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Performing Process Control Experiments Across the Atlantic

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University of Cambridge

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Background

Prof Clark Colton, MIT

Dr Markus Kraft, CU

"To explore the use of Internet accessible laboratory experiment in the chemical engineering curriculum"

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Why?

Why do I like the idea?

- Possibilities of the Internet
- Remote operation

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Why2

Why is this a good idea at the University of Cambridge?

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MIT iLabs Heat Exchanger

- Heat Transfer
- Process Control

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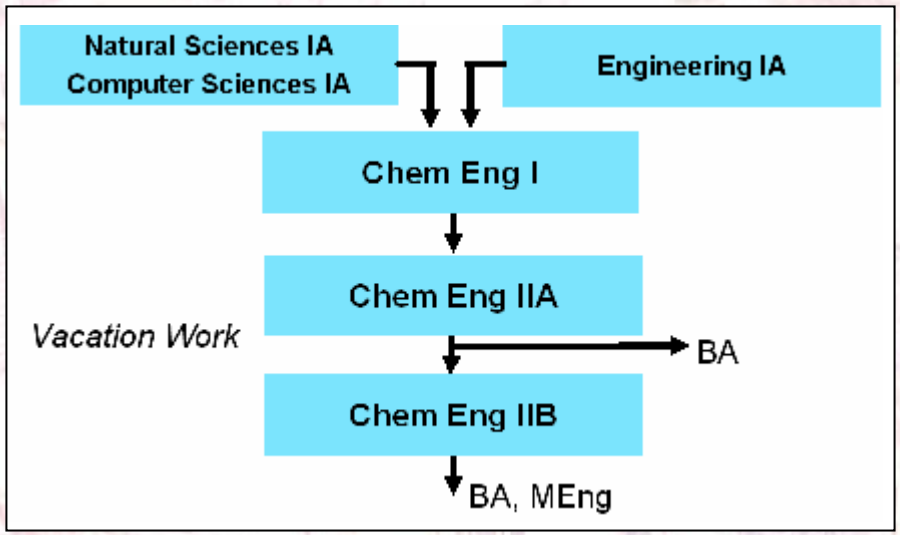
Chem Eng in Cambridge

M.Eng. (Chemical Engineering)

- 1st year either NST1, EGT1 CST1
- then 3 years of chemical engineering
- ~30-40 students in each of 3 years



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3rd year Chem Eng Part IIA

- Lectures
  - Fundamentals – more thermodynamics, more fluid mechanics
  - Process operations – reactors, separators, bioprocessing
  - Process systems – dynamics and control, process logistics, safety & environment
  - Enabling topics – optimisation, statistics, corrosion & materials
- Assessed exercises
- Major Design Project in Easter Term

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Exercises

- Extended activity
- Test of knowledge
- Challenge
- Report

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New Exercise

- New exercise in Process Dynamics and Control
- Replaced a pen and paper exercise
- Experimental part on MIT iLabs Heat Exchanger

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Assignment

- A few preparatory questions on control
- An experimental session on a real system
- Processing of data and discussion of results
- Feedback

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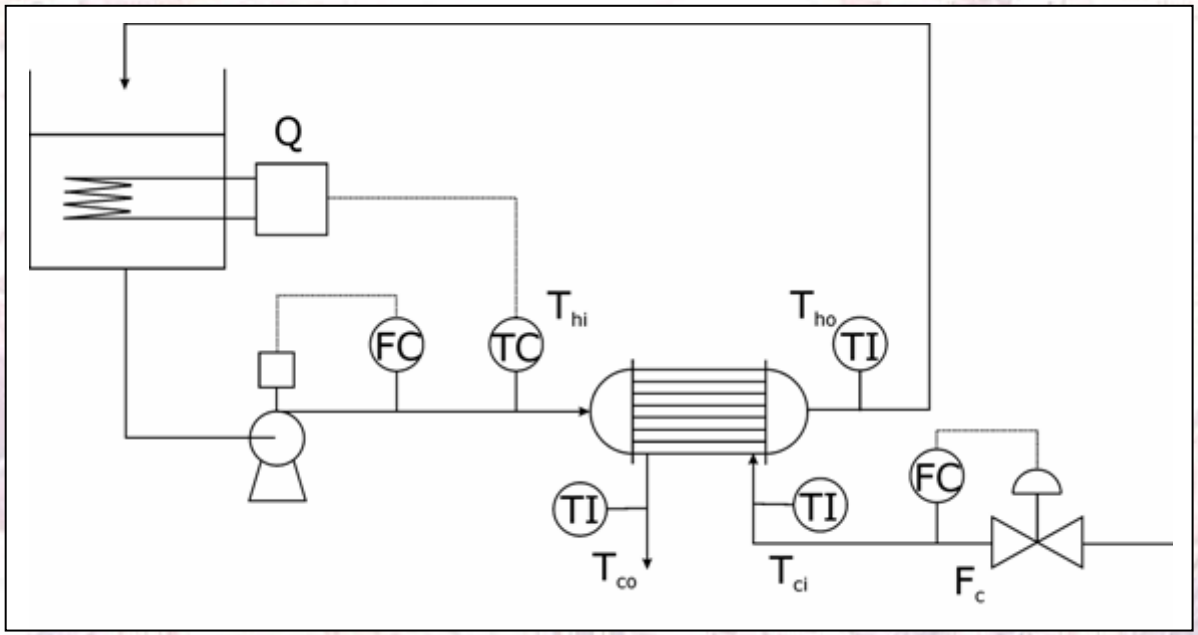
1. Preparation

- Identify parameters
- Open Loop Data
- Cohen-Coon



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2. Experimental session

- Log in
- P, PI and PID observation
- Fine tuning
- Alter settings and record responses

