CENTRE FOR SUSTAINABILITY, EQUALITY AND CLIMATE ACTION (SECA), QUB

Purposeful Transformation of Higher Education;

Some Engineering Perspectives on a Transdisciplinary Journey

Edmond Byrne
Chair Professor of Process & Chemical Engineering, Environmental Research Institute/MaREI
University College Cork, R. Ireland

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

E.P. Byrne, SECA, Queen's University Belfast   20th February 2024

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1. Context: Stasis in a time of crisis
2. *Struggling to see the wood from the trees*
3. A radical transformation of the mind
   ....and the world it creates
4. *Some Engineering Education insights*
5. Transforming education and institutions;
   A transdisciplinary endeavour
6. *Purposeful transformation of Higher Education?*

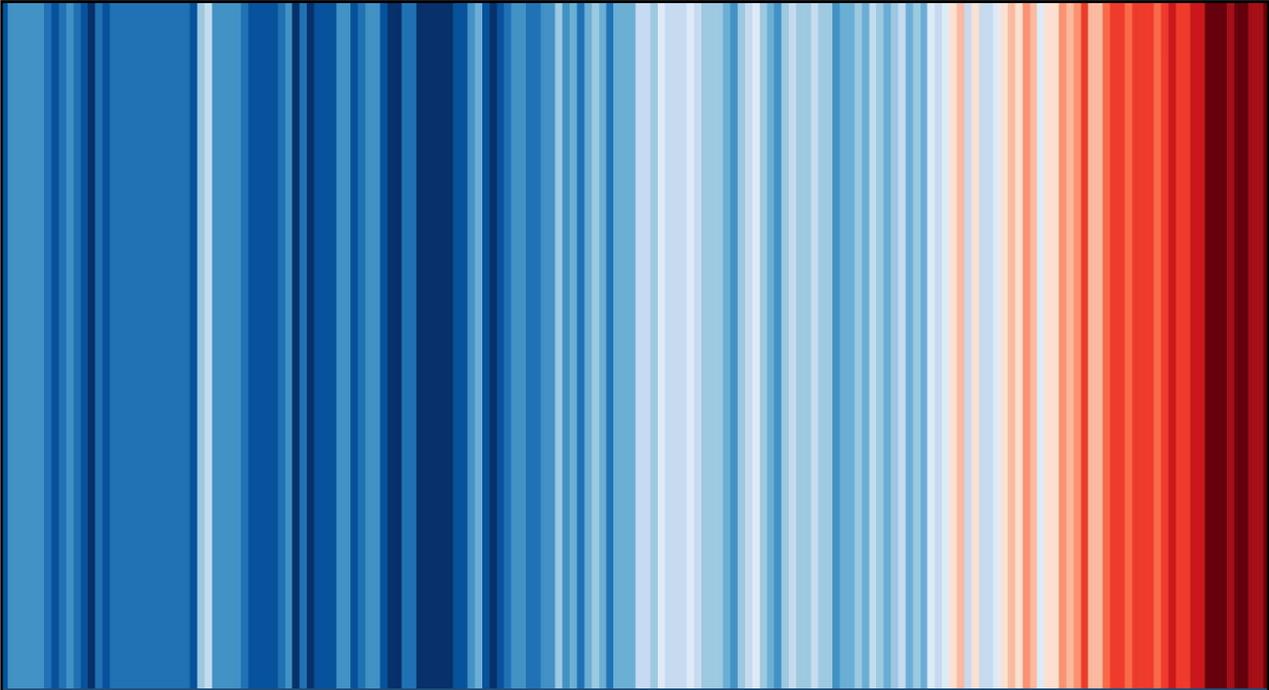E.P. Byrne, SECA, Queen's University Belfast   20th February 2024

1. Context: Stasis in a time of Crisis

E.P. Byrne, SECA, Queen's University Belfast   **20th February 2024**

"We live in a time of crisis. A time of accelerating climate change, environmental destruction, biodiversity loss, social inequality, misinformation, political instability and war."

Climate Stripes 1850-2023; (Link)   Prof. Ed Hawkins (U Reading): "2023 was off the end of the scale."

The Irish Times, 1 June 2023

THE IRISH TIMES

Economy powers ahead but emissions also rising

CSO data indicate modest decoupling of rising emissions from economic activity

People driving to work still far outnumber commuters taking public transport

Sea views in Sutton
Luxurious two-bed apartment in converted 19th-century Dublin castle for €1.395m
Residential Property

Karlin Lillington
The DPC's reasoning not to impose a fine on Meta makes little sense
Business, page 12

Eoin Morgan
Irish cricket – for all its problems – has grown beyond losing its best players to England
Sports Thursday

Salthill somersaults Swimmers cool down as temperatures rise

Three firms pay one-third of all corporation tax

Share amounted to 8% of total receipts, says advisory council warning of risks

Too late to save Arctic summer ice, climate scientists find

DAMIEN CARRINGTON

It is now too late to save summer Arctic sea ice, research has shown, and scientists say preparations need to be made for the increased extreme weather across the northern hemisphere that is likely to occur as a result.

Analysis shows that even if greenhouse gas emissions are sharply reduced, the Arctic will be ice-free in September in coming decades. The study also shows that if emissions decline slowly or continue to rise, the first ice-free summer could be in the 2030s, a decade earlier than previous projections.

The research shows that 90 per cent of the melting is the result of human-caused global heating, with natural factors accounting for the rest.

Since satellite records began in 1979, summer Arctic ice has shrunk by 13 per cent a decade, in one of the clearest signs of the climate crisis.

unfolding in the decades to come."

Other climate scientists said in 2022 that the world was on the brink of multiple disastrous tipping points.

Professor Seung-Ki Min, of Pohang University, South Korea, who led the new study, said: "The most important impact for human society will be the increase in weather extremes that we are experiencing now, such as heatwaves, wildfires and floods. We need to reduce CO_2 emissions more ambitiously and also prepare to adapt to this faster Arctic warming and its impacts on human society and ecosystems."

Emissions
In 2021, the Intergovernmental Panel on Climate Change (IPCC) concluded that the Arctic would not lose its summer ice if emissions were cut sharply and global temperature rises were limited to 2 degrees.

The Irish Times, 7 June 2023. p. 8
(citing *Nature Communications*)

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

The Irish Times, 1 June 2023. p. 6
(citing *Nature*)

Article

Safe and just Earth system boundaries

Johan Rockström[1,2,3], Joyeeta Gupta[4,5], Dahe Qin[6,7,8], Steven J. Lade[5,9,10], Jesse F. Abrams[11], Lauren S. Andersen[1], David I. Armstrong McKay[3,11,12], Xuemei Bai[13], Govindasamy Bala[13], Stuart E. Bunn[14], Daniel Ciobanu[2], Fabrice DeClerck[15,16], Kristie Ebi[17], Lauren Gifford[18], Christopher Gordon[19], Syezlin Hasan[14], Norichika Kanie[20], Timothy M. Lenton[11], Sina Loriani[1], Diana M. Liverman[18], Awaz Mohamed[21], Nebojsa Nakicenovic[22], David Obura[23], Daniel Ospina[9], Klaudia Prodani[4], Crelis Rammelt[4], Boris Sakschewski[1], Joeri Scholtens[4], Ben Stewart-Koster[14], Thejna Tharammal[24], Detlef van Vuuren[25,26], Peter H. Verburg[27,28], Ricarda Winkelmann[1,29], Caroline Zimm[22], Elena M. Bennett[30,31], Stefan Bringezu[32], Wendy Broadgate[9], Pamela A. Green[33], Lei Huang[34], Lisa Jacobson[9], Christopher Ndehedehe[14,35], Simona Pedde[9,36], Juan Rocha[3,9], Marten Scheffer[37], Lena Schulte-Uebbing[25,38], Wim de Vries[38], Cunde Xiao[6,39], Chi Xu[40], Xinwu Xu[7,8], Noelia Zafra-Calvo[41] & Xin Zhang[42]

