2023-10-27

Contemporary Landscape, Drivers and Developments in Engineering Education for Sustainability

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Plenary Presentation

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Chair Professor of Process & Chemical Engineering
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Contemporary Landscape, Drivers and Developments in Engineering Education for Sustainability

SEFI ANNUAL CONFERENCE
11-14 September 2023
TUDublin, Ireland

Contemporary landscape, drivers and developments in engineering education for sustainability

Edmond P. Byrne
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UCC University College Cork, Ireland Coláiste na hOllscoile Corcaigh

Chaired 10th Engineering Education for Sustainable Development conference (EESD2021), Cork.
Co-Editor:

- *Transdisciplinary Perspectives on Transitions to Sustainability (Routledge, 2017)*
- *Metaphor, Sustainability, Transformation; Transdisciplinary Perspectives (Routledge, 2021)*

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Edmond P. Byrne, University College Cork
SEFI Annual Conference, TU Dublin. 14 September 2023
SEFI ANNUAL CONFERENCE 11-14 September 2023 TU Dublin ENGINEERING EDUCATION FOR SUSTAINABILITY

Engineering Education for Sustainability/EESD:

1. Curricular Evolution of 'Sustainability' teaching
2. Progress made and Current Topics?
3. Evolving Accreditation Imperatives
4. Assessment; The tricky bit!
5. Whither now?

   Crises, Urgency ..and Radical Transformation?

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What WORD/S, TOPICS or LEARNING ATTRIBUTES do you think of when you consider:

"Engineering Education for Sustainability"

1. Curricular evolution of 'Sustainability' teaching in Engineering Education

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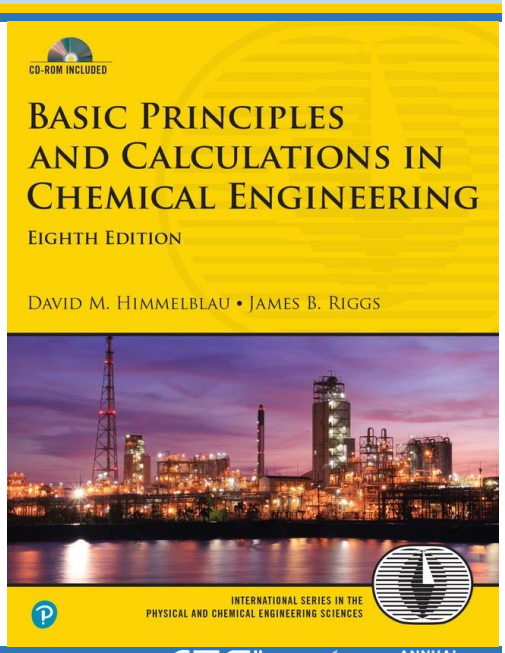
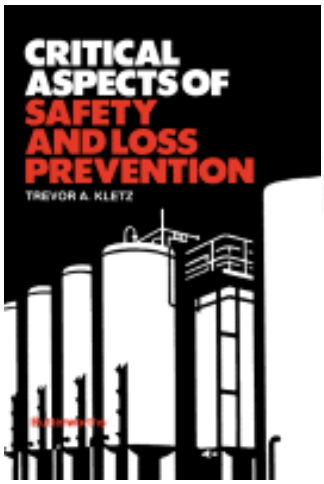
"For much of the **second half of the twentieth century,** there was a **broad consensus** of what content was expected in a chemical engineering course: **underpinning mathematics, physics and chemistry;** some **areas of science specific** to the understanding of processing materials ..and a range of techniques to apply these to the design of process plant."

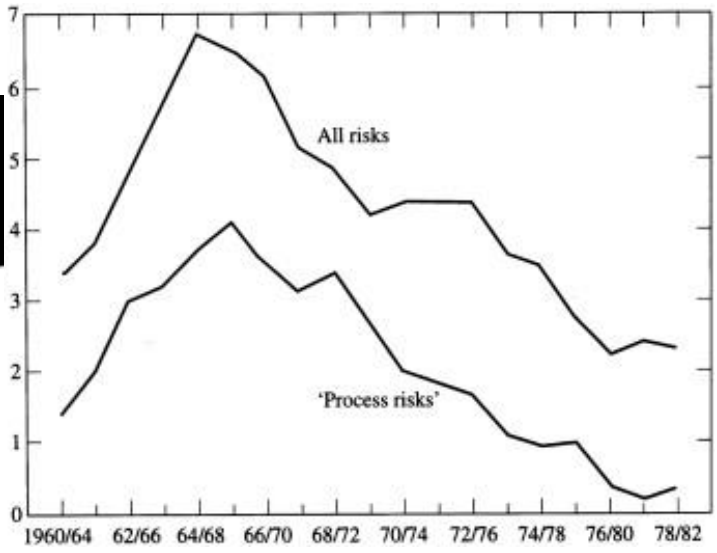
Bolton et al. (2023)



*L.W. Bolton, J. Glassey, E. Esther Ventura-Medina (2023), Updating chemical engineering degree accreditation in changing times, *Education for Chemical Engineers,* 43, pp. 31-36.

Safety; 1970's & 80's





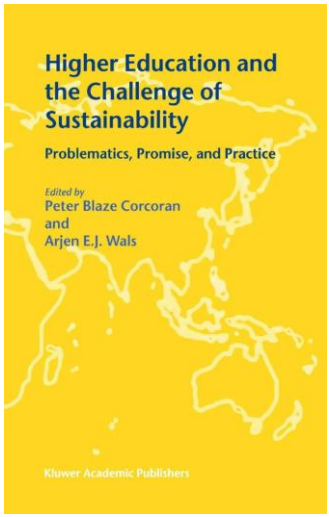
"Fatal accident rate from 1960 to 1982." (Kletz, 2012)

T. Kletz (2012), The history of process safety, *Journal of Loss Prevention in the Process Industries,* 25, 5, 763-765.

Environmental Engineering: 1980's & 90's:

THE EVOLUTION OF SUSTAINABILITY DECLARATIONS IN HIGHER EDUCATION

Tarah Wright



Environmental Education Foundations:

- Stockholm Declaration (1972): called for environmental education for all people from grade school through adulthood
- Belgrade Charter (1975)
- Tbilisi Declaration (1977): Environmental education…is necessary for students in all fields, not only natural and technical sciences, but also social sciences and arts, because the relationship between nature, technology and society mark and determine the development of a society
- United Nations UNESCO-UNEP International Environmental Education Programme, launched 1978.

