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Process Engineering:

Reflections on an evolving *journey* towards an award-winning programme for sustainability

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Edmond P. Byrne and John J. Fitzpatrick
Process & Chemical Engineering, University College Cork, Ireland



1. Introduction
2. The Journey
3. A Process of Directed Chance
4. International recognition; A Staging post
5. Conclusion and Learnings

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

EwS 2018, Institute of Technology, Sligo 20-22 August 2018 Byrne & Fitzpatrick



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Students and staff of UCC's IChemE Sustainability Teaching Award winning programme



Education for Chemical Engineers

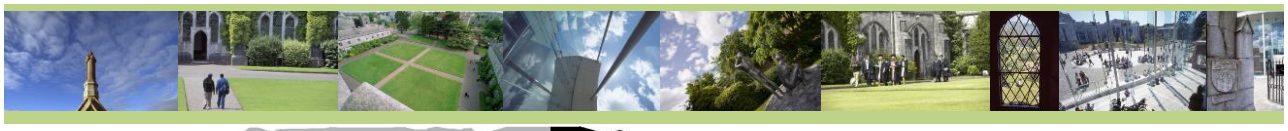
journal homepage: www.elsevier.com/locate/ece

Chemical engineering in an unsustainable world: Obligations and opportunities

Edmond P. Byrne, John J. Fitzpatrick*

Department of Process & Chemical Engineering, University College Cork, Ireland

"***Dedicated modules*** *and* ***elective streams*** *alone are* ***not in themselves sufficient*** *to demonstrate how sustainability should be the* ***context*** *through which 21st Century chemical engineering must be practiced. To do this programmes must* ***inherently*** *and* ***consistently*** *demonstrate the* ***need*** *for* ***sustainable practice***."





Engineering Sustainability — Proceedings of the Institution of Civil Engineers

Educating engineers to embrace complexity and context

Byrne and Mullally

ice | proceedings

Educating engineers to embrace complexity and context

Edmond P. Byrne MSc, MA, PhD — Senior Lecturer, School of Engineering, University College Cork, Ireland

Gerard Mullally MA, PhD — Lecturer, Department of Sociology, University College Cork, Ireland

Education represents a key intervention point in encouraging the emergence of a professional engineer [illegible] by a sustainability ethic. In terms of establishing an appropriate relationship between [illegible]

IJSHE 14,4

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Accepted 16 May 2012

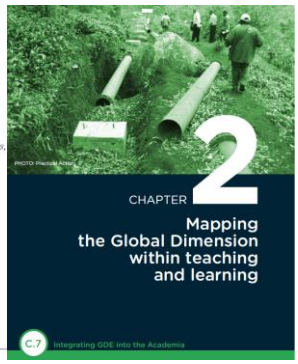
Exploring sustainability themes in engineering accreditation and curricula

Edmond P. Byrne
Department of Process and Chemical Engineering, University College Cork, Cork, Ireland

Cheryl J. Desha
School of Earth, Environment, and Biological Sciences, Queensland University of Technology, Brisbane, Australia

John J. Fitzpatrick
Department of Process and Chemical Engineering, University College Cork, Cork, Ireland, and

Karlson "Charlie" Hargroves
Mathematical Sciences, [illegible]de, Australia



CHAPTER 2

Mapping the Global Dimension within teaching and learning

C.7 Integrating GDE into the Academia

'*In my view at least, Cork's students are being prepared for a world that is increasingly connected and increasingly collaborative; for a fulfilling and successful public and private life.*' ICE Proceedings Editorial

36 *Int. J. Society Systems Science, Vol. 8, No. 1, 2016*

Why is there no meaningful change to a sustainable future?

John J. Fitzpatrick

School of Engineering (Process and Chemical Engineering), University College Cork, Cork, Ireland
Email: j.fitzpatrick@ucc.ie



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Does engineering education need to engage more with the economic and social aspects of sustainability?

John J. Fitzpatrick

Contents lists available at ScienceDirect

Sustainable Production and Consumption

journal homepage: www.elsevier.com/locate/spc

Sustainability insights and reflections from a personal carbon footprint study: The need for quantitative and qualitative change

John J. Fitzpatrick, Sinead McCarthy, Edmond P. Byrne*

Teaching engineering ethics with sustainability as context

Edmond P. Byrne
Department of Process & Chemical Engineering, University College Cork, Cork, Ireland

Abstract



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Ed's Journey:

'Our capacity for analysis sometimes leads us to an arrogant illusion: that we are so special and unique that nature isn't connected to us. But the fact is, we're inextricably tied.' (Gore, 2006).