> **"Seven of eight** globally quantified **safe and _just_ Earth System Boundaries** ..in over half of global land area are already **exceeded."**

Rockstrom et al., *Nature,* 31 May 2023
https://www.nature.com/articles/s41586-023-06083-8

The Irish Times 14 June 2023
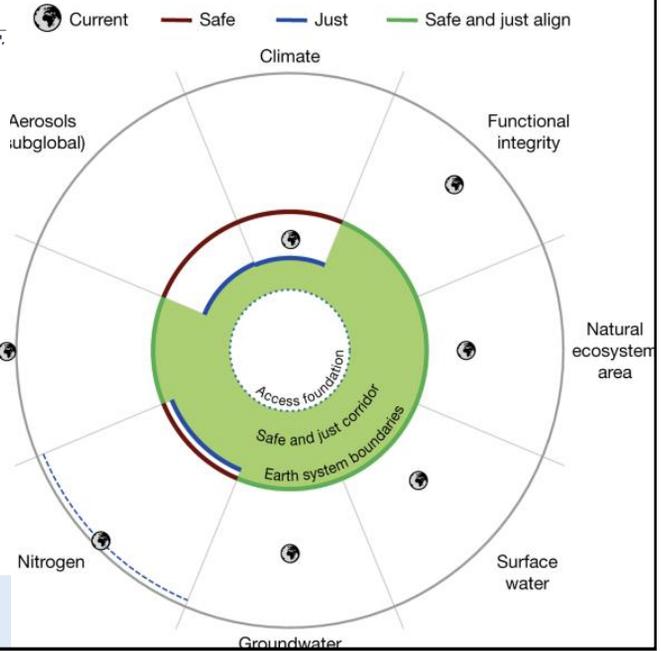
Water quality not improving, says EPA report

KEVIN O'SULLIVAN
Science and Environment Editor

Levels of polluting nitrogen and phosphorus in Irish watercourses arising from human activities such as farming and forestry are at unacceptably high levels, according to the EPA.

Belfast Telegraph, 14 February 2024, p.10

Ireland will fail to meet EU water quality goal, warns EPA

Main headline;
The Irish Times 14 October 2022

Belfast Telegraph

New Executive has its work cut out to reverse years of environmental neglect

NH$_3$ rich wastewater

Municipal wastewater treatment with Anaerobic Digestion

NH$_3$ from Haber Bosch + Sulphuric acid

Nitrogen Economy

Nitrogen Fixation to Ammonium Sulfate

2.5 kgCO$_2$e/kg AS

Food Nutrition

Nitrogen Uptake

System boundary

Nitrogen Fixation from atmospheric Nitrogen by nitrogen-fixing bacteria

Based on Graphical abstract. Credit: Science of The Total Environment (2022). DOI: 10.1016/j.scitotenv.2022.159499

NH$_3$ rich wastewater

Sidestream NH$_3$ recovery by Air Stripping

+ Sulphuric acid

Municipal wastewater treatment with Anaerobic Digestion

NH$_3$ from Haber Bosch + Sulphuric acid

Circular N economy: Ammonium Sulfate

Nitrogen Circular Economy

0.43 kg CO$_2$e/kg AS

Nitrogen Fixation to Ammonium Sulfate

2.5 kgCO$_2$e/kg AS

Food Nutrition

Nitrogen Uptake

System boundary

Nitrogen Fixation from atmospheric Nitrogen by nitrogen-fixing bacteria

GHG Emissions: ~6 times lower

Energy Input: ~5-10 times lower

Fertiliser Costs: -92%

Science of The Total Environment
Volume 857, Part 3, 20 January 2023, 159499

Life cycle assessment and techno-economic analysis of nitrogen recovery by ammonia air-stripping from wastewater treatment

Sourgiyoti Kar [a] [1], Rajveer Singh [a], Patrick L. Gurian [a], Adam Hendricks [b], Paul Kohl [b], Sean McKelvey [b], Sabrina Spatari [a c]

Based on Graphical abstract. Credit: Science of The Total Environment (2022). DOI: 10.1016/j.scitotenv.2022.159499

Reed bed technologies; use microalgae
Photo credit: https://www.yes-reedbeds.co.uk/

A true Nitrogen Circular Economy;
Using microalgae from reed beds, composting toilets, etc.

GHG Emissions:
~MANY? times lower

Energy Input:
~MANY? times lower

Fertiliser Costs:
-Much Lower??%

NH₃ rich wastewater

treatment with Anaerobic Digestion

Circular N economy: Ammonium Sulfate

Nitrogen Circular Economy

Food Nutrition

Nitrogen Uptake

System boundary

Based on Graphical abstract. Credit: Science of The Total Environment (2022). DOI: 10.1016/j.scitotenv.2022.159499

Nitrogen Fixation from atmospheric Nitrogen by nitrogen-fixing bacteria

Environment

Feed

Farm waste

GREEN Protein

Protein

Duck-weed

Economics

Duckfeed and Brainwaves projects, ERI, UCC (PI: Prof. Marcel Jansen)
https://www.ucc.ie/en/duckfeed/

Based on Graphical abstract. Credit: Bioresource Technology (2020)
https://doi.org/10.1016/j.biortech.2019.122673

"Integral approach is needed when no single optimal technological solution is possible."
Robles et al, (2020)

2. Struggling to see the wood from the trees

World ⌄ Business ⌄ Markets ⌄ Sustainability ⌄ Legal ⌄ More ⌄

Climate & Energy | Climate Change

China's smog-covered north on highest pollution alert as visibility drops

By Liz Lee

October 31, 2023 11:34 AM GMT · Updated 4 months ago

Asia > India

Toxic grey smog blankets Delhi as air pollution spikes to 100 times WHO limit

Air pollution reaches severe level and expected to remain aggravated next two to three weeks

Shweta Sharma · Friday 03 November 2023 11:07 GMT · Comments
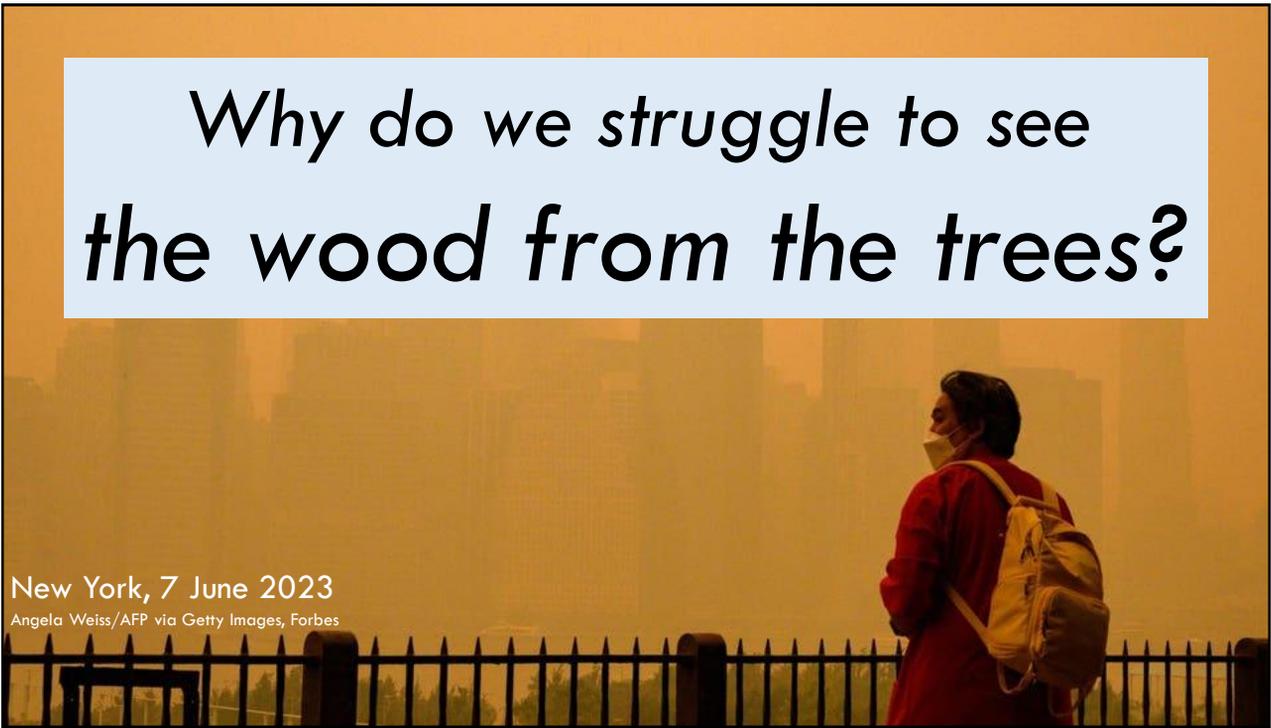
Why do we struggle to see the wood from the trees?