T. Wright (2004) The Evolution of Sustainability Declarations in Higher Education, pp. 7-19, In: Higher Education and the Challenge of Sustainability Problematics, Promise, and Practice, Editors: Peter Blaze Corcoran, Arjen E. J. Wals, Springer 2004

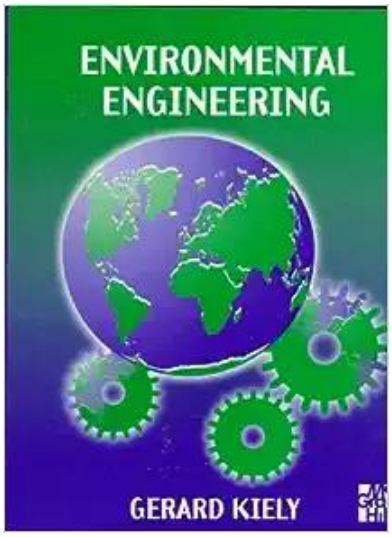
Environmental Engineering: 1980's & 90's

Department of Civil and Environmental Engineering, Imperial College London:*

*"In 1998, we **changed our name** to the Department of Civil and Environmental Engineering, to reflect the important role of our profession in the management and development of **both the urban and natural environments.**"*

1990: University of Michigan (Civil and Environmental Engineering)
1996: University of Alberta (Civil and Environmental Engineering)
1999: Princeton (Civil and Environmental Engineering)

*https://www.imperial.ac.uk/civil-engineering/about-us/history-of-the-department/



'Education for Sustainable Development'; Declarations; 1990's and 2000's;

"Environmental sustainability declarations specifically developed for higher education are relatively new, emerging in the early 1990s."[1]

- 1990: Talloires Declaration (over 275 signatories)
- 1991: Halifax Declaration (Conference on University Action for Sustainable Development)
- 1992: United Nations Conference on Environment and Development (Rio): *"had a profound influence on the development of environmental sustainability declarations."*[1]
- 2002: COPERNICUS Charter 2002 Conference of European Rectors (over 291 educational institutions)
- 2004: Barcelona Declaration (Engineering Education for Sustainable Development)[2] [Cork Amendment (2021)]
- 2005-2015: UN Decade of Education for Sustainable Development (DESD)[2]

1 T. Wright (2004) The Evolution of Sustainability Declarations in Higher Education, pp. 7-19, In: Higher Education and the Challenge of Sustainability Problematics, Promise, and Practice, P.B. Corcoran, A.E.J. Wals (eds), Springer.
2 R. Lozano, R. Lukman, F.J. Lozano, D. Huisingh, W. Lambrechts (2013), Declarations for sustainability in higher education: becoming better leaders, through addressing the university system, *Journal of Cleaner Production,* 48, 10-19.

Sustainability; from 'Constraint' to 'Context'

"[The 1990's] precipitated the beginning of a potentially paradigmatic shift from envisioning sustainability as (yet another) ***constraint*** *on engineering design and practice to one where sustainability is the very* ***context*** *of engineering practice."*

E. Byrne (2023) The evolving engineer; professional accreditation sustainability criteria and societal imperatives and norms, *Education for Chemical Engineers,* 43, 23-30.

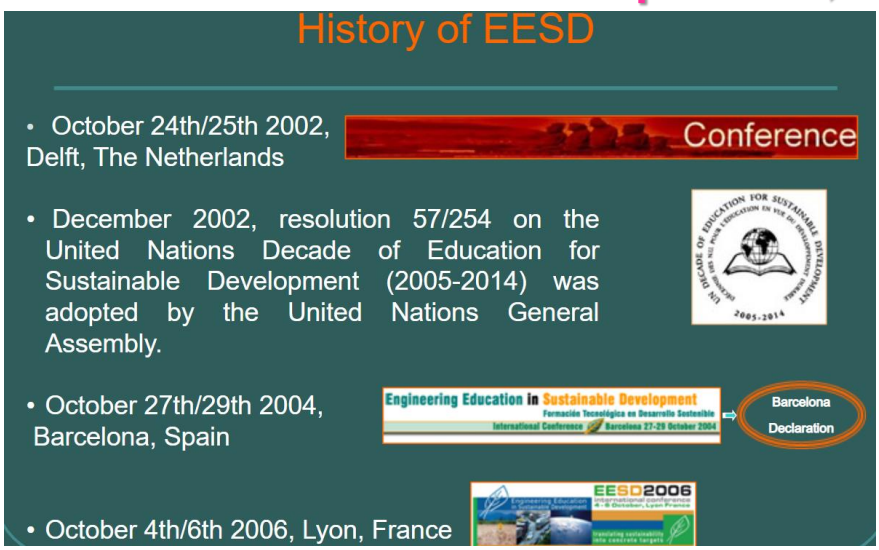
'Integration of sustainability in teaching'

"The 1997 Joint Conference on Engineering Education and Training for Sustainable Development in Paris, called on

*..professional engineering institutions to "adopt accreditation policies that require the **integration** of **sustainability in engineering teaching**".*

E. Byrne (2023) The evolving engineer; professional accreditation sustainability criteria and societal imperatives and norms, *Education for Chemical Engineers,* 43, 23-30.

'Education for Sustainable Development'; 2000's



https://slideplayer.com/slide/4660340/

EESD2002 Delft; A bold manifesto for 21st Century EESD!

New paradigms in engineering education

"Students should learn to **reflect critically on traditional engineering paradigms.** A **new engineering paradigm** has to be developed, targeting a sustainable society, enhancing new engineering careers and **new academic careers, from discipline-oriented approaches** to **integrated approaches.**"

(Mulder, 2003)

K.F. Mulder (2003), Engineering education for sustainable development; Results of the Environmental Engineering for Sustainable Development (EESD) Conference, Delft, The Netherlands, 24-25 October 2002, *International Journal of Sustainability in Higher Education*, 4, 2. 9-19.

EESD2002 Delft; A bold manifesto for 21st Century EESD!

Integration with social sciences

"*The transition to new paradigms asks investments to **close the gap between engineering and social sciences**. It comprises **a new choice of the system boundaries** in which engineering takes place. It requires consciousness about the **international and cultural differences** in the understanding and appreciation of needs for the **systems co-evolutionary approach**. In each region of the world a **unique path to sustainable development** has to be identified.*

*Problem oriented and function directed education and **inter- and trans disciplinary approaches** have to be elements in engineering courses.*" (Mulder, 2003)

K.F. Mulder (2003), Engineering education for sustainable development; Results of the Environmental Engineering for Sustainable Development (EESD) Conference, Delft, The Netherlands, 24-25 October 2002, *International Journal of Sustainability in Higher Education*, 4, 2. 9-19.

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Broader Higher Education for Sustainability Developments; Paradigmatic change..

"Sustainability implies a double learning challenge to higher education, concerning both **'paradigm'** and **'provision'.** ..The effect of **patterns of unsustainability** on our current and future prospects is **so pressing** that the response of higher education should not be predicated **only** on the **'integration of sustainability'** into higher education, because this invites a limited, adaptive, response. Rather, we need to see the relationship the other way round - that is, the **necessary transformation of higher education towards the integrative** and more whole state implied by a **systemic view of sustainability** in education and society, however difficult this may be to realise. [this] **implies a change of fundamental epistemology in our culture** and hence also in our educational thinking and practice. Seen in this light, sustainability is not just another issue to be added to an overcrowded curriculum, but a **gateway to a different view of curriculum**, of **pedagogy**, of **organisational change**, of **policy** and particularly of **ethos.** Sterling (2004)

Stephen Sterling (2004). Higher Education, Sustainability, and the Role of Systemic Learning. In: Corcoran & Wals (eds) *Higher Education and the Challenge of Sustainability.* Springer.

2. Two Decades on.. Progress Made and Current Topics?

Broader Vision of 'Sustainability'

"Over the last few decades, students have increasingly been expected to have the knowledge and ability to handle **broader implications of work** as a chemical engineer, such as **process safety management, health, environmental, and sustainability** issues (Lemkowitz, 1992, Jamieson et al., 2021, Glassey and Haile, 2012, Byrne and Fitzpatrick, 2009).
Even more recently, a wider range of other professional issues including **ethics** (Khraisheh et al., 2013, Butler et al., 2019, Bielefeldt et al., 2018), **risk, security** (Piluso et al., 2005), **diversity, inclusion** (Farrell and Minerick, 2018), **societal, commercial and economic considerations** have become part of the **expected professional capability set.**"

*L.W. Bolton, J. Glassey, E. Esther Ventura-Medina (2023), Updating chemical engineering degree accreditation in changing times, *Education for Chemical Engineers*, 43, pp. 31-36.