It soon became baldly apparent to me that the pillars of environmental engineering and engineering ethics were also closely linked, for as Gore put it as his academy speech:

'we need to solve the climate crisis: It's not a political issue; it's a moral issue.'

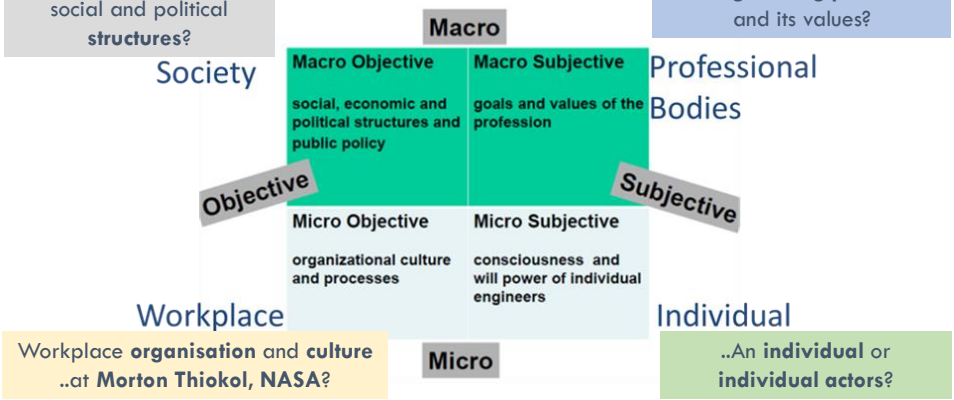




Who was responsible for the Challenger disaster?

Society and its economic, social and political **structures**?

The **Engineering profession** and its values?



Workplace **organisation** and **culture** ..at **Morton Thiokol, NASA**?

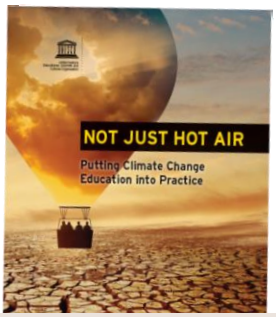
..An **individual** or **individual actors**?

(after Conlon, 2010))



Ed's Journey:

MA in Teaching and Learning in Higher Education (2008); helped facilitate development of a personal understanding of learning in terms of constructivist approaches, something alien to the traditional modernistic worldview as espoused by classical engineering education, but which is essential to effectively engage with sustainability issues and associated narratives, including education for sustainable development (UNESCO, 2015, p. 15).



Constructivist teaching and learning is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction, as opposed to passively receiving information. Learning always builds upon knowledge that a student already has, and learners are the makers of meaning and knowledge. Constructivist teaching fosters critical thinking, and creates motivated and independent learners.[4]



John's Journey:

- Over time, had the niggling feeling that the big challenges to moving humanity towards sustainability lay within economic and social domains.
- Indeed these are possibly the "game-changers" or critical levers for change (Fitzpatrick, 2017)



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Why is there no meaningful change to a sustainable future?

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School of Engineering (Process and Chemical Engineering),
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Cork, Ireland
Email: j.fitzpatrick@ucc.ie



John's Journey:

- Also had niggling feeling of being complicit in producing 'technically competent barbarians' who were not fit-for-purpose for contemporary sustainability challenges.

Technically Competent Barbarians?

"The major role in this was played by the universities, the academics. I keep returning to the question of whether we have indeed learnt anything, *whether we do not still keep producing technically competent barbarians in our universities*" (Bauer, 1998; emphasis added).

The 'barbaric' logic of modern neo-classical economics is destroying people and planet.

