# Integrating Problem-based & Project-based Learning in large enrollment freshman engineering courses

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# *Premise*

- above: student team designs a silicon-wafer processing station

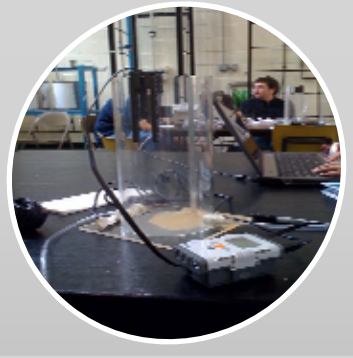
- at right: a project for studying rates of heat conduction through different metals

- Engineering freshmen want to *get to the point*!
- We must quickly establish a supportive peer network
- Contextualizing problem-solving skills with project-based activities is key

# Learning Objectives/Strategies

## Communication

- Teamwork
- Oral reporting
- Written technical summaries



## Engineering Topics

- Material Balances
- Units/Measurements
- Data collection & analysis
- Basic concepts for controlling processes

## Engineering Design

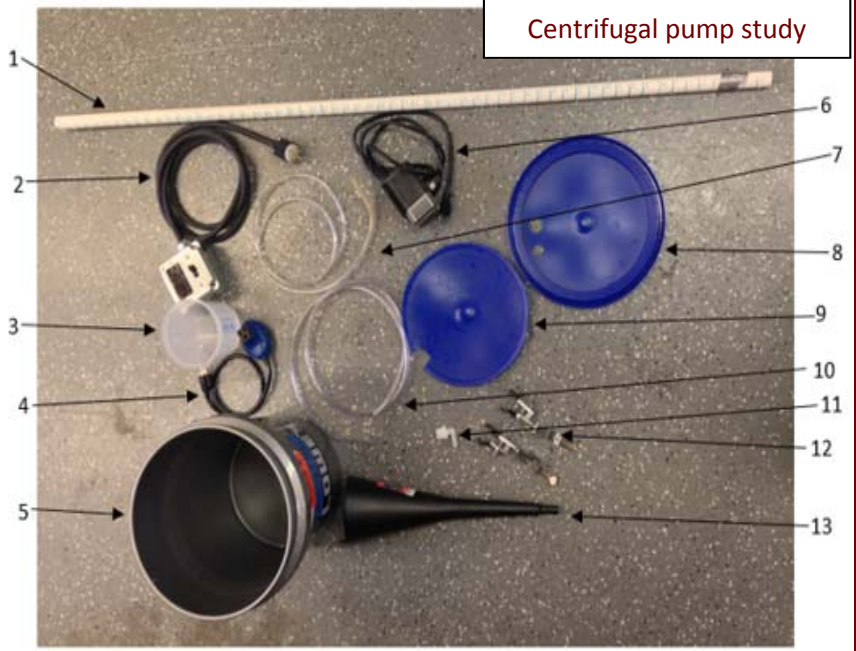
- Problem definition
- Brainstorming solutions
- Develop prototype from most promising possibilities
- Test, evaluate, improve
- Communicate "optimum"

