



Implementation of Project Based Learning in a Large Engineering Programme

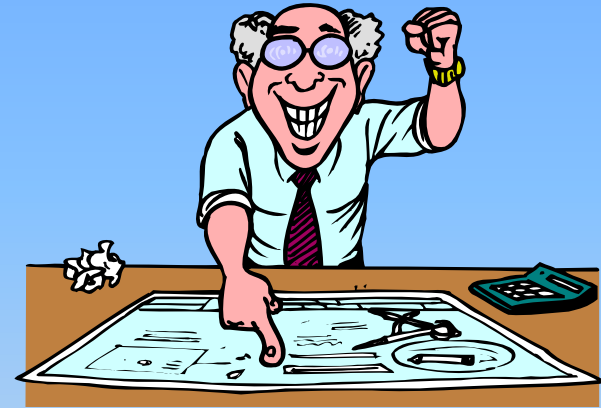
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Time for Change!

Drivers

- Industry demand it
- Irish Engineering Sector
- Bologna
 - 3+1+1. Five Year Accredited Degree (M.A.I.)
- Government Taskforce on Innovation



Time for Change!

Old

Engineering
“labs”

- Out of sync
- Formulaic
- Prescriptive

Objective

Move from podium based,
tiered lecture theatre
structures to small group
learning



Time for Change!



Time for Change!



Time for Change!

Challenges

Old

Existing “labs”

- Out of sync
- Formulaic
- Prescriptive

- Large student numbers (200)
- Resource intensive –
 - Curriculum design
 - Demonstrators
 - Equipment
 - Workspaces
 - Time-tabling
 - Continuous assessment corrections
 - Group work evaluation

Objective

Move from podium based, tiered lecture theatre structures to small group learning

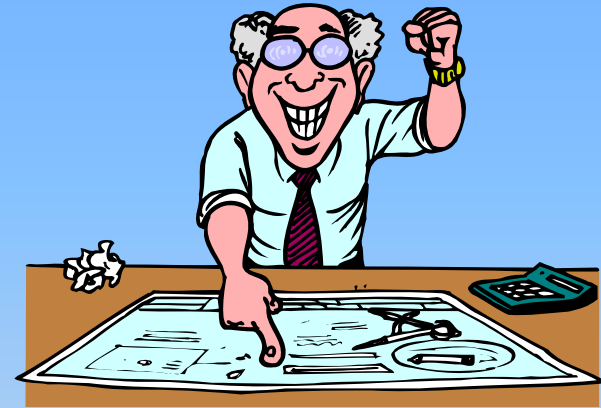


Time for Change!

Initiatives

- National “Knowledge Economy”
- TCD/UCD Alliance/Academy
- Vision 2020

Engineering Innovation & Creative Design



What is CDIO?

Conceive

Design

Implement

Operate



Time for Change - Proposals

Goals of CDIO to develop:

- A deep working knowledge of technical fundamentals.
- A refined ability to discover knowledge, solve problems, think about systems, and master other personal and professional attributes.
- An advanced ability to communicate and work in multidisciplinary teams.
- Skills to conceive, design, implement, and operate systems in an enterprise and societal context.



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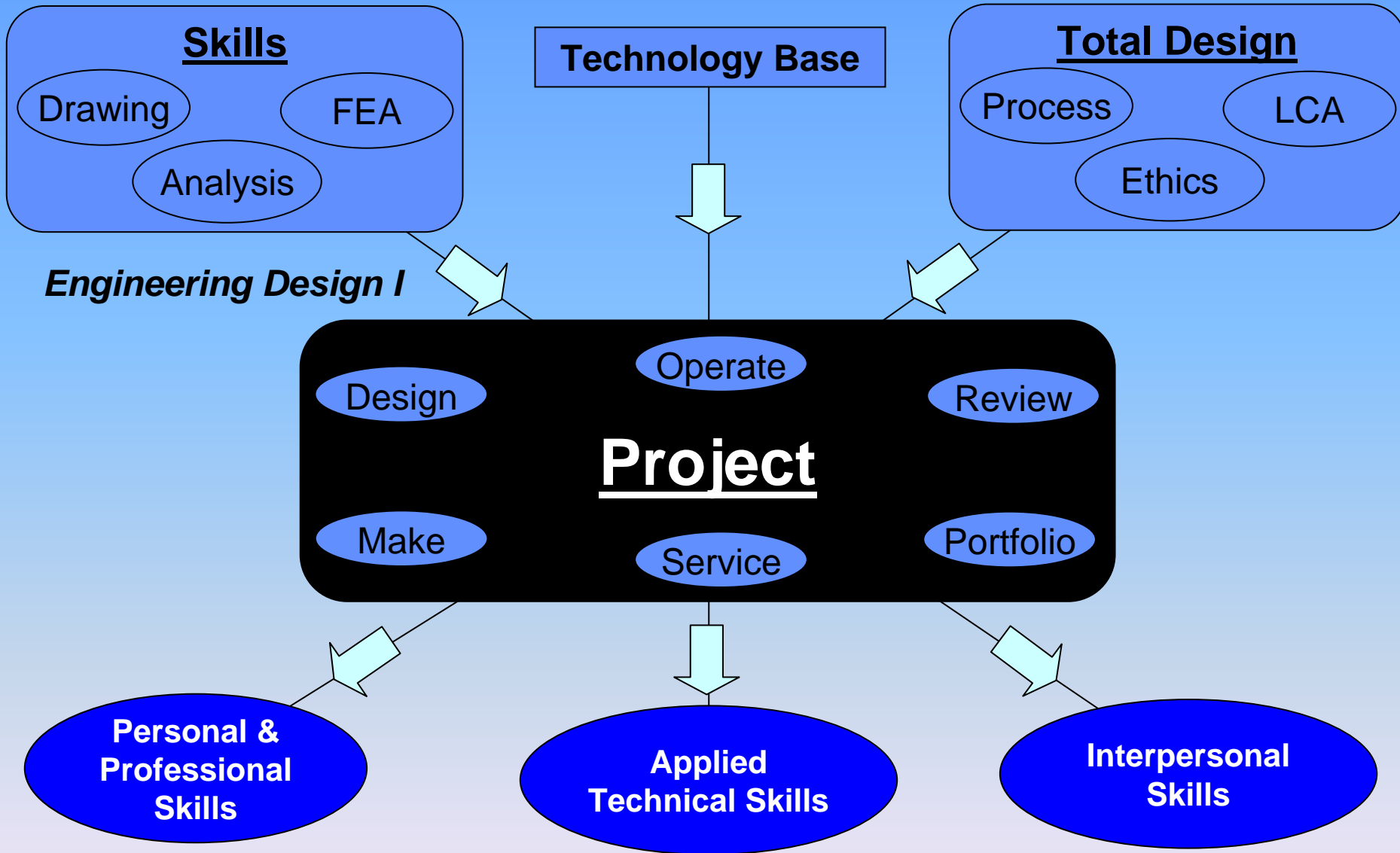
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Design Engineering - Project Based