John Barry (Queen's Univ. Belfast)





1. Introduction

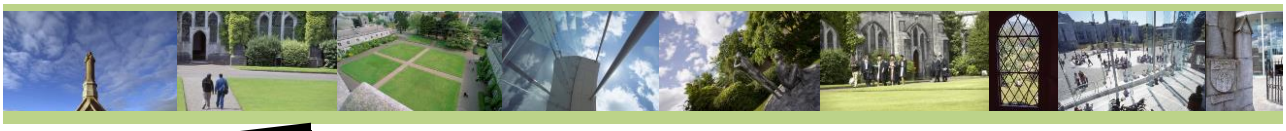
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ISEE2010: Educating Engineers for a Changing World; *Leading Transformation from an Unsustainable Global Society*

3rd International Symposium for Engineering Education UCC (ISEE2010)




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Exploring sustainability themes in engineering accreditation and curricula

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EESD Conference Series:
(Chalmers (2010), Cambridge (2013), Univ. British Columbia (2015), Bruges (2016), Rowan (2018), … Cork (2020)



PE3011 Sustainability in Process Engineering (ex 2010/1)

- Broad view taken; not just socio-technical (e.g. LCA), but also **making explicit** underlying **values** and **paradigms** around sustainability narratives and the nature of **complex** systems
- Essentially aiming to develop the **generic competencies**, including integrative approaches and critical thinking skills necessary for and that correspond with education for sustainable development (ESD) more generally (Bourne & Neal, 2008; UN, 2012; Byrne, 2014)
- e.g. Learning Outcomes include:
  - *Demonstrate understanding of contemporary frameworks, concepts, constructs, models, and values and ethics around sustainability and sustainable development*
  - *Develop an ability to understand different perspectives, framings, paradigms and worldviews and work collaboratively with others in seeking (through inter- and transdisciplinary approaches) to propose useful interventions and potentially transformative outcomes*
  - *Develop and refine capacity for critical reflective analysis and integrative and systems thinking*



On our call for '*The Need to Embed Sustainability*':

- Sustainability thread developed within **other modules** with support of colleagues (below).
- Macro environment facilitated by **professional accreditation bodies** (e.g. IChemE, Engineers Ireland Accreditation requirements, sustainability related prizes/initiatives, Code of Ethics (EI, 2018))
- Positive sustainability ethos & leadership in our **university** provides positively oriented **context**.

Primary Sustainability Modules	Secondary Sustainability Modules
PE1006 Professional Engineering Communication & Ethics	PE1003 Intro. to Process & Chemical Engineering
	PE2005 Introduction to Biochemical Engineering PE2011 Plant Design and Commissioning
PE3011 Sustainability in Process Engineering PE3008 Safety & Environmental Protection I	PE3001 Applied Thermodynamics and Fluid Mechanics
PE4004 Safety & Environmental Protection II PE4006 Design Project	PE4001 Advanced Process Design



Final Year Design Project

'Embedding Sustainability' into the final year capstone Design Project (rather than as 'bolt on')

Traditional 'end of pipe' approach: Do the design first → Then perform sustainability assessment at the end

Revised approach to placing sustainability as context of design project requires:

a) **Considering sustainability throughout a (semi-open ended) design process**
-Thus feed into design decisions from start, including framing

b) **Environmental aspects**
-Employ scientific/engineering tools & methods which can directly influence the design (e.g. LCA, EIS, material and energy balances)

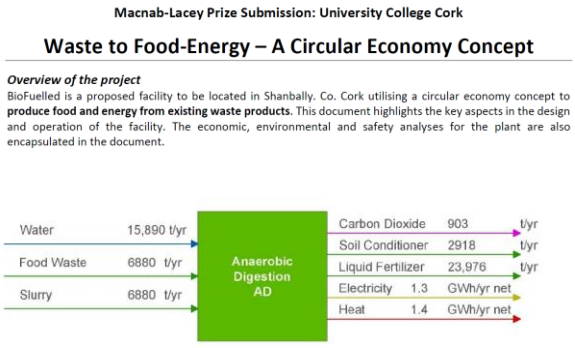
c) **Socio-economic aspects**
- More difficult but could be argued that the key sustainability 'game-changers' lie in this domain; consider/identify key problematic issues?



Final Year Design Project

- Authors provide some guidance on the sustainability requirements of the group design project

- Required output for the groups is a proposed entry into the **IChemE's Macnab-Lacey** final year **Sustainability Design Project Prize** (awarded annually by IChemE '*to the undergraduate student design project team whose design project submission best shows how chemical engineering practice can contribute to a more sustainable world*')





Supported by broader University 'Green Ecosystem':

- **University environment** encouraging; University College Cork was first university in world to receive **Green Flag** for environmental friendliness.