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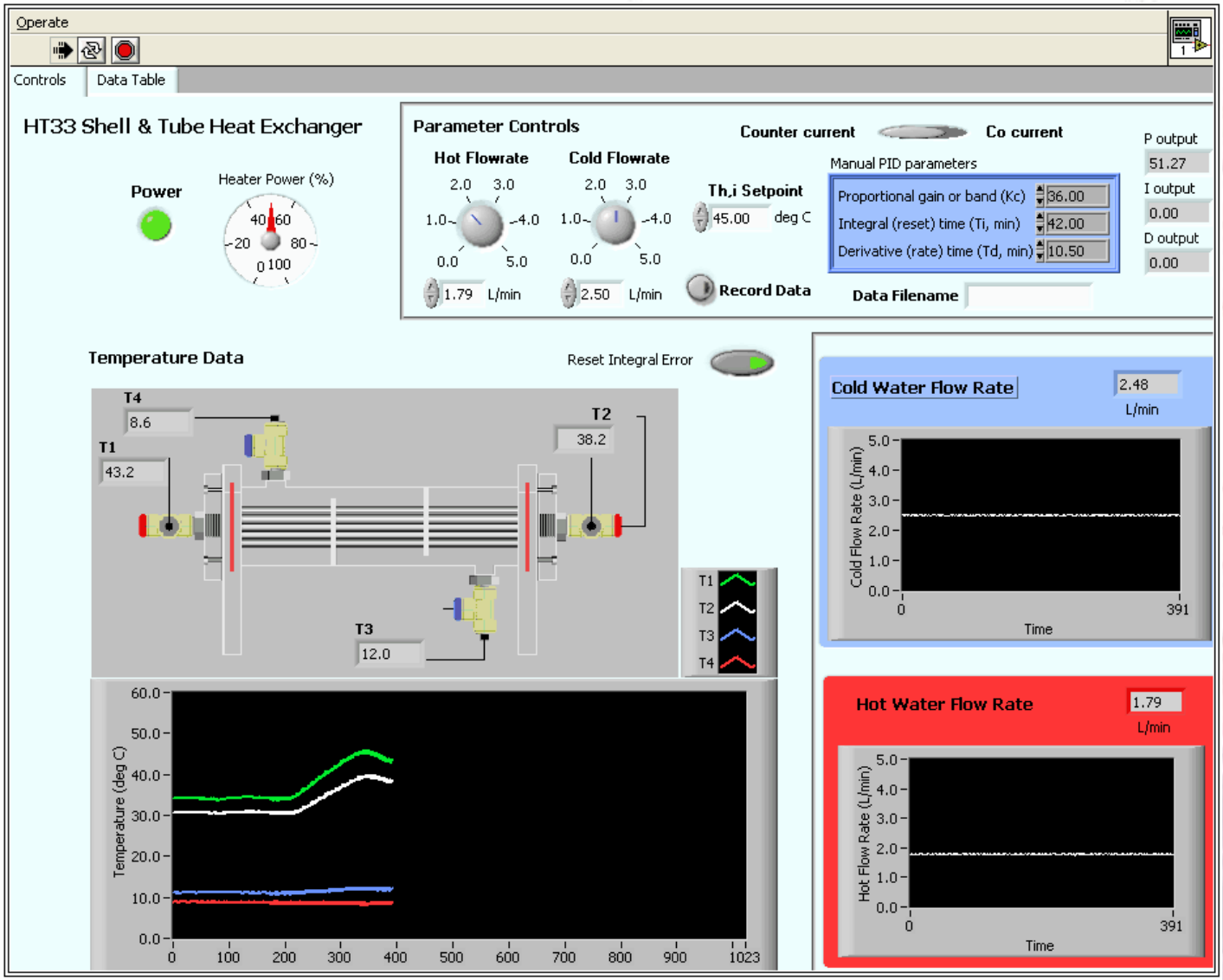
Interface



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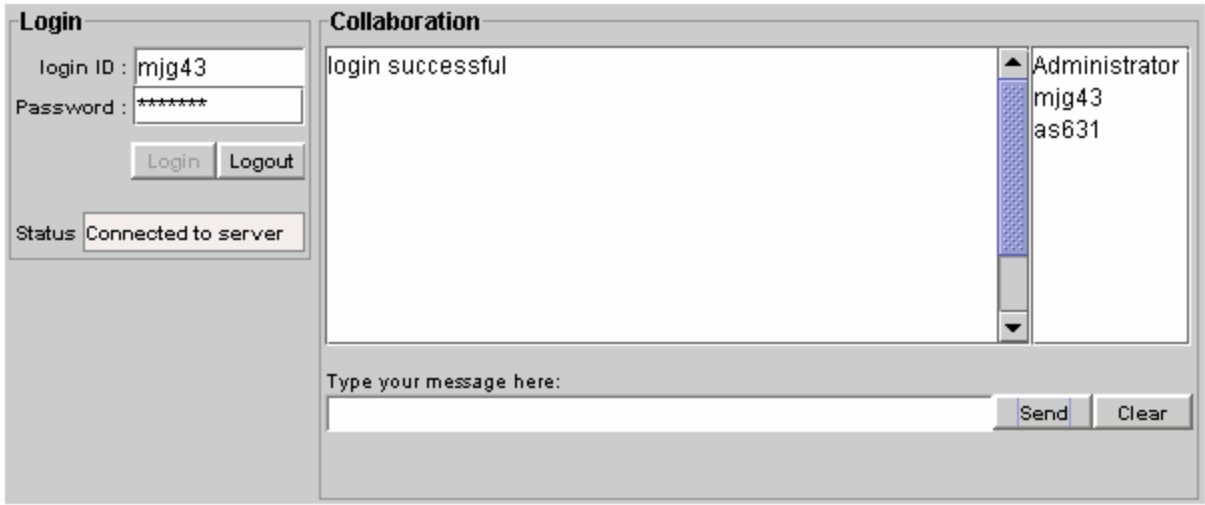
Chat