Design Project – Mangonel

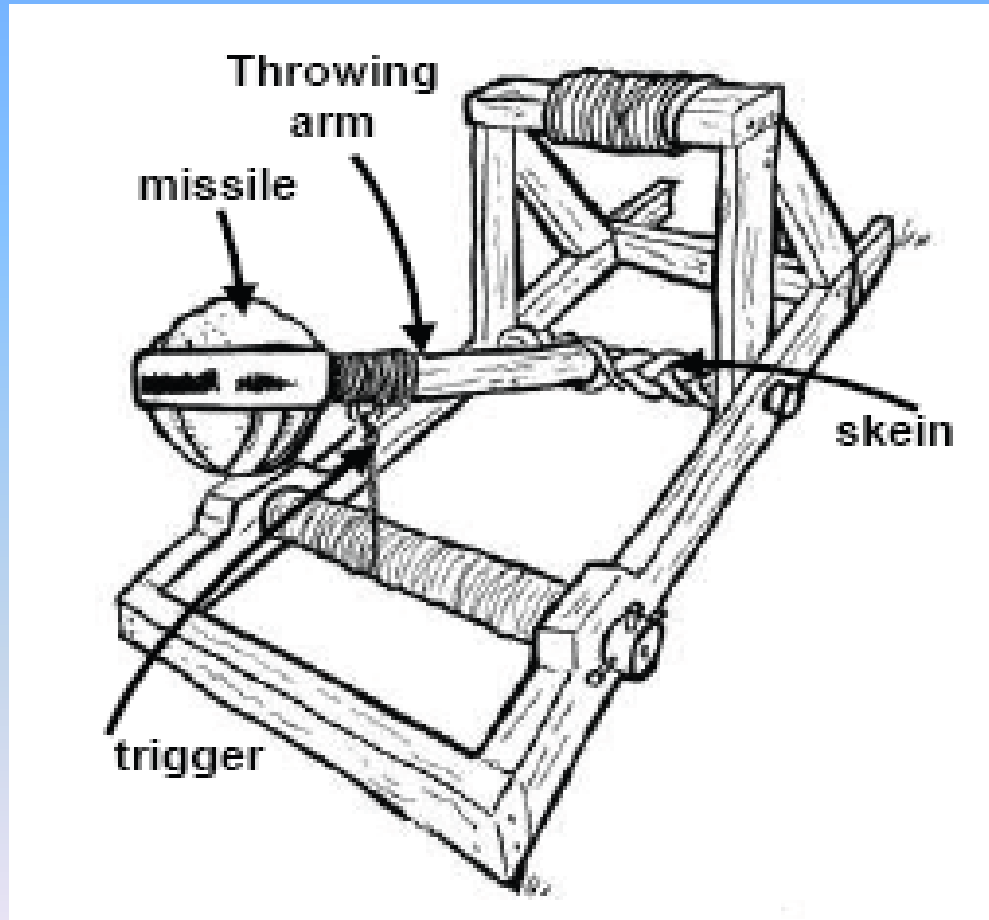
Conceive

Design

Implement

Operate

Engineering Design II



Design Project – Mangonel

Conceive

Design

Implement

Operate



Design Project – Mangonel

Conceive

Design

Implement

Operate

Outline of Programme

Introductory Lectures

- Materials
- Structures
- Modelling
- Dynamics
- Digital Electronics

Small Group Learning

In class assignments/laboratories

180 Students

- 4 streams of 45
- 9 groups per stream (2 demonstrators per stream)



