Mini Design Warm-Up Exercise

Instructions:

- Students get into groups of 6 (usually a 50:50 split, McGill:Polytechnique students)
- The instructor distributes a problem sheet to each group:
    - The problem involves calculating the flow rate of air through a vent with specific parameters (diameter, excavation depth, etc.)
    - Each group gets a vent with different parametric values, but groups do not know this, nor does the instructor tell them
- Groups spend time solving the problem and coming up with a fan power value. They are not allowed to consult other groups.
- Once all groups have completed the exercise, the instructor asks each group for their fan power value, which the instructor writes on the board:
    - Because each group started with different parametric values, their end fan powers are different, too
    - This causes some concern among students as they see the numbers going up on the board; they don't understand why everyone has a different fan power value
- The instructor then reveals that each group began with different parametric values.
- The instructor then proceeds to highlight the connections between the different parameters and their calculations
    - This is an important lessons for students because they learn to connect concepts (e.g., excavation depth, shaft diameter, shaft liner, air flow rate) with calculation (e.g., how shaft diameter impacts the fan power requirement and cost of ventilation, etc.)

Mini Design Instructions

Students work in the same small groups (6 people) throughout the course to solve three open design problems. Each mini design builds on the skills developed in the previous mini design.

- The first mini-design involves a pressure loss and fan power scenario, and students develop a design process.
- The second mini-design involves a ventilation network scenario (using simulation software), and students develop a design process, select and use engineering tools.
- The third mini-design involves a mine heating and cooling scenario (using simulation software), and students develop a design process, evaluate engineering tools and identify the tools' limitations.
- Groups are given 3 hours in class to complete a mini design, with a one day extension at home for their report write up.

The culmination of this group work is a final project, which builds on the skills that students developed during the mini designs.

Mini Design #1:

Students must manually calculate the pressure loss and fan power requirement through a vent, taking into consideration not only parametric values, but also factors such as economical (e.g., capital cost, excavating cost and operating cost) constraints.

Mini Design #2:

Students must repeat Mini Design 1 but with a more complicated ventilation network. This exercise cannot be completed manually; therefore, students must work and optimize their ventilation system using simulation software such as VentSim.

Mini Design #3:

Students build on Mini Design 2 by taking into consideration heating and cooling systems for their ventilation network. This again is completed using simulation software such as VentSim.

Final Design Project

The final design builds on the skills that students developed during the mini designs. Students work in the same groups as for the mini designs, so they are able to develop their teamwork skills. Students receive a rubric in advance to help them prepare their project. Students offer peers feedback on one another's reports, which can help them to prepare for their oral presentations of their final design project.

Instructions

- **Context**: students have been hired by a mining company to design a ventilation system. In groups, students are given the mine layout, but the vent design is left entirely to their discretion (open-ended design). Students must follow regulations in keeping with the engineering accreditation board of Canada as well as occupational health and safety for vent design, and they must assume some parameters, such as geotechnical, mine planning and costs.
- Students are given 1 of 3 mine locations:
  - 3 groups get a mine situated in Ontario
  - 3 groups get a mine situated in Québec
  - 3 groups get a (coal) mine situated in British Columbia
- The purpose of giving groups different mine locations and types is so that they take into consideration the specific conditions, such as health and safety provincial regulations, in order to optimize their vent design.
- **Bonus points**: encourage students to think sustainably (e.g., renewable energy to replace fossil fuel).
- **Timeline**: 10 days, with time allotted inside and outside of class.
  - Groups research the mine for which they have been employed to build a vent.
  - Using the information, calculations, and design processes from the mini design exercises, groups design a vent system for their given mine.
  - **Day 5 Check-In**: groups meet with the instructor to ensure that they are on track with their work.
  - Groups submit their reports at the end of the final design period.
    - After submission, the report is sent out to another group that is designing for the same mine location/type. That group must evaluate the report and provide peer feedback.
- **Presentation**: the 3 groups working on the same mine location/type present to each other and to the instructor.
  - Presentations are 20 minutes long (3 groups x 20 min = 1hr), followed by a 1 hr discussion period for all three groups.
  - Groups must come up with 5 critical questions (based on written report) to ask the presenting group.