Department of Civil Engineering and Chemical & Biological Engineering, Environmental Engineering (ENVL) Program, Faculty of Applied Sciences

Integrating Process Simulation into Environmental Engineering (ENVL) Curriculum - Promoting Sustainable and Reliable Design

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Purpose of the Project

This project integrates simulation modules into the curriculum of the new ENVL program to:

- Prepare students for the 4th-year Capstone design projects
- Equip students with skills for entry into industry

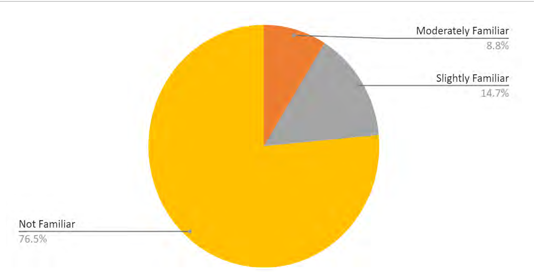
Simulation allows Environmental Engineers to make decisions using virtual experiments but must be applied with skill and caution.

Gaps in the Curriculum

- At year's start, 4th-year ENVL students indicated:
  - Low familiarity with the simulation tools they planned to use for their capstone projects
  - High interest in learning simulation and modelling software
- ENVL Faculty and industry advisors indicated the need for incorporating simulation into ENVL

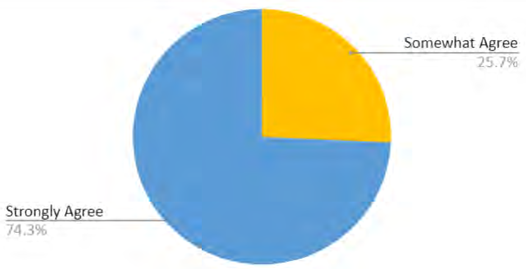
Student Feedback: Familiarity with Simulations

>75% of 4th-year ENVL students were not familiar with simulation tools they planned to use for capstone at the year's start



Student Feedback: Interest in Learning Simulation

All 4th-year ENVL students expressed that they were interested in learning more about simulations



Addressing the Gap

To address the gap, teaching materials were created to introduce students to: fundamentals of simulation, simulation tools commonly used in Environmental Engineering, guidelines for selecting a software, steps for using simulation tools, limitations of simulation and critical interpretation of results.

Training Materials

Component 1: Simulation principles

- Role of simulation
- Limitations of simulation
- Liability of Engineers conducting simulation
- Commercial Environmental Engineering simulation tools:
  - Database of commercial software tools including their:
    - Basis, capabilities and limitations
  - Decision tree for the selection of a suitable software

Component 2: Software-specific training

- Software-specific training
- Frameworks to document simulation inputs, assumptions and outputs

Focused on 4 target software tools

Component 3: Best Practices & Real-world topics

- Best simulation practices
- Result checking
- Validation and calibration
- Critical interpretation
- Real-world case studies

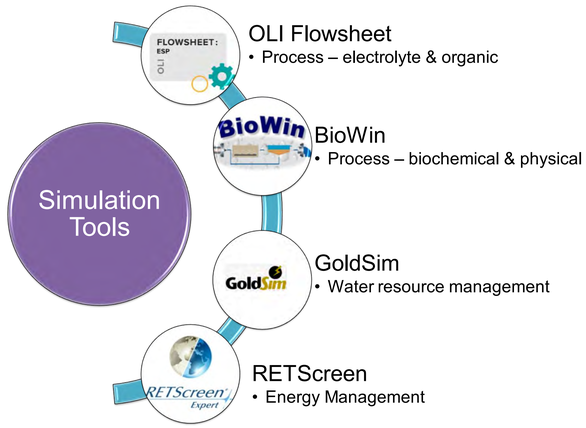
Instructor Guide

- Lesson plans
- Strategic integration plan into ENVL courses for all cohorts considering prior knowledge

Example: Software Tools

In component 1, a database is created to include a wide range of Environmental Engineering tools covering: process (thermodynamics, biochemical), hydraulics, hydrology, air quality, energy and resource management

In component 2, training focuses on 4 simulation tools. The aim is to help students apply skills acquired into any software.



Example: OLI Flowsheet

OLI Flowsheet is an electrolyte thermodynamic process simulation tool. *The image shows an example of OLI Flowsheet simulations may look like for a seawater desalination system.*

Students learn: software capabilities (databases), role of the simulation (desired outputs), how to build the simulation (inputs & assumptions), best practices, limitations, critically interpreting results, Engineer's liability

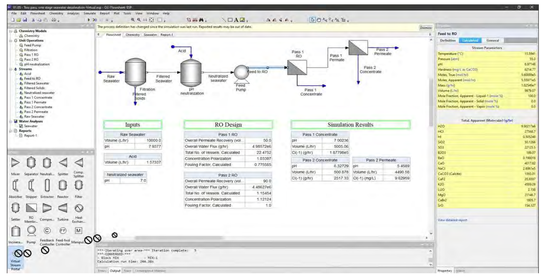


Photo credit: OLI Systems, 2022
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Phase 1 – Implementation

The materials created through this project have been partially integrated into various ENVL courses (ENVE 200, CIVL 204, ENVE 202, ENVE 401) which will continue.

The effectiveness is being evaluated through:

- Student surveys
- Student learning and knowledge assessment
- Student work placement
- Instructor and Academic Assistants reports

Preliminary outcomes: As an outcome of integrating materials into the capstone design course (with 6 capstone design groups) in 2023:

All 6 design groups indicated that they used a simulation tool for design, sizing or optimization

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In total, 5 different simulation tools were used across groups.

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Most groups researched and made the selection of the simulation tool

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82% of students across groups indicated they established some level of familiarity (low to high) with their tool

Phase 2 – Next Steps

Phase 2 aims to further implement the materials created during Phase 1 in additional courses, assess impact, collect feedback and refine the developed materials. It also aims to strengthen the real-world component, including case studies.

Acknowledgement

We gratefully acknowledge the financial support for this project provided by UBC Vancouver students via the Teaching and Learning Enhancement Fund. We also acknowledge:

- *Dr. Madjid Mohseni & Dr. Greg Lawrence (co-directors of the ENVL program)*
- *Natasha Pestonji-Dixon , CTLT*
- *Michael Sider, UBC Studios*

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