Design Project – Mangonel

Conceive

Design

Implement

Operate

Laboratory Assignments

Mechanical

Dynamics

Civil

Structural Analysis

Electronics

Angular Velocity Measurement Tool



Design Project – Mangonel

Conceive

Design

Implement

Operate

Trajectory Model

No drag

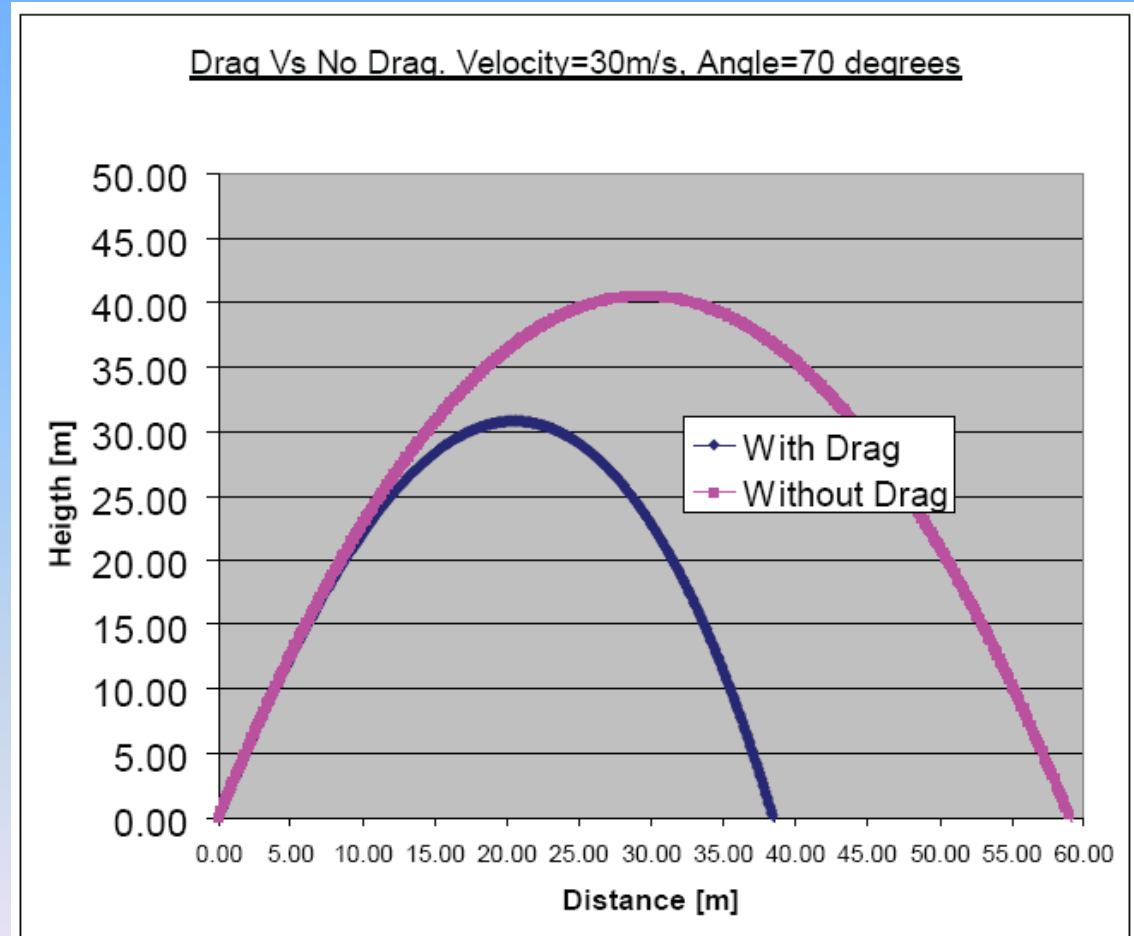
- *Equations for linear motion*
- *Numerical methods*

With Drag

- *Fluid dynamics*

Develop an analysis tool!

- What are important parameters?
- Check results once built!