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3. Processing

- Worst disturbance
- Error responses
- Suggest further tuning
- Compare to idealized system

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4. Evaluation

- No technical problems
- Questionnaires
- Likert scale, 1 - 7
- 23 questionnaires from 36 students

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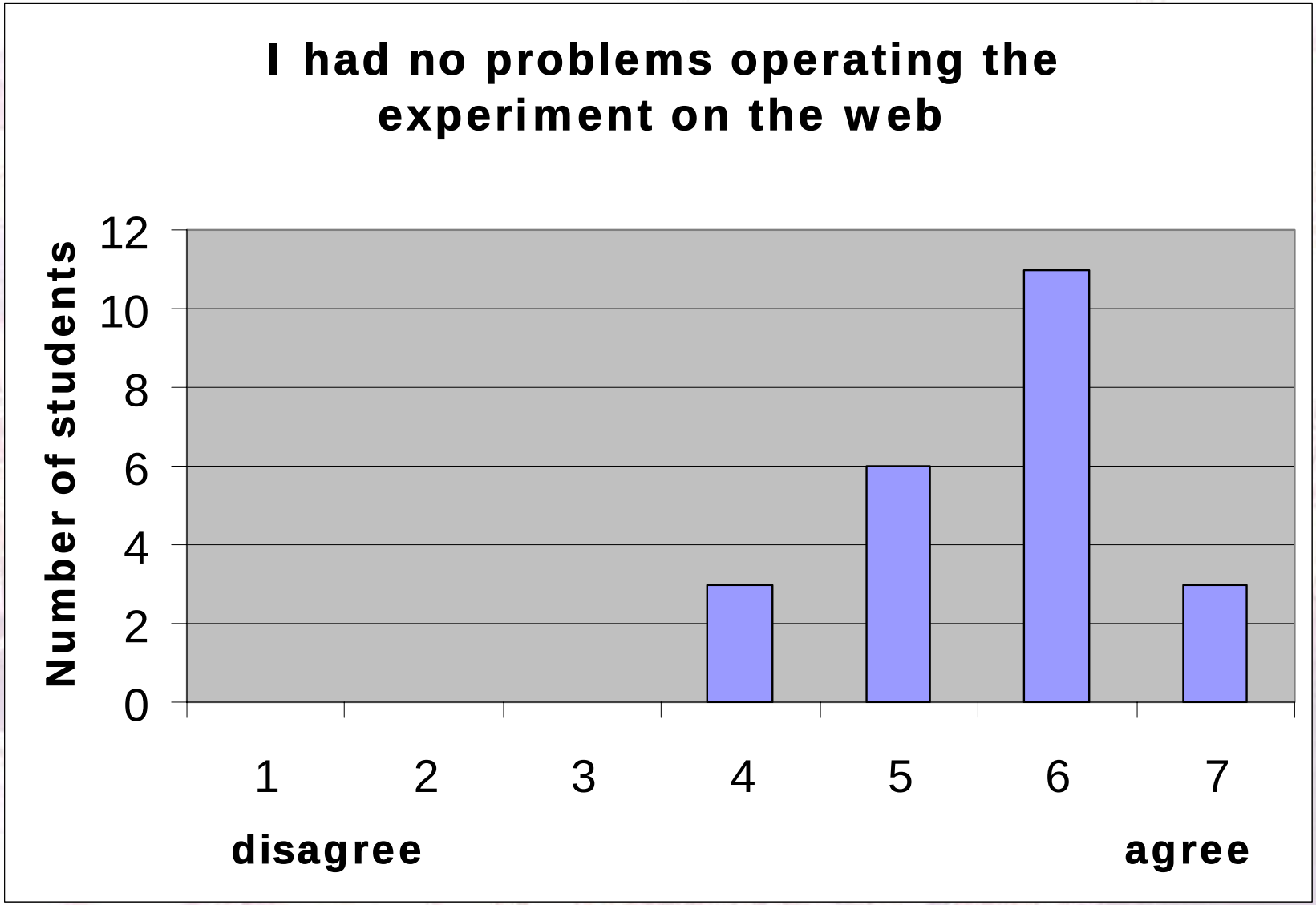
Usability



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Student Quotes

"The interface was plain and simple - very easy to operate and the use of the chat window was also very helpful"

"Interface was clear and easy to use. Instructions good"

"Quite user friendly system. Good instruction etc available"

