THE UNIVERSITY of EDINBURGH
School of Engineering
www.eng.ed.ac.uk

Experiments in Learning Design

Making space for creativity and continuity in design education

Dr Tim Stratford
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Why change? Why now?

Creating Space for Creativity

Fostering Design Learning:
- *Short projects*
- *Self-led and guided learning*

Who is Tim?

FABER MAUNSELL | AECOM

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School of Engineering

Four taught disciplines:

- Chemical Engineering
- Civil and Environmental Engineering
- Electronics and Electrical Engineering
- Mechanical Engineering

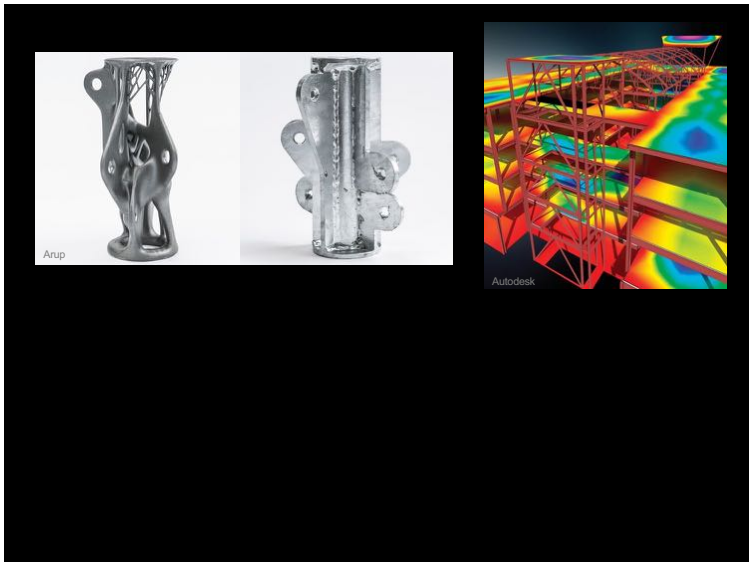
Three degrees in C&EE (about 90 students/year):

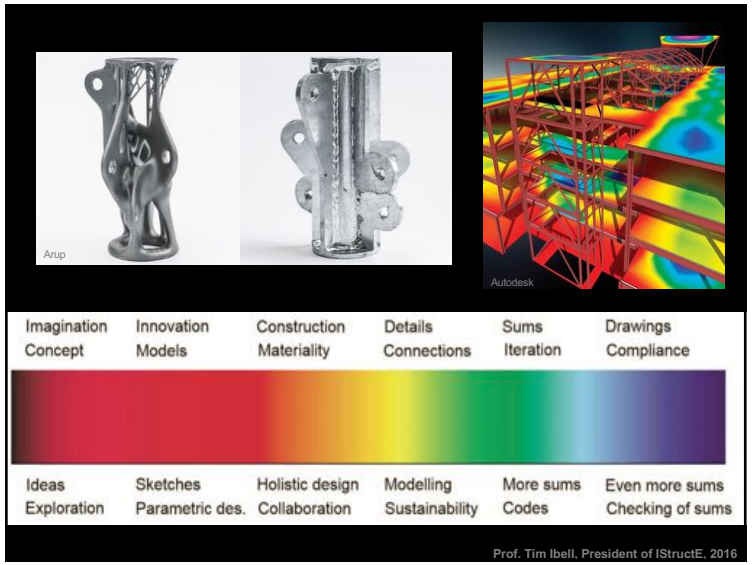
- Civil Engineering
- Structural Engineering with Architecture
- Structural and Fire Safety Engineering

As either:

- 4 year Bachelors of Engineering (BEng)
- 5 year Masters of Engineering (MEng)

Why change?
Why now?





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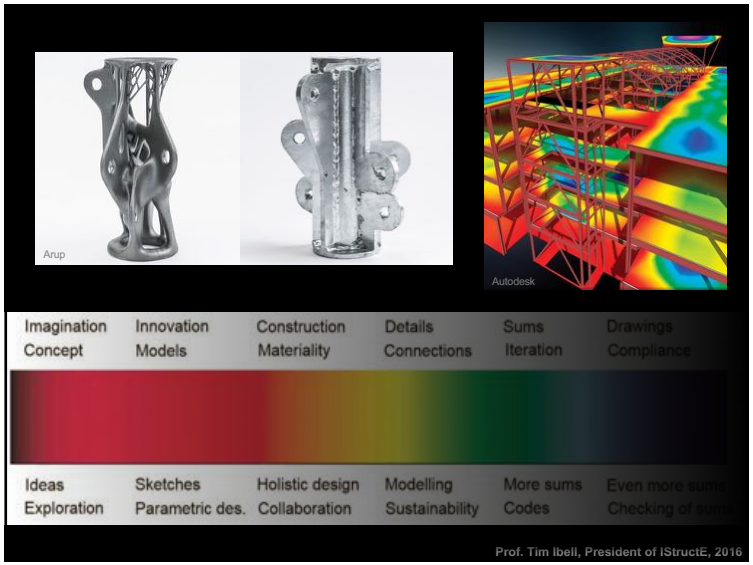