New York, 7 June 2023
Angela Weiss/AFP via Getty Images, Forbes

Arial shot of the Amazon, Para State, Brazil, August 2020
(AP Photo/Andre Penner)

Arial shot of the Amazon, Para State, Brazil, August 2020
(AP Photo/Andre Penner)

Struggling to see the wood from the trees..

Brazil's Amazon deforestation surges to 15-year high, undercutting government pledge
(J. Spring & A. Broadle, Reuters, Nov. 19, 2021.)
Cattle graze in a land recently burned and deforested by cattle farmers near Novo Progresso, Para state, Brazil,
Sunday, Aug. 23, 2020. (AP Photo/Andre Penner)
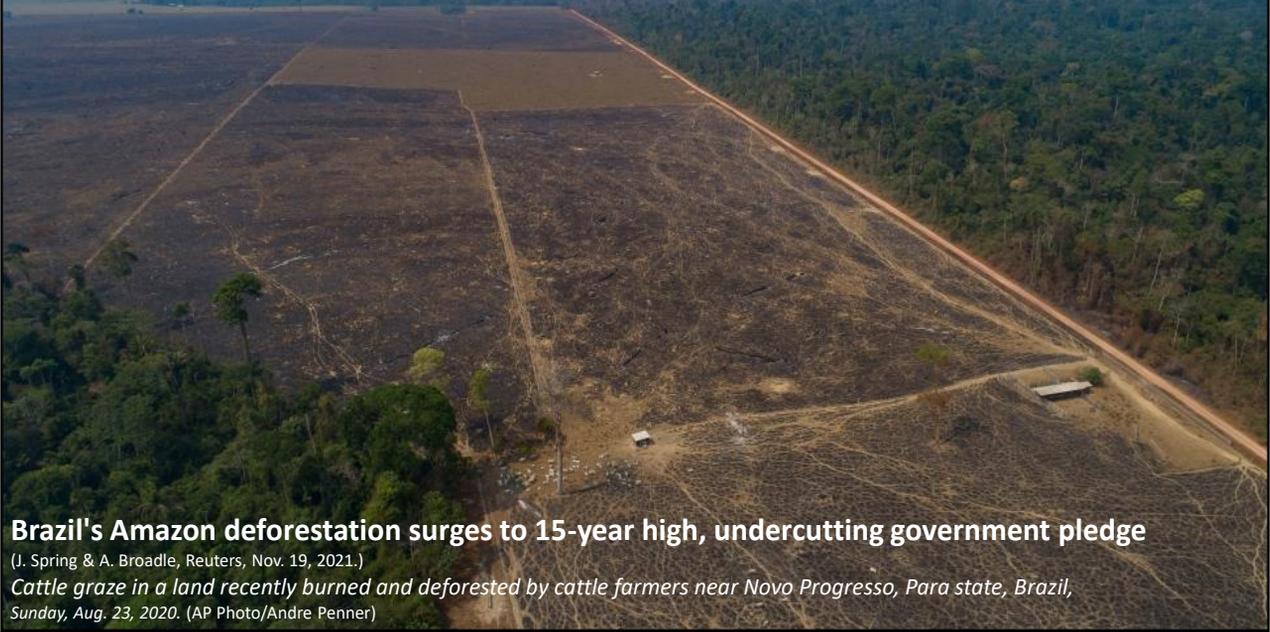
Analysis, Categorization   Whole picture ('Gestalt')

Left
Hemisphere

Right
Hemisphere
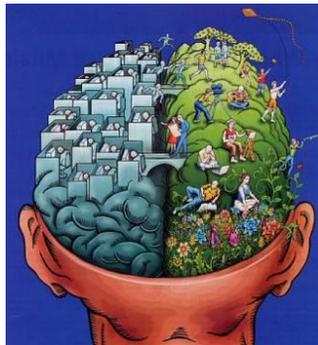
Neuroscience: BRAIN lateralization*

*Ian McGilchrist, The Master And His Emissary (Yale, 2009)

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Slide 1
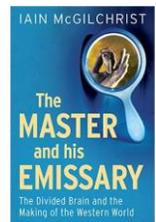
Modern **Integrative**

Positive/Optimistic   Melancholic

Analysis, Categorization   Whole picture ('Gestalt')

Technocratic   Technosceptic

Either/Or: 'Law of excluded middle' (Plato/Aristotle)

Integrative (Both/And): 'Logic of the included middle'

Left Hemisphere

EXTERNAL 'VIEW FROM NOWHERE'

RELATIONAL 'VIEW FROM SOMEWHERE'

Right Hemisphere

SYMBOLS, MODELS, MUSICAL NOTES, (denotative) LANGUAGE

MUSIC, SPIRITUALITY/RELIGION, (connotative & emotive) LANGUAGE: METAPHOR, IRONY, HUMOUR, POETRY

Dogmatic   Pragmatic

METAPHOR, SUSTAINABILITY, TRANSFORMATION
TRANSDISCIPLINARY PERSPECTIVES

IAIN McGILCHRIST

The MASTER and his EMISSARY
The Divided Brain and the Making of the Western World

Byrne (2022) pp.119-136 In: Hughes et al. / Ian McGilchrist, The Master And His Emissary (Yale, 2009)

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Slide 2

"The intuitive mind is a sacred gift, and the rational mind is a faithful servant.

We have created a society in which we honor the servant and have forgotten the gift"

Albert Einstein

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Perception of Reality inform **Societal Worldviews,** the **World we construct around us** and conceptions of **'Progress'** & **'Sustainability'**

Alone they [the two hemispheres] are destructive. ...right now they may be bringing us close to forfeiting the civilisation they helped us create.'