**CHE/PTE First year experience Course Content**

# *Context*

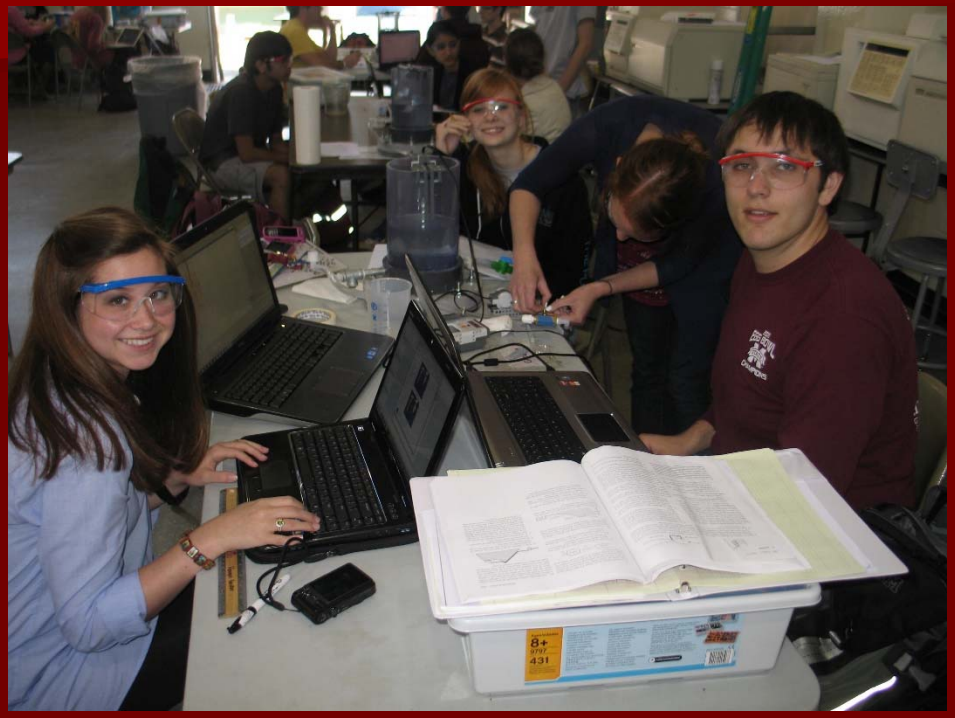
- Two-semester sequence meeting twice weekly (fall: 1 SCH laboratory; spring: 3 SCH with 1 hour lab and 2 hr lecture)
- 100+ enrolled
- Microsoft Excel for recording & analyzing data
- LEGO NXT robotics, Vernier sensors, auxiliary tubing, valves, pumps, tanks, etc.

Centrifugal pump study




| | | | |
|---|---|---|---|
| 1. Measuring pipe | 5. 5-gallon bucket | 9. Bucket insert | 13. Funnel |
| 2. Two-gang apparatus | 6. Water pump | 10. Tube 2 (larger) | |
| 3. 1000ml beaker | 7. Tube 1 (smaller) | 11. Tube 2 nozzle insert | |
| 4. Load tester | 8. Bucket cap | 12. Stand clamp (2) | |

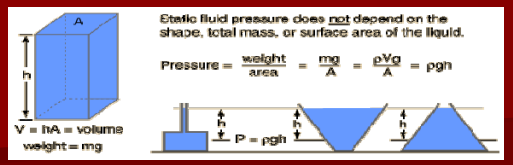
# Outcomes



Students design and operate a tank level control system

- Demonstrate ability to analyze & solve fundamental engineering problems
- Use basic Excel tools to collect and analyze data
- Design and build a workable solution to a technical problem
- Explain to someone in your family (or a non-engineer) what engineering is all about, giving practical examples

