WORLD ENGINEERS CONVENTION (WEC) 2019

"Engineering a Sustainable World: The Next 100 Years"

Melbourne Convention and Exhibition Centre, 20-22 November, 2019

Organized by:

World Federation of Engineering Organizations and Engineers Australia

Thursday, 21 November 2019

Session: General SDG (WFEO), 13.30-15.30, Room 217

"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"

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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

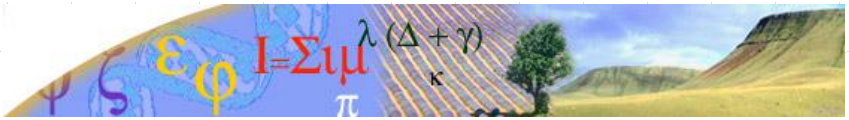
Australia: restructuring/un-employment, new engineers: 70% visa

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

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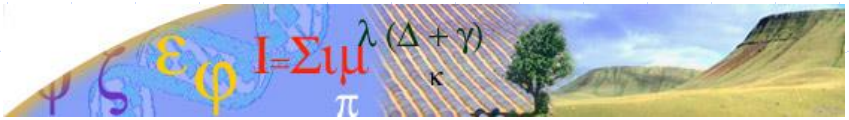

Daimler-UNESCO Mondialogo Engineering Award

Low cost bridge building: Rwanda-Germany

Mondialogo Engineering Award

Very popular with students

Some projects commercialised

Prosthetic foot – Colombia-USA

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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.

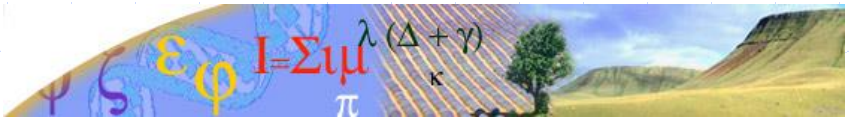
The SDGs follow UN Millennium Development Goals (MDGs) 2000-15

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

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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

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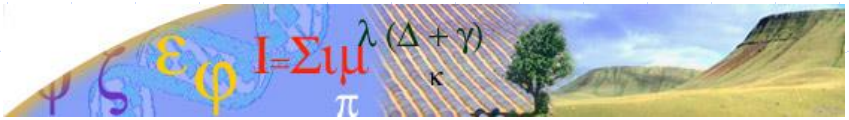