(McGilchrist (2009, p.93))

3. A radical transformation of the mind
....and the world it creates

Flourishing

"nothing more than a state recognized when one says,
*'All my **cares** are being **satisfied**,*
at least for the moment.'"
John Ehrenfeld, Flourishing (2013, p.104)

John Ehrenfeld's '*Tao of Sustainability*':
Flourishing **through *CARE* for (domains of):**
1] Self; 2] Others; 3] Natural Material
World; and 4] Non-Material World
(Spiritual/Transcendent/Numinous)

The Right Way to Flourish
Reconnecting to the Real World
JOHN R. EHRENFELD

Ethical

Sustainability

Natural

flourish

Human
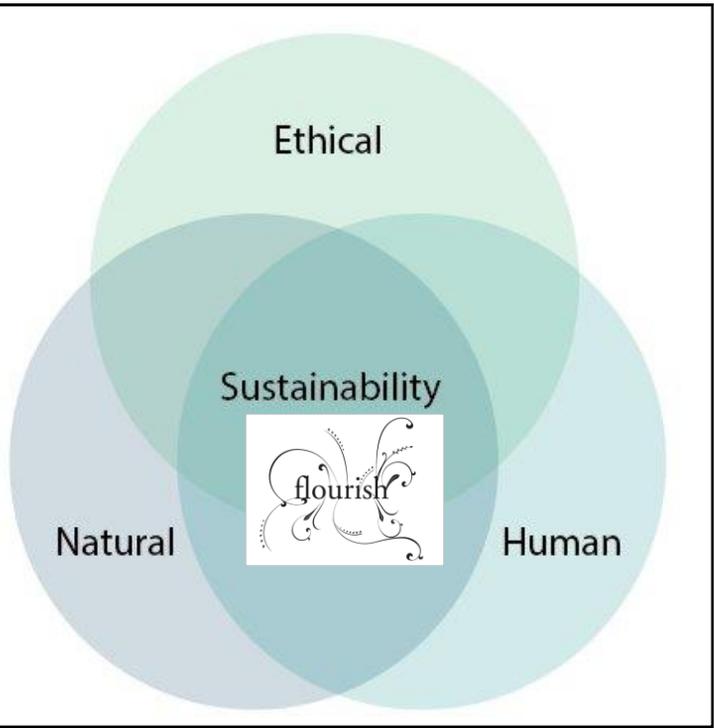
The running blog
Running

Why we love to run

"Racing along out on the trails, or even through the busy streets of a city, splashing through puddles, letting the rain drench us, the wind ruffle us, we begin to sense a faint recollection of that **childish joy**. Somewhere a **primal essence** stirs deep within us; this being **born** not to sit at a desk or read newspapers and drink coffee, but **to live a wilder existence**.

But if we push on, running harder, deeper into the loneliness, further away from the world and the structure of our lives, we begin to feel strangely elated, **detached yet at the same time connected**, **connected to ourselves**. With nothing but our own two legs moving us, we begin to get a vague, tingling sense of who, or what, we really are.

It may only be chemicals shooting around in your brain, but after a long run **everything seems right in the world.** Everything is at **peace**."

– and yet more than two million of us in the UK
week. Why? To launch **our new running blog**,
explains the enormous pleasure it brings – and
hardwired to do it

The Guardian, 5 Feb 2013

The Right Way to Flourish
Reconnecting to the Real World

JOHN R. EHRENFELD

John Ehrenfeld's 'Tao of Sustainability':
Flourishing through CARE for (domains of):
1] OneSelf; 2] Others; 3] Natural Material
World; and 4] Non-Material World
(Spiritual/Transcendent/Numinous)

Ethical

Sustainability

flourish

Natural

Human
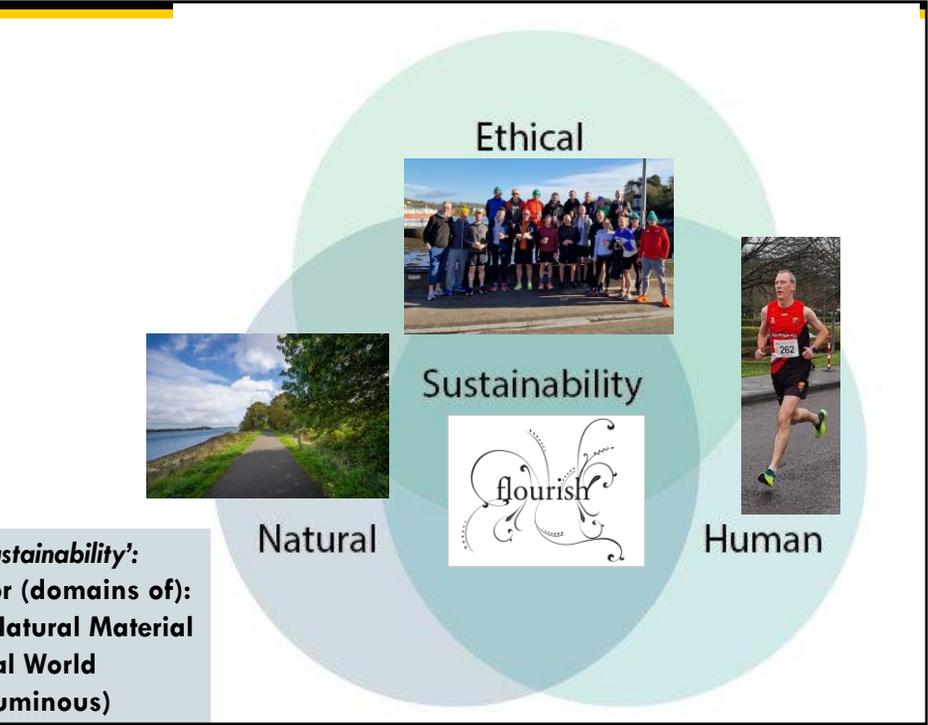
John Ehrenfeld's *Tao of Sustainability':*

"The spiritual domain is one of those important domains of Care, but is often overlooked today. Here, in this domain, one recognizes, in a deep and profound way, that the narcissistic needs that are directed inwardly are not as powerful or as enriching as the care that is directly outwardly. In the end, we will know the world and act authentically within it only if we adopt a new and more nuanced way of relating to it: complexity, which blends objective elements of the scientific method with the subjective elements of pragmatic, spiritual, and loving Being."

Ehrenfeld, Flourishing (2013, p.104)

Ethical

Sustainability

flourish

Natural

Human
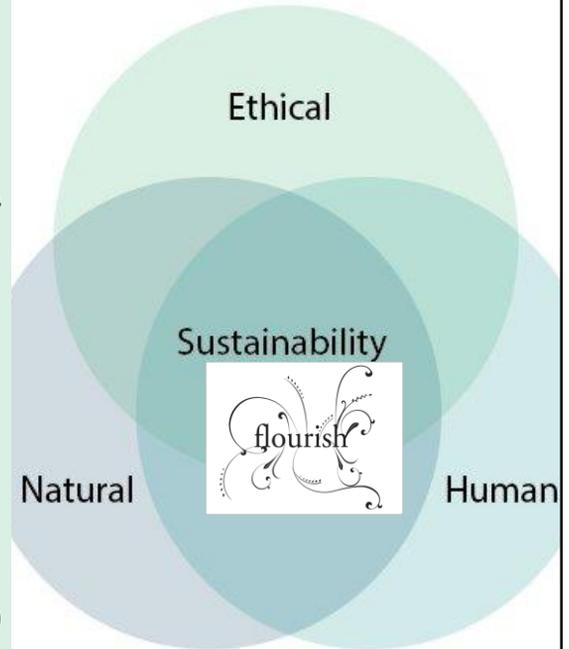
Charles Eisenstein's Mother Earth metaphor of Care/Love (Climate – A new story, 2018): **'Why should I love my son?'**

"..Maybe I'll **abandon him**—what do you think?
..Well, Charles, if you do that you might go to jail for **child neglect**. And even if you get away with it, he won't be willing to **support you in your old age**. Besides, what will the **neighbors think**?

"You're right," I say. "I guess I'd better take care of him after all."

Herein lies a problem: that answer also implies that **if your health and livelihood are not threatened**, then **you needn't care**. Moreover, even if you intellectually accept that biodiversity loss threatens human well-being, there is little in our lived experience to confirm it, since modern life so thoroughly insulates us from nature. "When we propose the question "**Why should I care**?" and offer an answer, we have forfeited the argument. **Caring** about **other beings, about life, about our planet** is **aboriginal to our humanness. To offer someone a selfish reason for caring is an insult**. It says, "I know you. If it weren't for the threat to your wealth, health, or ego, you'd be just as happy to trample everything else for personal gain.""

