BME

BEYOND BLUEPRINTS

A CASE FOR INTERDISCIPLINARITY IN CIVIL ENGINEERING CURRICULA

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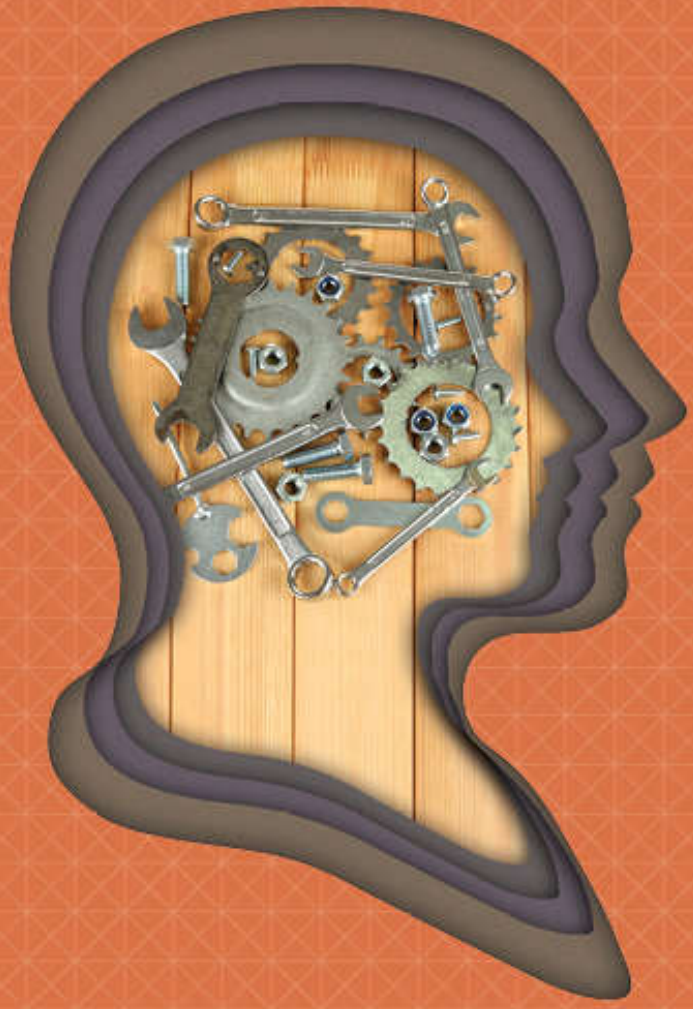
UCL ENGINEERING
CHANGE THE WORLD

UCL

TO CHANGE THE WORLD, YOU NEED TO BE TAUGHT DIFFERENTLY.



IEP Integrated Engineering Programme

UCL ENGINEERING
Change the world

What is Engineering?

