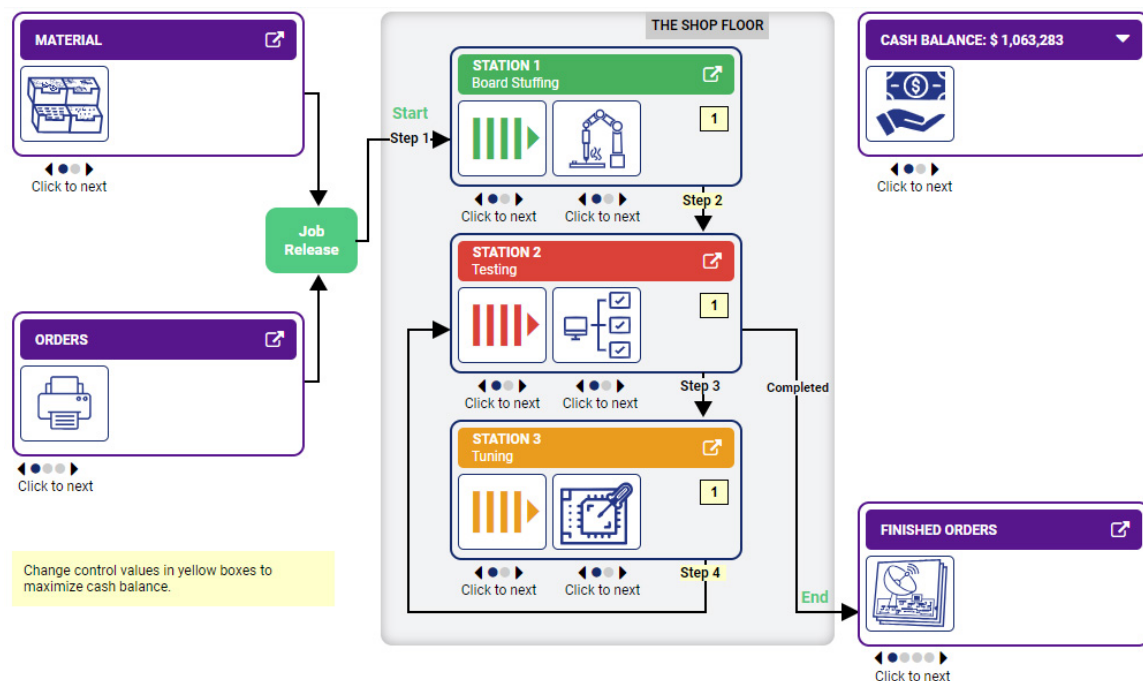


# Littlefield Technologies: Overview and Assignment<sup>1</sup>

## Simulation Overview

Littlefield Technologies assembles Digital Satellite System (DSS) receivers. These receivers are assembled from kits of electronic components procured from a single supplier. The assembly process consists of four steps carried out at three stations: **Board Stuffing**, **Testing**, and **Tuning**. In the first step, components are mounted onto PC boards and soldered at the Board Stuffing station (Station 1). In the second step, the digital components are briefly tested at the Testing station (Station 2). In the third step, key components are tuned at the Tuning station (Station 3). Finally, in the fourth step, the boards undergo exhaustive “final testing” at the Testing station (Station 2) before delivery to the customer. Every receiver passes the final test. All stations consist of automated machines that perform the operations.

You may purchase additional machines during the simulation. Board Stuffing machines cost \$90,000 each, testers cost \$80,000, and Tuning machines cost \$100,000. You can also sell any machine at a retirement price of \$10,000, provided at least one other machine remains at that station. Operators are paid a fixed salary, and increasing the number of machines at a station does not require additional operators.



<sup>1</sup> Based on the instruction written by Sunil Kumar and Samuel C. Wood at the Stanford University Graduate School of Business. Copyright 1998. No part of this document may be reproduced without permission from Responsive Learning Technologies, Inc., at [info@responsive.net](mailto:info@responsive.net).