COP28

"There is no science out there, or no scenario out there, that says the phase-out of fossil fuel is what's going to achieve 1.5."
A **phase-out of fossil fuels** would not allow sustainable development *"unless you want to take the world back into caves"*
COP28 president Sultan al-Jaber
(Online, to Mary Robinson, 21 Nov. 2023)

Credit: THAIER AL-SUDANI/REUTERS

H.E. Dr. Sultan Al Jaber
COP 28 President

United Nations | COP28UAE

COP28

END FOSSIL FUEL.
SAVE OUR PLANET
AND
OUR FUTURE

COP27 HLC

United Nations
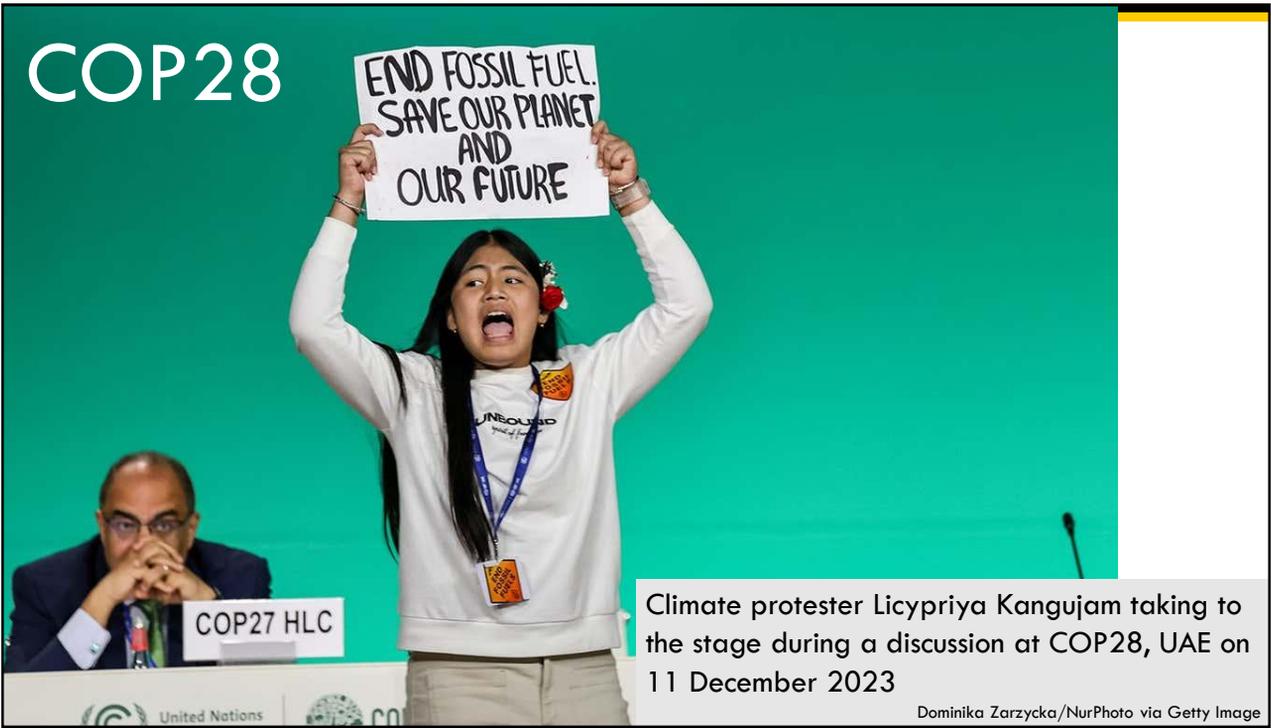
Climate protester Licypriya Kangujam taking to the stage during a discussion at COP28, UAE on 11 December 2023

Dominika Zarzycka/NurPhoto via Getty Image

Climate: A New Story with Charles Eisenstein (2020)

Stop Extracting Fossil Fuels

Heal the Earth   Sacred ('Mother') Earth   Stop Toxifying
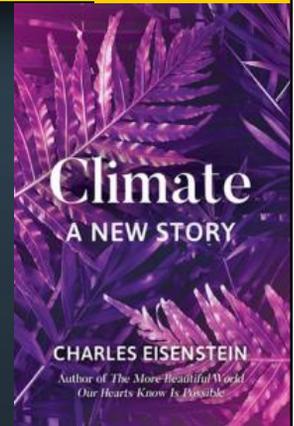
4. Some Engineering Education insights

Safety; 1970's & 80's

"Fatal accident rate from 1960 to 1982." (Kletz, 2012)
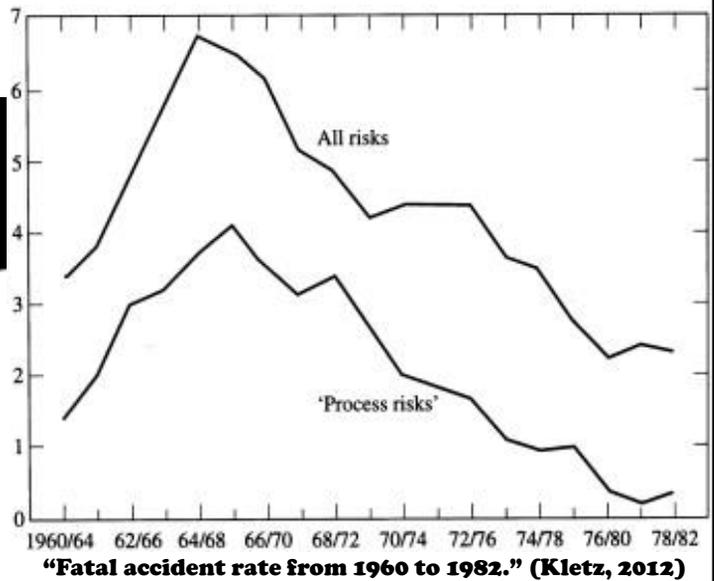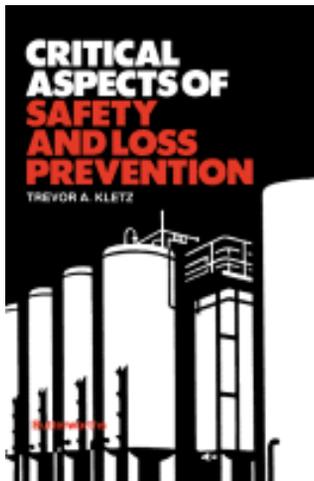
T. Kletz (2012), The history of process safety, *Journal of Loss Prevention in the Process Industries*, 25, 5, 763-765.

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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/

ENVIRONMENTAL ENGINEERING

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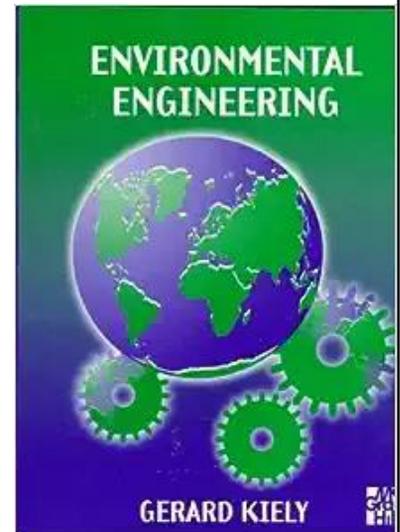
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'Education for Sustainable Development'; Declarations; 1990's and 2000's;

"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)

[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.

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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.

Engineering Education for Sustainable Development (EESD2002), Delft:

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.

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Engineering Education for Sustainable Development (EESD2002), Delft:

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."*

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*

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A 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.