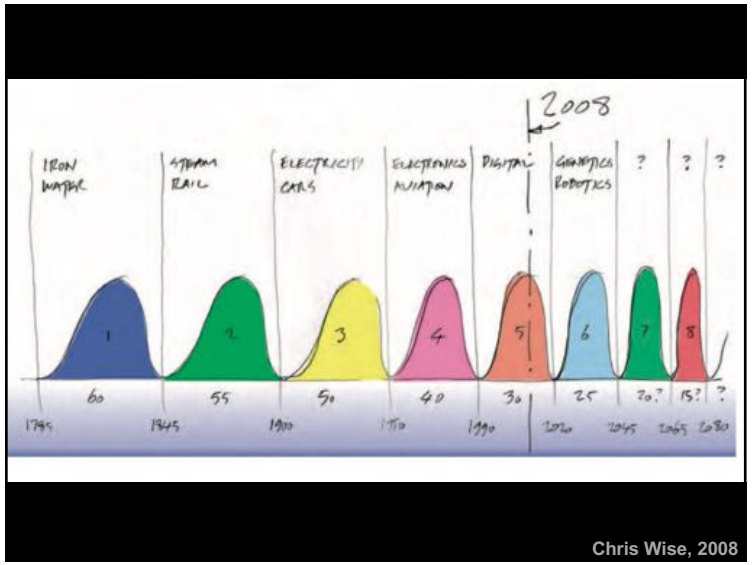

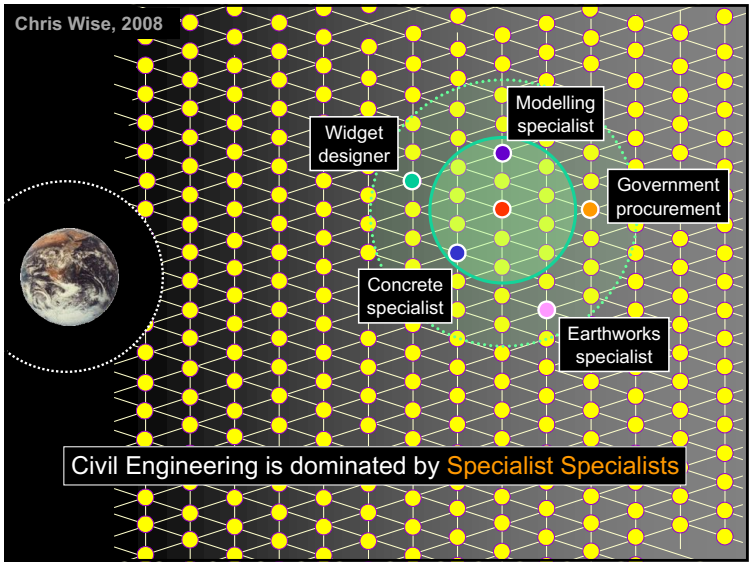

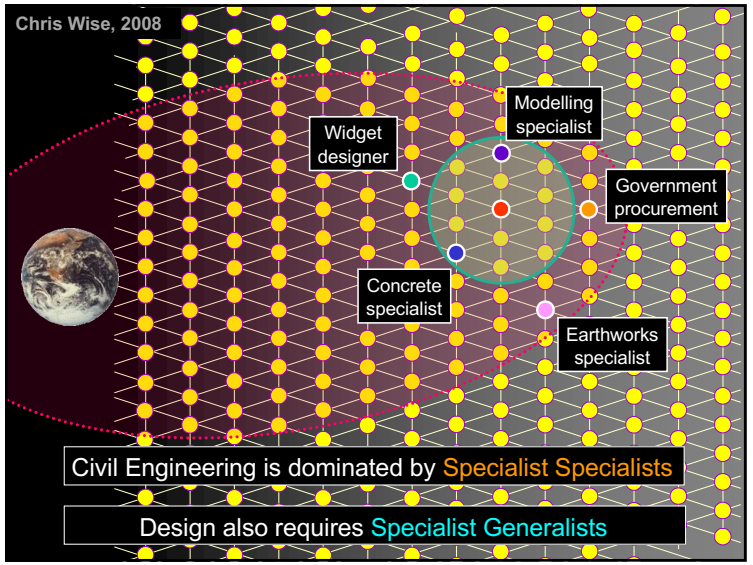

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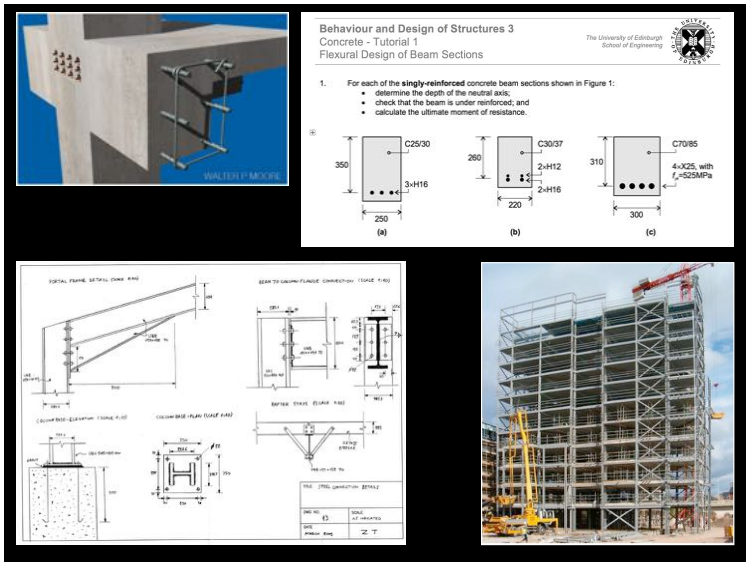
How were we teaching "design" in 2008?

"Design" Courses in 2008

1. Civil Engineering 1 — *Hydropower project*
2. Behaviour and Design of Structures 2 — *Code design of steel and concrete*
3. Detailed Design of Structures 3 — *Code design of steel and concrete buildings*
4. Civil Engineering Design Project 4 — *Tunnel design*
5. Structural Engineering Design Project 5 — *Bridge Design*

Interdisciplinary Design Projects 4 (cross-Engineering)