Customer orders arrive randomly at the factory, with each order consisting of 60 receivers. If an order arrives and there are fewer than 60 raw kits in the materials buffer, the order is placed in the customer order queue, pending the arrival of raw kits. Additionally, orders are not accepted if the total number of orders in the system (either waiting for kits or in process) exceeds 100.

You may choose to release each order into the factory as one lot of 60 receivers, two lots of 30 receivers, three lots of 20 receivers, or five lots of 12 receivers. Processing a lot on each machine entails performing a setup on the machine, processing each kit in the lot (one at a time), and then sending the completed lot to the next station. Once all the receivers in an order are completed, the order is shipped immediately. An order is not shipped to the customer until all its lots have been completed. Management has resisted splitting a customer order of 60 receivers into multiple manufacturing lots in the past because each lot requires setup time at both the stuffer and the tester. Thus, splitting an order into lots would increase the fraction of time each stuffer and tester spends on setups.

Raw kits are purchased from a single supplier at a cost of \$10 per kit. There is also a fixed cost of \$1,000 per shipment, regardless of the shipment size. The supplier requires four days to deliver any quantity of raw kits. An order for new raw kits is placed with the supplier only when the following three criteria are met: (1) the inventory of raw kits is below the material reorder point, (2) there are no outstanding orders for raw kits, and (3) the factory has sufficient cash to purchase the specified order quantity. No order is placed if any of these three criteria are not met. You may set the reorder point and order quantity independently, in multiples of 60 kits, including zero.

Kits are purchased in multiples of 60 because orders arrive in batches of 60. The reliable supplier delivers the exact order quantity of batches, four days after the order is placed and paid for. Management considers the physical cost of holding inventory negligible.

The current pricing contract is as follows: an order does not leave the factory until all 60 receivers in the order are completed. A customer order filled within the quoted lead time of 7 days earns \$750. However, if an order remains in the factory for more than 7 days, a lateness penalty is incurred. Specifically, the total revenue for an order decreases linearly from \$750 for a 7-day lead time to \$0 at the maximum lead time of 14 days. Orders taking longer than 14 days to fill generate no revenue.

Customers are willing to pay a premium for faster lead times, and you have three pricing contracts to choose from:

- price = \$750; quoted lead time = 7 days; maximum lead time = 14 days. (This is the contract that the factory starts with, described above.)
- price = \$1000; quoted lead time = 1 day; maximum lead time = 2 days.
- price = \$1250; quoted lead time = 0.5 days; maximum lead time = 1 day.

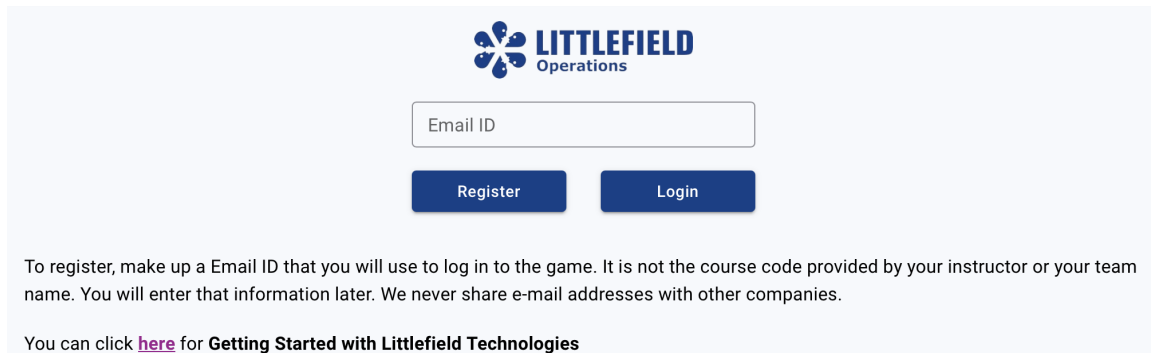
A contract is assigned to an order as soon as it arrives at the factory, and that contract cannot be changed afterward for that order.