Design Project – Mangonel

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Implement

Operate

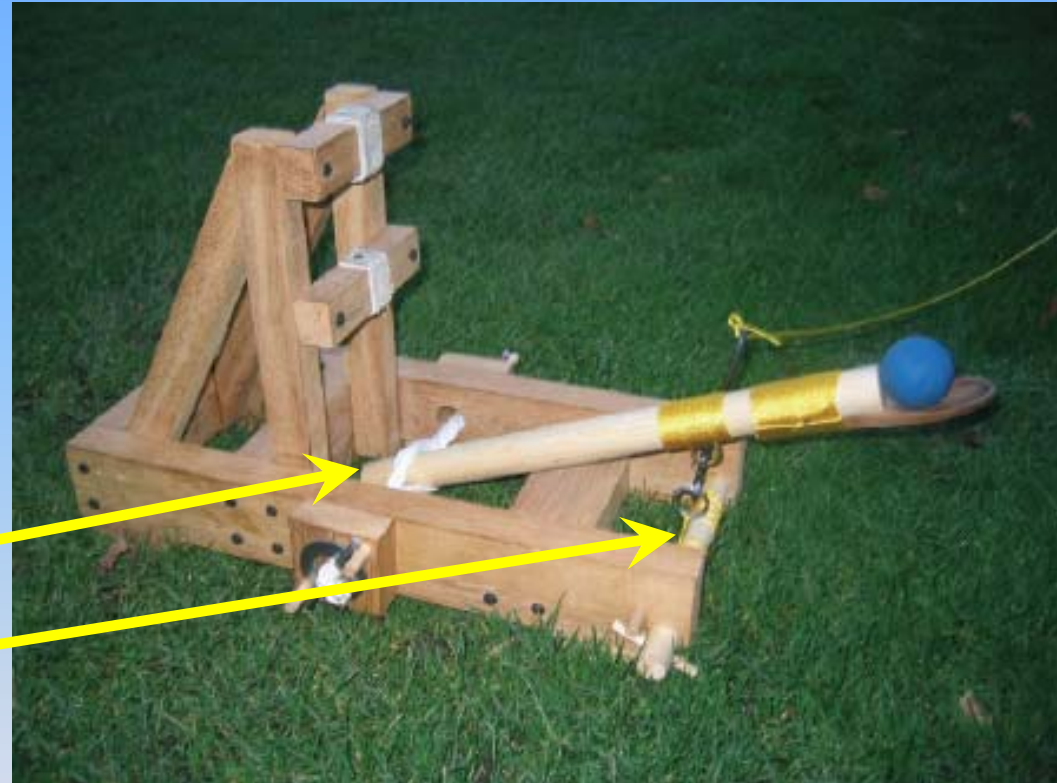
Structural Analysis

Static

- *Failure stress (experimentally) of*
 - *Wood (bending)*
 - *Trigger chord (in tension)*
- *Load at trigger (experimentally)*

Can design

- *Diameter of arm*
- *Diameter of spindle*



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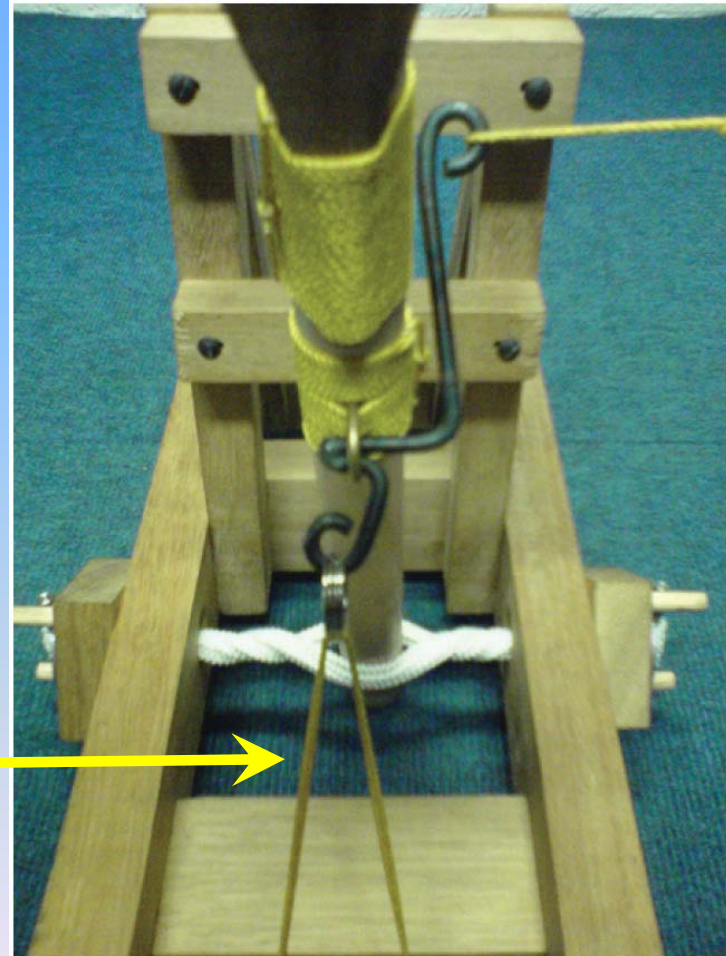
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- *Diameter of arm*
- *Diameter of spindle*
- *Diameter of Chord*



Design Project – Mangonel

Conceive

Design

Implement

Operate

Structural Analysis

Dynamically

- *Failure stress (experimentally) of*
 - *Wood (bending)*
- *Velocity at impact (experimentally)*

Can design

- *Parameters for arm*
- *Discuss potential/kinetic energy balance*



Design Project – Mangonel

Conceive

Design

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Operate

Build Mangonel

- **Parts**
- **Bill of Material**
- **Tools**
- **Drawings**
- **Assembly Instructions**



