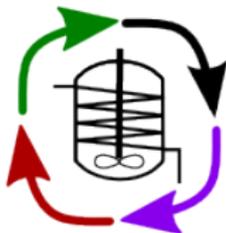


Engineering Economics and Problem Solving

ChE 4N4



© Kevin Dunn, 2014

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<http://learnche.mcmaster.ca/4N4>

Revision: 38 (December 2014)

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We appreciate:

- ▶ if you let us know about **any errors** in the slides
- ▶ **any suggestions to improve the notes**

All of the above can be done by writing to

`kevin.dunn@mcmaster.ca`

or anonymous messages can be sent to Kevin Dunn at

<http://learnche.mcmaster.ca/feedback-questions>

If reporting errors/updates, please quote the current revision number: 38

Special thanks to the TAs

- ▶ Myrto Korogiannaki
- ▶ Heera Marway
- ▶ Tyler Homer

Administrative

Course evaluations: <https://evals.mcmaster.ca>

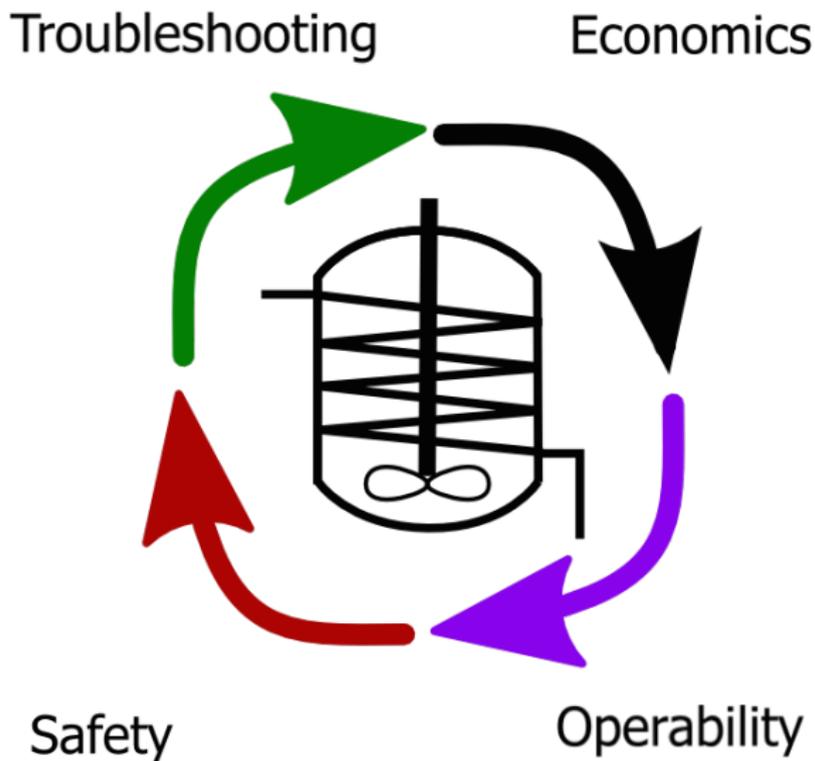
- ▶ We take these seriously
- ▶ Suggestions for improvement are always welcome
- ▶ Every year 4N4 has evolved significantly based on your ideas:

Administrative

Course evaluations: <https://evals.mcmaster.ca>

- ▶ We take these seriously
- ▶ Suggestions for improvement are always welcome
- ▶ Every year 4N4 has evolved significantly based on your ideas:
 - ▶ more weight for the midterm
 - ▶ peer evaluation
 - ▶ suggestion for a wireless mic for the videos
 - ▶ same SDL project for the entire class
 - ▶ tutorials used questions from the SDL project to build it up
 - ▶ switched the Safety and Operability topics around
 - ▶ more troubleshooting exposure: “before” and “after” tutorials
 - ▶ group meetings are more focused
 - ▶ good quality guest speakers

Main topics covered in 4N4

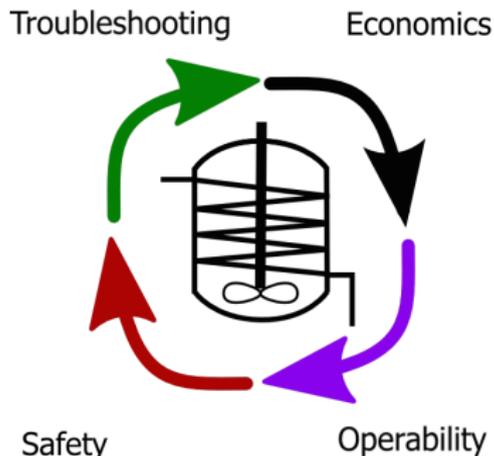


This is a unique course: not taught anywhere else.

What you've learned ...

There's a whole lot more to a system

- ▶ Every unit you've learned about before has more complexity than you thought
- ▶ Economics: how do costs scale?
- ▶ Operability aspects of the unit
- ▶ Safe operation of that unit?
- ▶ How would you troubleshoot it?