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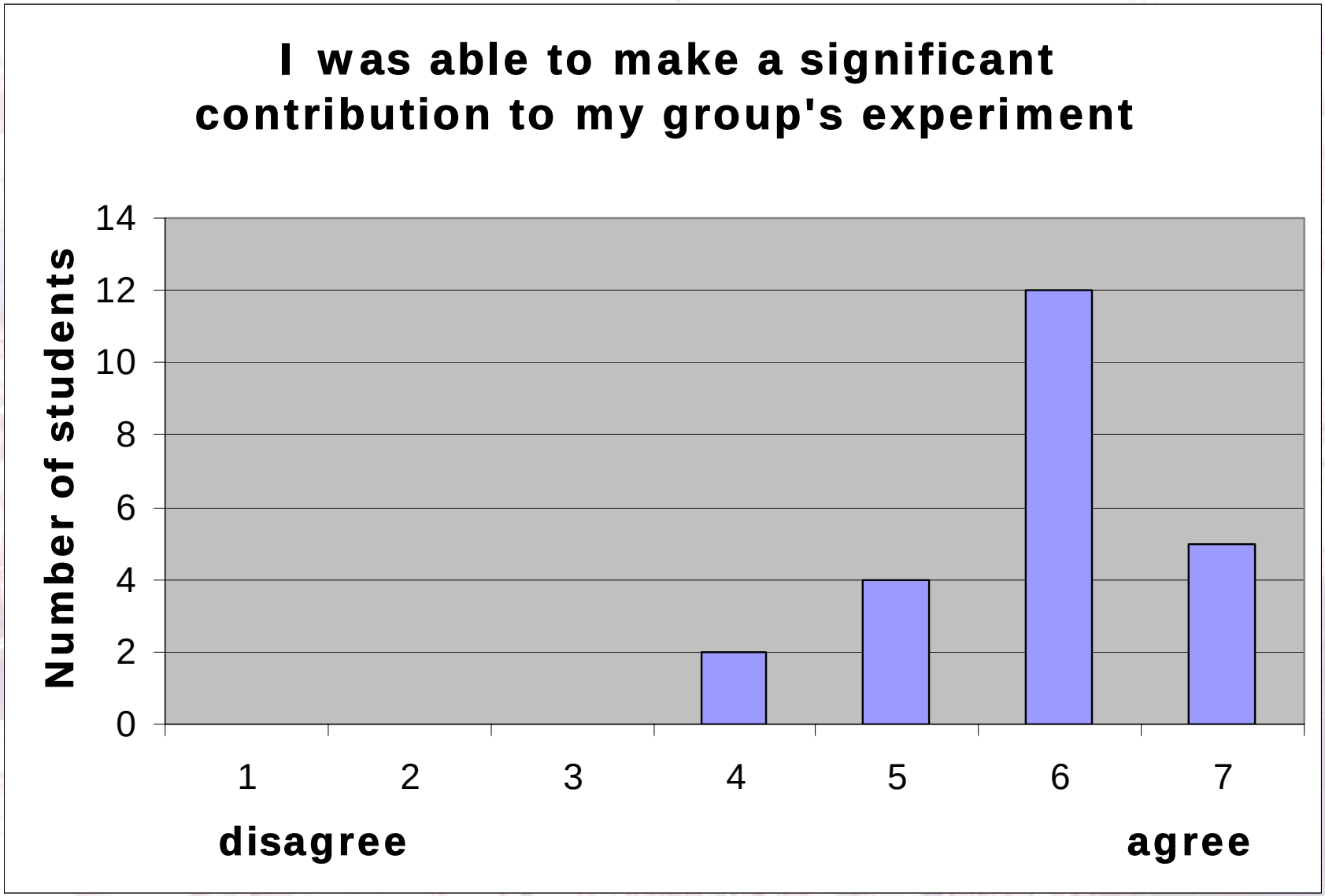

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Group Work

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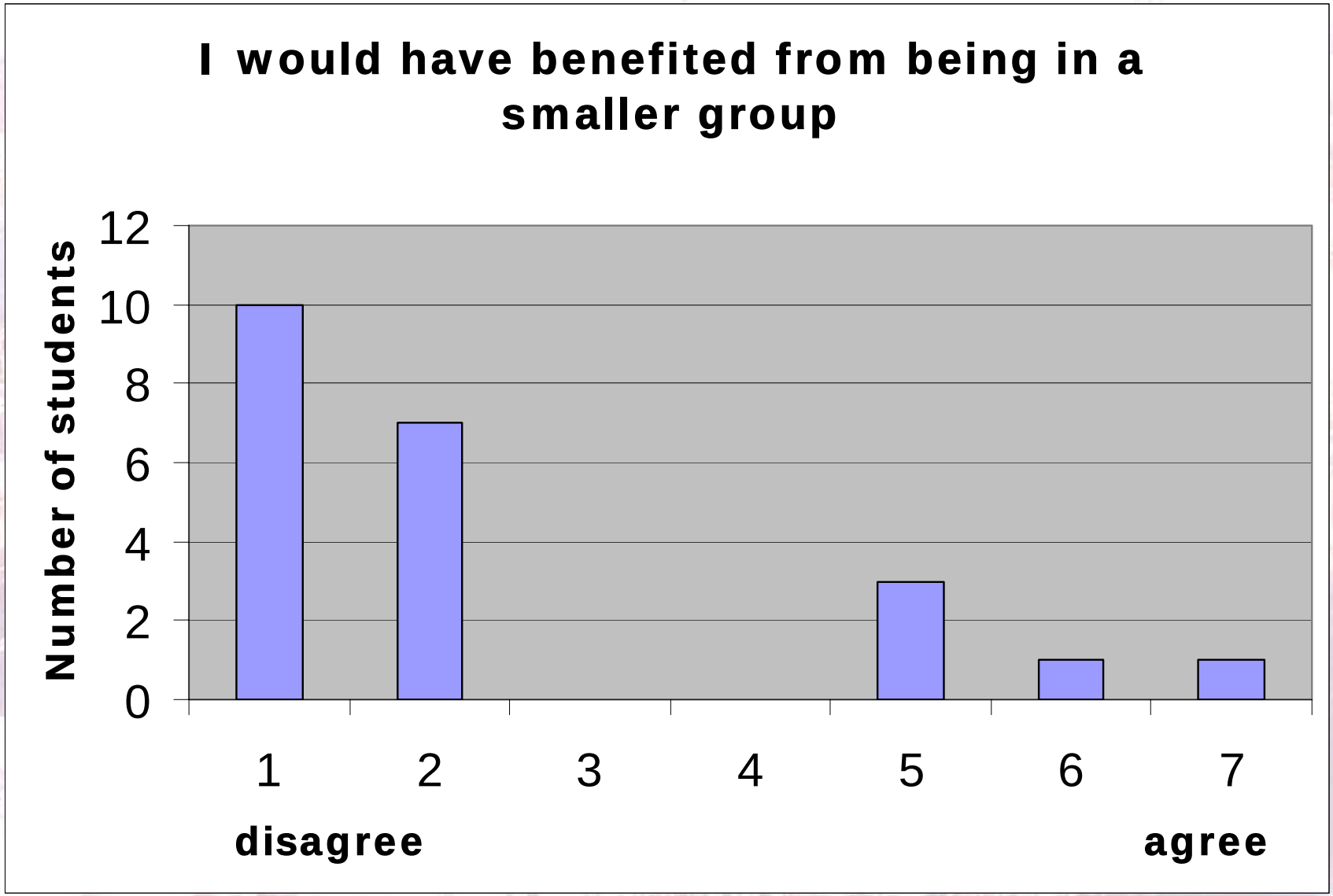