Design Project – Mangonel

Conceive

Design

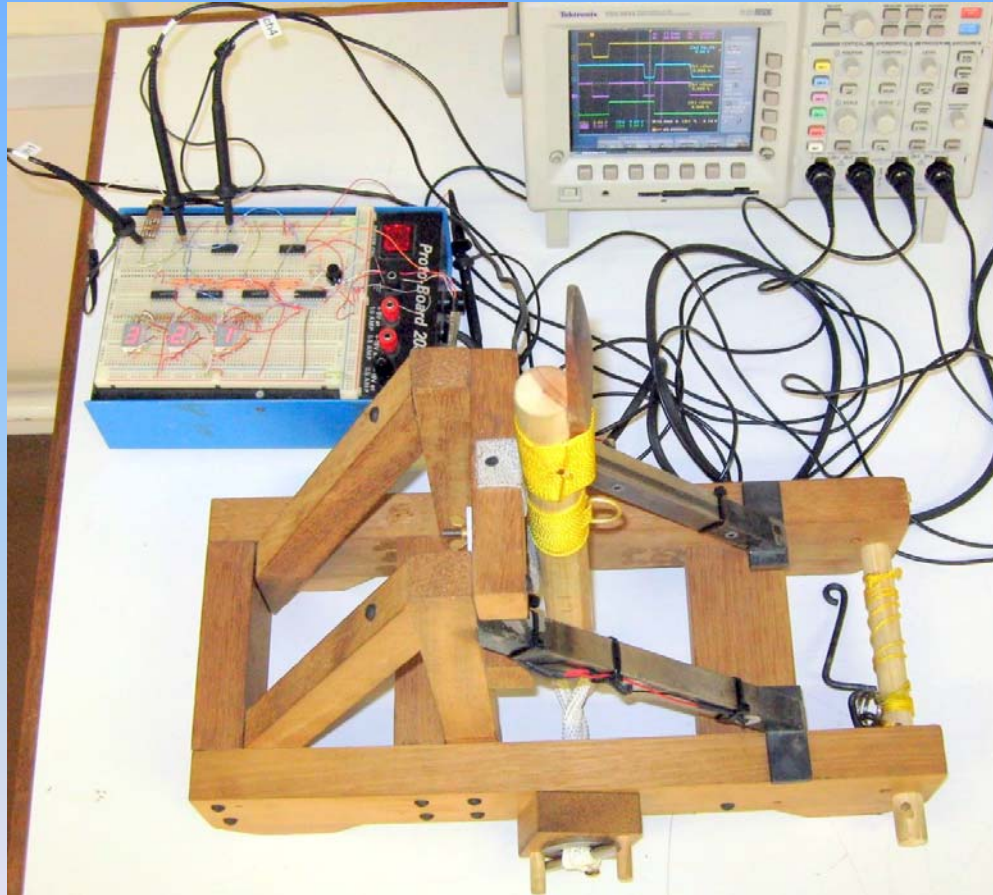
Implement

Operate

Measure Arm Velocity

- *Instrumentation*
- *Software*
- *Hardware*

Result is a useful measurement tool!



Design Project – Mangonel

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Design

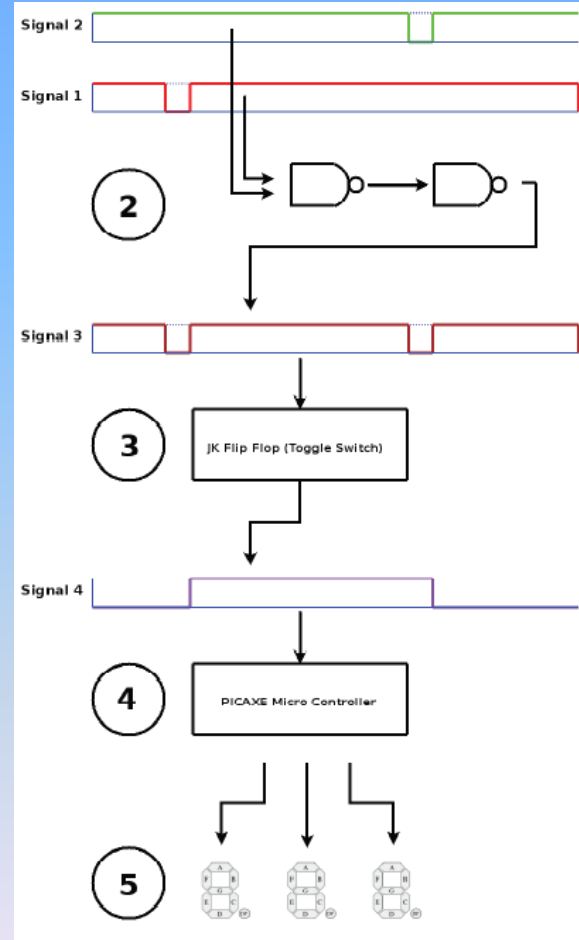
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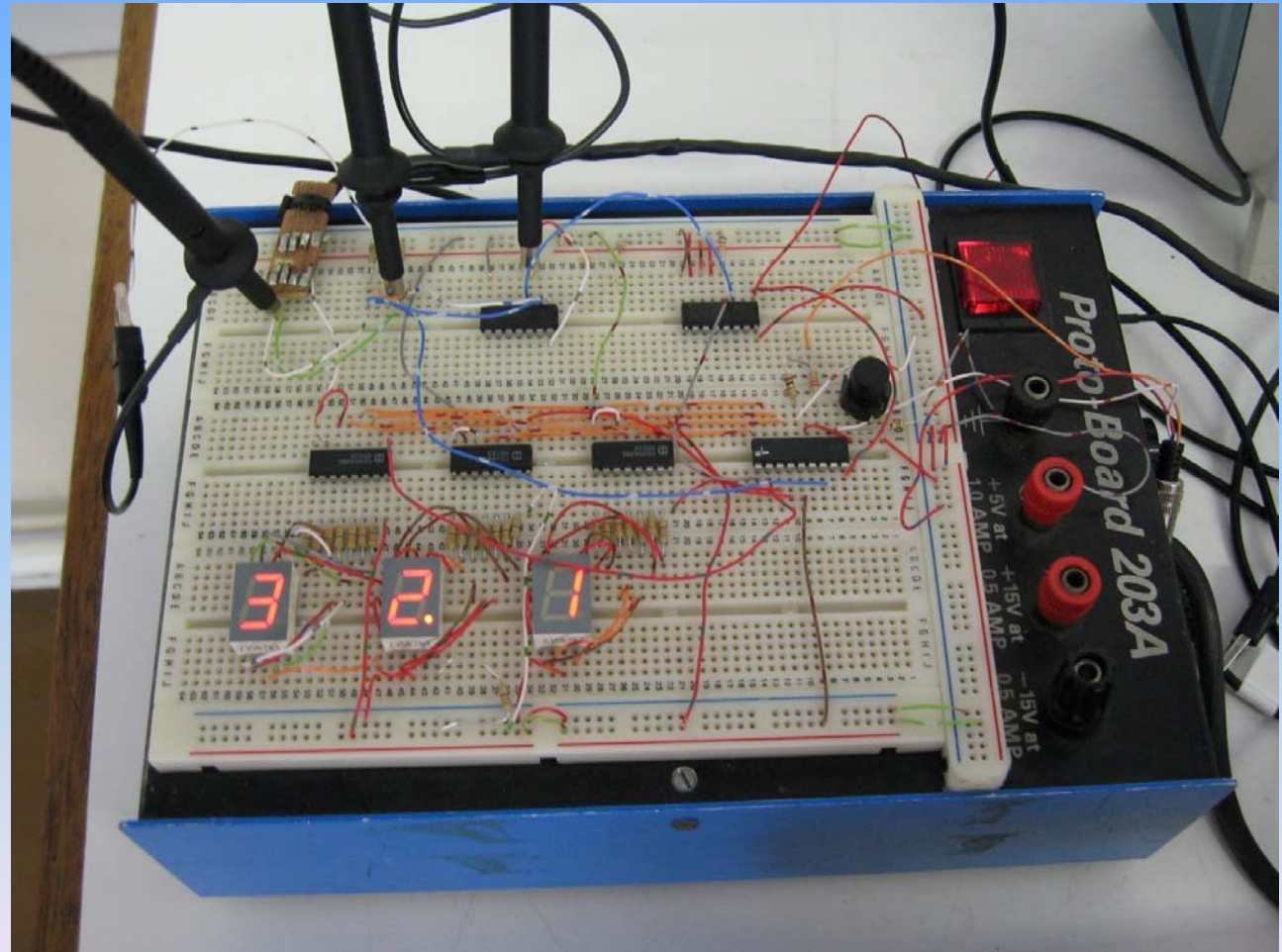
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Design Project – Mangonel

