

## **61h Operability in Undergraduate Chemical Engineering Education**

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Undergraduate students in Chemical Engineering are introduced to the concept of operability in their design course. Often, the term is used in a narrow sense that concentrates on the dynamic responses of variables. In this paper, the term is given a broader meaning consistent with engineering practice. In addition, examples are provided to demonstrate the value of teaching operability in (1) reinforcing engineering sciences and (2) extending design from a "point" to successful operation over a region.

Current textbooks provide limited coverage of selected operability topics. For example, Turton et al (1998) provide a brief coverage of process control and trouble shooting. In contrast, Biegler et al. (2000) provide detailed coverage of the operating window. Also, Seider et al (2004) address dynamic simulation and plant-wide loop pairing. Finally, older books such as Peters and Timmerhaus (1991) do not address operability.

This paper proposes a broader definition of the design problem to explicitly include operability, which consists of the following topics.

- \* Operability Window, including methods for increasing the window and determining that operation is possible at all points within the window
- \* Reliability, including reliability calculations for simple process structures and methods for improving the reliability of a plant
- \* Flexibility, including tests to ensure that flexibility is located correctly to achieve controllability, with examples of methods for expanding operability
- \* Safety, including the six levels of safety protection (AIChE) and HAZOP studies
- \* Efficiency, including designs to improve operating profit
- \* Startup and Shutdown, including extra equipment required
- \* Dynamic performance, including designs to give good feedback performance
- \* Monitoring and Diagnosis, including sensors for monitoring and plant trouble shooting

The integrated coverage of the topics allows the students to recognize that flexibility, provided for reliability or high capacity, provides opportunities for affecting efficiencies and dynamic performance within the operating window.

Some excellent resources are available for some of these topics, but they are neither identified in a common source nor integrated by highlighting common approaches. The proposal in this paper is to establish a method for instructors to share WEB-based resources for teaching and engineering practice.