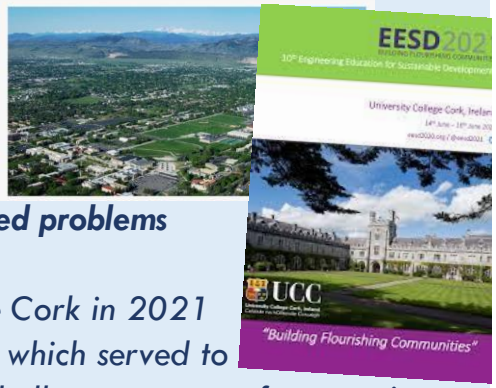
Reflections on Engineering Sustainability: Progress, Pedagogy, Principles and Practice

Richard Fenner (EESD2023 Leo Jansen Award Keynote):

[Reflecting on progress from the 2004 Barcelona Declaration (on EESD)]:

*'This transition from a narrow **reductionist approach** to a **complex systems outlook** is now recognised by many engineering institutions who accept the **technical fix alone** can only achieve partial solutions to the **wicked problems facing all communities and societies.***

Eleventh International Conference on Engineering Education for Sustainable Development (EESD2023)
Colorado State University, Fort Collins, Colorado, U.S.A. June 18-21, 2023
EESD2023 QUEST FOR SUSTAINABLE SOCIETIES



*The last EESD Conference hosted by University College Cork in 2021 produced an Amendment to the Barcelona Declaration which served to update and refocus attention on the new educational challenges we now face, stating: "Engineers must play a **critical** and **collaborative** role in **restructuring how humanity lives** on the Earth to achieve the broad societal and economic **transformation needed.**'*

Drivers for change?

- Developing scientific understandings of impacts of climate change and unsustainability more generally
- Increased impacts/urgency re: climate change and unsustainability
- Evolution of societal norms and imperatives
- Evolving University/Institutional imperatives around Sustainability
- Evolving Accreditation requirements of Professional Bodies

3. Evolving Accreditation Imperatives for Engineering Professional Bodies

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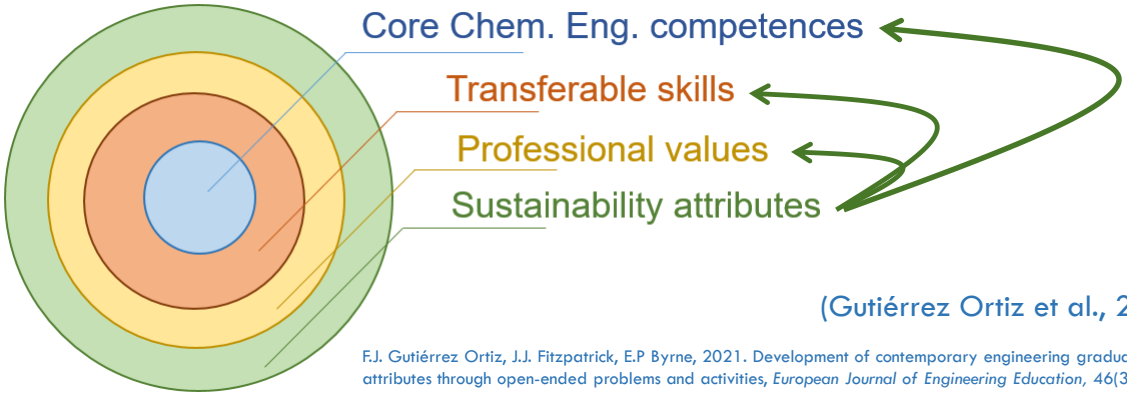
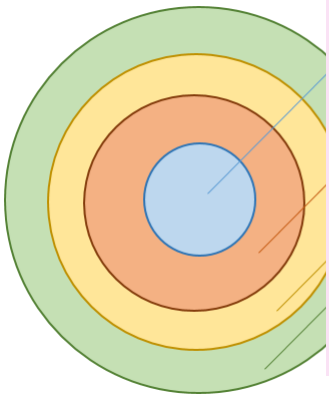
Beyond '**CORE ENGINEERING COMPETENCES**', engineering programmes seek to develop both **TRANSFERABLE SKILLS** and **PROFESSIONAL VALUES** in the engineering graduate. Moreover, and to an increasing extent, accreditation bodies require that graduates are equipped with a range of **SUSTAINABILITY ATTRIBUTES**, which can traverse and transcend each of the aforementioned domains. (Gutiérrez Ortiz *et al.*, 2021)



(Gutiérrez Ortiz et al., 2021)

F.J. Gutiérrez Ortiz, J.J. Fitzpatrick, E.P Byrne, 2021. Development of contemporary engineering graduate attributes through open-ended problems and activities, *European Journal of Engineering Education*, 46(3), 441-456



- **Sustainability (core) knowledge** and **understanding**, knowledge around the issues and challenges; importance of the social, ethical, ecological and economic dimensions of sustainability, and interconnectedness of each.
- **Sustainability skills:** ability to develop appropriate greener technologies, processes and approaches.
- **Sustainability values:** e.g. concern for the environment, commitment to sustainable development, empathy, quality, diversity, commitment to social justice, flourishing communities, human well-being, etc.

F.J. Gutiérrez Ortiz, J.J. Fitzpatrick, E.P Byrne, 2021. Development of contemporary engineering graduate attributes through open-ended problems and activities, *European Journal of Engineering Education*, 46(3), 441-456

Increasingly, '*accreditation bodies require that graduates are equipped with* ***a range of sustainability attributes*** *(Byrne, 2023), which can* ***traverse and transcend*** *each of the aforementioned* ***domains*** *(Gutiérrez Ortiz et al., 2021)'.*

a. Sustainability/Sustainable/Sustainable Development/United Nations SDGs
b. Equity/Equality, Diversity, Inclusion, EDI/DEI
c. Ethics/Ethical
d. Global
e. Environmental/Environment
f. Society/Societal/Social
g. Cultural/Multicultural
h. Multidisciplinarity/Interdisciplinary/Transdisciplinary
i. Complex Systems/Complex/Complexity

E.. Byrne, E.P., 2023. The evolving engineer; professional accreditation sustainability criteria and societal imperatives and norms. *Educ. Chem. Eng.*, 43, 23-30.