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Testing

Verify distances(vel., angle)

Check structural integrity

Competition

Optimise parameters

Modify design

€500 sponsorship

Irish Times Coverage



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Evaluation

Continuous Assessment (WebCT based)

Assignments

- Dynamics
 - Questions and Excel Spreadsheet X 2
 - Online M.C.Q. X 1
- Structural Analysis
 - Questions Spreadsheet X 2
- Electronics
 - Questions X 1
 - Software Evaluation
 - Hardware Evaluation
 - Online M.C.Q. X 1

Competition

- Monetary Prize (& prestige!)



Initiatives

Engineering Design III

Design and Construction of a Refugee Shelter

- Design a refugee shelter for an extreme climate
- Design of a solar cooker to boil one litre of water based on a solar flux of approximately $1\text{kW}/\text{m}^2$



'The Cardboard Cradle', a design which incorporated recycled cardboard tubes from cardboard manufacturers

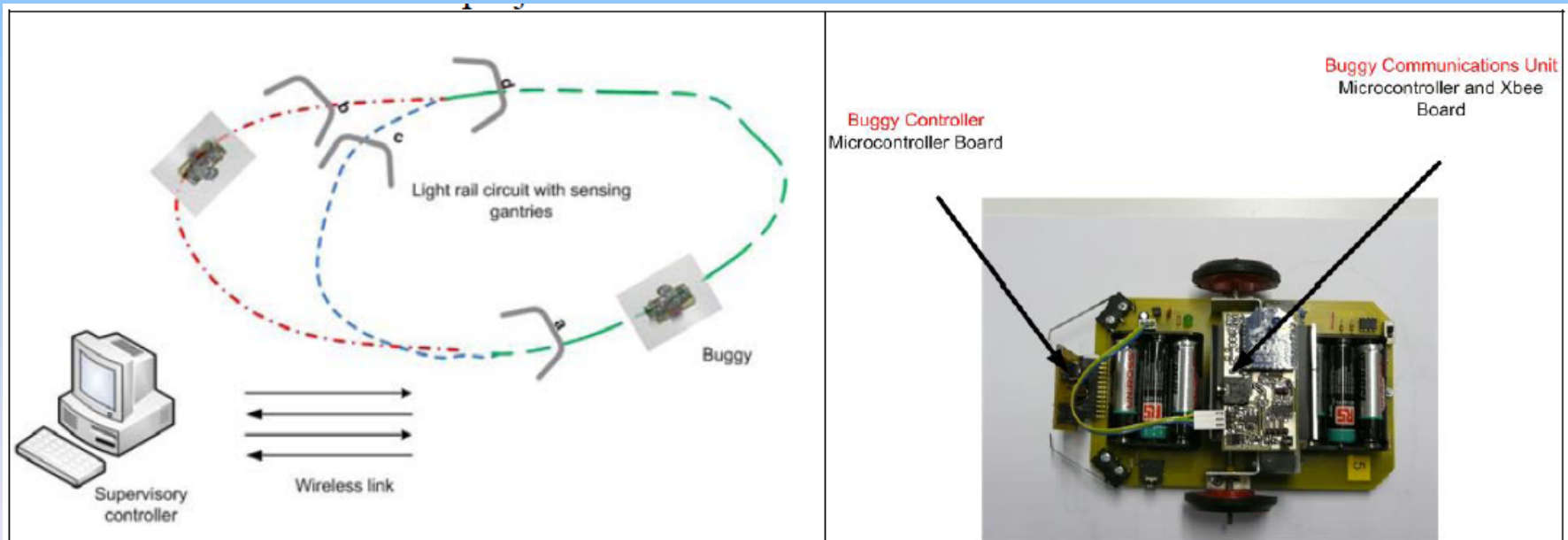


Initiatives

Engineering Design IV

Design of Wireless, Autonomous Vehicle

- Design and implement a micro-simulation of a light rail system
- Create an autonomous vehicle, that is under wireless supervisory control from a remote station