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Student Quotes

"No problem - useful to be able to discuss things"

"Beneficial having a group of people to discuss/explain ideas"

"Very useful to have people to talk it through with"

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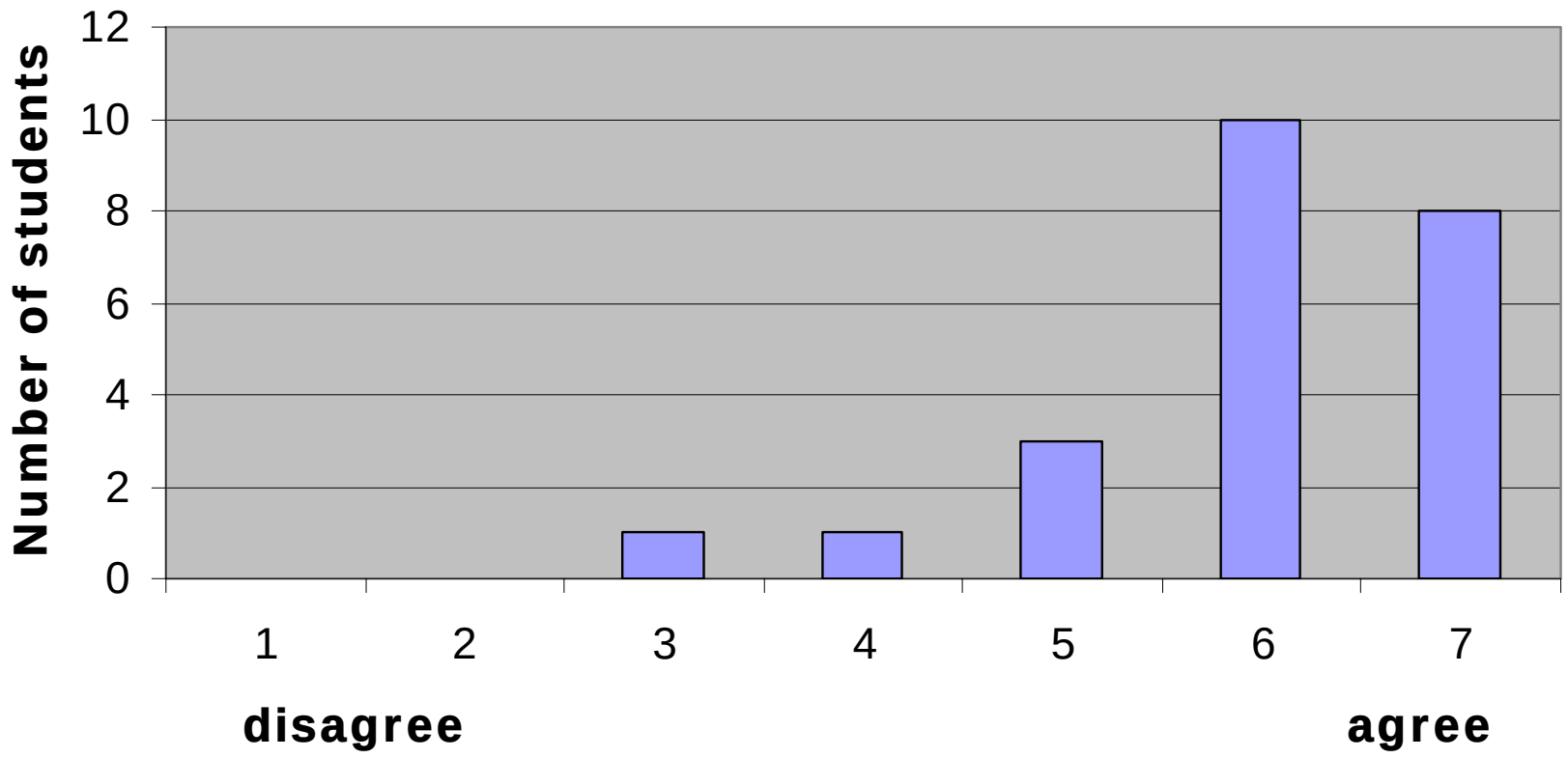
Educational

The remotely controlled experiment provided an experience of qualitative behavior of P, PI and PID control



