

# McMaster Chemical Engineering (McChem Inc.)

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**To:** Colleagues in Chemical Engineering 4N04  
**cc:** Danielle Maitland, Chris Ewaschuk  
**Date:** 05 October 2013  
**From:** Kevin Dunn  
**Subject:** Self-directed learning project

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## Self-directed learning / Life-long learning

Projects in the 4N4 course have typically started as the economics section is coming to an end. This year is no exception. The operability project provides you with the opportunity to:

1. apply all material in the course (including economics, safety, and all the operability topics from the last half of the course),
2. learn more about an interesting flow sheet,
3. build your life-long learning skills through independent inquiry and investigation, and
4. continue to improve your communication skills via the formal report,
5. build up your group skills.

Since technology changes continually you will require skills in the workplace that are not even taught at university, or may not even exist yet. This is the reason why engineering professionals engage in life-long learning. This activity involves identifying subjects about which you want/need to learn, setting goals, and checking your achievements. In Chemical Engineering 4N4 we will refer to this activity as Self-Directed Learning (SDL).

In this course we will build SDL skills while learning about process design (from 3G4), and extending it to the major topics taught in 4N4.

## SDL project report

The final project report is not to exceed 30 pages. More details in bullet point form follow, which you should use as a checklist before submitting your project:

- A single page cover letter (no cover page please) should be provided as your first page.
- All group member names and group number appear in the cover letter.
- A table of contents is **not** required, but a sample table of contents below provides you with an idea of the report's structure and an overview of the topics you are expected to investigate during the project. The specific issues within each topic depend upon the focus area assigned to your group.
- The report must be submitted electronically, no paper copies will be accepted.
- The report should preferably be a native Google Document, shared with full editing permissions. Alternatively, a shared PDF is also acceptable.
- Do not use a font smaller than 11 points; single line spacing is preferred.
- Pasted figures from other sources, e.g. P&IDs must be of high resolution. Low quality figures (if uncertain, please redraw the figure), and figures without attribution will be **heavily penalized**.

- Figures must be numbered sequentially. Pages must be numbered.
- Pages may be switched to landscape orientation if it assists in the display of wide tables.
- We prefer not to have any appendices. Supply the necessary data and information in line. The reason becomes clear if you think about how one reads an electronic document: it is not easy to flip forward/backward in pages. Referring the reader to an appendix only for them to come back is clumsy. If the reader isn't going to refer to the material, then s/he can just scroll past it.
- It is clear from the previous point that you will have to decide what your group deems important. Follow these rules: if you expect the reader will require the information, e.g. to allocate grades effectively, then leave the information in. Similarly, pages of repeated details are unnecessary: if you can do it once well, we assume you can repeatedly do it well.
- The P&ID should have the level of detail as in the assignments where you performed the hazard and operability studies. The rest of the flowsheet can be a basic block diagram with the control systems shown.
- A **mandatory extra (31st) page is required**, and will be a detailed table with two columns. The first column will show each group member's name. The second column will be a bullet-point list of the sections that the person significantly contributed to (e.g. "4.1.2 Capital cost estimation of major units"). A significant contribution is where that person wrote the section or co-authored it. Editing and minor changes are not considered as significant. Other contributions from that person may however be listed (e.g. "Document compiler", or "Overall document editor").
- A sensitivity analysis is required in your economics section.
- In the capital cost estimations, show the calculations for at least 1 unit that operates at high temperature, high pressure and/or manufactured from more expensive materials of construction. The calculations for remaining units may simply be calculated without showing the details. Always report the cost estimate's range and source of information though. Please note, you are expected to research and use other correlations from Seader *et al.*, and Turton *et al.* (detailed reference on the course website) when you find the Woods correlations are not complete. Report economics costs in 2012 dollars.

## Meetings

Meetings with your manager will be held during the week of 28, 29, 30 October and the following Monday, 04 November. You must provide an agenda for the meeting 48 hours in advance, and provide minutes of the meeting within 48 hours afterwards. The agenda, the meeting, and the minutes will be graded. The meeting must be well-organized and chaired appropriately.

You must book your meeting in one of the [time slots available](#). All members of the group must attend. Bookings are on a first-come first-served basis. The meeting location will be specified in my reply email.