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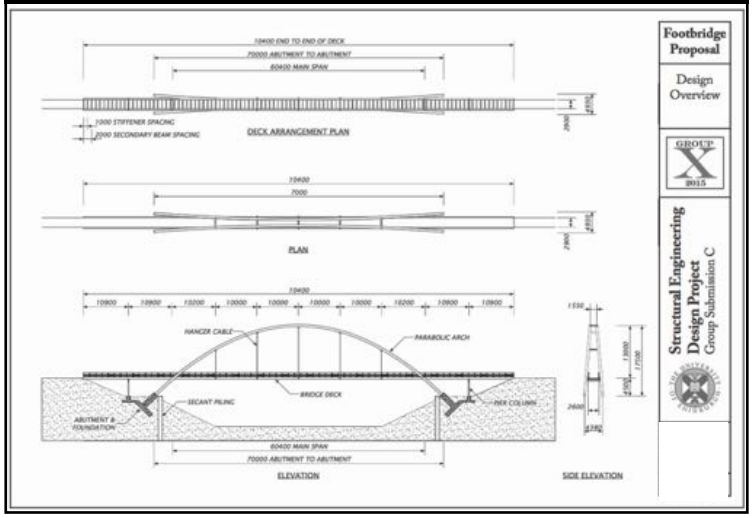
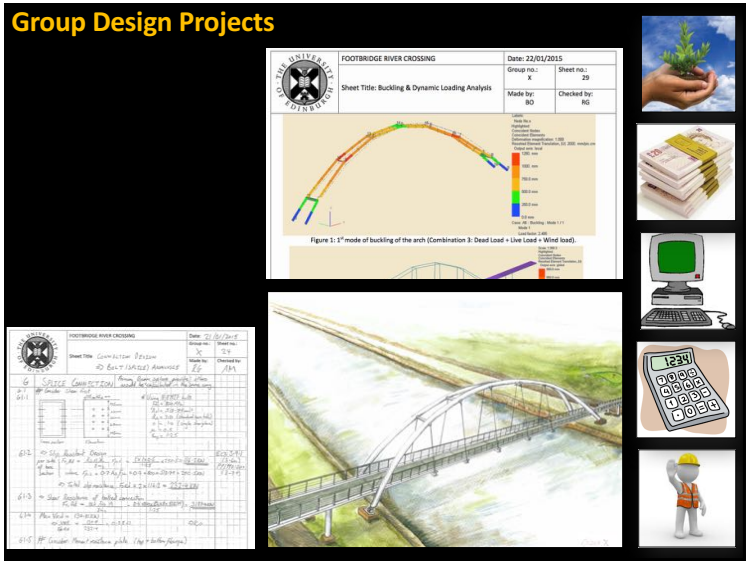
Group Design Projects



Group Design Projects



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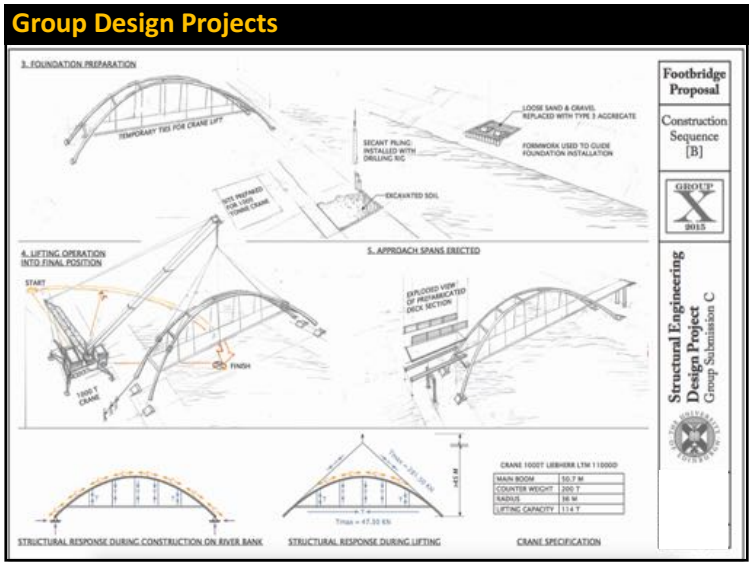
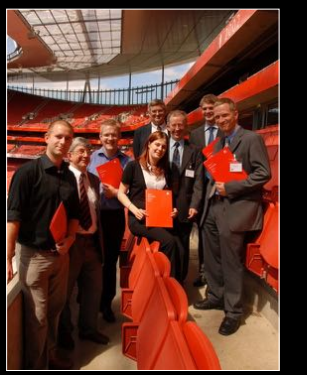


Group Design Projects

2013 - 1st place
2010 - 2nd place
2009 - 3rd place
2007 - 1st place
2006 - 3rd place
2001 - 2nd place



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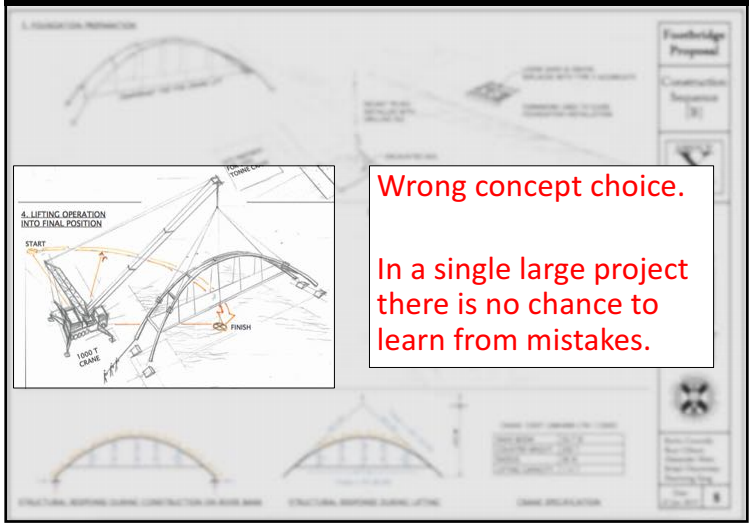
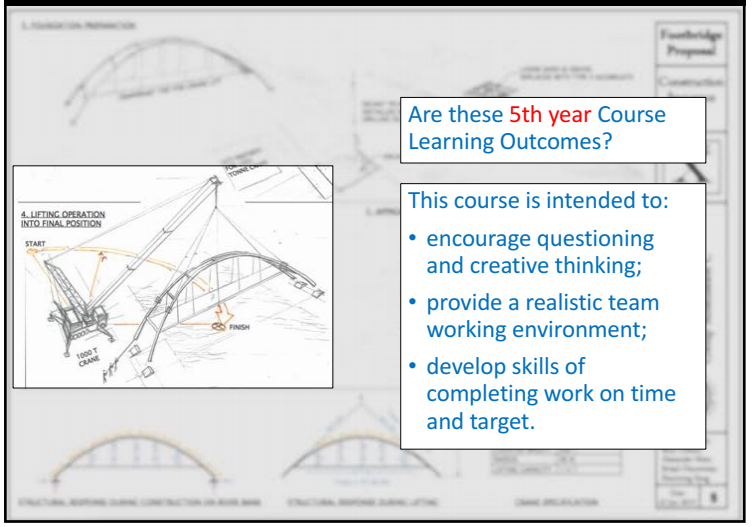


Wrong concept choice.