# Team Challenges

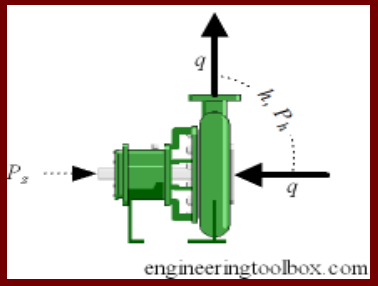



Centrifugal pump study

Internals placed in 5 gallon bucket

Discharge from manometer returned to bucket

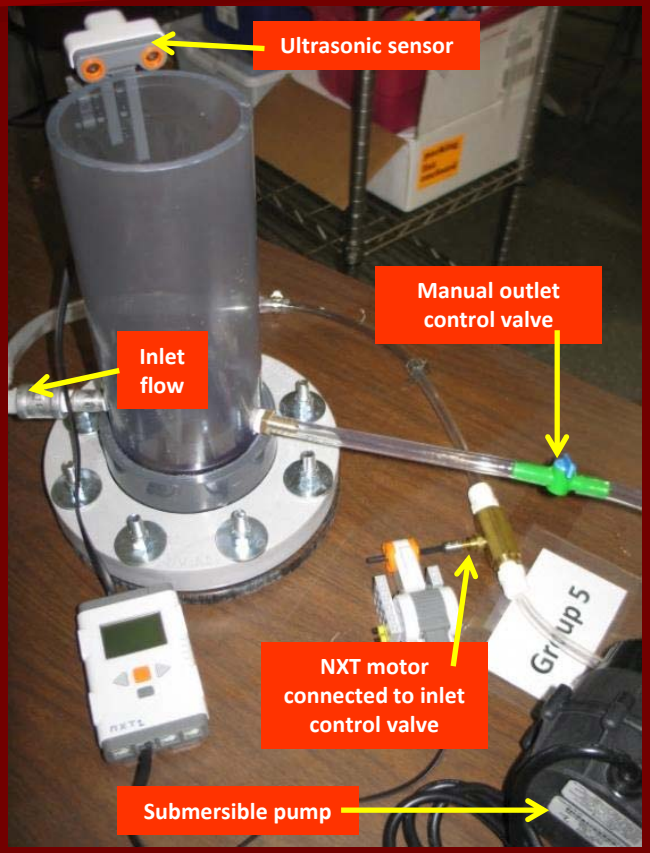
- Introduces importance of centrifugal pumps to industry
- Concepts covered include static column of fluid and a reduced mechanical energy balance (written around the pump)
- Data collected for discharge points at various heights
- Summary reports produced by Teams of 4
- Cost per unit ~$45



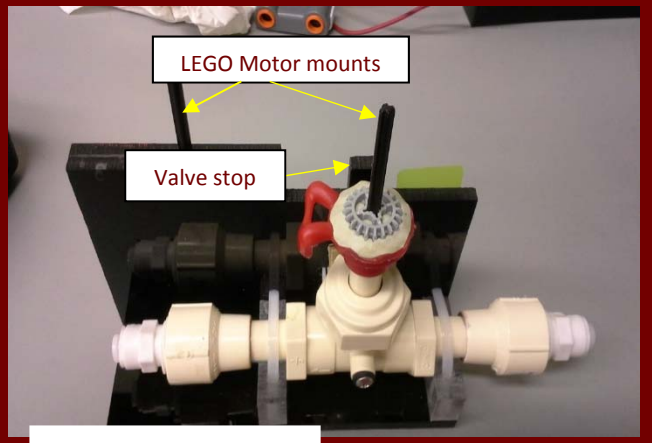
# Team Challenges

## Tank level control study

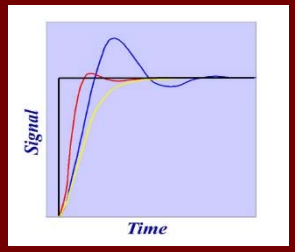
- General intro to automatic process control
- Highly visual process
- Simple NXT programming allows experimentation over wide range of performance
- Cost per unit ~$500

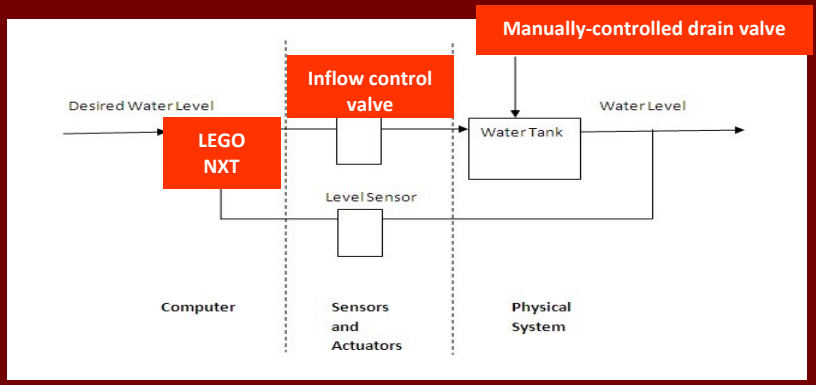



Components of level control system




Automatic Control Valve



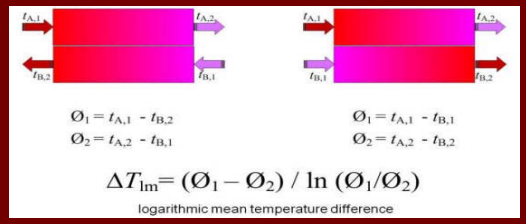
# Team Challenges

Double-pipe Heat Exchanger study

Disassembled view of double pipe heat exchanger


Assembled view

- Student's learn about heat transfer by assembling and operating double pipe exchanger
- Concepts covered include heat transfer in flowing systems
- Data collected: steady-state inlet & outlet temperatures for various flow rates of hot/cold water
- LMTD method used to characterize exchanger performance
- Cost per unit ~$75