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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.**
The last EESD Conference hosted by University College Cork in 2021 produced an Amendment to the [2004] 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.**"*
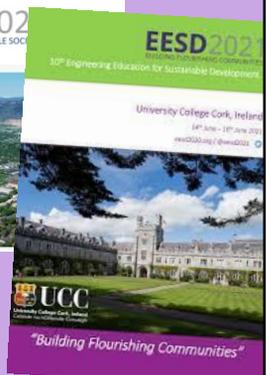
Eleventh International Conference on Engineering Education for Sustainable Development (EESD2023)
Colorado State University, Fort Collins, Colorado, U.S.A. June 18-21, 2023

EESD202

EESD2021

University College Cork, Ireland

UCC

"Building Flourishing Communities"

E.P. Byrne, SECA, Queen's University Belfast   **20th February 2024**

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***

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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)

Core Chem. Eng. competences
Transferable skills
Professional values
Sustainability attributes
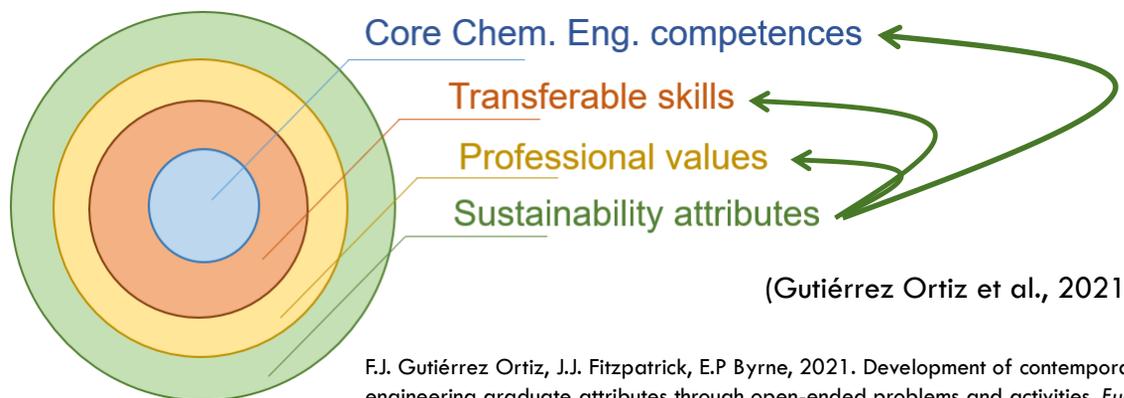
(Gutiérrez Ortiz et al., 2021)

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

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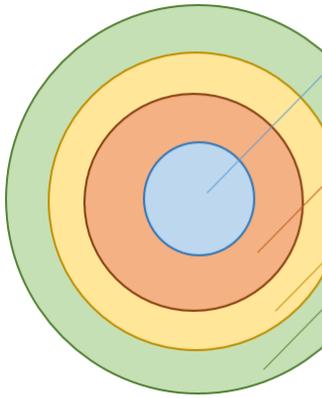
❖ **Sustainability (core) knowledge** and **understanding**, knowledge around the issues and challenges; importance of the social, ethical, ecological and economic dimensions of sustainability, and interconnectedness of each.

❖ **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, equality, 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

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Increasingly, 'accreditation bodies require that graduates are equipped with ***a range of sustainability attributes'*** *(Byrne, 2023):*

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

Byrne, E.P., 2023. The evolving engineer; professional accreditation sustainability criteria and societal imperatives and norms. *Educ. Chem. Eng.,* 43, 23-30.
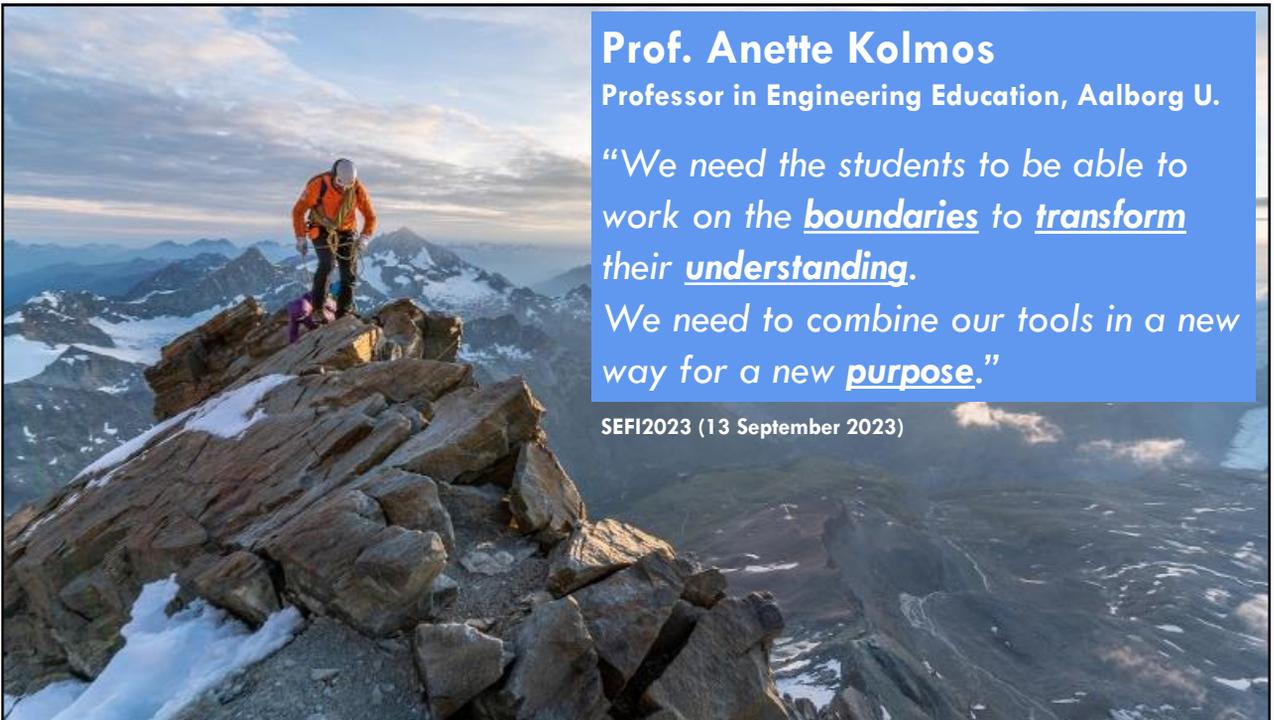
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5. *Transforming education and institutions; A transdisciplinary endeavour*