In a single large project there is no chance to learn from mistakes.

Group Design Projects



Are these 5th year Course Learning Outcomes?

This course is intended to:

- encourage questioning and creative thinking;
- provide a realistic team working environment;
- develop skills of completing work on time and target.

Creativity and Continuity ?

> *Civil Engineering is the art of directing the great sources of Power in Nature for the use and convenience of man;*
>
> *being that practical application of the most important principles of natural Philosophy which has in a considerable degree realized the anticipations of Bacon, and changed the aspect and state of affairs in the whole world. The most important object of Civil Engineering is to improve the means of production and of traffic in states, both for external and internal Trade. This applied in the construction and management of Roads - Bridges - Rail Roads - Aqueducts - Canals - river navigation - Docks, and storehouses for the convenience of internal intercourse and exchange; - and in the construction of Ports - Harbours - Moles - Breakwaters - and Lighthouses, and in the navigation by artificial Power for the purposes of commerce.*
>
> *Thomas Tredgold*
> *Institution of Civil Engineers, Royal Charter, 1828*

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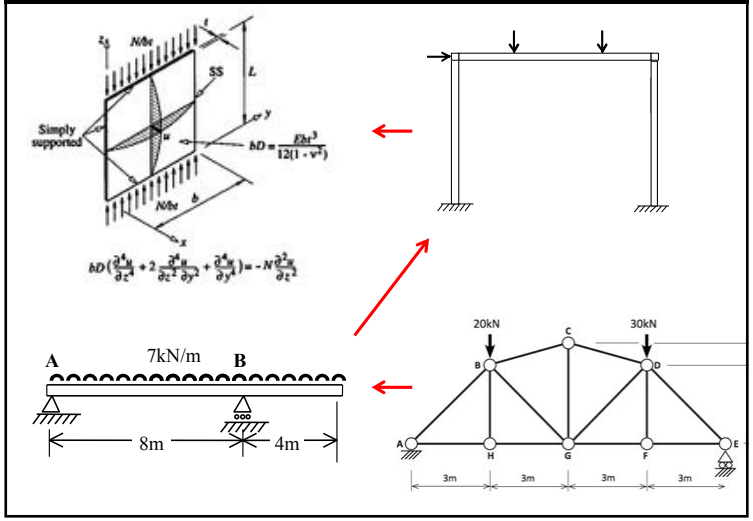
> *Engineering problems are under-defined, there are many solutions, good, bad and indifferent. The art is to arrive at a good solution. This is a creative activity, involving imagination, intuition and deliberate choice.*
>
> *Ove Arup*

> *Engineering is the art of modelling materials we do not wholly understand, into shapes we cannot precisely analyse so as to withstand forces we cannot properly assess, in such a way that the public has no reason to suspect the extent of our ignorance.*
>
> *Dr A R Dykes (IStructE, 1976)*

A Structures Learning Thread



Creating a Design Learning Thread

Civil Engineering 1	4 x pm	Road design; bridge inspection
	6 x pm	Hydropower reservoir
Tools for Engineering Design 2	1 x pm	1 minute designs; 15 minute designs
	2 x pm	KB engineering estate upgrade
	2 x pm	Education masterplans in Africa
	3 x pm	Design-build-test
	3 x pm	Calculation, drawing, reflection tasks
Conceptual Design for Civil Engineers 3	1 x pm	Timber design initial concepts
	1 x pm	Restaurant cantilevered off cliff face
	2 x pm	Cable car over dockyard
	5 x pm	TRADA Timber design project
Interdisciplinary design project 4	10 x pm	Passive house / potable water / hydropower
Civil Eng Des Proj 4	2 wks full time	Geotechnical design (immersed tube tunnel; wind turbine foundations). Transportation design
Structural Des Proj 5	2 wks full time	Bridge design

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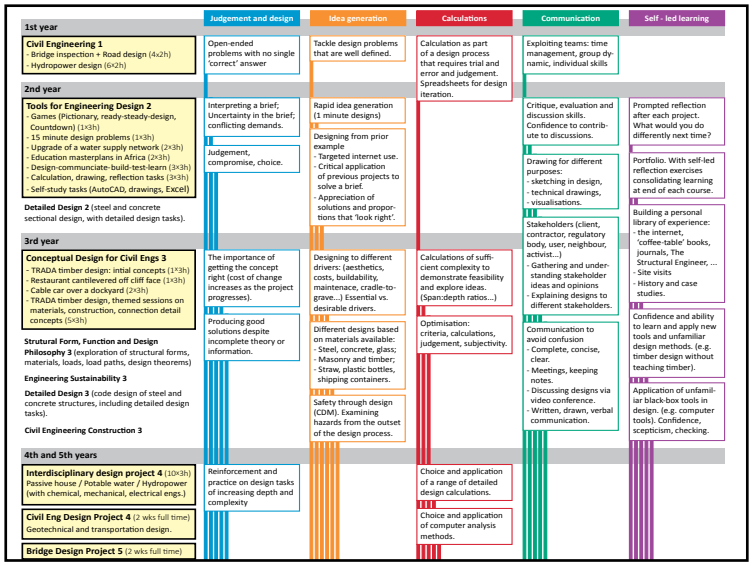