The purpose of the 45 minute meeting is to ask questions about your focus area in the flowsheet, review all work done to that point, and outline the plans for future work so that you meet the project due dates. The agenda must reflect the list of questions you want to ask ahead of time.

## Flowsheet breakdown

We covered the [project flowsheet in class](#) on 27 September 2013. As you noticed, it is fairly extensive, so we have broken down the flowsheet in sections, so each group will have a different focus area.

1. Groups A1, A5, A9, B3 and B7 will consider the Gasification and Hydrogen Upgrading sections of the process (assume we will purchase oxygen as a utility). Furthermore, groups A1, A5 and A9 will consider the feed to be biomass, while groups B3 and B7 will use coal for operating cost purposes.

2. Groups A2, A6, A10, B4 and B8 will consider the Water Removal and Syngas Cleaning step. You may retain Dr. Adams “Magic COS removal” and “Magic CO<sub>2</sub> removal” blocks, and assume they cost zero dollars in capital and operating costs.
3. Groups A3, A7, B1, B5 and B9 will consider the Methanol Synthesis section of the flowsheet.
4. Groups A4, A8, B2, and B6 will consider the Carbon Dioxide Sequestration and Gas Combustion sections of the process.

The above defines the “*focus areas*” of the process.

You will use the focus areas for your capital and operating cost estimates. When estimating the capital costs, include the cost of all major units, including pumps, heat exchangers and storage vessels. For operating costs, estimate the cost of operators, utilities, raw materials, and all the usual operating costs.

You will report the capital and operating costs in a spreadsheet, to your manager, Kevin, by 08 November 2013. He will then use these data to return capital and operating costs for the entire flowsheet. You will use these values then to compute the sales price, and an **overall** economic analysis for the entire flowsheet, not just on your focus area. Include discussion on the project’s NPV, DCFRR, and a detailed sensitivity analysis.

## Example table of contents for the SDL/LLL Operability Report

1. Introduction
2. Process overview for your focus area
  - What is the purpose of the process section
  - What alternative technologies exist to achieve the same goal?
  - What are typical physical dimensions?
  - Provide detailed process drawings: valves, control loops, pumps, piping, and materials of construction
  - Process capacity (specify production rates, temperature, pressures and flows)

Assume that the audience has taken an undergraduate ChE program. So highlight what is essential and not obvious (e.g., corrosion, reliability)
3. Economics - estimation of capital costs, operating costs
  - What are the typical operating costs for your focus area
  - What are the detailed estimates of capital costs for your focus area
  - Detailed economic analysis on the entire process’s profitability, including a sensitivity analysis.
4. Safety issues
  - Six levels of safety
  - HAZOP for a **major unit** in your focus area. You will consider 1 nodes, 2 parameters, and 3 guide words.
5. Operability
 

Cover the operability issues identified in the course, except for safety, which is in the previous section

  - Operating window
  - Flexibility and controllability
  - Reliability
  - Efficiency

- Transitions during start up and shut down
- Dynamic performance
- Monitoring

## 6. Conclusions

The first (and probably only) appendix in your report must clearly document the report sections and specific pages contributed by each member of the group. Each section and associated pages must be reported.

## Grading

The grading is based on 25% due to meetings and communication with your manager and TA, and 75% on the project report.

There is one additional aspect that you must be aware of. As this project is performed outside of class, the instructor is not able to observe your work. Therefore, you have essential information regarding the individual contribution by everyone in your group. We will employ the peer evaluation method we have used throughout the course where every student must provide a confidential peer evaluation of all other members in his/her group. This evaluation will be completed electronically.

- We expect that you will provide your honest opinions, as soon-to-be professional engineers.
- This is not a popularity contest; you should treat close friends the same as other classmates.

## Timing

The following dates are critical to note, and have been posted on the course calendar:

Date	Event
28 October to 04 November	Formal progress meeting of group with instructor/TAs
08 November 2013	Provide detailed capital and operating costs for your focus area
18 to 22 November 2013	Potentially no classes for 4N4: <i>to complete project</i>
22 November 2013	All project reports are due at 09:30 (no exceptions)

## Groupwork

Lastly, this project contains more work than a single person can humanly perform in the requested time period. Effective group work is essential, which is why you have worked on multiple assignments in the same group, right from the first week of class. Your team should be operating smoothly by now and have got past the usual hiccups that a new team always experiences.

Sincerely,

Kevin Dunn