CONSTRUCTIVISM AND COMPLEXITY:

A PHILOSOPHICAL BASIS FOR EXPERIENTIAL LEARNING MODELS IN ENGINEERING DESIGN EDUCATION?

University of Bristol

Thea Morgan & Chris McMahon KIT Workshop 2017 28.06.17

OVERVIEW

- Different paradigms of learning: ***positivism & constructivism***
- Current learning models: ***lecture-based & project-based***
- Issues in engineering design education: ***reflection***
- Design activity as constructivist inquiry
- Complexity as meta-paradigm
- Supporting reflection in project-based learning

DIFFERENT PARADIGMS OF LEARNING

Engineering Science:

Positivist paradigm

- Search for knowledge as objective truth
- Knowledge is explicit (codifiable into language)
- Can be learnt through direct teaching

Design:

Constructivist paradigm

- Construct knowledge from meaningful experience
- Knowledge is tacit (not codifiable into language)
- Must be learnt experientially

DIFFERENT PROBLEMS TO SOLVE

Rational problem-solving

- Problem is defined
- Reduce/divide/abstract
- Quantitatively model
- Recombine

Positivist

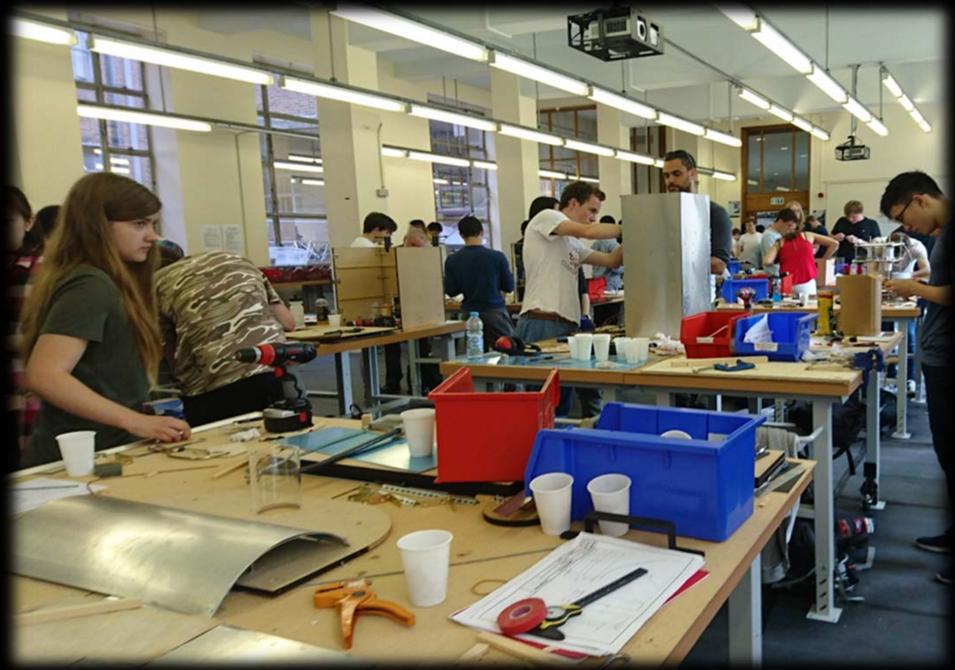
Design problem-solving

- Problem/solution coevolve
- Embrace complexity
- Identify patterns/themes
- Develop a frame

Constructivist

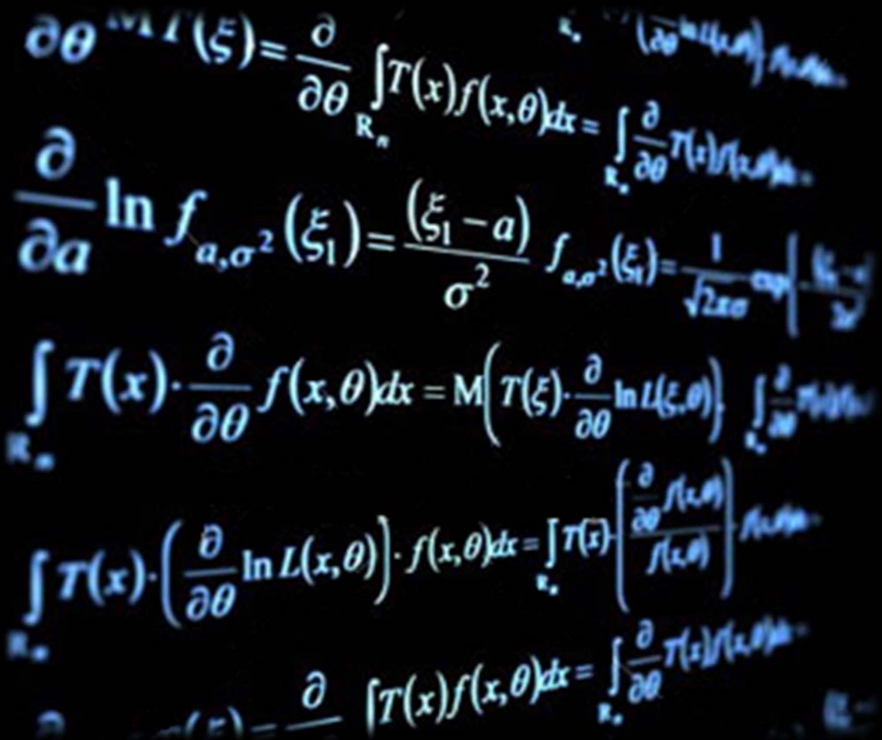
PROJECT-BASED-LEARNING

- Experiential learning through reflection
- Group projects
- Studio-type setting