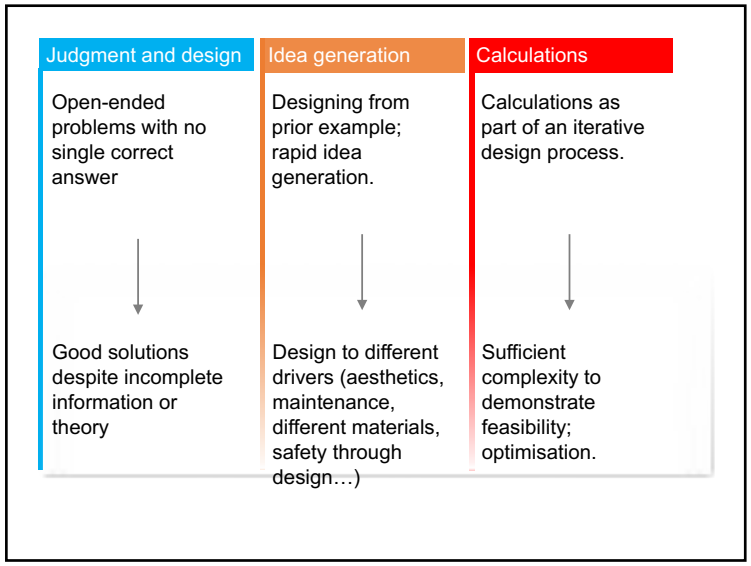

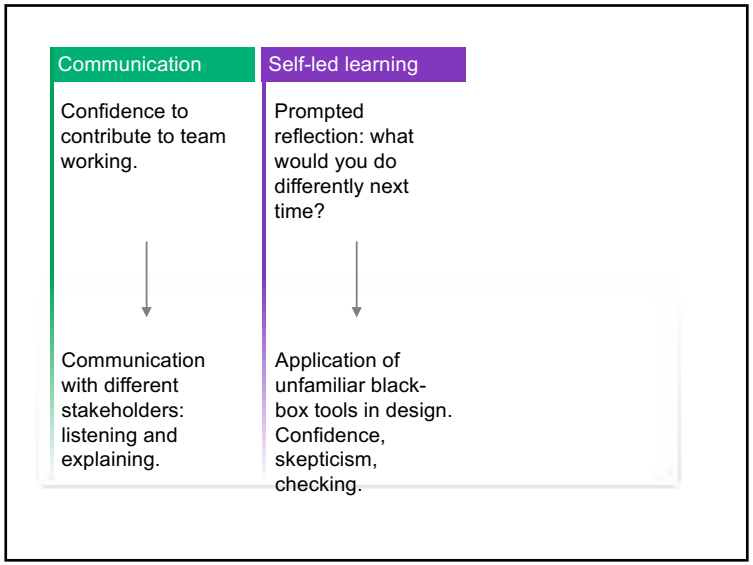

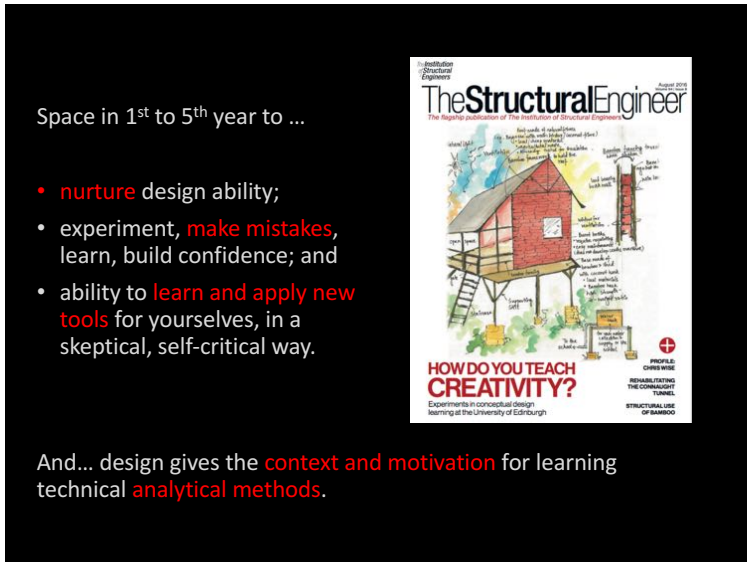

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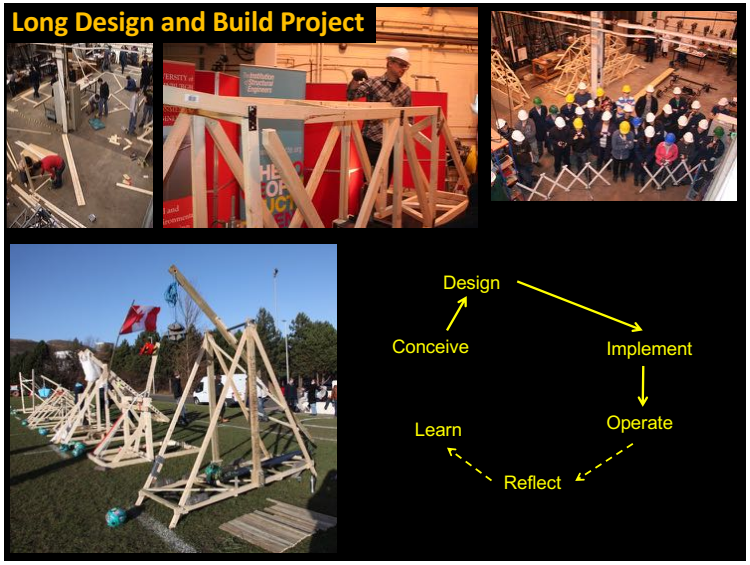
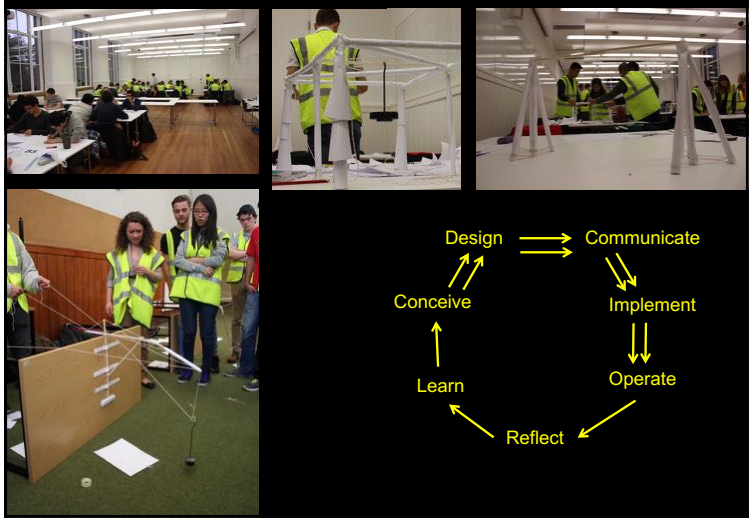
How to Foster Design Learning?

