A project and competition to design and build a simple heat exchanger

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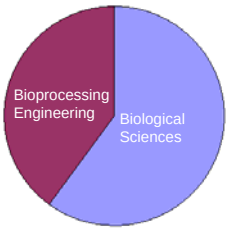
Background

- BSc Biotechnology
- 60% Biological sciences (microbiology, biochemistry, cell biology, immunology and genetics)
- 40% Bioprocess engineering, mathematics and chemistry



Challenge

- Boost engagement with engineering aspects of the course
- Emphasise role of engineering in biotechnology
- 2nd Year engineering programme
  - Heat & mass transfer
  - Energy balance
  - Fluid flow

Aims of Project

- Introduce students to:
  - problem solving techniques
  - group work
  - engineering design process
  - engineering drawing
  - practical use of hand tools, fittings etc.

Presentation

- Main issues:
  - Running of the practical
  - Practical setup & preparation
  - Results and student evaluation

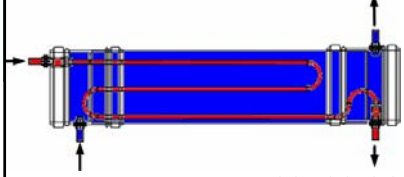
General Concept

- Shell and tube fluid-fluid heat exchanger
- Project: To design and build a low cost working heat exchanger.
- Highest heat transfer metric
- Selection of materials
  - Inner pipe; 8mm, 10mm,1/2" (€8)

$$\eta = \frac{Q}{\Delta T_{Lm} C}$$

Rate of heat transfer

Cost of inner Pipe

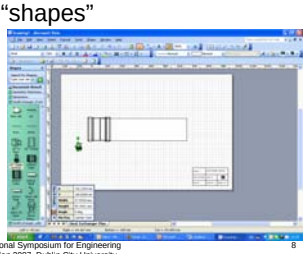


Project Structure:

- Semester 1:
  - Heat exchanger theory
  - Heat exchanger design sessions
    - Factors: cost, heat transfer, assembly
  - MS Visio drawing
  - **Outcome:** Engineering report
- Semester 2:
  - Integrated into engineering lab module
  - Workshop safety & assembly methods
  - Assembly
  - Testing
  - **Outcome:** Working heat exchanger assessment.
  - Prize giving

Engineering Drawing

- Working drawing basics introduced
- 2 Lab tutorials using MS Visio
- Library of custom “shapes”
- Template set up



Preparing the project

- 3 Months lead in required
- Feasibility study & material survey
  - Could reasonable heat exchangers be made using cheap plumbing fittings & pipe?
  - Leaks
- Building of prototypes
  - Varying designs
  - Numerous Concepts built & tested
- Trial runs

Materials Available:

- Common plumbing fittings
- Wavin uPVC soil pipe (2 sizes)
- Copper pipe (3 sizes)
- Brass compression fittings
  - **Interconnectivity**
- Copper solder fittings
- Tetite “quickfit” fittings

Tools Used:

- Basic plumbing hand tools

Laboratory Layout

- Bioprocessing Lab
- No special requirements.
- 3 “Work stations”
- Portable bench
- Engineers vice

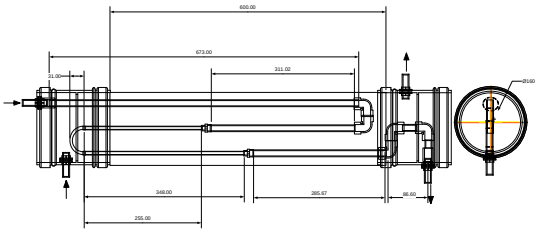
Workshop Safety

- Lab coats
- Glasses
- Gloves
- Respirator - solvent cement
- Power tools
- Gas soldering



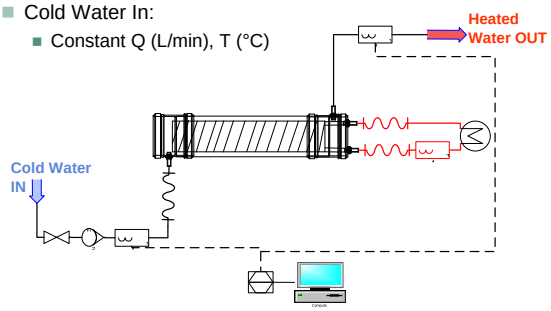


Designs Produced



Testing of Heat Exchangers

- Cold Water In:
  - Constant Q (L/min), T (°C)



Analysis Rig:

Assembled Heat Exchangers



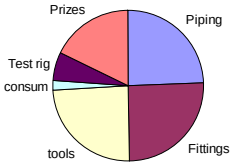

Assessment of Projects

- Metric
- Quality of build
- Completed on time
- Post assembly report

$$\eta = \frac{Q}{\Delta T_{Lm} C}$$

Expenditure Breakdown:

- Total Budget: €3400* – *10 Heat Exchangers*
- Piping: €830
- Fittings: €860
- Tools: €820
- Consumables: €80
- Testing Rig: €210
- Prizes: €600
- MS Visio – Part of DCU Licence



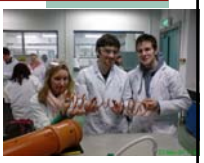
- *Teaching & Learning Innovation Grant

Results

- All groups produced:
  - Engineering drawing & reports
  - Working heat exchanger
  - Previous practical knowledge no real advantage
- All assembly problems solved
  - Leaks
  - Pipe mismatch

Evaluation of Project

- Students Perspective
  - Improved insight into engineering
  - Engaged with & enjoyed the project
  - Benefited from working in groups
  - Positive competitive spirit
  - Class Interaction



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- Thank You!