Rank each of the following 'Sustainability attributes' in order of greatest shortfall (compared to where it should be) in your opinion?

a. Sustainability/Sustainable/Sustainable Development/United Nations SDGs
b. Equity/Equality, Diversity, Inclusion, EDI/DEI
c. Ethics/Ethical
d. Global
e. Environmental/Environment
f. Society/Societal/Social
g. Cultural/Multicultural
h. Multi-/Inter-/Transdisciplinarity
i. Complex Systems/Complex/Complexity

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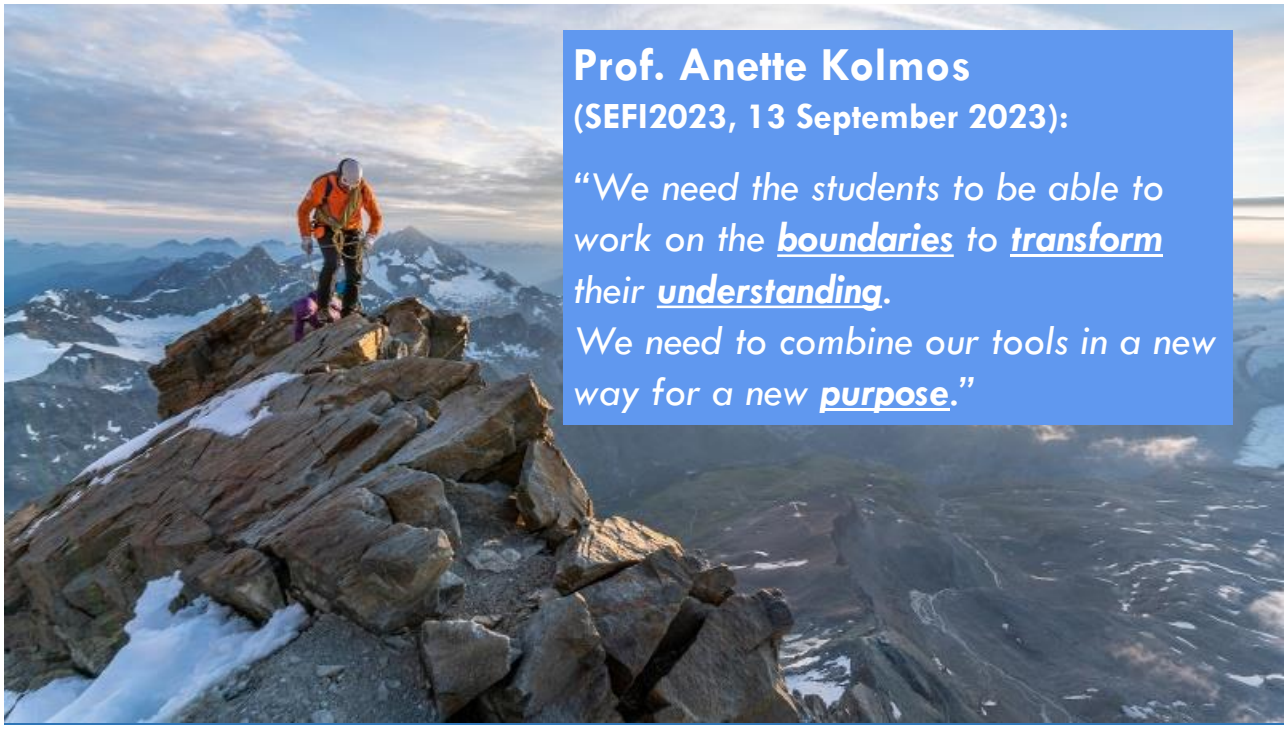
Table 1
Sustainability attribute mentions in accreditation criteria documentation.

	Sustainability/ Sustainable/ Sust. Dev./SDGs	EDI	Ethics	Global	Environment	Society/ Societal/ Social	Multi/ Cultural	Multi/Inter/Trans Disciplinarity	Complexity
ABET	1	7	1	2	2	3	2	1	3
(2022–23)	(1/0/0/0)	*32%*	*5%*	*9%*	*9%*	(0/1/2)	(0/2)	(1/0/0)	*14%*
	5%					*14%*	*9%*	*5%*	
EUR-ACE (2021)	1	0	2	2	4	9	0	2 (2/0/0)	10
	(0/1/0/0)	-	*7%*	*7%*	*13%*	(5/3/1)	-	*7%*	*33%*
	3%					*30%*			
Engineers	12 (4/7/1/0)	2	3	1	6	7	4	2	10
Australia	*26%*	*4%*	*6%*	*2%*	*13%*	(2/0/5)	(2/2)	(1/1/0)	*21%*
						15%	*9%*	*4%*	
Engineers	4	0	6	0	7	11	3	5	8
Ireland (2014)	(4/0/0/0)	-	*14%*	-	*16%*	(3/1/7)	(1/2)	(5/0/0)	*18%*
	9%					*25%*	*7%*	*12%*	
Engineers Ireland	12 (6/3/1/2)	2	10	1	14	15	4	0	16
(2021)	*16%*	*3%*	*14%*	*1%*	*19%*	(5/2/7)	(1/3)	(4/0/0)	*21%*
						20%	*5%*	*0%*	
IChemE	12 (9/0/3/0)	0	28	0	23	9	2	2	17
(Aug 2017)	*13%*	-	*30%*	-	25%	(2/1/6)	(2/0)	(1/1/0)	*18%*
						10%	2%	2%	
IChemE	29 (22/5/1/1)	13	40	4	32	35 (10/16/9)	9	2	56
(Oct 2021)	*13%*	*6%*	*18%*	*2%*	*15%*	*16%*	(9/0)	(1/1/0)	*25%*
							4%	*1%*	
Total mentions	*71*	*24*	*90*	*10*	*88*	*89*	*24*	*14*	*120*
	13%	*5%*	*17%*	*2%*	*17%*	*17%*	*5%*	*3%*	*23%*



Rank each of the following 'Sustainability attributes' in order of greatest curricular shortfall (compared to where it should be)?

a. Sustainability/Sustainable/Sustainable Development/United Nations SDGs
b. Equity/Equality, Diversity, Inclusion, EDI/DEI
c. Ethics/Ethical
d. Global
e. Environmental/Environment
f. Society/Societal/Social
g. Cultural/Multicultural
h. Multidisciplinarity/Interdisciplinary/Transdisciplinary
i. Complex Systems/Complex/Complexity

*Steep Challenges ahead: Recognizing and handling **Complexity**; A call for **Transdisciplinarity?***

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Contemporary Complex 'Wicked' Problems Transcend Disciplines:

Engineering & Science:
(Green/) Technologies & Energy,
Artificial Intelligence, Smart society, nanotech, etc.
<--- technological

(Applied) Social Sciences <------ social,

Finance and Economics <----- economic,

Science <---------- environmental

Law <---------- legal

Governance/Politics <--- political

Philosophy
Theology <------ philosophical, theological

Humanities <----- Narratives, Stories, Metaphor

Social Sciences <- Worldviews, Framings, Paradigms

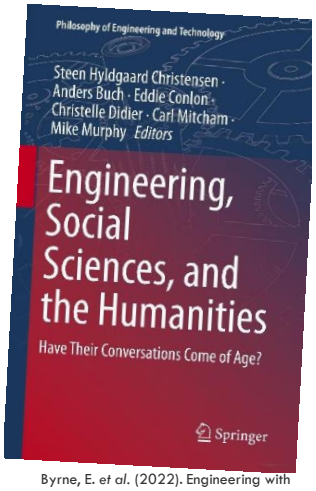
Los Cuatro Postes, Ávila, Spain

Transdisciplinarity;
seeking ***emergent*** knowledge,
built on strong ***disciplinary*** pillars,
while ***transcending*** them

"Many [recent] **technological developments** have emanated from **economic and policy drivers,** but what has often been **less developed** has been an initial regard for **broader societal contexts,** including **ethical implications,** potential **unintended consequences,** the **precautionary principle** and/or **local public acceptability.**

'Wicked' societal problems ...are both **normative** and **deeply contested,** and which necessarily impinge upon **ethical** and **social** domains, as well as those in **environmental, technical** and **economic** spheres.