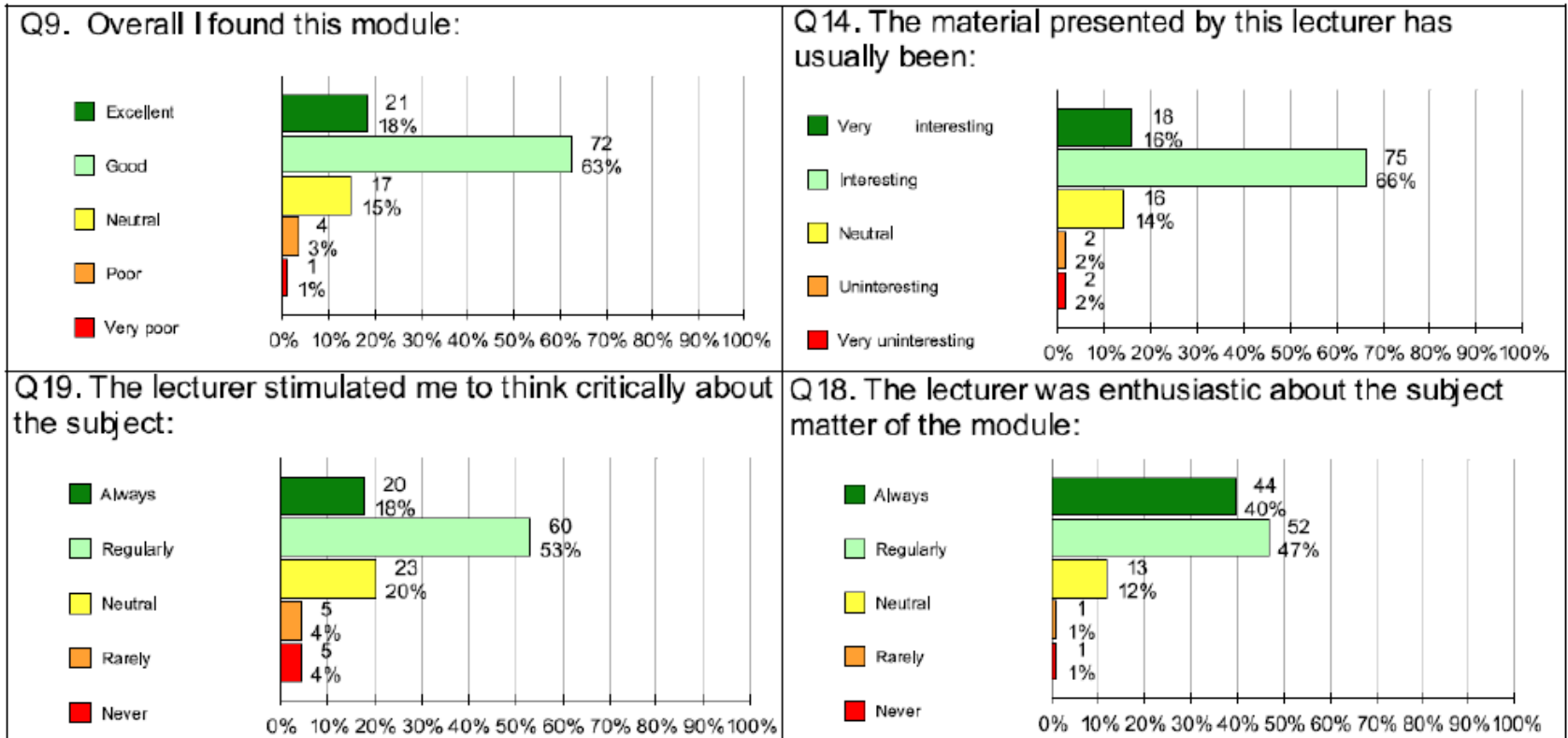


Results

Independent Survey

•Students Motivated

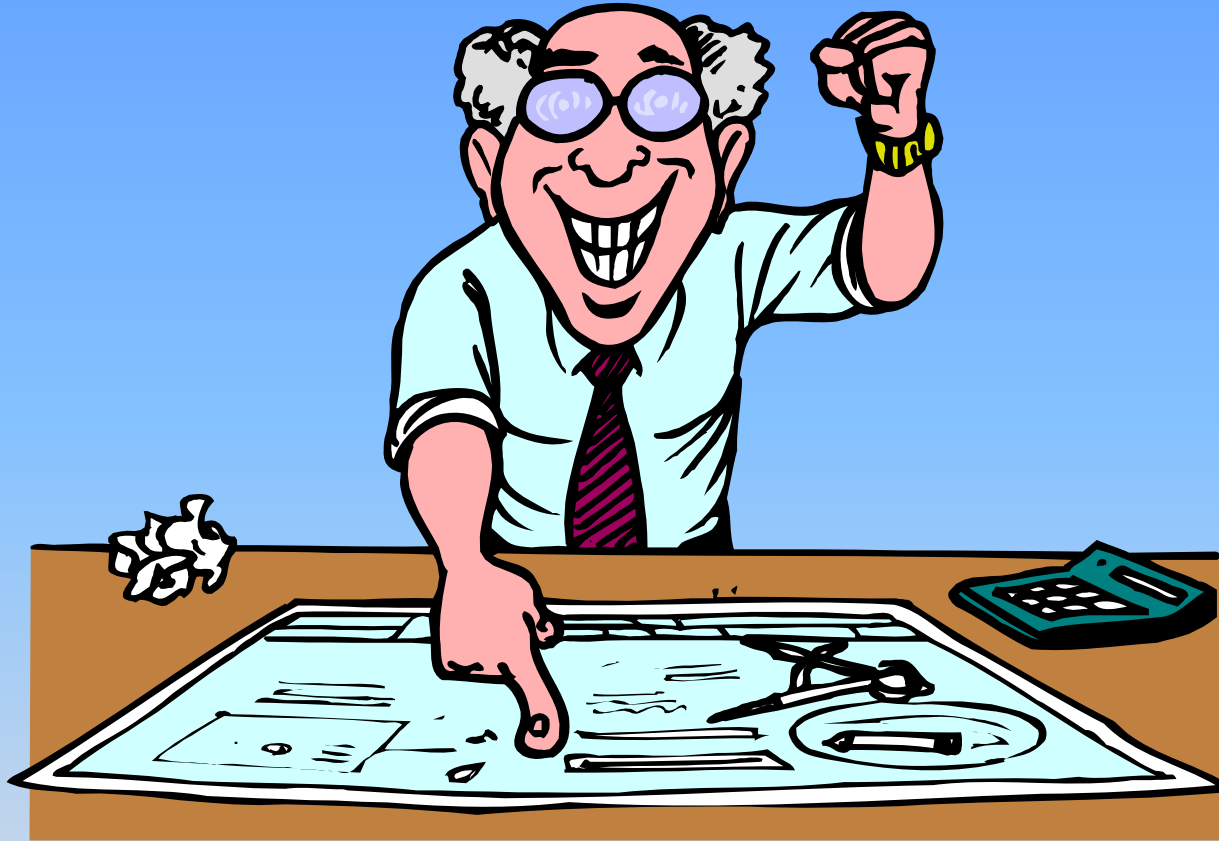
•High Attendance



Conclusions

- **Project Based design courses implemented in Freshman Cycle**
- **Large Class sizes**
- **CDIO “compliant”**
 - **Provided only cursory technical fundamentals**
 - **Encouraged to research independently**
 - **Work in groups**
 - **Promote Innovation**
- **Resource Heavy**
- **Well Received**





Thank You



- must compete internationally on quality and innovation
- aims to provide an environment that fosters the curiosity that enables creativity to thrive
- **2020 Vision** for Trinity Engineering which will focus on **Engineering innovation & Creative Design**
- envisages a remoulding of the traditional concepts of discipline based activities in both our teaching and research activities to produce the interdisciplinary education necessary to underpin breakthrough technologies for the future
- Our undergraduate curriculum has been extensively revised to ensure that students are introduced to the concept of “making things” as a focus for the engineering sciences and mathematics so that context is the most relevant aspect of their education.
- plan to extend our established international research activities so that our graduate education and research programmes continue to be of high impact and industrial relevance so that design and innovation are integral to our activities.
- nurture a multidisciplinary, broad-based approach to solving critical aspects of relevance to key global issues.
- an education that combines rigorous academic study with the excitement of discovery
- To establish an environment which encourages the understanding, curiosity and creativity necessary to provide innovative solutions for the global challenges
- engineers will always require an understanding and mastery of specific disciplines, innovative solutions will increasingly come from collaborative efforts involving technical, social and medical partnerships.
- curiosity and creativity as important influences in the pursuit of discovery and entrepreneurship
- innovation is multidisciplinary and occurs at the interface between traditional disciplines
- Government's taskforce on Innovation recommended six principles as fundamental to creating the innovation ecosystem necessary to transform Ireland into a Global Innovation Hub. - **education**
- Our undergraduate curriculum has been extensively revised with the introduction of design and build projects in the first two years of the undergraduate programme. This is to ensure that students are introduced to the concept of “making things” as a focus for the engineering sciences and mathematics so that “context” is the most relevant aspect of their education ;