First year students at Bristol University during a PBL experience

ISSUES IN ENGINEERING DESIGN EDUCATION



EXPERIENCES IN INDUSTRY

- Small engineering design consultancy
- Innovative conceptual design
- Mostly recent graduates
- Perceptions of design did not match design behaviour

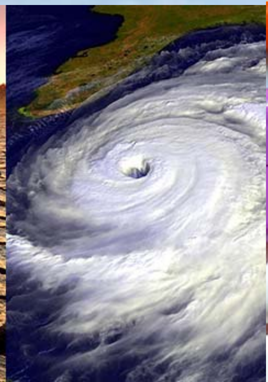
RADICALLY NEW PROBLEMS

"Open, complex, dynamic, and networked problems"

Dorst (2015)









REFLECTION

Experiential learning =

'Learning through reflection on experience'

REFLECTION

Experiential learning =

'Learning through reflection on ***PERCEIVED*** *experience'*

HOW CAN WE BETTER SUPPORT PBL EXPERIENCES?

"the mission of adult education is to emancipate people from a self-imposed restrictive view of the world, to one that is open to new ideas". Moon (2013).

So in this context, the mission of engineering design education is to emancipate students from a restrictive (purely positivistic) worldview about the nature of engineering design knowledge and learning.

Students must be aware of, and comfortable in, multiple paradigms of learning.

THE STUDENT STUDIES

Research Question:

How can student design activity during group PBL design experiences in engineering design education be explored, described, and made-sense of, to inform new pedagogical aids to reflection in PBL design environments?

THE STUDENT STUDIES

- Two ethnographic case studies (Y1 and Y5)
- Group PBL experiences
- Design activity was filmed
- Two narrative accounts of student experience produced
- Sensitising concepts guided theme analysis of primary data

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DESIGN AS CONSTRUCTIVIST INQUIRY: CASE STUDY RESEARCH

Five key themes

- Collecting data
- Interpreting and analysing data
- Identifying themes
- Theory-building and testing
- Telling the story

Case = design project

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CASE STUDY RESEARCH

Is focused on the ***singular***, the **particular**, and the **unique**

It is "an in-depth exploration, from multiple perspectives, of the complexity and uniqueness of a particular case in a real-life context"
Simons (2009)

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COMPLEXITY: A META-PARADIGM FOR ENGINEERING DESIGN EDUCATION?

Complexity:

"The generation of rich, collective, dynamical behaviour from simple interactions between large numbers of subunits in a complex system. The interactions generate emergent properties in the unit system that cannot be reduced to the subunits (and that cannot be readily deduced from the subunits and their interactions)."

Rickles et al. (2007)

- A design project can be considered as a complex, dynamic, indeterminate system.
- In case study research a case can also be a complex, dynamic, indeterminate system.

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COMPLEXITY: A META-PARADIGM FOR ENGINEERING DESIGN EDUCATION?

“instead of a problem, we have state A of a system; instead of a solution, we have state B of the system; and the designer and the user are part of the system”.

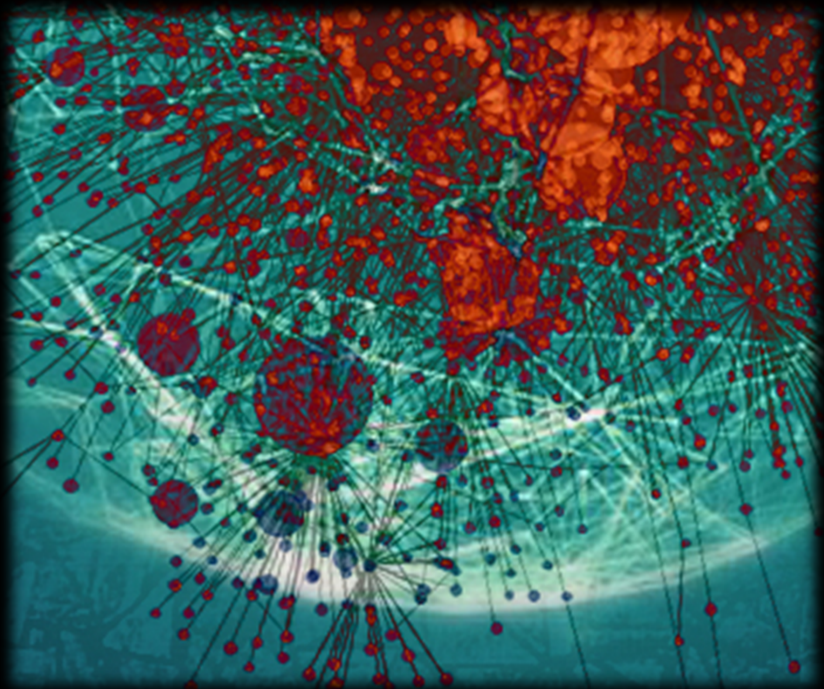
“a system, and especially a human or social system, is best understood from within, through a constructivist approach.”