The art and practice

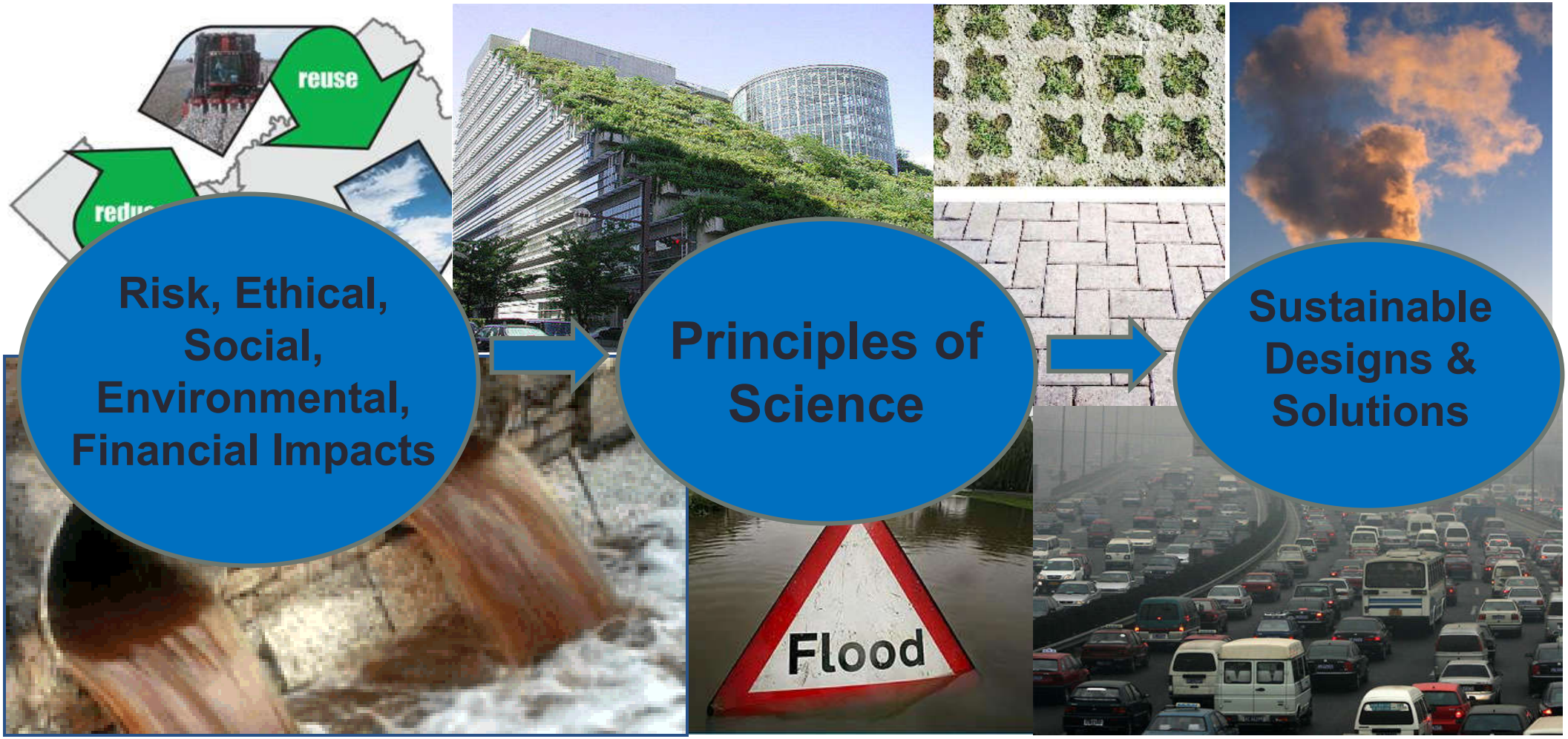
of

changing the (physical) world

for

the use and benefit of all

Engineering in Context



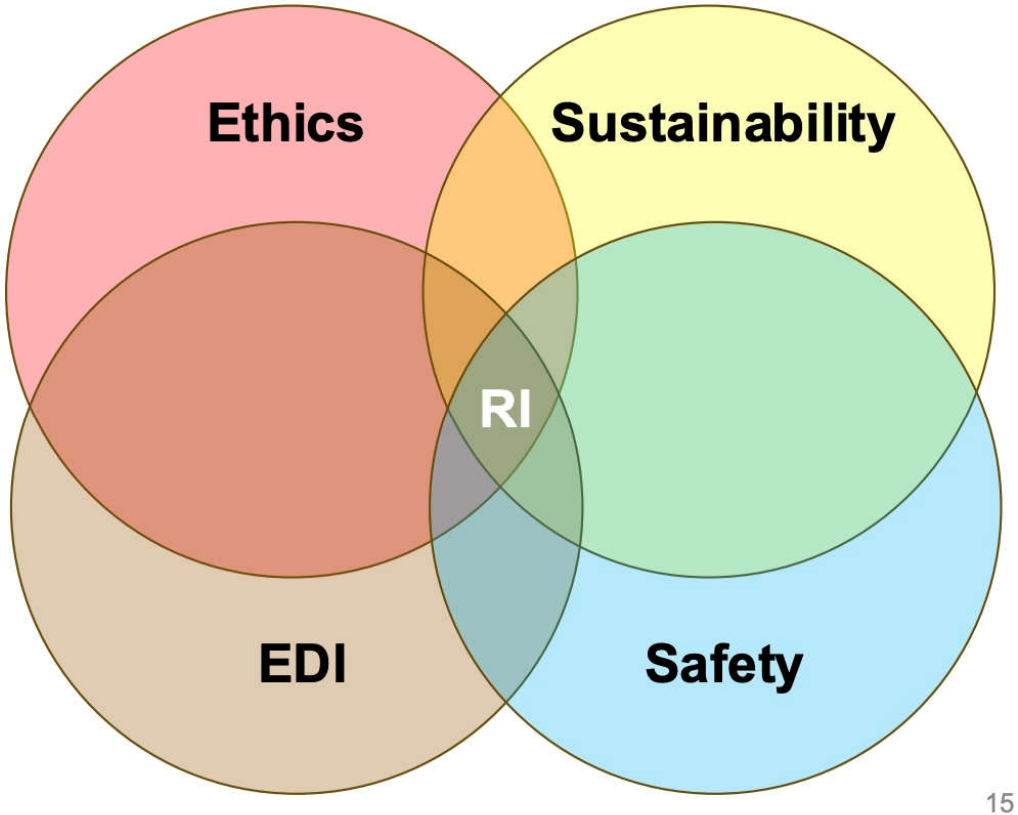
Responsible Innovation

Ethics & Social Sustainability
- Ensure technologies align with moral principles and consider societal impacts.

Climate Justice & Environmental Sustainability
- Minimize ecological footprint and promote eco-friendly practices.

Risk Mitigation & Safety
- Identify and mitigate potential hazards with rigorous safety standards.

Equity, Diversity, and Inclusion (EDI)
- Foster inclusive innovation processes and ensure equitable access and benefits.