A **holistic, integrative and complexity embracing paradigm** would embrace each and all of the aforementioned **domains."**



Byrne, E. *et al.* (2022). Engineering with Social Sciences and Humanities; Necessary Partnerships in Facing Contemporary (Un)Sustainability Challenges?. In: Christensen *et al.*, (eds) Springer.

4. Assessment; The tricky bit!

Some Curricular & Pedagogical Interventions on:

'PE3011 Sustainability and Environmental Protection'

taken by:

- *3rd year undergraduate Engineers*
- *HDip Sustainability & Enterprise (mature) students*

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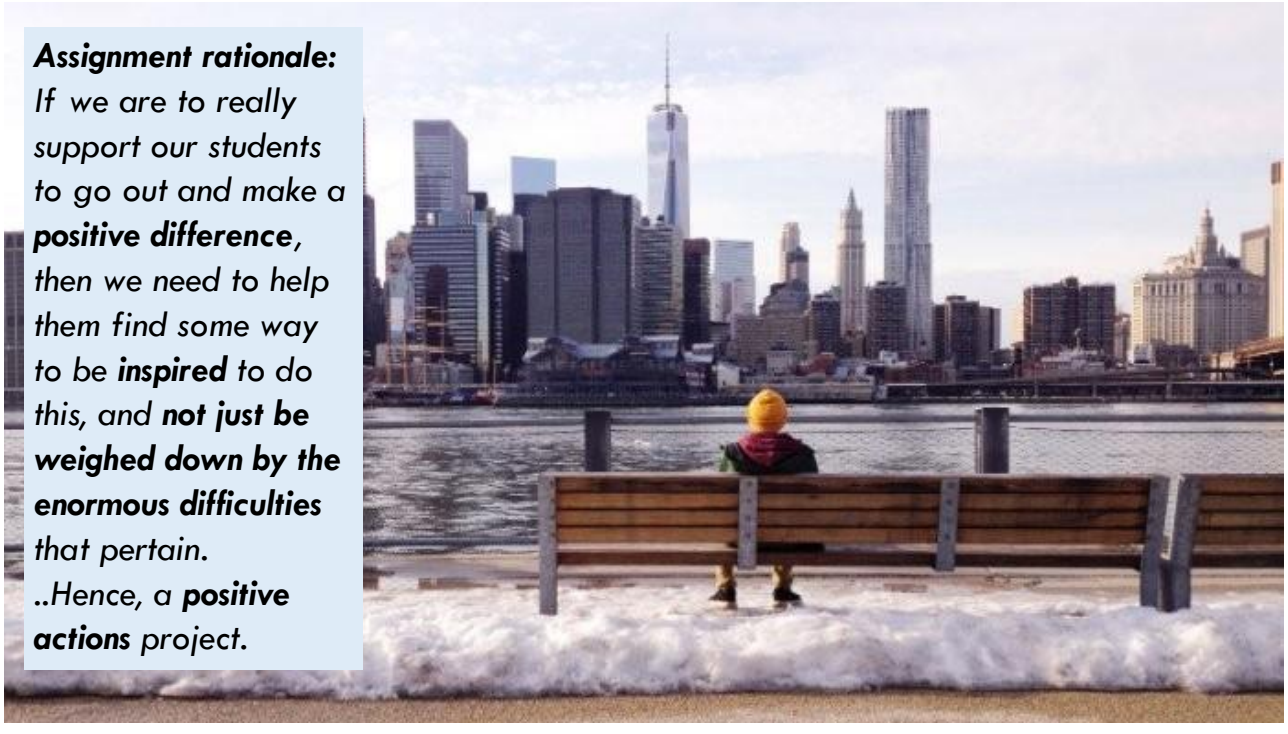
Group Assignment:
'The power of positive acting'

Assignment rationale: *If we are to really support our students to go out and make a* ***positive difference****, then we need to help them find some way to be* ***inspired*** *to do this, and* ***not just be weighed down by the enormous difficulties*** *that pertain.*
..Hence, a ***positive actions*** *project.*



Spec: *"Identify, research and outline an example or case study of an* ***authentically positive initiative or idea*** *which can genuinely help precipitate* ***transformational change towards sustainability****. …****critique*** *its implementation, identifying potential* ***barriers*** *for implementation, how these might be overcome, potential consequences, difficulties or problematic issues."*

Pfandsystem (plastic bottle deposit returns) The Pfand system of plastic bottle deposit returns that is very popular in Germany, and across mainland Europe.

https://dpg-pfandsystem.de/index.php/en/

Frugal design

"Good design is as little design as possible." Dieter Rams

"The capacity to simplify means to eliminate the unnecessary so that the necessary may speak."
Hans Hofmann.

Reverse innovation, which evolved from the core concept of frugal design, aims to design out complexity to achieve simple, functional products with minimal waste and excess components.

- Reducing Complexity while Maintaining Core Functionality
- Design out Non-Essential Components and Materials
- Incorporate Locally Available Materials and Resources
- Sustainability Based Value Proposition to Gain Market Share

Beara Atlantic temperate rainforest (Beara peninsula, west Cork, Ireland) The Beara Rainforest initiative, run and coordinated by eco-entrepreneur Eoghan Daltun on his 72 acre woodland area on the Beara peninsula.

WASP 3D Printing Architecture/eco-homes. This appealing concept helps bring people back in touch with nature, working with what the planet naturally provides, but respectfully. Involves transformative change, alongside the creativity that architecture can bring, while seeking to be ecologically sound.

TECLA | A 3D printed global habitat for sustainable living

21 January 2021

A new circular housing model, created using entirely reusable, recyclable materials taken from the local terrain.

Crane WASP

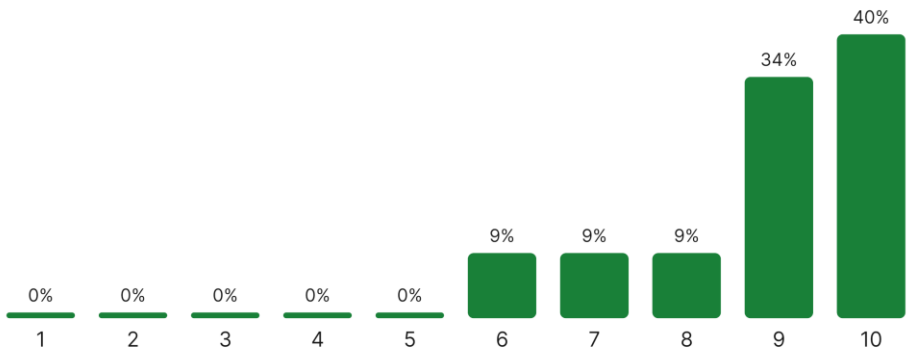
Giant 3d printer for building 3d printed house

Peer Paper Reviews and Reflections Assignment

How would you rate the teaching and learning experience for PE3011 as a whole? (Ed Byrne's section only)

Rating Poll · 35 votes · 35 participants

Score: **8.9**



slido

Student reflections: How (/Has) your conception of 'Sustainability' evolved?

It has allowed me to think about sustainability in a different light and highlights the **complexity** of the issue.

Seeing sustainability in the sense of a **complete system**, from the **social** to the **universal**, the **constraints** and **impacts**.