You will have some cash on hand when the assignment begins. This amount will decrease as you purchase machines and raw kits from the supplier. Revenue earned from filled orders will increase the cash balance. The balance earns interest (compounded every simulated day) at a compounded rate of 10% per year. There are no taxes. All fixed overhead costs over which you have no control, such as salaries, rent, and utilities, are ignored. To reduce the risk of bankruptcy, you are not allowed to purchase a machine if doing so would leave the cash balance too low to cover the cost of a raw materials order at the current order quantity. Once the market matures on Day 100, a bank will extend a line of credit to Littlefield Technologies at an annual interest rate of 20%, compounded daily. Additionally, a 5% loan processing fee will be incurred when the loan is issued.

**The winning team is the one with the highest cash balance at the end of the game.** The cash balance is calculated as the cash on hand minus any outstanding debt.

## Registration Steps

To play the simulation game, you need to register on the simulation website and create and join your team. Below is a step-by-step procedure for doing this. First, set your browser to [op3.responsive.net/lf/yale/](http://op3.responsive.net/lf/yale/), which will display the following page:



**LITTLEFIELD**  
Operations

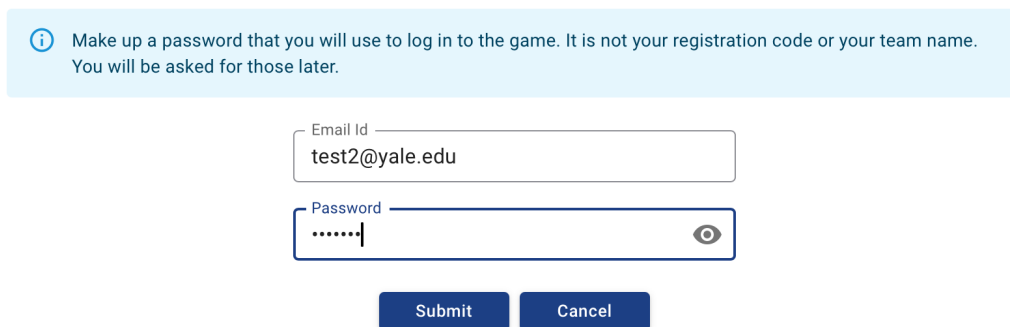
Email ID

Register Login

To register, make up a Email ID that you will use to log in to the game. It is not the course code provided by your instructor or your team name. You will enter that information later. We never share e-mail addresses with other companies.

You can click [here](#) for **Getting Started with Littlefield Technologies**

Enter your ID (email address), then click the “Register” button. On the following page, you will be asked to enter a password. **Important: Both the ID and password may consist only of numbers, lower-case letters, and the \_ and @ symbols.** Be sure to keep a record of your ID and password.




*i* Make up a password that you will use to log in to the game. It is not your registration code or your team name. You will be asked for those later.

Email Id test2@yale.edu


Password .....

Submit Cancel

After entering the password, click on the “Submit” button. This will take you to the next page, where you will be prompted to enter the course code.

 Please enter the course code provided by your instructor.

Here, enter the code **‘bulldog’** and click on the “Submit” button. On the next page, you will be prompted to enter your last and first names. Enter the requested information. The first student to do this for each team should also “Create New Team” and input your pre-determined team name and create a key (password). All subsequent team members will be able to join teams that have been created by finding their team’s name in the drop down menu and inputting the key (password).

 Complete or revise the following and click Submit to continue.

.....

