ECE 100 Introduction to Engineering Design
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Retailer Inventory Dynamics Simulation

Problem. The objective of this in-class exercise is to obtain an appreciation for engineering-based decision strategies involving feedback and feedforward control mechanisms by *manually* adjusting orders to meet customer demand in the retailer node of a single-product supply chain. A schematic representation of a "fluid" analogy to this control system is shown in Figure 1.

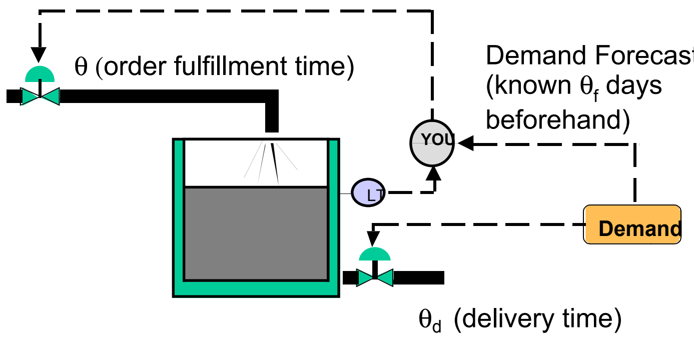

Figure 1: Fluid analogy for inventory management in a retailer node of a supply chain

Your task is to work with the "Interactive Order Simulator - Mark I" (developed by Mike Pew, Course Teaching Assistant, in collaboration with Dr. Rivera) to evaluate the effect of applying various control strategies on a retailer node characterized by an order fulfillment time of $\theta = 3$ days and a $\theta_d = 0$ day delivery time under a variety of conditions. These conditions are represented by a series of eight *scenarios* summarized below:

Scenario 1. Deterministic step change in demand under high initial on-hand inventory conditions. No forecasts available (only historical data).

Scenario 2. Deterministic step change in demand under low initial on-hand inventory conditions (only historical data).

Scenario 3. Deterministic step change in demand under low initial on-hand inventory conditions; an accurate five-day ahead forecast of demand (i.e., $\theta_f = 5$ days) is available.

Scenario 4. Deterministic step change in demand under low initial on-hand inventory conditions; an inaccurate five-day ahead forecast of demand (i.e., $\theta_f = 5$ days) is available.

Scenarios 5, 6, 7 and 8. Scenarios 5 through 8 mimic Scenarios 1 through 4, except that the demand changes are stochastic in nature (i.e., they involve randomness). As a result, the forecasted demand values for Scenarios 7 and 8 (which mimic Scenarios 3 and 4) represent averaged quantities.

Please follow Dr. Rivera's instructions for working with the interactive simulator. To avoid complete predictability in the deterministic scenarios, the magnitude and start day of the demand change will vary from run to run. Strive for controlling the system so that total costs are minimized with respect to a 30-day run (for the stochastic cases a 60-day run may be more appropriate). Try to avoid the occurrence of backorders under all circumstances. Please answer the following questions:

1. Rank order the scenarios, from the easiest to control to the hardest. What problem features make a specific scenario easy (or alternatively, hard) to control?

2. Identify the feedback and feedforward mechanisms that you used while manually controlling this system.

3. From your experience, what system operating conditions (or system information) lend themselves to creating a control system that is "optimal" with respect to customer satisfaction (that is, no customer backorders or delays are ever experienced)? What implications does this have from a cost-optimal standpoint? What are ways in which one can address the tradeoffs involved?

We will adjourn after these questions have been discussed as a class. You will be requested to put these answers in writing as part of Modeling Assignment No. 3 and Project No. 1.