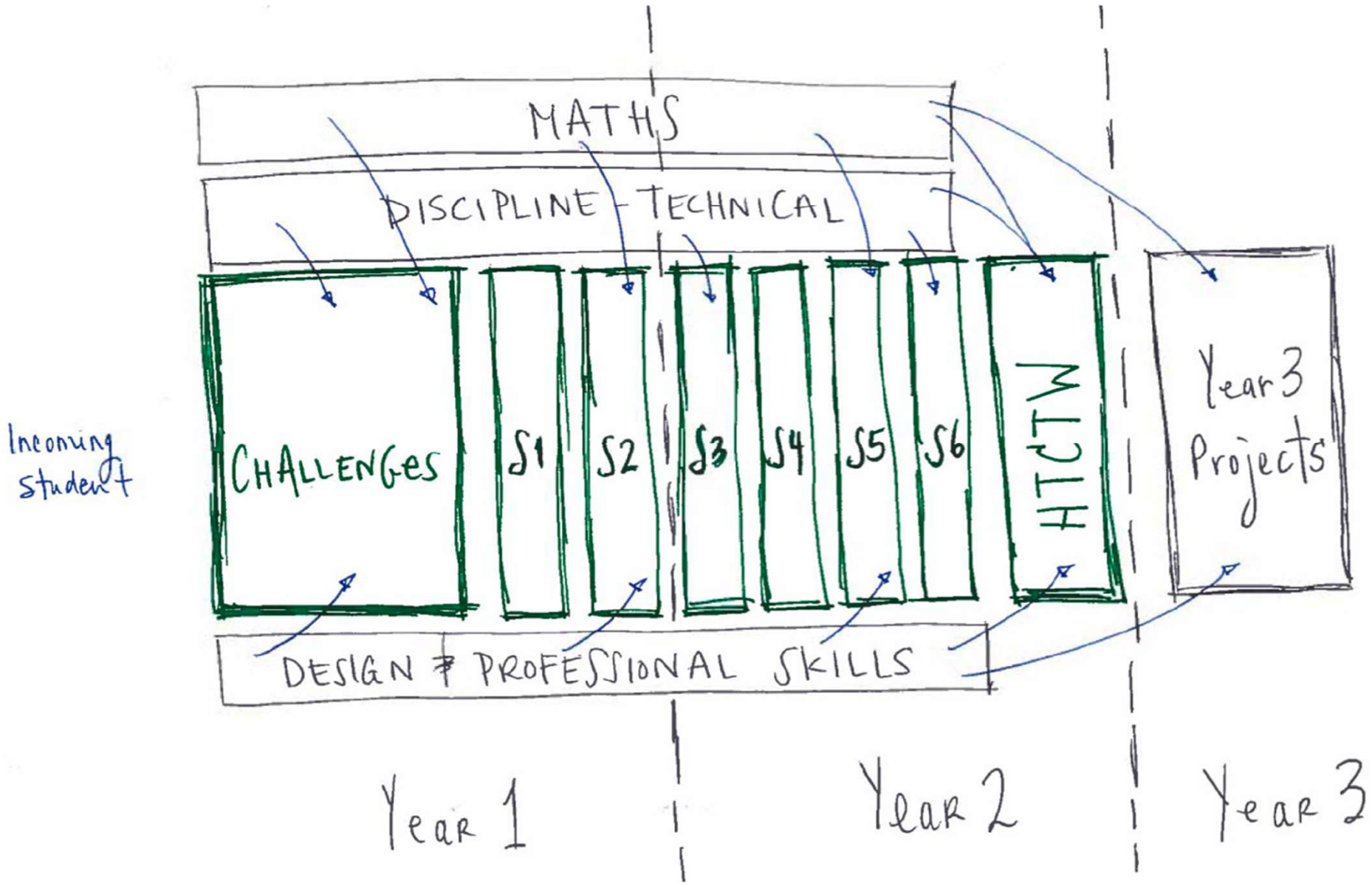


Worldview in Engineering Education

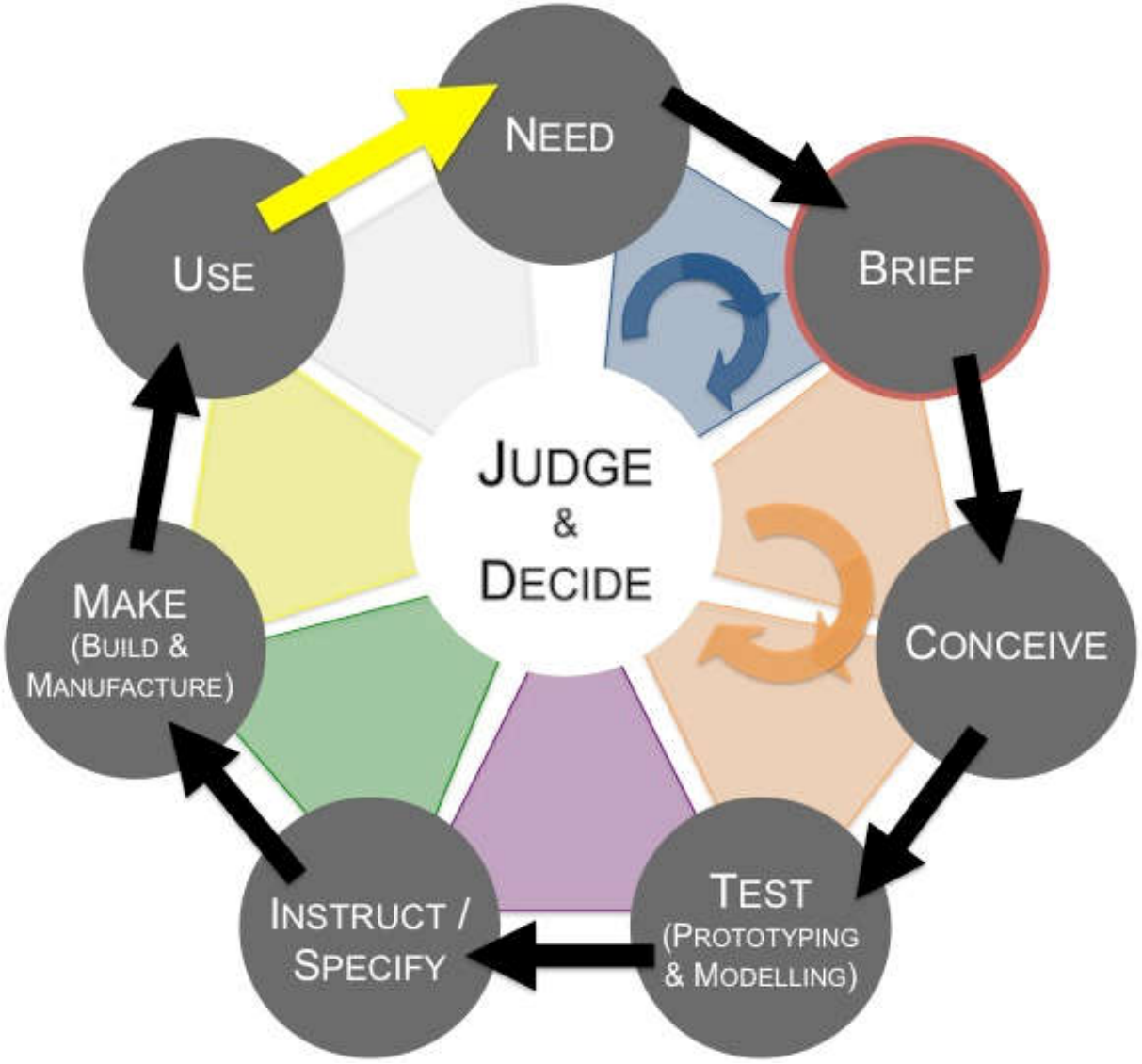
A worldview curriculum innovation **includes situating disciplinary students and their whole-selves within inter/trans-disciplinarity learning with increasing use of**:

- Inquiry / Problem and/or Project-based learning (IBL/PBL/PjBL),
- Research-centred education,
- Team-based learning and assessment,
- Authentic / workplace learning, and
- Purposeful real-world scenarios, with broad stakeholders which manifests in “Challenge-led education"

IEP Engineering Project Spine



IEP Engineering Design-based Curriculum



Innovative Pedagogy for 21st Century – Project based Learning (PjBL)

Two essential components

Not just an administrative framework***

Process-led activity

Criteria for PjBL **

- Central to the curriculum
- Focused on problems that "drive" students to encounter principles of a discipline
- Students involve in constructive investigation
- Student-driven: student autonomy, choice, unsupervised work time and responsibility
- Realistic-feeling of authenticity

What is learned and how

* Blumenfeld et al., 1991, p. 371

** Thomas 2000, p. 3

*** Hammell and Savin-Baden, 2013

Wider Consideration of Learning Outcomes

Knowledge

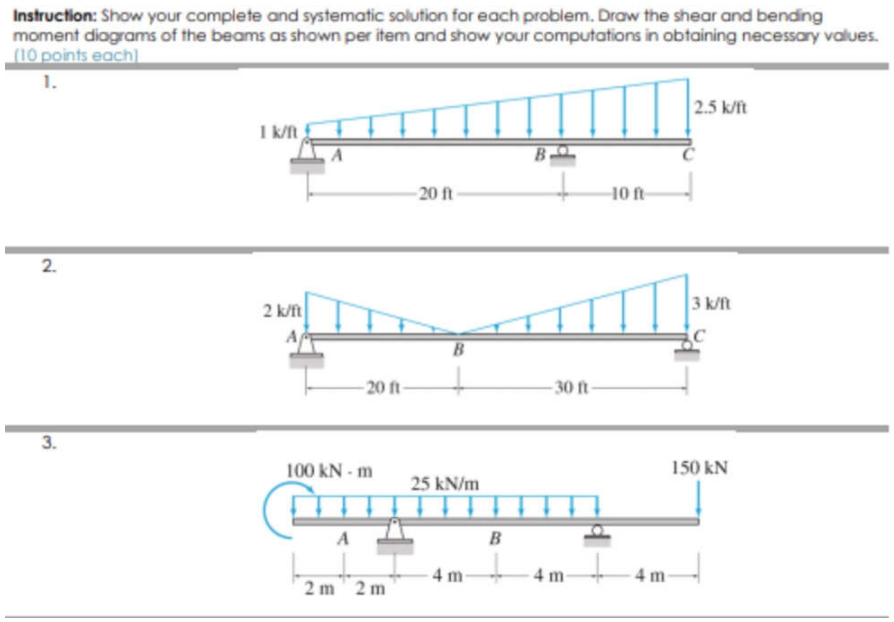
Skills

Context (world-view)

Values

Metacognition

From discipline-bound problem-solvers, and



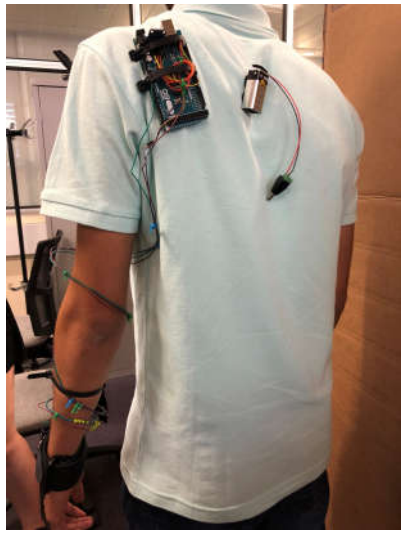
extending to interdisciplinary, challenge-ready collaborators