Choose Team

Select

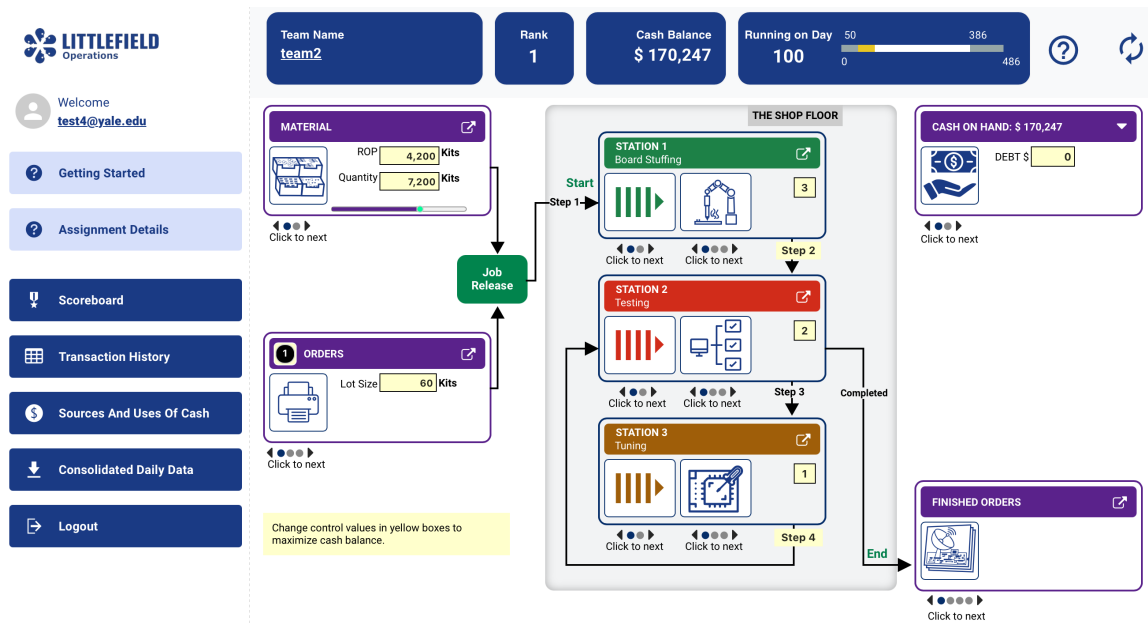
Your team is identified by your team name on the game scoreboard.



Registration will be completed once you click the “Submit” button.






After completing the registration but before the simulation begins, you can change your password on the starting page ([op3.responsive.net/lf/yale/](https://op3.responsive.net/lf/yale/)) by entering your ID, clicking “Register,” and then entering your old password. You will then see a form where you can update your registration information, including your password. If you need to change your password after the simulation has begun, log in to the simulation website and click your ID in the upper-left corner of the main interface.

## Accessing Your Factory

Once the simulation begins, you can access your factory by entering the ID and password you registered at [op3.responsive.net/lf/yale/](http://op3.responsive.net/lf/yale/). Be sure to click the “Login” button, not the “Register” button. After logging in, you will be directed to the main page, which displays the factory schematic and various information, as shown below.




If your browser window is narrow, you may not see the menu options on the left side of the schematic. If this happens, clicking  in the upper-left corner will reveal the menu. Below is a description of the essential elements of the schematic. More details are provided in the “Getting Started” document, which can be accessed from the menu on the left (click ).

- Clicking a thumbnail icon or  opens a panel displaying more details about that part of the process, including additional information, parameters, and data plots. If a parameter is changeable, the edit icon  will appear next to it.
- Changeable parameters are **highlighted in yellow** while the simulation is running. You can change a parameter value at any time during the simulation by clicking it, then entering a new value after clicking . If the simulation is suspended or completed, the parameters are displayed in **grey** and cannot be edited.
- Clicking  allows you to cycle through different plots showing the last 50 days of selected data relevant to that part of the process.
- Clicking  from the menu on the left downloads historical data in an Excel spreadsheet. This is especially useful for preparation before the simulation starts; by examining the pre-populated data, you will gain a better understanding of the simulation settings (see the *Your Task* and *Deliverable* sections below for more details).

## Playing the Simulation Game


The simulator runs continuously. This means that if you view the site at 10 a.m. on a Monday and then again at 11 a.m. the same day, some simulated time will have elapsed. **24 hours of real time corresponds to 67 days of simulated time (hence, about 2.8 simulated days per actual hour).** You have no control over the simulator's clock. **It may take a few simulated days to see the effects of your decisions, so constant monitoring is not necessary.**

When you log in, your factory status is automatically updated. Whenever you make a change (e.g., increasing the number of machines at one of the stations), the factory is also updated. To manually update the factory status, click the update button  in the upper-right corner of the schematic. Due to the slow speed of the simulator, frequent updating is usually unnecessary.



