



15.879 Advanced System Dynamics Modeling

Spring 2025

Exercise 5- Management Drug Development Pipeline

Submit your model to the shared dropbox before the class on Friday 3/7/2025

From inventory management to maintaining desired workforce, products, or investments, stock management is a critical real-world problem, which has been at the heart of a lot of SD models. In this exercise you want to build on and expand the standard stock-management formulation to managing leaky stocks.

Specifically, consider the drug development pipeline for a pharmaceutical. This is a critical part of their business, where years of investment in drugs is accompanied with high failure rates in every stage, with the hope of getting a few successful drugs at the end which can make good money and compensate for all the costs. Consider a simplified development process consisting of 4 stages for candidate drugs: phase 1, phase 2, and phase 3 clinical trials, followed by drugs in the market. Drugs may fail in the first 3 stages, leaving only a small fraction to reach the market successfully. Those in the market will be lucrative while under patent, and lose their value once out of patent. The company's stock-management task is to start enough candidates into the phase 1 trials in order to maintain the desired revenue from those in-market. Your task is to formulate a (deterministic) model to achieve this goal.

Use plausible assumptions for success rates in each phase (with one minus that fraction failing), delays per phase and patent life, and annual revenue per drug, to formulate the start rate of phase 1 launches of new candidates.

A good formulation should enable the company to match its desired revenue when that desired revenue patterns, not only when that revenue is constant, but also when it is growing with a fixed fractional rate (i.e. exponentially). Make sure that the model is robust to various shocks (such as major failures in different stages of clinical trials) and starts from equilibrium. A good formulation will also speed up convergence to the desired stock level while minimizing the risk of oscillations. Besides testing the model against exponential inputs, test its performance in response to linear and oscillatory inputs and comment on its general applicability for different desired revenue trajectories.

As a bonus you may consider the costs and benefits more explicitly, noting that the marginal promise of pushing more drugs into the pipeline shrinks the more drugs you propose (per unit of time). That reduction should then inform both the pipeline's failure rates down the line, and the decision to add new drugs into the pipeline in the first place, leading to a problem of optimized pipeline management rather than just tracking a desired revenue at any costs.

Submission Instructions

Put your Vensim model(s) in the shared dropbox folder under session 5. Please name your model submissions as: S05-<Last Name>-DrugPipeline.mdl
for example, "S05-Rahmandad- DrugPipeline.mdl".

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