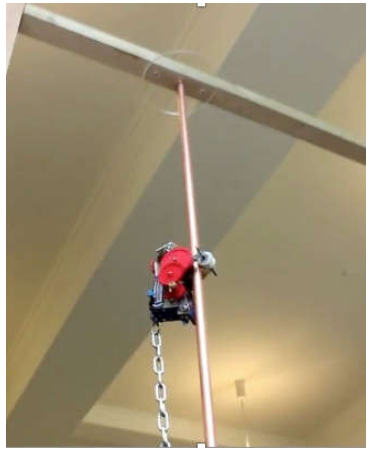
Scenarios: 1-week Intensive PjBLs

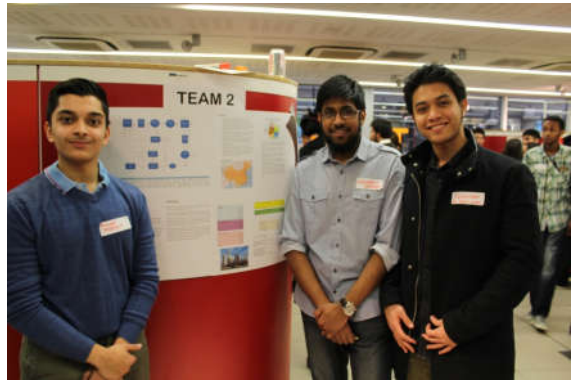
Discipline Specific Projects / Content

- Year 1 – Term 2, 2 projects
- Year 2 – Term 1 & 2, 4 projects
- Attend no other classes
- 6 projects, 6 different teams, integrated taught material
- Projects are part of their Core Learning
- Supported by Industrial, Community or Research partnerships

Scenarios: Department Examples







What is being learned in disciplinary PjBL ?

2018 UCL Research Study

Methodology: Observations of learning and discussions with students in situ.

Higher Education to Employment Transition
Work readiness; Employability; competencies, capabilities, attributes, graduate 'skills and attributes'…

Engineering Employers
… innovative problem-solving skills ; balance between scientific and technical understanding and application to problem solving.

Engineering working practice
collaborative problem-solving and solution finding; Nature of learning at work.

'Non-technical' and social practices associated with disciplinary aspects
Communication
Team working etc.

Turning theoretical work into:
- **own knowledge**
- **'real solutions'**
- **problem solving**
- **solution finding**
- **starting with the minimum**
- **problem finding/defining**

Collaborative Learning
- learning expectations

Lahiff, A., Tilley, E., Broad, J., Roach, K., & Detmer, A. (2019). **Disciplinary learning in project-based undergraduate engineering education: The case for new knowledge**. *Proceedings of the 8th Research in Engineering Education Symposium, REES 2019 - Making Connections*, 578-587.

Disciplinary PjBL: What is learned?

Depends on:

- Type/complexity of Project; degree of autonomy expected; scaffolding required.
- “The ubiquitous presence of and interaction with technological objects … frames the learning process” (Nerland, 2008)
- Cross curricula expectations, induction and many opportunities for presentation and communication of work/ideas
- Active mediation of learning through feedback, questioning and reflection (with peers, PGTAs, lecturers and external experts)

Disciplinary PjBL: What's required?

Requires:

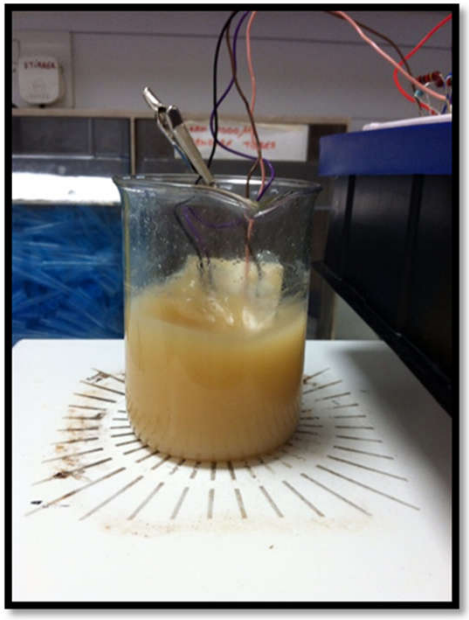
- An understanding of learning as a *social practice.*
- Project groups to feature '*distributed cognition*'.
- A series of interactions between students over time (de Graff and Kolmos, 2007; Illeris, 2009)
- Not simply 'applying' what has already been learned, as this limits the opportunity for creation of new knowledge
- Recognition that knowledge 'becomes a lens' through which problems, situations and practices specific to the domain are being scrutinised (Damşa & Nerland 2016)

Cornerstone Approach to Interdisciplinary PBL

Engineering Challenges
Year 1
Term 1
10 weeks
4-8hrs/wk
Future Focused Socially
Reflective Problem

Disciplinary Pairing

Biochemical
Chemical
Biomedical



Civil
Mechanical

Computer Science
Electrical

Authencity: Student perspective

To probe the pedagogy of interdisciplinary experiential learning, we asked students,

"What did you like most about the Interdisciplinary Engineering Challenges?"