And most importantly: **integrating these ideas across a whole flowsheet of units.**

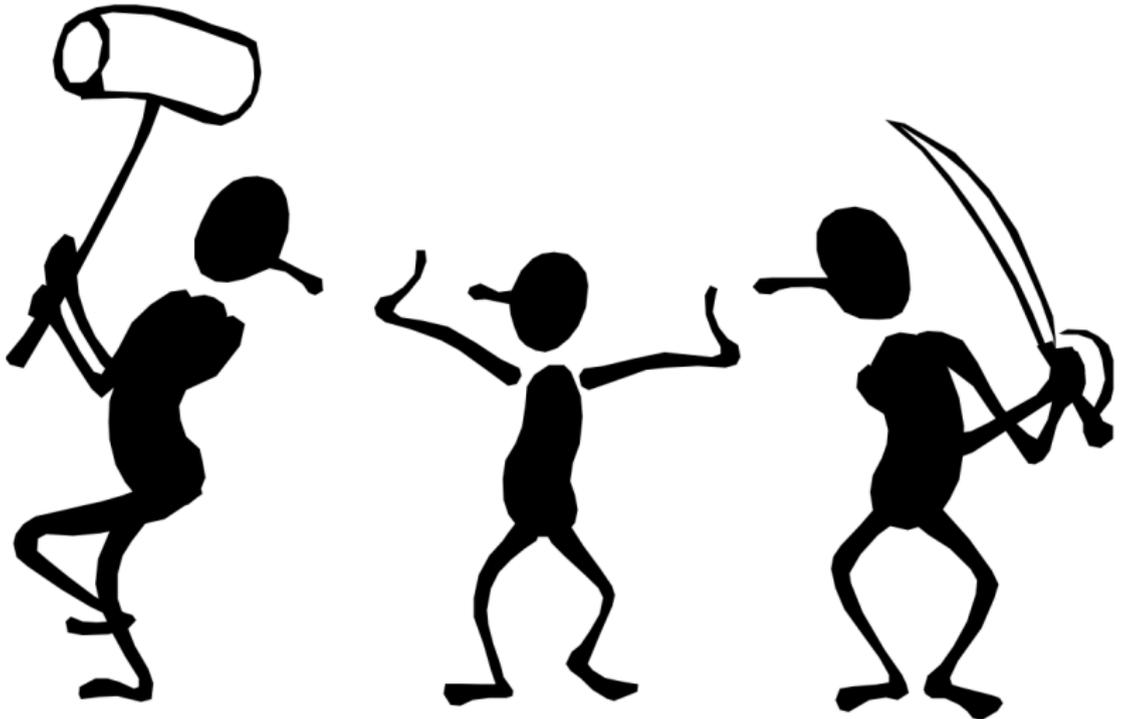
What you've learned ...

You are capable of more than you thought.

- ▶ Constant exposure to the material via group-based assignments helped you learn
- ▶ Surprised at how previous courses were brought together
- ▶ Improved your writing skills
- ▶ Learned you can't do all the work yourself
- ▶ Some realized that "this" isn't for them

Group work

Some had tough dynamics: *"as strong as your weakest link"*



Group work

Most had successful collaboration



Many enjoyed the rotating chairperson role.

Life-long learning / Self-directed learning

- ▶ Challenging; felt you were without guidance
- ▶ Open-ended assignments and projects were a challenge
- ▶ Forced to use group-work to complete them in time
- ▶ You've become good at locating information required
- ▶ Sorting out “what's necessary” from “nice-to-have”
- ▶ Become far more efficient at managing your time

SDL after 4N04

You will keep learning:

- ▶ from the plant
- ▶ running experiments
- ▶ talking with experts
- ▶ reading websites
- ▶ company-sponsored courses, seminars and conferences
- ▶ reading books, journal publications, trade journals

Remember: it was in the Code of Ethics. You are encouraged to do this, as well as encourage your colleagues and people working under you to do this.

Your course reflection

A course reflection will be posted

- ▶ It is worth 5% of your course grade
- ▶ due by 17 December 2014, at 16:00

Questions asked:

- ▶ what 1 key piece of advice do you have for the 2015 students?
- ▶ troubleshooting experience: round 1 compared to round 2
- ▶ participation in class (active learning)
- ▶ your skills learned with self-directed learning
- ▶ group-work skills you learned
- ▶ time-management skills you learned
- ▶ surprising thing(s) learned in 4N
- ▶ did you accomplish your goals for 4N4?

