Creating an Integrated Curriculum for a STEM Discipline

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An ethos embedded within the University

“a goal of all formal education should be to graduate students to lead lives of consequence”

John Henry Brookes
1891 - 1975
UK-SPEC
(Benchmark Statement) – CEng
Graduate Employability is...

“a set of attributes, skills and knowledge that all labour market participants should possess to ensure they have the capability of being effective in the workplace…”

[Universities UK, 2010:6]

“… a curriculum issue and the acquisition of subject specific knowledge & employability skills are complementary not oppositional. Preparing graduates for the ‘world of work’ is an integral part of our strategy”

[Universities UK, 2011:13]
What do Engineering Students have to Learn?

- Mathematics and modelling
- Thermo-dynamics
- Dynamics
- Stress
- Engineering design and practice
- Materials
Inspirational Learning – Why is it Necessary?

- Wide range of student ability
- Formula Student and similar competitive hands on activities satisfy students aspirations to practice engineering for real.
- Need for something else?
Teaching Philosophy

- Bridge the gap between subject theory and the realities of professional practice
- Provide authentic (professional focused) contexts for learning
- Face realistic and relevant situations / contexts
- Introduce students to the culture of the workplace
- Analyse experience to make appropriate professional interventions
- Contemplate and develop a professional identity
- Practice professional teamwork / collaboration
- Develop cultural awareness

[Errington, (2010). Educators for the professions.]
Principles of Authentic Assessment

• ‘Assessment tasks which authentically assess a range of learning outcomes’- real world contexts

• ‘Tasks which are complex and / or contextualized enabling students to demonstrate their competency in a more ‘authentic’ setting.

• Highly aligned to the employability agenda. With professional identity

• Often mixed up with “education versus training’, but here there is independent, critical, thinking evidenced with synthesis of ideas.

Wiggins (1993) describes authentic assessment as tasks and procedures in which students are engaged in applying skills and knowledge to solve “real world” problems, giving the tasks a sense of authenticity…. Replicating the challenges and standards of performance [facing the professional].
Pedagogical Approach

- An **INTEGRATED** curriculum is one that draws together all aspects of the curriculum and does not draw artificial boundaries between knowledge and learning in modules.

- An **EXPLICIT** curriculum is one where key learning outcomes are specifically assessed in modules deemed most appropriate for that assessment.

- **INTEGRATED but EXPLICIT** refers to a curriculum that brings together all aspects of the programme but specifically targets explicit modules to assess core learning outcomes and skills.
Industry Inspirational – Stirling Engine Project

DYNAMIC

ENVIRONMENTAL

ASTHETIC

TANGIBLE

EXPLAINABLE
Industry Inspirational – Stirling Engine Project

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Exploiting the ‘Integrated but Explicit Curriculum’

- Mechanics includes analysis of the components, engine power & speed.
- Engine can be instrumented to provide real live data.
- Thermodynamics includes the Carnot cycle, modifications necessary to adapt it to be the Stirling cycle.
- Alternative materials that can be used.
- Simple modifications for a non-optimised design.
- Mathematical models for position, displacement, acceleration, force, work & power.
- Analysis of dynamic properties, inertia, balance, power & friction.
Related Pedagogical Inputs

- Suitable for students from a wide range of abilities.
- Can be manufactured in two days workshop time.
- Competitive element that students enjoy.
- Clear links in every module that refer to the project.
How does this Help Students Learn?

Confucius says:
“*I hear and I forget.*
*I see and I remember.*
*I do and I understand.*”

In today’s world of Tertiary Education we can create our own saying to reflect this wisdom.

“*I make and I enjoy.*
*I study and I learn.*
*I study what I’m making and I enjoy learning.*”
Feedback from Students – Survey Questions

1. The timetable, organization of the week, lectures then problem sessions, lab day on Friday

2. Lab day, it’s fun you are learning well vs it’s not much fun, you’re not learning much

3. The analytic subjects are good, I am learning and teaching is good vs I’m getting left behind and not coping.

4. I know what is expected of me and I know what I’ve got to do in order to do well vs I don’t know what is expected of me and I don’t know what I’ve got to do in order to well.

5. I feel I’m really getting to understand what engineering is all about vs I don’t feel that I understand what engineering is all about.
Feedback from Students – Survey Questions

1)  [Rating scale with marks]

2)  [Rating scale with marks]

3)  [Rating scale with marks]

4)  [Rating scale with marks]

5)  [Rating scale with marks]
What They Make...

Competition
Industry Inspirational – Stirling Engine Project

Instrumentation for speed and temperature

Temperatures and Speeds

Project Development
Stirling Engine
Refined Design and Instrumentation
Stirling Engine
Refined Design and Instrumentation
Instrumentation for Device

- Screen
- Hood
- Arduino processor
- Thermistor
- Thermistor optical sensor
“What We Make!”

Josh Shires Mous inventor

F1 Renault (formerly Lotus)
Unsung Hero’s of Research

Philip Hughes Terence Floyd
Technical Instructors

Ian Spacksman
Workshop Manager
Summary

• An integrated, but explicit approach was presented in which students were presented with an authentic experience that was found to inspire and motivate students, increase progression and allow deep learning regarding the relationships of the different facets of Level 4 curriculum.

• The approach is being developed to widen the breadth of the experience especially in relation to electronics…
Thanks & Further Information!

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