84% of the cohort (~900 students) made reference to **authenticity** of the learning experience, particularly in terms of the **real-world context and authentic disciplinary pairing**, the sharing and peer learning of **technical and non-technical task practicalities**, or the need to use **professional skills** for successful completion.

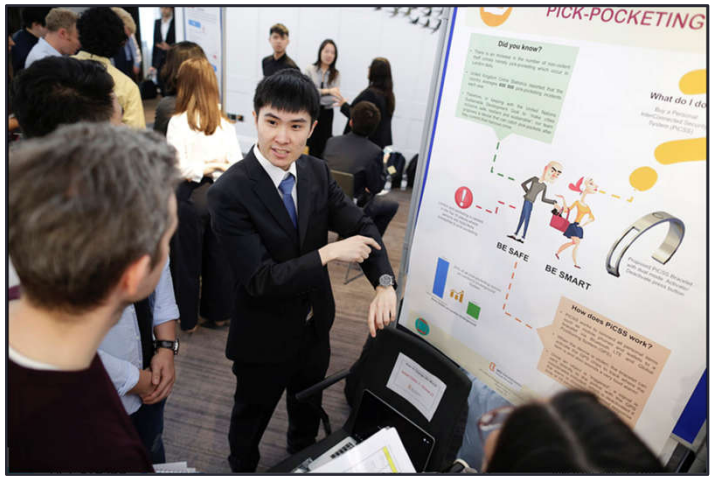
Authenticity in PjBL (Roach et al. 2018)

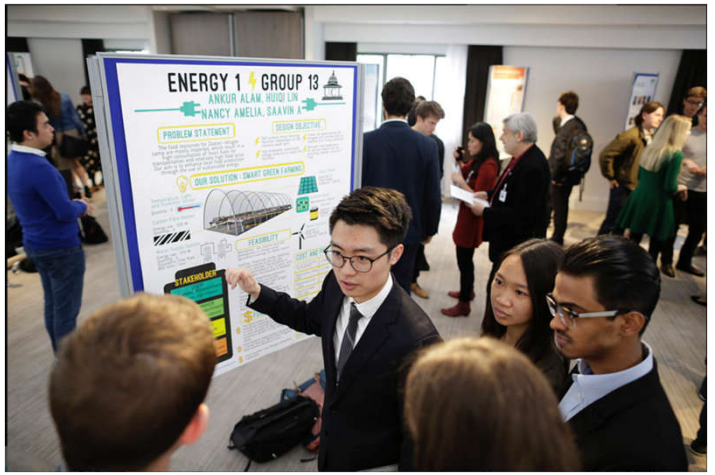
- **Context Authenticity**: Content is or resembles real world content (e.g.: the data, the problem, the stakeholders etc.).
- **Task Authenticity**: The process/activities resemble real world activities (e.g.: design, research, teamwork, reports etc.).
- **Impact Authenticity**: Student outputs are used outside the education environment (e.g.: community or industry-based projects).
- **Personal/Value Authenticity**: Strobel et al. (2012) propose two additional dimensions of authenticity,
  - Personal authenticity, in which projects are close to personal life,
  - Value authenticity in which students' own questions get answered or the project itself satisfy personal needs.

Capstone Approach to Interdisciplinary PBL

How to Change the World
Year 2
Term 3
2 Week Intensive
Socially Driven Problem
UK or Global Contexts