Prof. Anette Kolmos
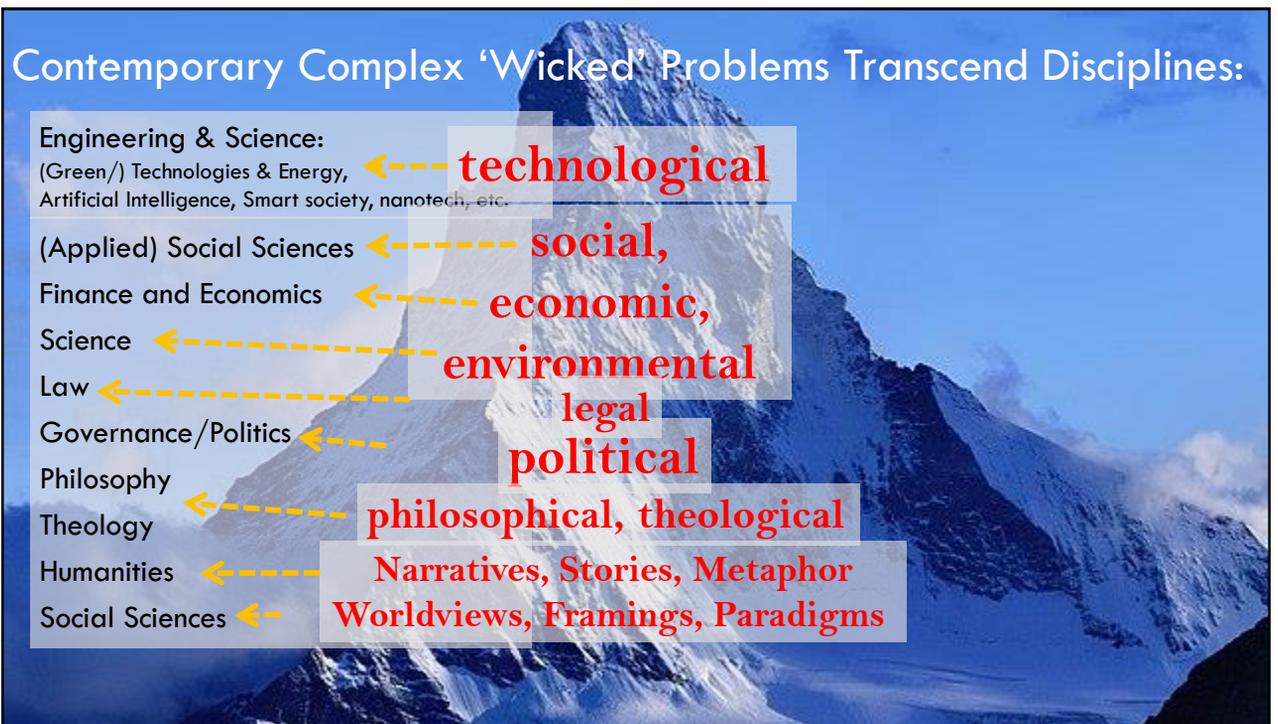**Professor in Engineering Education, Aalborg U.**

"We need the students to be able to work on the __boundaries__ to __transform__ their __understanding__.
We need to combine our tools in a new way for a new __purpose__."

SEFI2023 (13 September 2023)

Steep Challenges ahead:
A *Transdisciplinary journey*

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**

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

Los Cuatro Postes, Ávila, Spain

'An Elephant in the Room!'

Prof. Kristina Edström
Professor in Engineering Education Development, KTH

"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."

SEFI2023 (11 September 2023)

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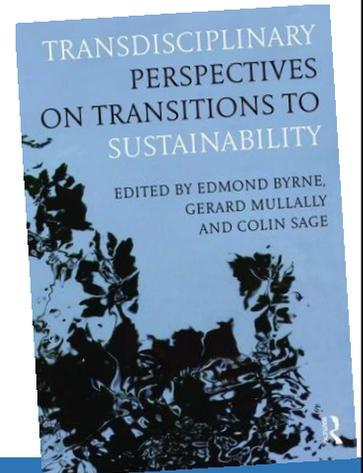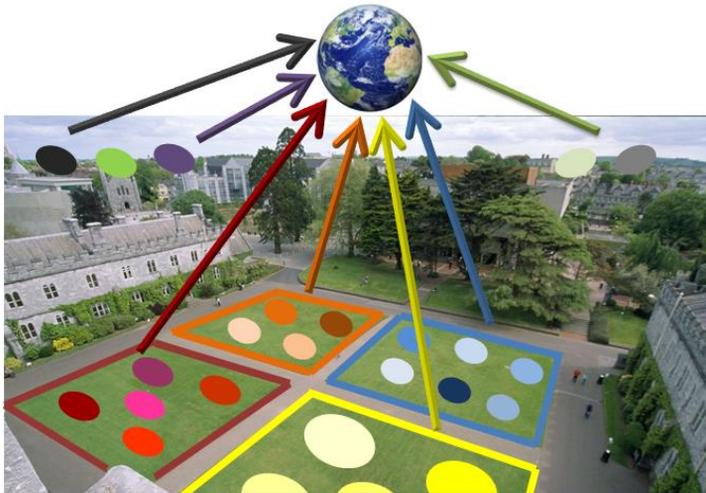
"Essentially, amid the **'silo-ised' constraints of the university** (or should that be 'multiversity'?), the whole was not greater than the sum of the parts. More broadly, within a world of increasing ecological degradation, social upheaval and economic inequality we were making **relatively feeble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

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

"Many [recent] **technological developments** have emanated from **economic and policy drivers,** but what has often been <u>less developed</u> 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.**"
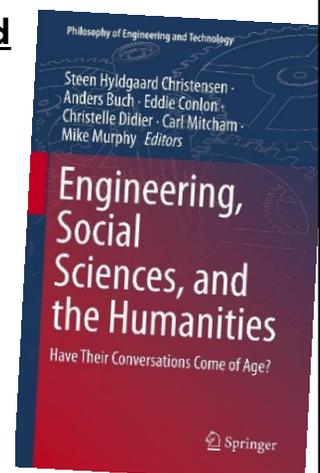
Byrne, E. *et al.* (2022). Engineering with Social Sciences and Humanities; Necessary Partnerships in Facing Contemporary (Un)Sustainability Challenges?.
In: Christensen *et al.,* (eds) Springer.

Deep Societal Innovation for Sustainability and Human Flourishing (DSIS)

Prof. Edmond Byrne (Engineering & Architecture, ERI/MaREI); Prof. Maggie O'Neill (Sociology & Criminology, ISS21), Dr Ian Hughes (ERI/MaREI)

DSIS: an inter- and transdisciplinary initiative, which seeks to develop a methodological basis for conceptualising the **deep whole of society transformation** required to engage on a trajectory towards **authentic sustainability and human flourishing**, to create **narratives** for deep, rapid, whole of society transformation, and employ those narratives to inform **policy making** and **public discourse** on climate change and sustainability. It doing this, it considers six pillar institutions: **politics, economics, technology, gender, education, religion.**

UCC University College Cork
Coláiste na hOllscoile Corcaigh
University College Cork, Ireland

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Latest News

UCC researchers awarded €3.7m for new research to address climate and environmental challenges

14 Feb 2024

Photo (L-R): UCC's EPA Research Call 2023 Awardees - Professor Edmond Byrne, Dr Noreen Byrne, Dr Tracy Bradfield, Dr Archishman Bose, Dr Aaron Lim, Dr Niall Dunphy, Dr Michelle

E.P. Byrne, SECA, Queen's University Belfast   20th February 2024

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6. Purposeful transformation of Higher Education?

..to what Purpose?

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> *"Curricula are informed by curriculum ideologies*
>
> *…these are **not value free** decisions.*
>
> ***Curriculum ideology** is defined by Eisner as 'beliefs about what schools **should teach**, for what ends, and for what reasons (Eisener, 1994, p. 47.)'*
>
> *..Curricula, I assert, not only represent a value position but a shared way of life that teaches a certain **worldview** or **set of values** through **action**."*

Gemma O'Sullivan (2023)
Shaping transdisciplinary, challenge-based education using knowledge creating teams from five European universities: A realist evaluation. PhD thesis, TCD, p. 34-36.

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We should be about *"transforming the universities into wealth creating machines"*
Craig Barrett, ex Intel CEO, RTÉ Radio interview, July 13 2013

Universities as Engines of Economic Growth

"This concept of the university as an **engine of economic growth** originated in the mid-1990s when universities became "**explicit instruments of economic growth** in the **knowledge economy**" (Wissema, 2009) through the **Triple Helix thesis** (the interconnection between **university, industry and government**) at a time when **universities and industry** were exhorted by policy makers to work together more closely for the **benefit of society** derived from the **commercialisation of new knowledge.** Innovation became a factor of economic success (Scholz, 2020).   ..This integration of a mission of economic development by universities, next to their traditional activities of research and teaching is also known as the **Third Mission** (Minshall et al., 2007, p. 3)."