Long Design and Build Project

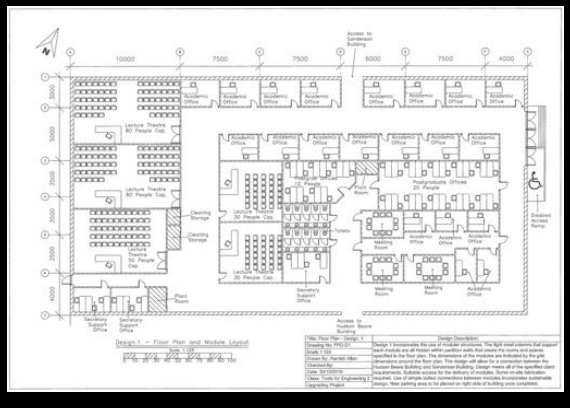


Short Design and Build Project



Short Projects

- Space to make mistakes, reflect, learn, try again…
- Guided learning



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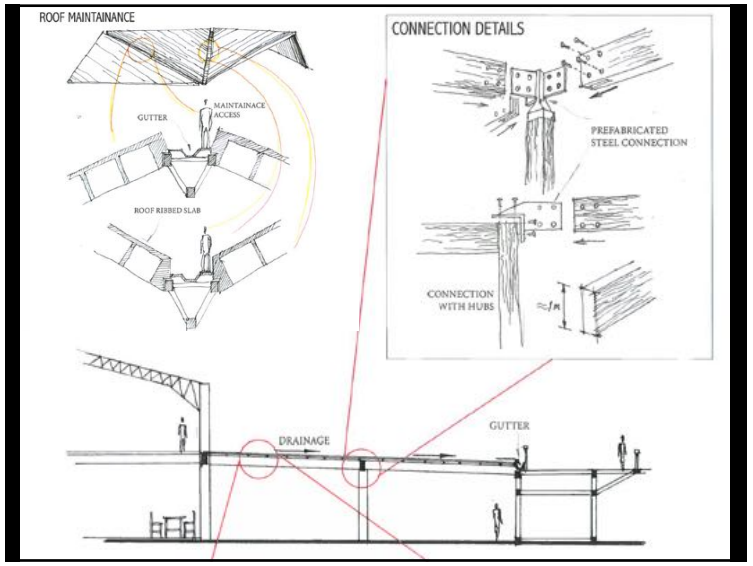
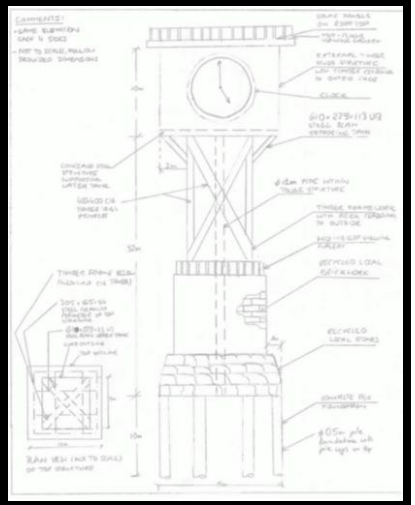
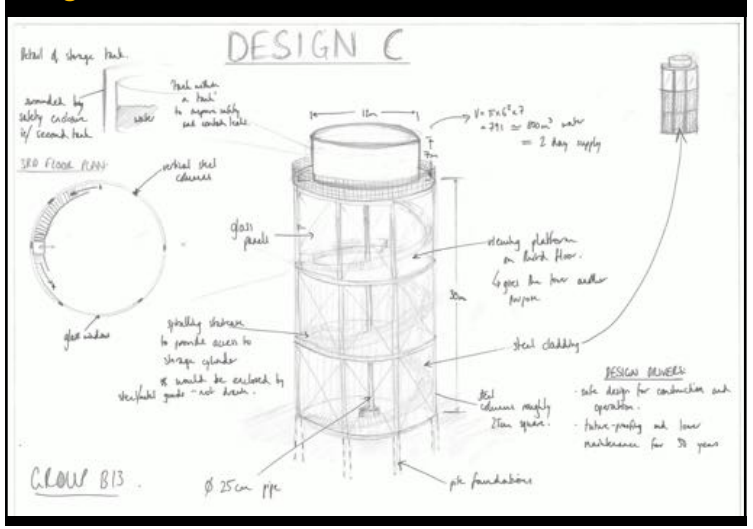


Design Drivers

Groups			Driver
B1	B6		Future-proof and maintenance free for 50 years
B2	B7	B10	A transparent landmark structure
B3	B8	B11	Carbon-neutral construction and operation
B4	B9	B12	Minimise the whole-life cost of the project
B5		B13	Prioritise safety during construction, operation, and de-construction at the end of life.