Findeli 2001

DESIGN AS CASE STUDY ‘RESEARCH’ QUESTIONS

- ‘How can this system in state A be explored and understood’?
- ‘Why does state A of the system lead to these particular emergent properties?’
- ‘How can the system be moved to a state B, in order to generate preferred emergent properties?’

Design concepts are ‘theories’ about possible state B alternatives



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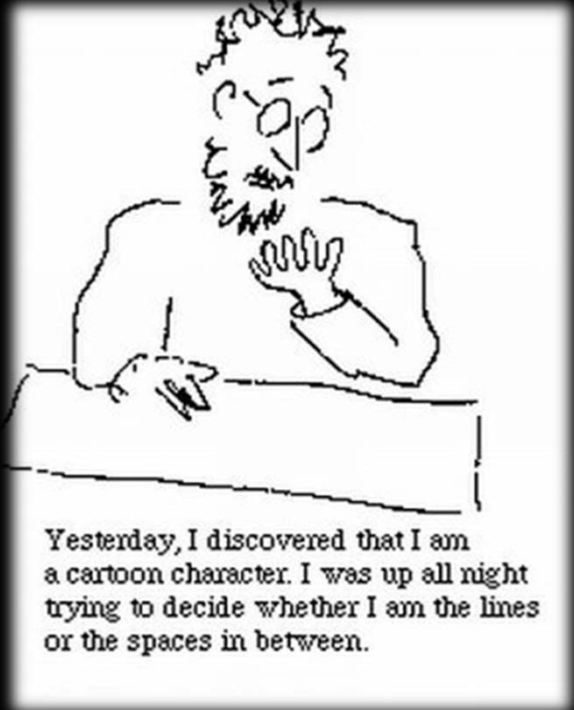
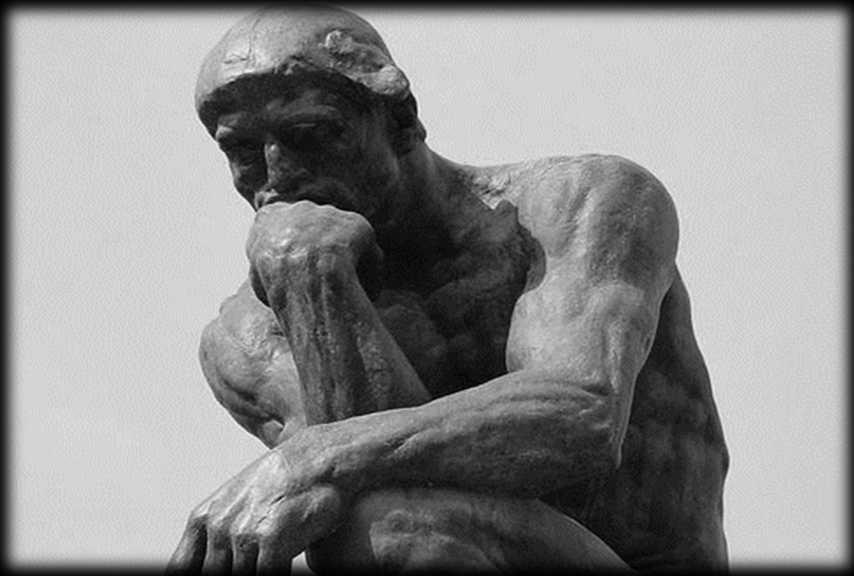
BENEFITS OF USING A CASE STUDY RESEARCH AND COMPLEXITY APPROACH

- Reflexivity and the self is key in CSR
- Designer is part of the complex system so needs to be reflexive
- Designer has responsibility to 'do no harm' – users, society, environment
- Complexity, constructivism, and case study research are established areas of intellectual endeavour



ENABLING REFLECTION IN PBL EXPERIENCES



Teaching 'philosophy and design' – paradigms of learning and nature of design knowledge

Assessment through structured learning journals, using CSR methodology

CONCLUSIONS

If students were able to understand that learning to design is a journey of **knowledge construction** which occurs within a **meta-paradigm of complexity**, where they are a **case study researcher** looking to **make-sense** of a **complex system**, then they may be better enabled to **reflect** on their own learning.

They may come to ***understand what*** they do when they design, and not just learn to ***do*** it.

THANK YOU

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