My grasp of the **complexity of the world** we live in and how a simplified perspective of that world fails to account for really important **dynamics** - has evolved from this class.

Sustainability is a compound of a **number of disciplines- complex,** with **no one answer**.

5. Whither now?

Crises, Urgency…

Radical Transformation?

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Eng. Education for Sustainability; Progress Stalling?

Segalas et al (2018):
"real EESD is not happening at the pace it should at universities"

Mulder (2019):
..in recent decades ..access to higher education has been curbed by **deteriorating support schemes**. ..education has been promoted as a key factor in **international competition.** As a result, academic educating became more geared to **demands of the labor market.** The result of these developments was that **engineering students** were, during their studies, **increasingly focusing on their professional qualification.** ..for a **career as an (engineering) specialist."**

J. Segalas, R. Drijvers, J. Tijseen (2018) 16 years of EESD. A review of the evolution of the EESD conference and its future challenges. EESD2018, Rowan U, NJ, USA.
K.F. Mulder (2019) Is Progress to Sustainability Committed Engineers Stalking? *Journal of Modern Education Review*, 9, 1, 23–28.

Eng. Education for Sustainability; Progress Stalling?

Beagon et al (2023):
[There's] "overall an agreement that there needs to be better integration of [the required competences to support the SDGs] into the engineering curriculum. However, we have to recognise that **it is challenging to implement EESD in an overcrowded engineering curriculum** with numerous existing **obstacles**"

Fenner (2023):
"Others have concluded that **EESD is not happening at the pace it should** in many Universities despite initiatives to promote the integration of sustainable development in higher education. The **commodification of higher education** has also been highlighted as a barrier and impediment to a **clear institutional commitment** to the Barcelona Principles with **university rankings** (and the metrics which underlie these) becoming increasingly more important for measuring universities global competitiveness"

U. Beagon, K. Kövesi, B. Tabas, B. Nørgaard, R. Lehtinen, B. Bowe, C. Gillet & C. Monrad Spliid (2023) Preparing engineering students for the challenges of the SDGs: what competences are required?, European Journal of Engineering Education, 48:1, 1-23.
R.A. Fenner (2023) Reflections on Engineering Sustainability: Progress, Pedagogy, Principles and Practice. EESD2023 Keynote. CSU, CO, USA.

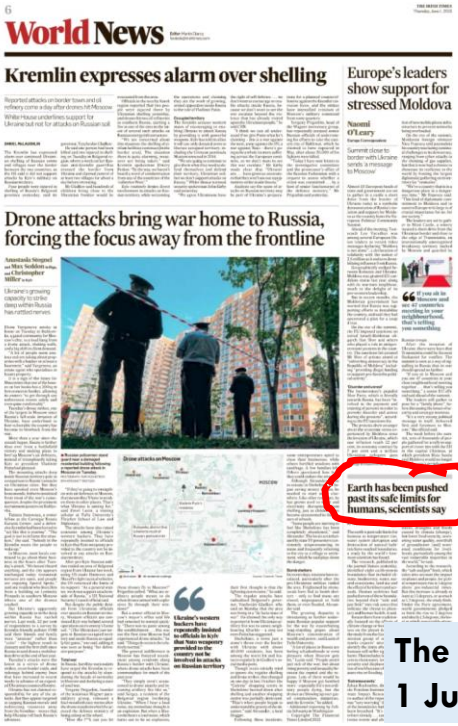
Contemporary landscape, drivers and developments in engineering education for sustainability
Edmond P. Byrne, University College Cork
SEFI ANNUAL CONFERENCE 11-14 September 2023 TU Dublin ENGINEERING EDUCATION FOR SUSTAINABILITY

Looking at the bigger picture..

Edmond P. Byrne, University College Cork

New York, 7 June 2023

Angela Weiss/AFP via Getty Images, Forbes



6

World News

Kremlin expresses alarm over shelling

Europe's leaders show support for stressed Moldova

Drone attacks bring war home to Russia, forcing the focus away from the frontline

Earth has been pushed past its safe limits for humans, scientists say

"Ukraine's western backers have repeatedly insisted to officials in Kyiv that Nato weaponry provided to the country not be involved in attacks on Russian territory"

The Irish Times, 1 June 2023. p. 6

Earth has been pushed past its safe limits for humans, scientists say

ATTRACTA MOONEY

The earth is past safe limits for humans as temperature rise, water system disruption and destruction of natural habitats have reached boundaries, a study by the world's foremost scientists has found.

The research, published in the journal Nature yesterday, identified eight earth-system boundaries that included climate, biodiversity, water, natural ecosystems, land use and the effect of fertilisers and aerosols. Human activities had pushed seven of these boundaries beyond their "safe and just limit" into risk zones that indicate the threat to planetary and human health, it said.

pacts which go beyond heatwaves, droughts and floods caused by climate [change], but lower food security, worsening water quality, overdraft of groundwater [and] worsened conditions for livelihoods, particularly among the vast vulnerable majorities in the world," he said.

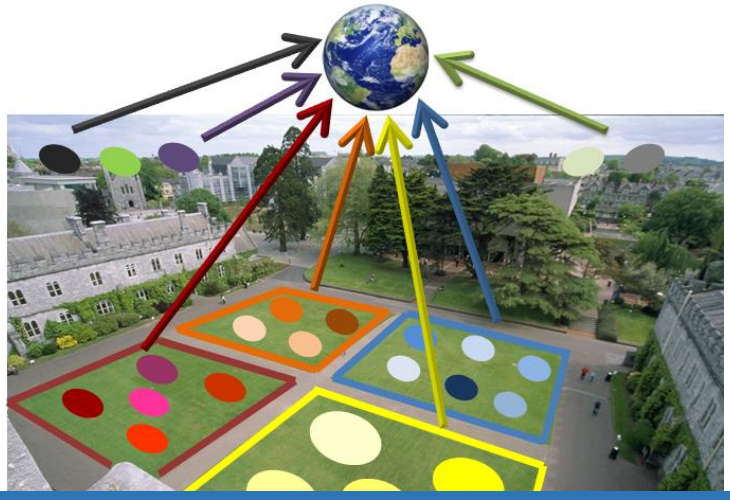
According to the research, the "safe and just" limit, which takes into account the impact on planet and people, for global temperature rise is 1 degree above pre-industrial times. But this increase is already at least at 1.1 degrees, or as much as 1.2 degrees, the study finds. Under the Paris agreement, world governments pledged to limit the rise to 2 degrees

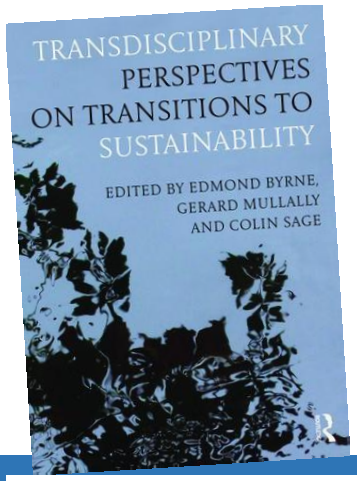
Elephant #2 in the Room?

Prof. Kristina Edström
(SEFI2023, 11 September 2023):

"There is a weakness;
a lack of interest in other disciplines/scholars.
…It's a sign of our maturity that we can learn from other disciplines."