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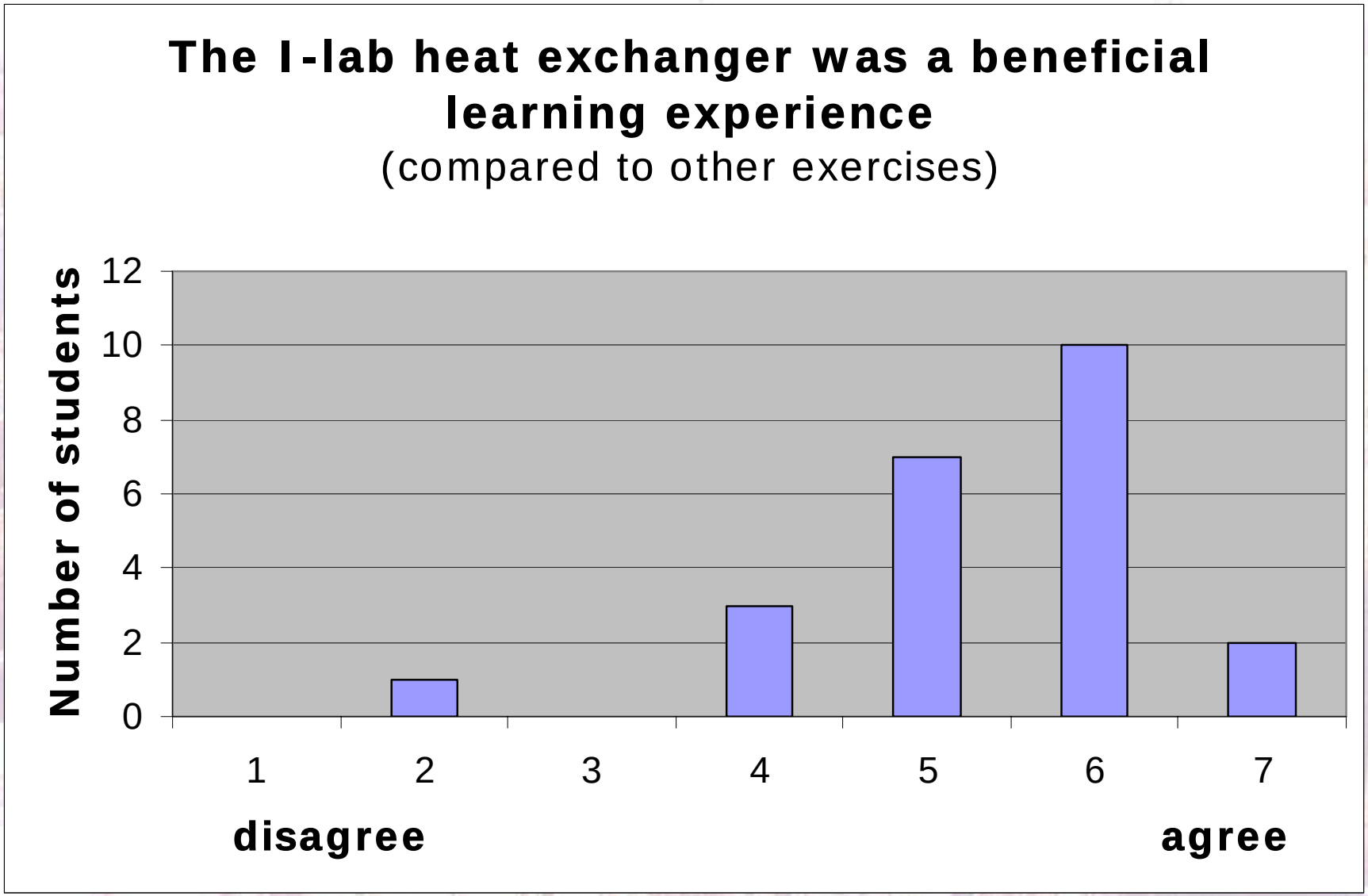
Comparison



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Student Quotes

"Useful to experience a system that is close to reality than ideal systems studied in lectures"

"More hands on. I had control of a real experiment and was able to see the responses to adjustments I made, in real time"

"Good to obtain and analyze real data, not just theoretical exercises"

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Summary

- Control experiment performed across the Atlantic
- Technology available and stable
- Appreciated by students

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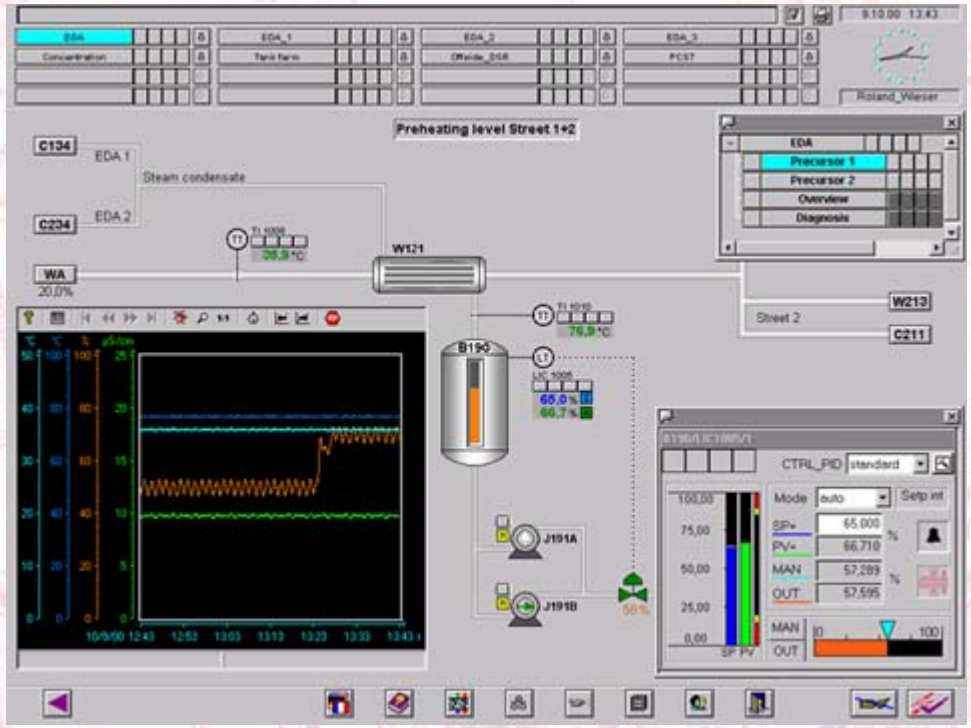
Current Work