O'Sullivan (2023), p. 74

The 21st C 'Knowledge Economy'

"*The **knowledge economy** and society stem from the combination of four interdependent elements:*
- *the **production of knowledge**, mainly through **scientific research**;*
- *its **transmission** through **education and training**;*
- *its **dissemination** through the **information and communication technologies**;*
- *its use in **technological innovation**.   (European Commission, 2003 p. 4-5)*

*The EC said Bologna should define a framework for skills "as a key measure in **Europe's response to globalisation** and the shift to **knowledge-based economies**, and emphasised that people are Europe's main asset" (Official Journal of the European Union, 2006). This reflected the **race for countries globally** in the **twenty-first century** to have a **world class university**: the ushering in of an* "**age of academic hype**" *(Deem et al, 2008, p. 21)."*

O'Sullivan (2023), p. 80

"These developments were supported and, in some cases, driven by **policy** and the **direct link between employability, earning power** and the **possession of a higher-level degree** led to policy encouraging the **massification** of higher education.

There are major **implications of massification: financial** and **infrastructural challenges** and **quality assurance.** The perception of the university as an engine for the global economy both in terms of profit and employment has led to universities being treated as **businesses** (Connell, 2019) with all the performance monitoring and target setting that sit at home in a business model. A body of material that has emerged in the 'consultancy' realm regarding the role of universities in society (for example Ernst & Young, 2022) with **increasing despondency** in terms of the **economic viability of universities.** From this perspective, universities are viewed as **economic engines that are failing their central task**: to get students jobs and make economies powerful and competitive. Their **cost-effectiveness is repeatedly questioned** in this grey literature and in the popular media."

O'Sullivan (2023), p. 74-76

Fit-for-Purpose?

..Role for the University in Crisis Transformation?

'Sustainability' and 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 <u>integrative</u>** and more whole state implied by a **<u>systemic view of sustainability</u>** in education and society, however difficult this may be to realise. [this] **<u>implies a change of fundamental epistemology in our culture</u>** 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 <u>different view </u>of curriculum**, of **pedagogy**, of **organisational change**, of **policy** and particularly of **<u>ethos</u>.**   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.

Role for the University in Crisis Transformation?

Sterling (2021):

"In her book on our "dark age" and the possibility of **<u>avoiding cultural and social collapse</u>** through renewal, Jacobs (2005) underlies the **crucial role of education**: A vigorous culture **capable of making corrective, stabilizing changes** depends heavily on its **<u>educated people</u>**, and especially on their **critical capacities** and **depth of understanding. <u>But time is short.</u>**
Given this context, the overriding questions are these:

• How can universities **<u>urgently transform their ethos, policies and practices</u>** 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 **<u>transformist response</u>** that the **<u>crises require</u>**?

• How can ..learning within entire university systems ..engender their **ability to make <u>a critical contribution to human, biotic and planetary survival and flourishing.</u>**

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

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 i Sustainability*, *4*, 1166642.

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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.
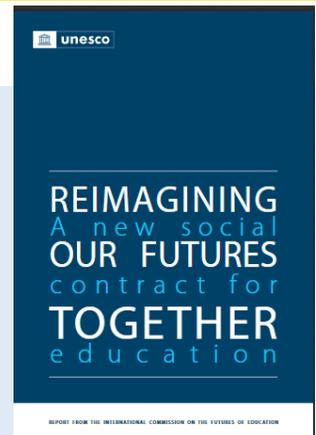
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Pedagogies embracing
Interdependence and Interdisciplinarity

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.

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"The idea of **transdisciplinarity** as problem-solving and <u>**creating knowledge purposively**</u> can be seen to originate in the work of Eric Jantsch (1970) who argued that **universities and knowledge should be organised for a <u>purpose</u>** and the university should take an **active role** in **societal planning** and **service to society.**"

O'Sullivan (2023), p. 45

"**Transdisciplinarity** is perceived as a new paradigm that can **systematise sustainability education.** The transition to sustainability is seen to necessitate collaboration among disciplines and fields of practice towards tackling large societal problems (Charli-Joseph et al., 2016) and universities are motivated to do TD to develop TD research capabilities.
…Second to sustainability, TD curricula are evident when disciplinary areas articulate a desire to give students an understanding of how their **disciplinary** area is **affected by** and **interconnected** with **complex societal challenges**"

O'Sullivan (2023), pp. 56-57.

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"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.

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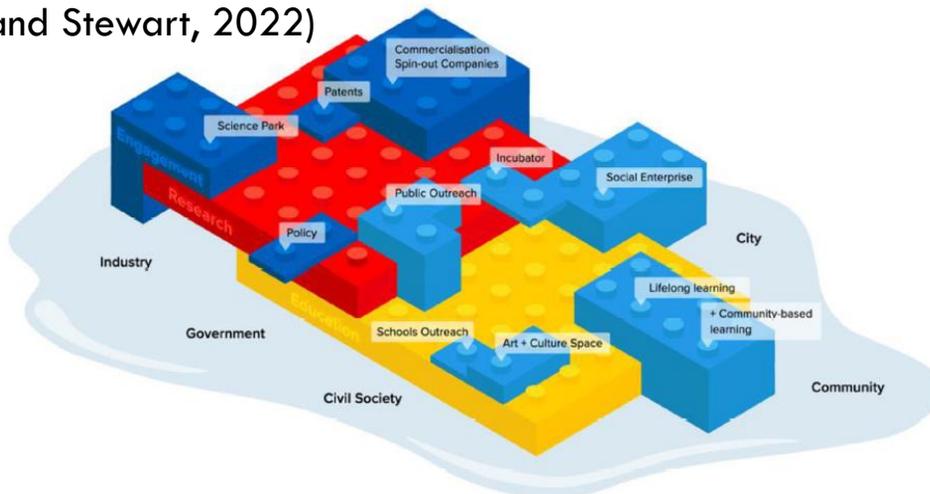

FIGURE 4 | The Amalgam of university third mission activities. In many universities, recent "third mission" activities are often bolted on to their long-standing twin missions of education (yellow) and research (red). Some of these third mission activities are focused on business and innovation ventures (dark blue) whilst others are more socially and community directed engagements (light blue), resulting in a complicated amalgam of extra-mural functions.

"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.

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"Re-purposing Universities: The Path to Purpose"

Three possible strategic directions:
- The BAU University (business as usual)
- The ESV University (enlightened shareholder/self-interested value)
- **The Purpose-Driven University** 🙂

"Arguably, <u>no university</u> 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 <u>**wellbeing of all people and planet in the long-term (sustainability).**</u>"

V. Hurth, I.S. Stewart (2022) Re-purposing Universities: The Path to Purpose. *Frontiers in Sustainability.* 05 January 2022.

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Why business must harness the power of purpose

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)

Tesco Bag Flag, London
(Banksy, 2008)

A "Purpose" Driven Organisation?

"Purpose is Everything" (Deloitte, 2020)
"<u>Purpose</u> 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]."

"<u>wellbeing of all people and planet in the long-term (sustainability)</u>" (Hurth and Stewart, 2022)

"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** <u>Purpose</u>?
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

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Big Questions and Implications for Higher Education, and our Disciplines..

*If the **<u>Purpose</u>** of our Universities is*
*for deep seated **radical change** to secure*
<u>"the wellbeing of all people and planet in the long-term (sustainability)",</u>
<u>how might this be operationalised,</u>
including across our disciplines?

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Fit-for-Purpose Higher Education?
Today's first year student.
2050: Aged 45

E.P. Byrne, SECA, Queen's University Belfast   20th February 2024

CENTRE FOR SUSTAINABILITY, EQUALITY AND CLIMATE ACTION (SECA), QUB

Purposeful Transformation of Higher Education;

Some Engineering Perspectives on a Transdisciplinary Journey

Edmond Byrne
Chair Professor of Process & Chemical Engineering, Environmental Research Institute/MaREI
University College Cork, R. Ireland

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