Credit: Walmart





Byrne, E. *et al.* (2017). Transdisciplinary within the university. In: Byrne, Mullally & Sage (eds.), Routledge.

"Essentially, amid the **'silo-ised' constraints of the university** (or should that be 'multiversity'?), the whole was not greater than the sum of the parts. More broadly, within a world of increasing ecological degradation, social upheaval and economic inequality we were making **relatively feeble attempts to address the 'grand challenges' around (un)sustainability**." Byrne *et al.* (2017)

Role for the University in Crisis Transformation?

McGeown and Barry (2023):

"Universities have a **crucial leadership role** to play in shaping responses to and acting on the **climate and ecological emergency**.
However, ..as they are currently constituted, **universities are complicit in reproducing unsustainability and inequality** in ways that undermine and frustrate concerted and effective action on the planetary crisis.
..[thus] Universities themselves must first or simultaneously undergo **radical transformations** if they are to step up to this challenge. .. and maximise their potential as **"agents of sustainability"** ..to unsettle the status quo ways in which they operate, including the **ecocidal imperatives** and interests of neoliberal capitalism to which they have become overwhelmingly captive. ..This democratisation could and should take place as**: (1) *Research*, (2) *Education* and (3) *Outreach and engagement*.**

C. McGeown & J. Barry, 2023. Agents of (un) sustainability: democratising universities for the planetary crisis. *Frontiers in Sustainability*, *4*, 1166642.

Role for the University in Crisis Transformation?

Sterling (2021):
"In her book on our "dark age" and the possibility of **avoiding cultural and social collapse** through renewal, Jacobs (2005) underlies the **crucial role of education**: A vigorous culture **capable of making corrective, stabilizing changes** depends heavily on its **educated people**, and especially on their **critical capacities** and **depth of understanding**. **But time is short.**
Given this context, the overriding questions are these:
• How can universities **urgently transform their ethos, policies and practices** to function in service of the **survival and well-being of humanity and the planet**, at a time of **growing instability and existential threat**?
• How do we avoid universities adopting a **reformist position** in response to the multiple global crises, rather than the **transformist response** that the **crises require**?
• How can ..learning within entire university systems ..engender their **ability to make a critical contribution to human, biotic and planetary survival and flourishing.**

S. Sterling (2021) Concern, Conception, and Consequence: Re-thinking the Paradigm of Higher Education in Dangerous Times. *Frontiers in Sustainability*. 2:743806.

UNESCO (2021): 'Transform Education'

"Humanity has only **one planet;** however, we do **not** share its **resources well** or use them in a **sustainable** manner.

..Education is the key pathway to address these **entrenched inequalities**. ..in a world of increasing **uncertainty, complexity and precarity**. ..**We need to transform education**.

This act of **reimagining** means **working together** to create futures that are **shared and interdependent**. A **new social contract for education** must be anchored in two foundational principles: (1) the **right to education** and (2) a commitment to education as a **public societal endeavour** and a **common good**."

UNESCO (2021), Reimagining our futures together - A new social contract for education. UNESCO, Paris.

Pedagogies embracing Interdependence and Interdisciplinarity

Pedagogies need to reflect **interdisciplinarity,** just as the problems and puzzles of the planet do not limit themselves to the confines of **disciplinary boundaries.** Yet, as there are many possible solutions to a given problem, **pedagogical approaches** must be selected that also cultivate the **values** and principles of **interdependence** and **solidarity.**

UNESCO (2021), Reimagining our futures together - A new social contract for education. UNESCO, Paris.

"Re-Purposing Universities for Sustainable Human Progress" (Stewart et al, 2022)

"The fast pace of technological change will mean that **technical skills** are likely to quickly become **obsolete.** This, in turn, necessitates a more fluid curriculum and intellectual experience that provides the tools for students to **think critically, systemically and creatively** about multiple problems that **cross traditional disciplinary divides**.

A vital first step in that **transformation** process is for **universities to recognize that there is a problem**. …Transformational intent necessitates a **whole-institution cultural shift in mindsets,** across research, teaching, knowledge transfer, and campus operations.
..it needs to be supported by a facilitative rather than directive executive leadership, allowing everyone - staff, students, and stakeholders - to **co-produce the mission and shape the transformation.**"

I.S. Stewart, V. Hurth, S. Sterling (2022) Re-Purposing Universities for Sustainable Human Progress. *Frontiers in Sustainability.* 2:743806.

"Re-purposing Universities: The Path to Purpose" (Hurth and Stewart, 2022)

These three fundamental academic missions -**education, research, and societal engagement-** form the basis of how universities are expected to respond to the **global unsustainability challenge.**

But it is in universities' more recent **"third mission" - the direct transfer of knowledge and technology to society** that their contribution to society has been most effectively expanded [..via] **enterprising and entrepreneurial activities.**

However, this premise arguably rests on **questionable assumptions deep** within the **current economic paradigm** about **what wellbeing is** and **how it is best delivered to society.** [..thus] fundamental problems arise when seeking to advance the third mission because our **current economic way of organising tends to be regarded as deeply complicit in the current socio-ecological crisis.**

V. Hurth, I.S. Stewart (2022) Re-purposing Universities: The Path to Purpose. *Frontiers in Sustainability.* 05 January 2022. https://doi.org/10.3389/frsus.2021.762271

Universities' **Education (yellow),** **Research (red)** and **"third mission"** activities; **social (light blue)** and **business/innovation (dark blue)** (Hurth and Stewart, 2022)

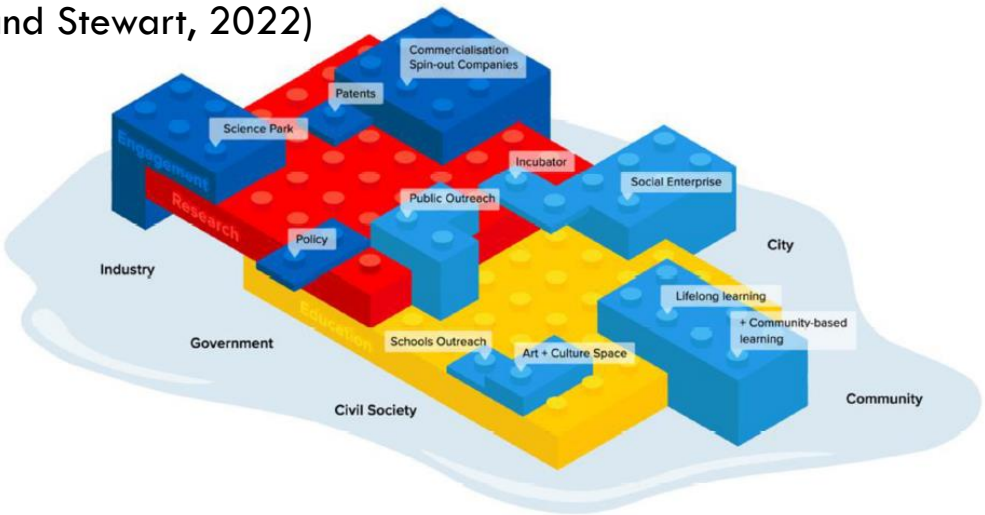


FIGURE 4 | The Amalgam of university third mission activities. In many universities, recent "third mission" activities are often bolted on to their long-standing twin missions of education (yellow) and research (red). Some of these third mission activities are focused on business and innovation ventures (dark blue) whilst others are

"Re-purposing Universities: The Path to Purpose" (Hurth and Stewart, 2022)

Three possible strategic directions:

- The BAU University (business as usual)
- The ESV University (enlightened shareholder/self-interested value)
- **The Purpose-Driven University**

"Arguably, no university has taken the lead from business and explicitly embarked on a **purpose-driven journey**. ..many businesses appear further down the road on the journey to **purpose**.