What's in the exam

1. Engineering Economics
2. Operability
3. Process Safety
4. Troubleshooting
5. Engineering Professionalism and Ethics
6. Everything covered in tutorials, assignments and class

Economics: what we covered

1. Personal finance
2. Cash flows
3. Time value of money $F_n = \frac{C_n}{(1+i)^n}$
4. Profitability estimation: payback time; ROI; for independent projects we required $DCFRR \geq MARR$ and $NPV \geq 0$
5. Tax and depreciation: **always taken into account**
6. Sensitivity analysis
7. Capital and operating cost estimation
8. **Bring the list of CRA classes and CEPCI cost indices to the exam**

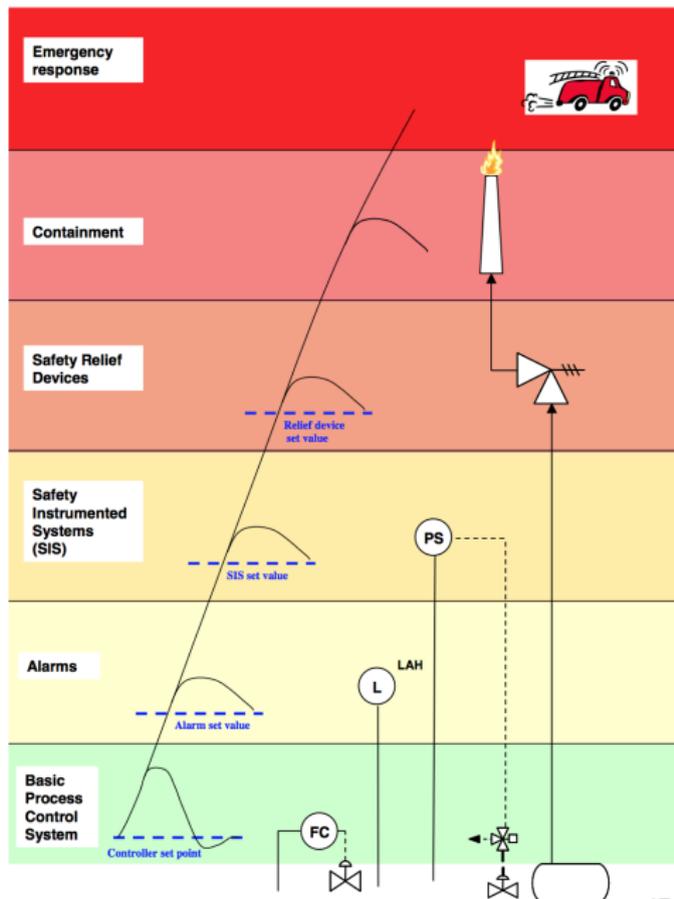
Operability

Recognize the plant must still operate under conditions, and in situations, different to what it was designed for.

1. **Operating window** at steady state
2. **Flexibility** and controllability: degrees of freedom; what's manipulated? what's controlled?
3. **Reliability**: parallel and series structures; duplicate units
4. **Transitions**: maintenance, start-up and shut-down, regeneration, and grade changes. Bypass, batch-continuous interfaces; storage.
5. **Scheduling**: ideas related to batch sequencing and scheduling

Process Safety

1. Hierarchy
 - 1.1 BPCS
 - 1.2 Alarms
 - 1.3 SIS
 - 1.4 Relief
 - 1.5 Containment
 - 1.6 Emergency response
2. HAZOP: nodes, parameters and guide words
3. Case study: BP in Texas City



Troubleshooting

1. **Engage:** *I want to and I can!*
2. **Define:** what is and isn't, fact vs opinion; where do you want to be?
3. **Explore:** fundamentals, important variables, cause-and-effect
4. **Plan and diagnose:** root causes in a table, collect evidence, initiate diagnostic experiments (actions)
5. **Implement:** short-term and long-term solutions
6. **Look back:** reflection ... what worked and what didn't

You have seen 7 case studies for troubleshooting

- ▶ More are available in Dr. Marlin's textbook
- ▶ Two others appear under the "Practice Problems" section on the course website

Troubleshooting will appear in the exam.

Professionalism and Ethics

- ▶ The material we covered in class
- ▶ The material posted on the course website
 - ▶ there are 11 extra case studies for you to practice with
 - ▶ detailed guidelines are given on how to approach the cases
- ▶ **Bring the Code of Ethics sheet to the exam**

Final exam

- ▶ 13 December 2014 at 19:30 in MDCL/1105
- ▶ Printed materials (textbooks, any papers, etc.) are allowed
- ▶ Any calculator is allowed
- ▶ Pencil is OK, as long as it is dark
- ▶ Answer questions in any order
- ▶ Answer each question on a new page
- ▶ Please use bullet points to answer, where appropriate
- ▶ Never repeat the question back in your answer
- ▶ **Something is unclear, or seems incomplete, make a reasonable assumption and continue with the question.**

Preparing for the exam:

- ▶ Please read Dr. Marlin's notes (not just slides, the notes)
 - ▶ Safety
 - ▶ Operability
 - ▶ Troubleshooting
- ▶ Please review the slides, videos, guest lectures, and material covered in class

Thank you

- ▶ For your feedback in class, after class and anonymously
- ▶ **Thank you for being a great class to teach.** See you in 4C3 and 4G3.

4W04 — Bring it on! I'm ready!