Design Drivers



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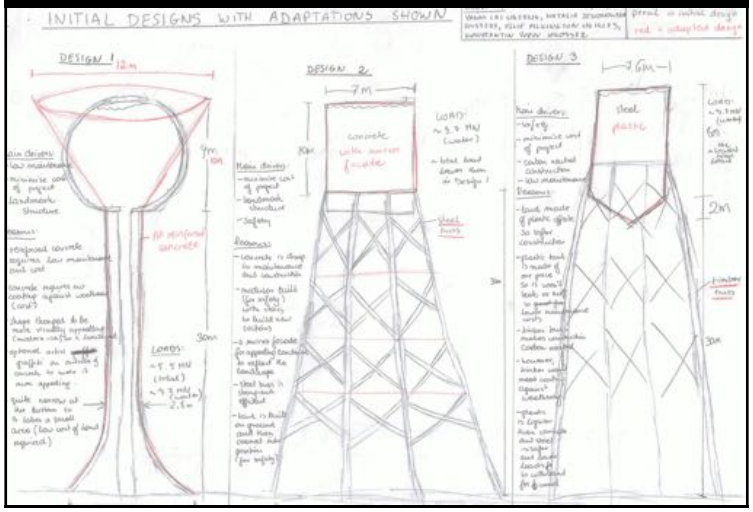
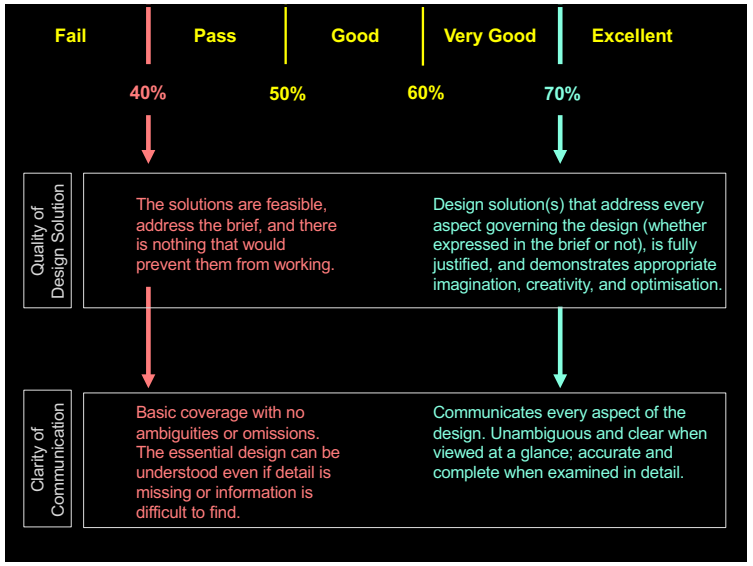
Design Drivers





Self-Learning at the Heart of Design

Self-led Learning

Learning new tools.

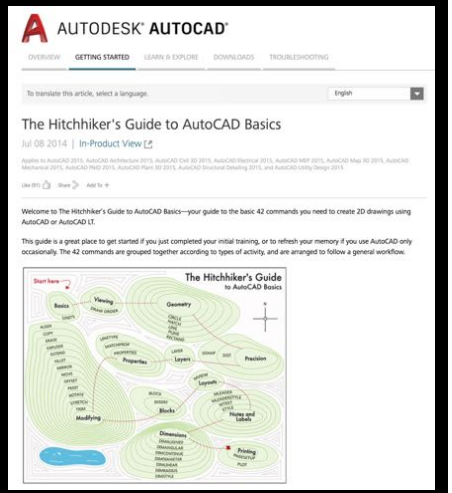
+

Applying them in a skeptical, self-critical manner.

⇓

Sensible black-box design.

Use of CAD



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Self-led Learning

Learning new tools.

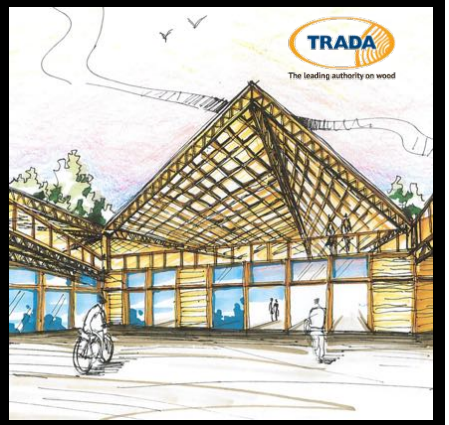
+

Applying them in a skeptical, self-critical manner.

⇓

Sensible black-box design.

Drawing skills



Self-led Learning

Learning new tools.

+

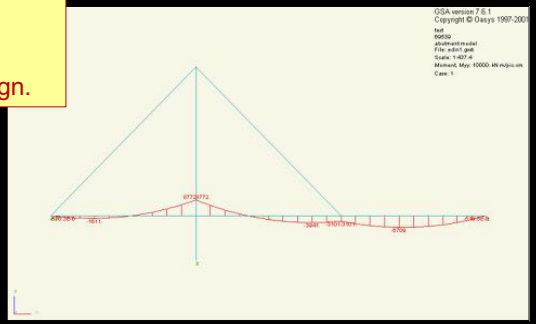
Applying them in a skeptical, self-critical manner.

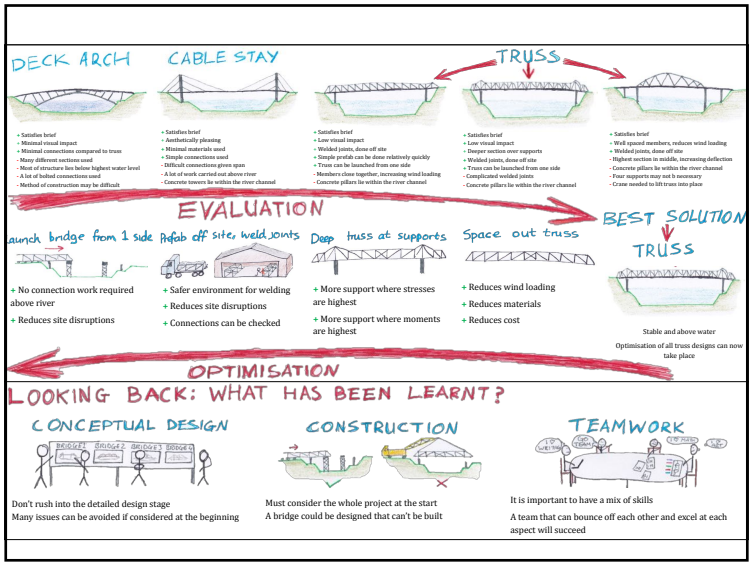
⇓

Sensible black-box design.