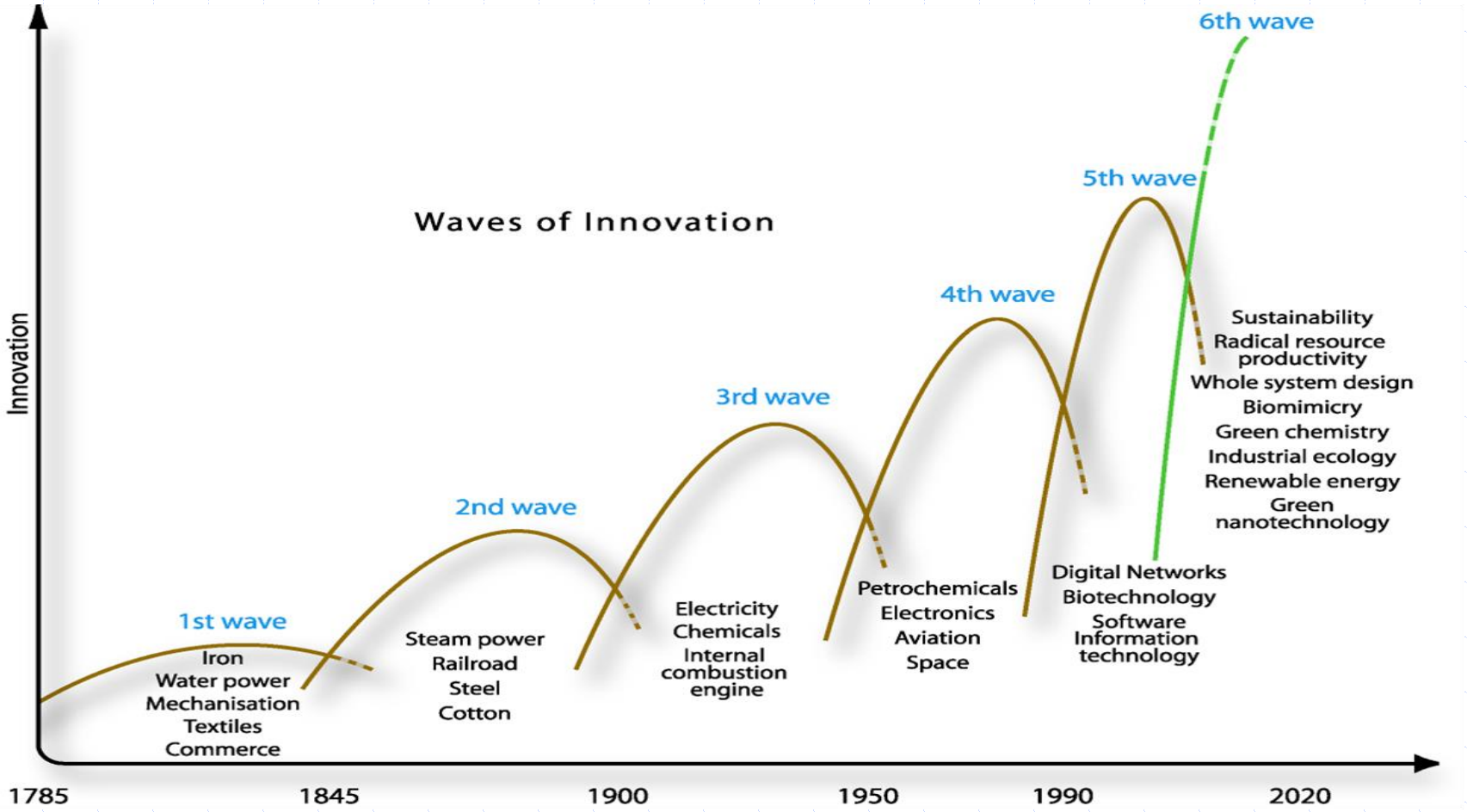
Engineering and engineering education

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

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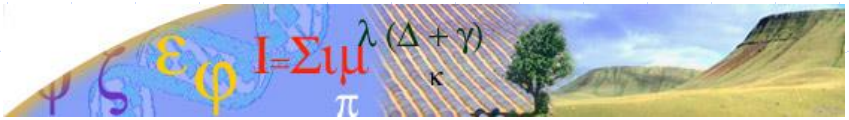
Engineering education

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 eng ed moving from curricula to attributes + competencies

Cognitive, knowledge-based approach

Input to output, teaching to learning, to students (great unwashed)

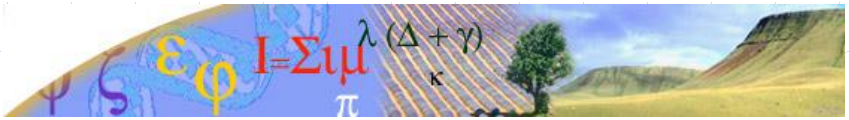
International Engineering Accord (IEA) + Washington Accord (WA)

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

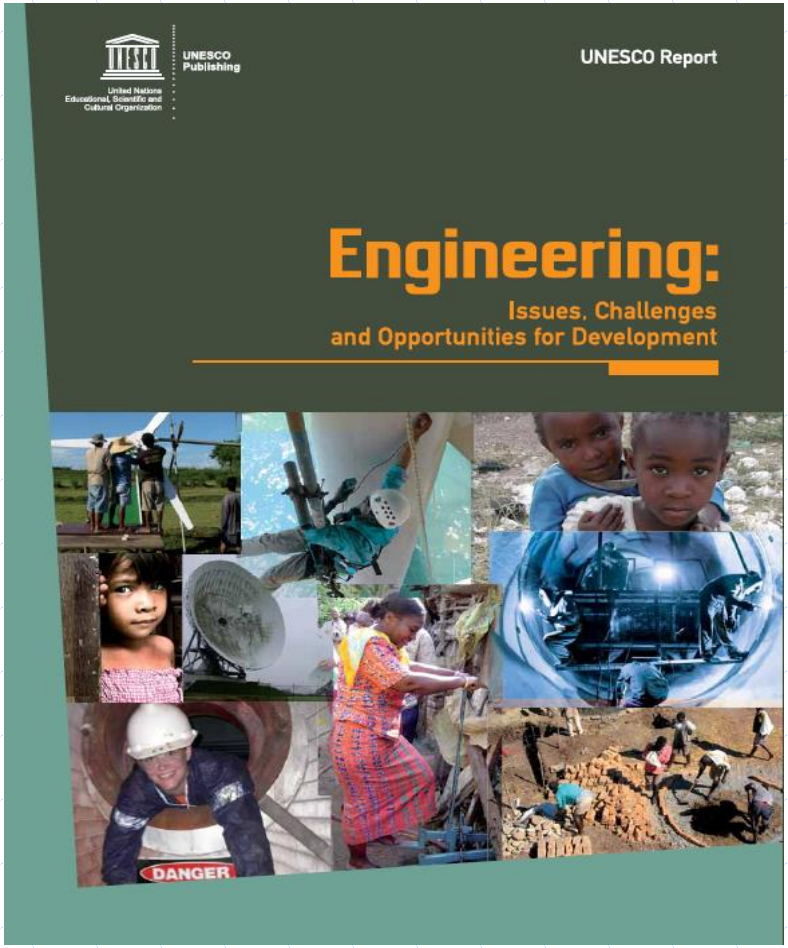
Engineering accreditation focus - student attributes, competencies

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



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