!)
- PBL focus on active learning rather than teaching, not passive/listening
- Confucius: hear-forget, see-remember, do-understand (slower forget?)
Engineering accreditation – Professional attributes and competencies

Focus in engineering moving from curricula to attributes + competencies
Cognitive, knowledge-based approach
Input to output, teaching to learning, to students (great unwashed)

New educational approaches for next generation of engineers
What engineers do we need, will we need?

12 WA Graduate Attributes and Prof Competencies – half non-tec:

- Engineering knowledge
- Prob analysis
- Design/develop solutions
- Investigation
- Modern tool usage
- Engineer/society
- Environment/Sustainability
- Ethics
- Individual/team work
- Communication
- Project management/finance
- Life-long learning
Shortages of engineers?

Young people - declining interest/enrolment in engineering
Shortage of engineers – in some fields, some levels, some locations
Increasing Government concern around the world
  Increased migration – but, also increased brain drain

Needs and Numbers – how many engineers do we need?

Developed: 20/50 scientists/engineers per 100,000 population
Developing: ~5 scientists/engineers per 100,000 population
Least developed: <1 scientist/engineer per 100,000 population

Useful to benchmark against other professions, eg medicine:
  Similar numbers doctors per 100,000 population
  Models for demand of doctors – need similar for engineering

Need better metrics/data/indicators on engineering
Concluding remarks 1: engineering and the challenges we face

Particular challenges for engineering:
- Shortages of engineers in some fields, areas and countries
- Decline of interest/enrolment young people in engineering

Need for engineering to attract and retain young people, esp women

Address negative views – engineering boring, hard work, nerdy, dirty

Promote clean/green engineering as part of solution of SDGs:
- poverty reduction, sustainability, climate change mitigation/adapt

Positive link to the SDGs - this attracts young people

But also need to make engineering education more fun

Student-centred, problem/project-based learning
- link theory to practice/needs – learning by doing, not just listening
- learning to respond to changing knowledge and needs
Concluding remarks 2: transforming engineering/education

Engineering/education is changing, but fast enough?
Engineers innovate and need to innovate in education/knowledge
Problem/project-based learning for the problem-solving profession
  Just-in-time, hands-on, theory and project-practice
Knowledge-based approach for changing knowledge and needs
Engineering for the SDGs – put aspirations into practice
Engineering accreditation focus - student attributes, competencies
Drivers of change – accreditation, information, policy/planning
Transformative actions:
  Emphasise need for change, change process, results of change
Better information, statistics and indicators on engineering
Development of engineering policy and planning
Engineering the SDGs: Put Aspirations and Action into Practice
Thank you