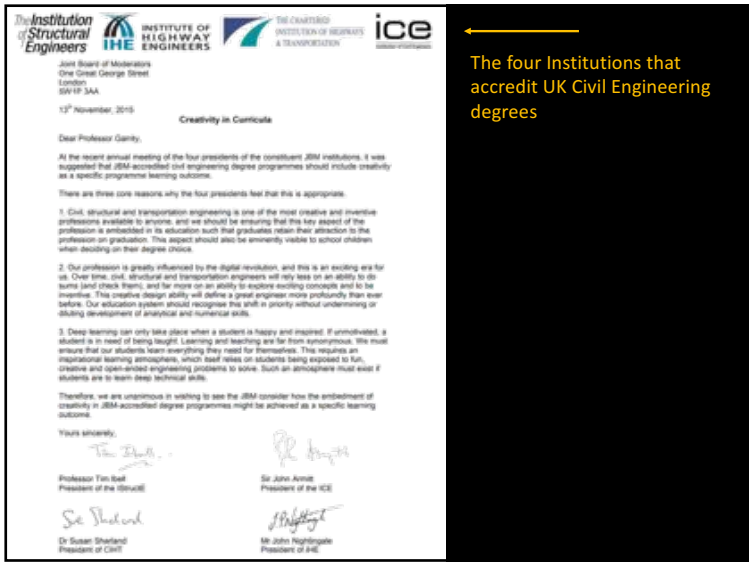
Analysis software

… without being taught the theory

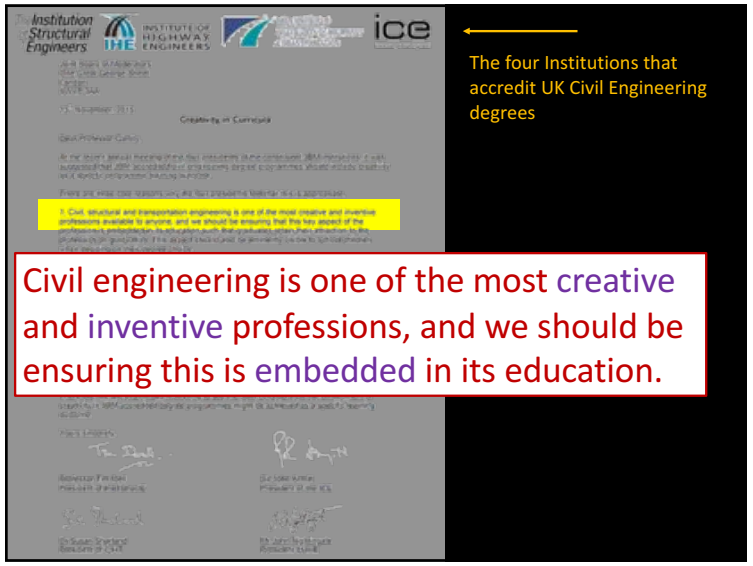




Summary



The four Institutions that accredit UK Civil Engineering degrees



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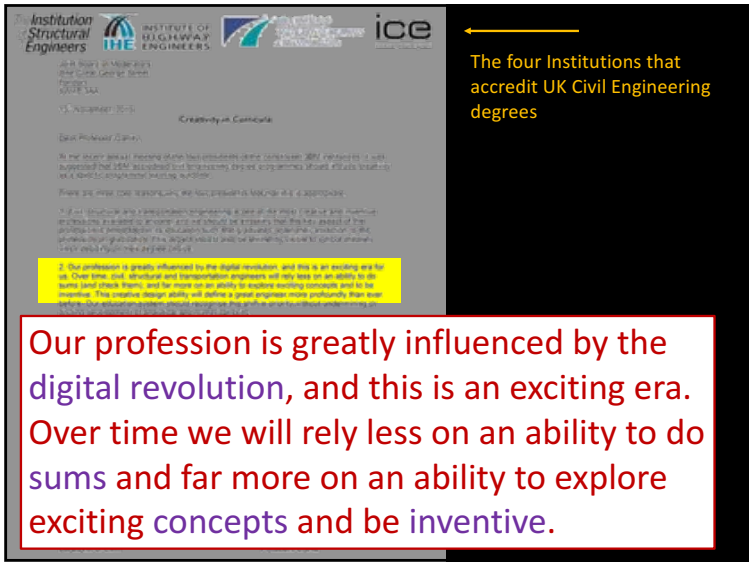
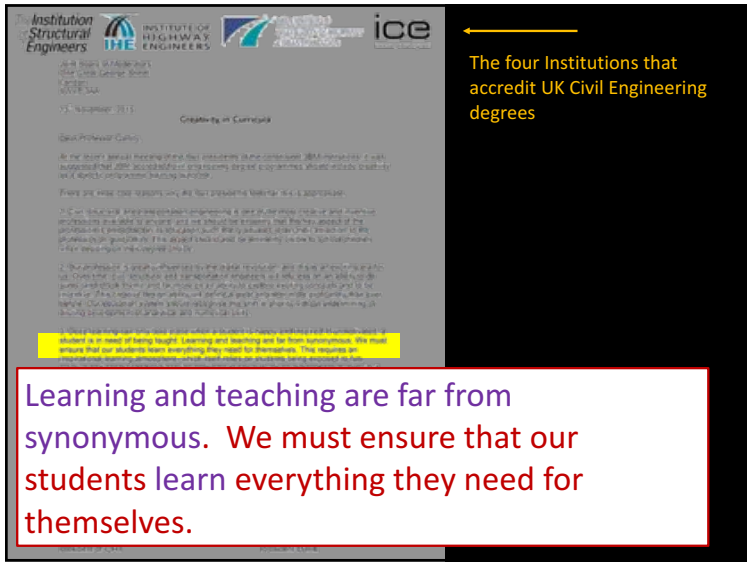
Civil engineering is one of the most creative and inventive professions, and we should be ensuring this is embedded in its education.



The four Institutions that accredit UK Civil Engineering degrees

Our profession is greatly influenced by the digital revolution, and this is an exciting era. Over time we will rely less on an ability to do sums and far more on an ability to explore exciting concepts and be inventive.



The four Institutions that accredit UK Civil Engineering degrees

Learning and teaching are far from synonymous. We must ensure that our students learn everything they need for themselves.

With particular thanks to:

Martin Gillie (University of Manchester)
Martin Crapper (Northumbria University)
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Oliver Riches (Arup)
Barry Colford (AECOM)
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Brian Bell (Network Rail, ret.)
Ed McCann (Expedition Engineering)
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