- Chemical reactors
- Collaboration with Siemens
- Industrial experience



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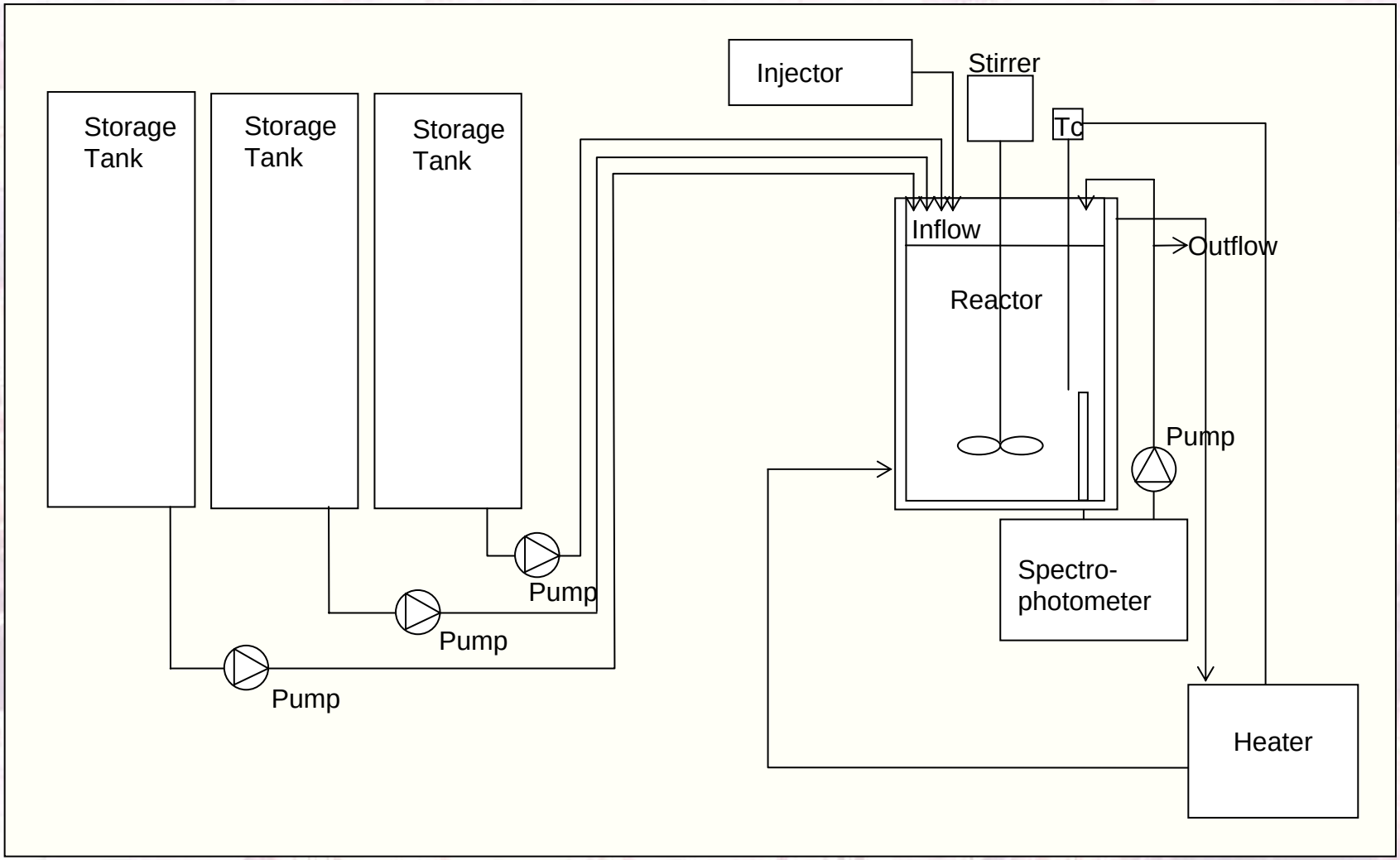
Setup



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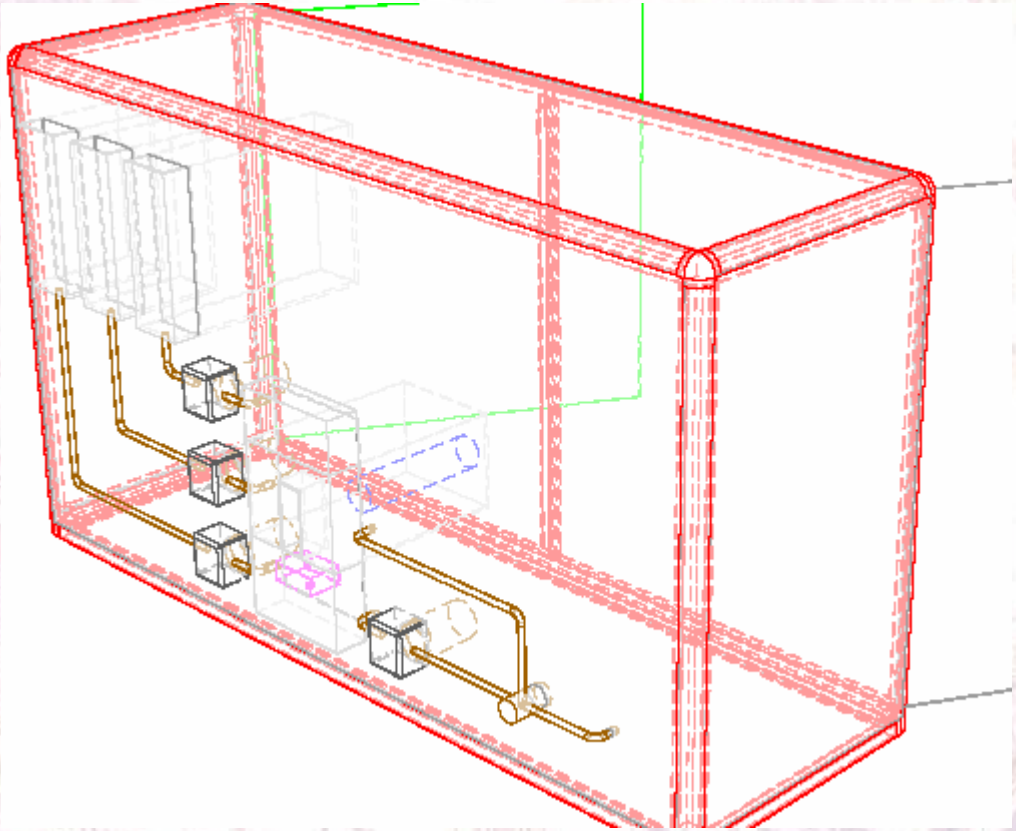
Setup