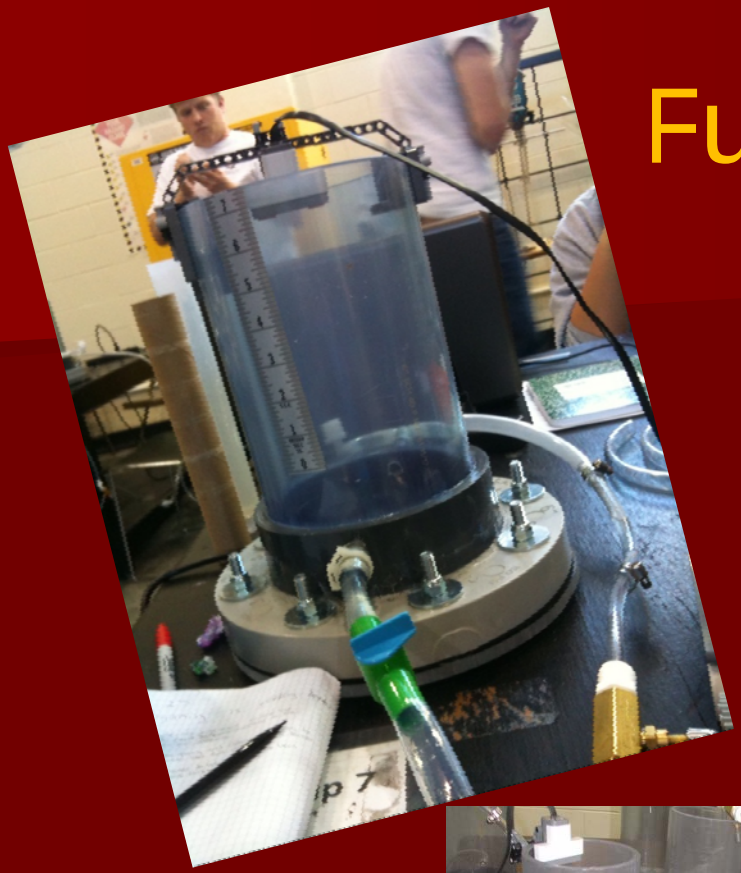


# *Student , Alumni & Employer Responses*

- Doc! I just got a co-op offer! I think my description of the heat exchanger project "cinched the deal"! (Freshman in Analysis, Spring '17)
- Dr. E, they loved the work I did at my co-op this summer! That work we did with Excel in the freshman year really helped me. I became the "go to" person when it came to spreadsheets. (Sophomore, Fall '16)
- "The practical exposure to essential industrial processes is critical to helping students get a clear picture of engineering practice—especially early in their careers" (Advisory Board member and ChE alumnus, Spring '17)
- Whatever you are doing over there, keep it up! Almost every student shares something about their team projects in our co-op and summer internship interviews. (Prospective employer, Spring '16)

# The "*Bonus*"

- Team Challenges are ideal platform for K-12 outreach through AIChE!
- ChE freshmen are readily engaged in service learning activities
- Promotes STEM learning through an interesting, interactive approach
- Activities include Boy & Girl Scout Merit Badge days, and K-12 "day visits" to Mississippi State and to public school classrooms around the state of Mississippi



# Future Goals

- Modify existing ChE Freshman Orientation course to expand studio concept across the freshman year
- Better integration with our ongoing K-12 & Community College outreach program
- Proposal development to extend to a general freshman engineering course
- Funding!

# Questions?