Fully Interdisciplinary





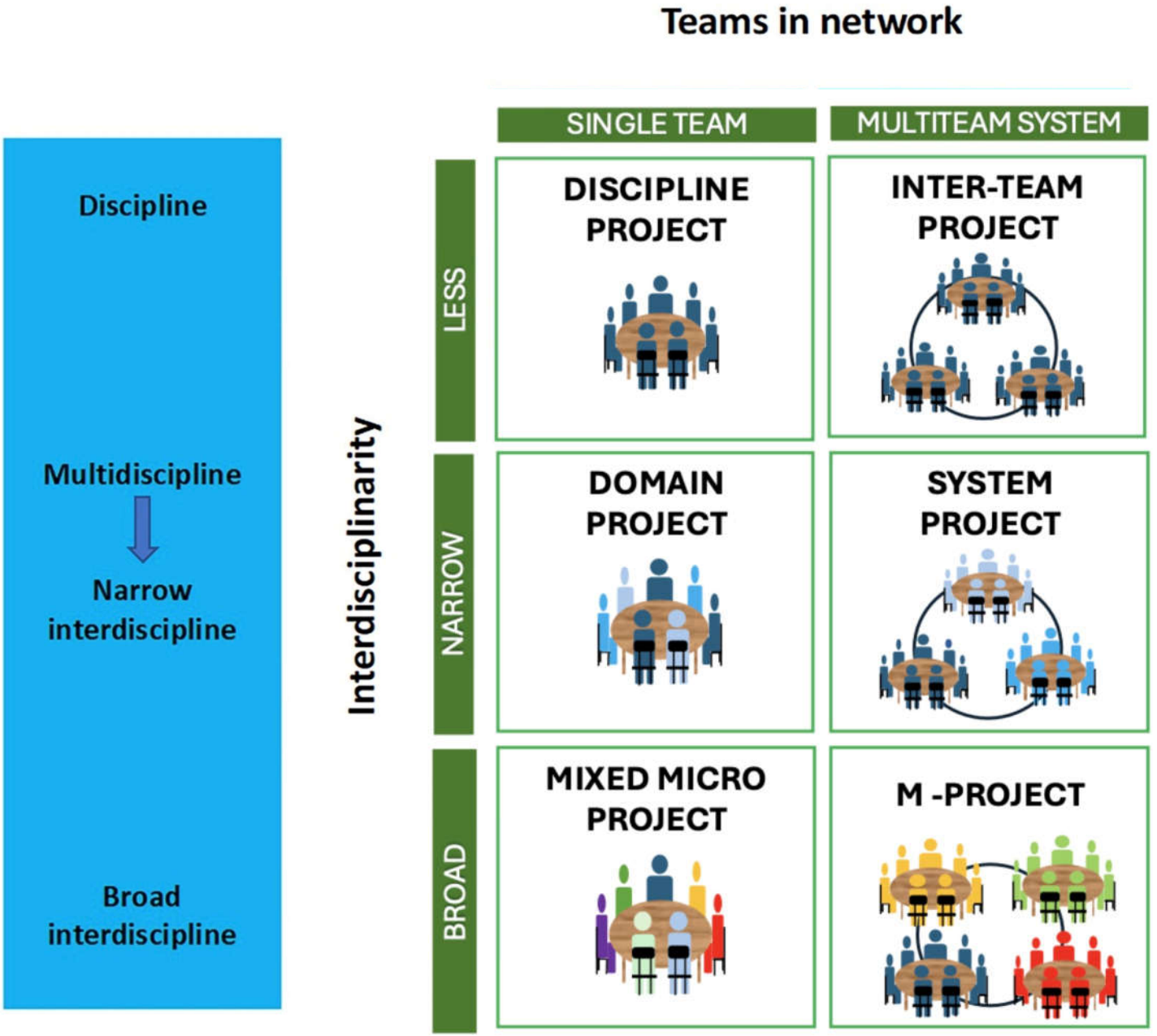
Interdisciplinarity PjBL for Open-mindedness

A Major Finding from observations of **How to Change the World** Scenario in Year 2:

In Interdisciplinary teams, students are **more open minded to different perspectives of the problem and approaches to the solution, as students work to bring their disciplinary practice and knowledge to the interdisciplinary team project.**

Originally with A Detmer, A Lahiff, J Broad, K Roach,
Extended with F Truscott, J Mitchell

Project Types: Kolmos et al. (2024)



SINGLE … TEAM SYSTEM

Discipline

Multidiscipline

Narrow interdiscipline

Broad interdiscipline

Interdisciplinarity

LESS

NARROW

DISCIPLINE PROJECT	INTER-TEAM PROJECT
DOMAIN PROJECT	SYSTEM PROJECT
MIXED MICRO PROJECT	M -PROJECT

SUSTAINABLE DEVELOPMENT GOALS

Tim Brown • Following
Chair at IDEO,Vice Chair at kyu Collective
6yr •

"For organizations seeking to become more adaptive and innovative, culture change is often the most challenging part of the transformation. "

My IDEO colleague **Bryan Walker** and Stanford Graduate School of Business' **Sarah Soule** on the importance of movements, not mandates, in leading cultural change in an organization: **http://ideo.to/RUPxRG**.

Changing Company Culture Requires a Movement, Not a Mandate

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Education is not the filling of a pail, but the lighting of a fire.

– *William Butler Yeats, poet*