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Assignment

- Determine reaction constants etc based on supplied batch data
- Use these to estimate reaction time needed for desired conversion based on ideal reactor model
- Derive equations for non-ideal reactor model
- Perform residence time experiment to estimate level of non-ideality for the experimental setup
- Use this data and derived equations to estimate reaction time needed for desired conversion for the setup
- Perform kinetics experiment based on ideal and non-ideal reaction time and compare to what was predicted using the ideal/non-ideal model

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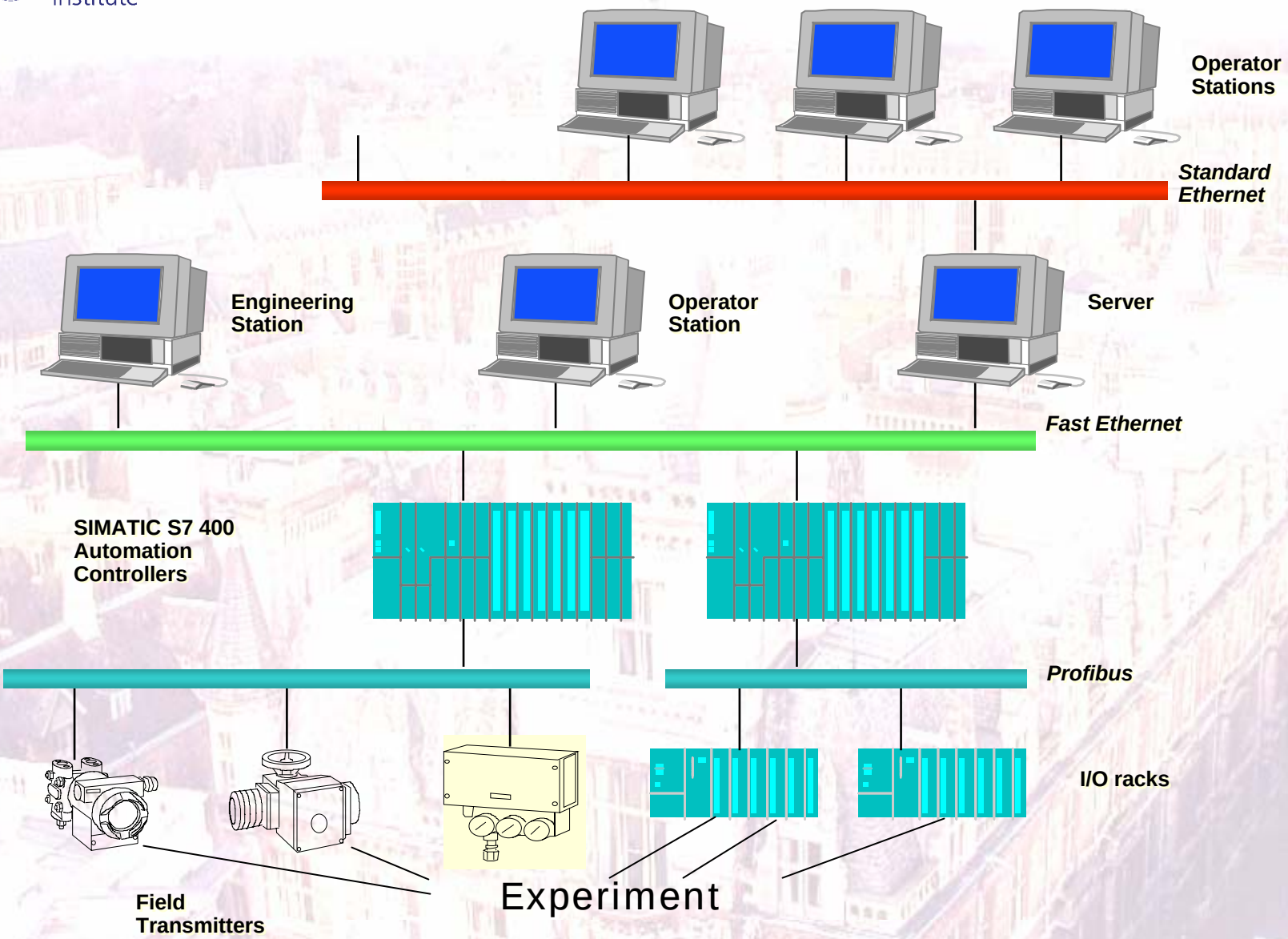

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Thank You

- The Cambridge-MIT Institute (CMI)
- MIT iLabs (part of iCampus)
- Siemens Automation and Drives Cooperates with Education (SCE)