System Description

• Current high throughput drug screening techniques determine which compounds proceed to the clinical testing phase of development

• Current techniques can only test compounds for a one cell signaling marker

• False positives and negatives can cost pharmaceutical companies millions of dollars in the drug development process

• This new system offers a disposable sensor array than can screen a compound using several cellular activity markers

• The new system is high throughput while also adding higher information content

• These sensor modules are amenable to many current drug screening infrastructures, which will reduce integration costs for pharmaceutical companies
Application Portfolio Outline

- This application portfolio explores the various uncertain financial aspects to the manufacturing and marketing these sensor systems
- Parts 1-3 explore various system designs and uncertainties
- The system is described in detail and the primary sources of uncertainty are quantified
- Parts 4-6 of the portfolio investigate, using NPV, the various methods of uncertainty analysis and flexible design
- Such analysis techniques include decision trees and binomial lattices
- Overall simulation conclusions
Part 1: Defining the Topic

- The disposable sensor system consists of a disposable plastic injection molded “peg” array that fits into standard 96-well plates.
- The end of each “peg” is coated with a patented optical ion sensor.
- A flow through diagram of a standard screening system is shown below:

There are several ways to present this sensor system for decision analysis.
- The next sections simplify the sensor module into two possible disposable sensor packages for manufacturing.
Part 2: Defining Salient Uncertainties

- This section outlines the major uncertainties in manufacturing a drug-screening sensor system.
- It was decided that the primary two uncertainties in the system are:
  1. Market demand
  2. Manufacturing Costs
- For each of these two parameters, information was gathered that could be used to develop future parameter values and variances.
- Example data sets that represent future parameters are shown below.
Part 3: Defining System Designs to be Analyzed

- To keep the decision analysis simple, the sensor array is split into two manufacturing approaches

  **System 1: Fixed – Sensor Plate**
  
  - Large single array (covers entire plate)
  - Requires a single large manufacturing plant
  - Large capital investment
  - Could take advantage of economies of scale if production is high

  **System 2: Flexible – Sensor Strips**
  
  - Sensor pegs reside on a single strip (~ 12 strips / plate)
  - Smaller manufacturing plants
  - Equivalent economies of scale to the larger plant
  - Allows plants to be built or shut down over time
Part 4: 2-Stage Decision Analysis of Alternative Designs

- Both fixed and flexible design approaches are evaluated using a 2-stage decision analysis with market demand as the uncertainty.

- Both systems yield a positive NPV.

- Flexible system offers and additional $120 million in NPV over the eight year time period.

- Choose the flexible design approach with the given design parameters.
Part 5: Lattice Analysis of Evolution of a major uncertainty

- To model market demand uncertainty, a binomial lattice is employed.
- Input parameters for the lattice (P, U, D) are chosen from Invitrogen's revenue data over the last five years (company that produces a similar product).
- The PDF plots of the lattice are shown below.
- It must be noted that since the growth rate is larger than the standard deviation, P is greater than 1.
- P is set to 0.95 for this analysis; however, it should be noted that since the actual P is greater than 1, the lattice is a poor model for this system.
Part 6: Decision Analysis Using Lattice

- The binomial lattice parameters developed in part 5 are used to develop a decision lattice.
- At time zero, many plants are built to anticipate high demand. If demand is lower than expected, a plant can be closed down (Put option).
- Since the probability is high, the put option is only exercised when manufacturing costs are higher than expected.
- The value of the option is plotted against yearly manufacturing costs below (sensitivity analysis).
Conclusions

- 2-stage decision analysis shows advantages in a flexible system design; however, the calculations would become highly intensive if the number of stages increases over two or three.

- The binomial decision lattice is easily setup in a spreadsheet, but since the predicted growth exceeded the variance, this model is less appropriate.

- The lattice did prove very useful in performing a sensitivity analysis on production parameters, such as manufacturing costs.

- This portfolio dictates the use of a flexible design approach (sensor strips).

- The portfolio results also advocate being able to open and close plants over time (options ON the system).
Assumptions

- Used a fixed discount rate for all NPV calculations
- Manufacturing parameters were only estimates (actual parameters could be much different)
- Only investigated market demand as the uncertainty variable
- Market models did not include competition, marketing, and unknown demand markets
- Assumed path independence for all binomial lattice simulations