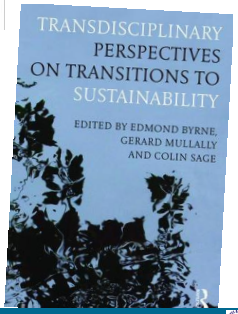








- **Practicing Transdisciplinarity:** '*Sustainability in Process Engineering*' module coupled with '*Sociology of the Environment*' module; group assignment helps students 'walk the walk'/hear other disciplinary languages/problem solve.



- **Transdisciplinary** Environmental Citizenship **Research** Priority Area ('Sustainability in Society'): seeks to (re)consider sustainability in a way which both draws from disciplinary contexts and knowledge but also transcends and builds on new contexts.



Student Feedback; Seen as positive/valuable

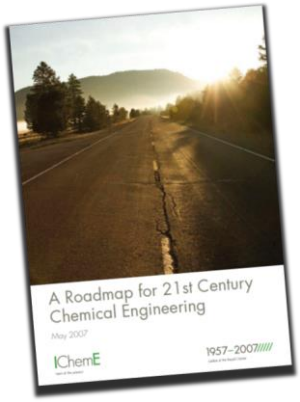
Imperial College London research: ***'make a difference to the world'*** (Alpay et al., 2008) in their careers was a key driver in choosing engineering, especially among females.

Our experience also; Students **very positive** about both ethos and the respective modules.
e.g. *Sustainability in Process Engineering* module feedback:

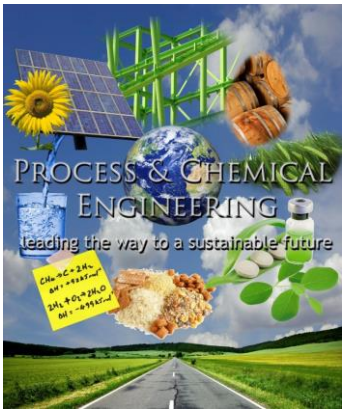
- *'A major learning point of this was taking on board alternative perspectives of problems, outside of engineering solutions.'*
- *'[The] transdisciplinary approach was enlightening – an engineering solution isn't always the only option.'*
- *'Working in a team with vastly different opinions is hugely valuable to our careers in the future.'*



Sustainability ethos as **soft marketing tool** to attract potential students to the programme. Inspired by the IChemE's visionary 2007 'Roadmap', strategic plan for the profession for the century ahead.



IChemE's Roadmap for Chemical Engineering (2007)



University College Cork Process & Chemical Engineering:
Making a positive difference by leading the way (with others)



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International Recognition; A Staging post

Inst. of Chemical Engineers instigated ***Sustainability Teaching Award*** (in 2015) to encourage '*development of better approaches to integrating sustainability principles and values into undergraduate teaching*'.

We entered for the second iteration in 2016 and won!

IChemE: '*particularly impressed by your integration of sustainability teaching across the curriculum, with good examples of interdisciplinary projects and varied assessment with student comments indicating their appreciation of the approach.*'

'*University College Cork demonstrated that they could integrate sustainability teaching principles across the curriculum, which will provide their chemical engineering students with a set of values to apply to their future careers.*'





Sustainability Teaching Award presentation
IChemE AGM, Birmingham, England (May 2017)



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In Conclusion..

- We've found the **journey** from a traditional programme whereby sustainability is envisaged narrowly (e.g. boosting efficiencies, improving environmental emissions) to one where it explicitly seeks to **add value (and values)** to contemporary chemical engineering education, to be both **fascinating and rewarding**.
- This means recognising that '*the key ingredient required ..is an aspiration to enable and empower learners to meet their full potential by developing the* ***necessary skills and aptitudes*** *(critical, reflective and complex thinking, self-awareness and empathy, teamwork, listening and communication skills) to be* ***fit-for-purpose***' (Byrne, 2014) contemporary chemical engineers.
- As we've attempted to push various **doors** (via students, colleagues, accreditation bodies, industry, peers), we've found that they've **swung open** with surprising ease, opening altogether **new and exciting vistas**.
- We see this as **'core' chemical engineering**, to **educate fit-for-purpose graduates** in addressing contemporary, emergent **21st century challenges**, able to **contribute meaningfully** towards authentic societal sustainability and human flourishing.

Come join us and share your experiences of the journey at:

Engineering Education for Sustainable Development

EESD2020

UCC, 7-10 June 2020

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