Purpose provides universities with a template for transformation. ..that would involve **blending the triple helix of academic missions** (education, research and social engagement) under an **overarching reason to exist** that is a strategic contribution to the **wellbeing of all people and planet in the long-term (sustainability).**

V. Hurth, I.S. Stewart (2022) Re-purposing Universities: The Path to Purpose. *Frontiers in Sustainability*. 05 January 2022. https://doi.org/10.3389/frsus.2021.762271

By **EY Global**

Multidisciplinary professional services organization

18 minute read
15 Dec 2020

For an increasing number of businesses and their employees, the pursuit of profit is no longer enough.

Nobel Prize winning economist Milton Freidman once wrote that there is "one and only one social responsibility of business – to use its resources and engage in activities designed to increase its profits, so long as it stays within the rules of the game, which is to say, engages in open and free competition without deception or fraud." (*Capitalism and Freedom*, Milton Friedman, 1962)

A "Purpose" Driven Organisation?

"Purpose is Everything" (Deloitte, 2020)
"**Purpose** answers an all important question, **"Why does a company exist?"**
Purpose-driven companies witness **higher market share gains** and grow on average three times faster than their competitors, all the while achieving **higher employee and customer satisfaction**[1]."

"wellbeing of all people and planet in the long-term (sustainability)"

"Report of the Future of the Corporation" (The British Academy 2021):
"We have concluded that the social responsibility of business should not merely be to increase its profits, but rather: 'to **create profitable solutions** for the problems of **people and planet, while not profiting from creating problems** for either.'"

Deloitte (2020). Purpose is Everything https://www2.deloitte.com/us/en/insights/topics/marketing-and-sales-operations/global-marketing-trends/2020/purpose-driven-companies.html
British Academy (2021). Policy & Practice for Purposeful Business. Available online at: https://www.thebritishacademy.ac.uk/publications/policy-and-practice-for-purposeful-business/
[1] Jim Stengel "Purpose" (jimstengel.com) –"The surest path to growth – pursue an aim greater than profit"

Questions for Purpose Driven Transformation:

Hurth and Stewart (2022):

1 What **Worldviews** (including **Values**) do we really Have and which do we want to Create?
2 What is our **University's Purpose**?
3 How do we assess what **Value** our University is currently **Creating** and **Destroying**?
4 How can we **Embed Purpose** to create the value intended, in the way intended?
5 How do we ensure **Stakeholders,** including the internal academic community, are able to **support Our Purpose**?
6 In What ways are we **Accountable** to Society and our Stakeholders for **Our Purpose** and how it is delivered?
7 Is Our **Governance Fit for Purpose**?

V. Hurth, I.S. Stewart (2022) Re-purposing Universities: The Path to Purpose. *Frontiers in Sustainability.* 05 January 2022. https://doi.org/10.3389/frsus.2021.762271

Big Questions and Implications for Engineering Education (for Sustainability)..

*If the **Purpose** of our Universities is*
*for deep seated **radical change** to secure*
the wellbeing of all people and planet in the long-term (sustainability),
how might this be operationalised
across Engineering Education?

Big Questions and Implications for Engineering Education (for Sustainability)..

Specifically;

- How might **'sustainability' (as flourishing!)** be the ***purpose*** of all we teach and do?
- How might **transdisciplinarity** be fully developed within our programmes, in concert with others (disciplines/communities)?
- How might the **social imperative** of (engineering) education be better incorporated, including that of **DEI/EDI**?
- How might the **urgency** of the situation be most appropriately addressed, across programmes, where change is traditionally decadal, or slower?
- What role might and ought, **professional bodies** play in promoting required transformation?

Contemporary landscape, drivers and developments in engineering education for sustainability

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UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

SEFI ANNUAL CONFERENCE 11-14 September 2023 TU Dublin
ENGINEERING EDUCATION FOR SUSTAINABILITY

Outcome from Live Poll Results Held During SEFI Plenary Presentation

Edmond P. Byrne
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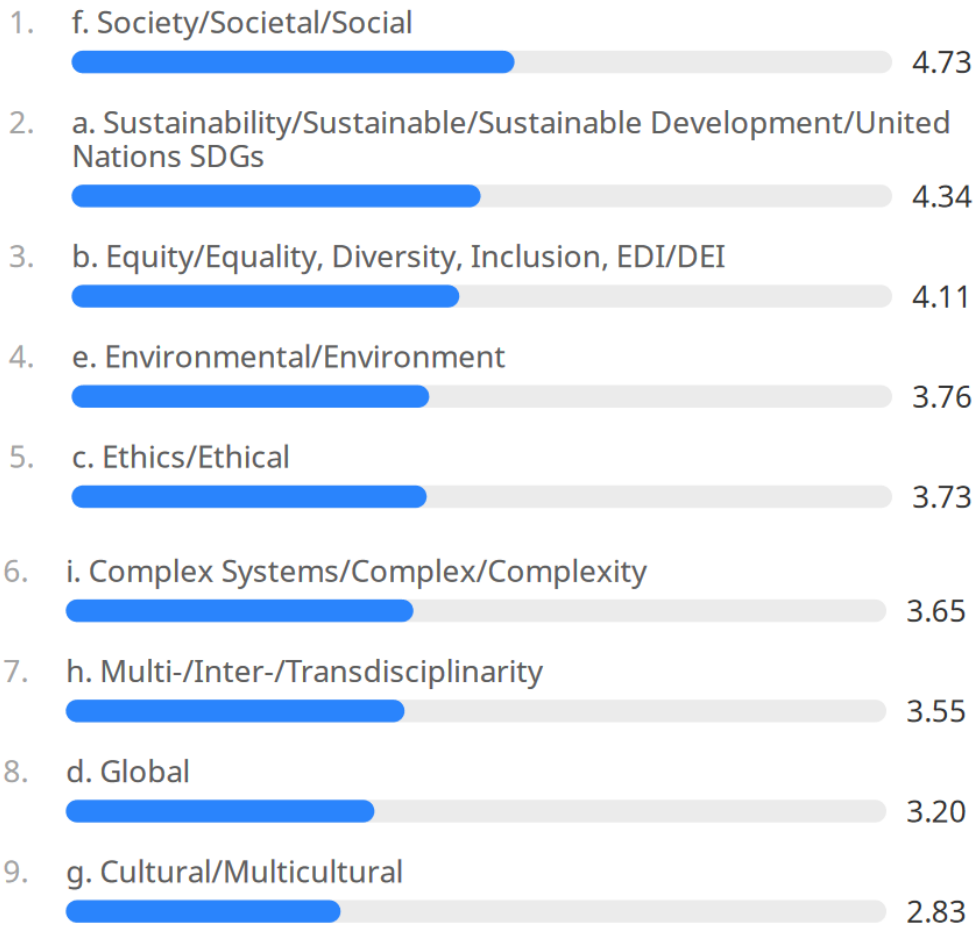
Rank each of the following 'Sustainability Attributes' in order of greatest shortfall (i.e. compared to where it should be), in your opinion?
(1/2)



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