The product lifetime of many high-tech electronic products is short, and the DSS receiver is no exception. After 485 days of operation, the plant will cease producing the DSS receiver. At that point any remaining equipment and inventory is worthless and the factory is retooled for the next technology generation. Demand is random but stable over the entire 485 days. In other words, even though orders arrive randomly, long-run average demand will not change.

When the game begins, you will have 50 days of history. Afterwards, 67 simulated days will elapse every real day (24-hour period) for exactly 5 real days, corresponding to  $67 \times 5 = 335$  simulated days. Exactly 335 simulated days after you have access to the game, you will lose control of the factory and the final 100 simulated days will be run over a few minutes. After all days are run, you can access your factory's final status but you cannot make any changes to the factory.

Data points are recorded at the start of each day. In the "Inventory level in kits" plot, available from the Material section of the schematic, fractional days are included to show the exact times when new material orders arrive and when inventory reaches zero. You may notice a few days where zero jobs exit the factory. On such days, the daily average lead time and daily average revenues are meaningless, and a value of zero will appear in those plots.

To change certain features of the factory, click a thumbnail icon or  in the schematic and edit the parameter values. Click any of the three **Station** thumbnails to sell or buy machines at the corresponding station by entering the total number of machines. In **Station 2** ("Testing"), you can also change the scheduling policy (note: FIFO means "first-in, first-out"). In the **Orders** section, you can enter the lot size and select a quoted contract for future orders. In the **Material** section, you can change the reorder point and/or the order quantity for raw materials. **If, at any time during the game, you want to suspend the placement of new raw material orders, set the order quantity to zero. You cannot suspend new orders by adjusting the reorder point. Alternatively, you can prevent**

**orders from being placed by setting the order quantity so high that there is insufficient cash to place an order.**

Sources and uses of cash can be viewed by clicking the **Cash on Hand** thumbnail or the  Sources And Uses Of Cash menu option. Cash sources include revenue from filled orders, proceeds from the sale of machines, and interest earned. Cash uses include raw material (kit) purchases and the acquisition of additional machines. You can borrow and repay loans starting on Day 100 by clicking the “**Debt**” entry box in the Cash on Hand section and entering the amount to increase or decrease the debt. Finally, you can check your team’s overall standing by clicking the **Rank** section at the top or the  Scoreboard menu option.

## Your Task

The Littlefield factory began production by investing most of its cash in capacity and inventory. Specifically, on Day 0, the factory started operations with three stuffers, two testers, one tuner, and a raw materials inventory of 9,600 kits. This left the factory with no cash on hand.

Management is currently quoting 7-day lead times, but it would like to charge higher prices that customers are willing to pay for significantly shorter lead times. Additionally, because the factory is essentially bootstrapping itself financially, management is concerned about running out of cash.

The factory has been running for 50 simulated days, and management has hired a high-powered operations team (you) to manage the capacity, scheduling, purchasing, lot sizing, and contract quotations to maximize the cash generated by the factory over its lifetime. Management is not providing any operating budget beyond the cash generated by the factory itself. You will have control of the factory from day 50 to day 385. At 67 simulated days per real day, this translates to 5 real days. At day 385, you lose control of the factory, and the simulation will quickly run another 100 days of simulation. When you lose control of the factory, management expects you to leave the factory parameters set to maximize the factory’s cash balance when the factory shuts down on day 485. After the simulation ends on day 485, you can check the status of your factory, but the factory will no longer be running. Team scores and ranking are based on “cash balance,” which Littlefield Technologies defines as cash on hand minus debt.

## Deliverables

Your team performance of the simulation exercise will be evaluated based on team scores and two write-ups: (1) **Action Plan** (to be submitted before the simulation starts) and (2) **Summary Report** (to be submitted after the simulation ends).

### Action Plan (pre-simulation):

Prior to the simulation, your team should turn in an action plan. This plan should not exceed one page and summarize your rough analysis of the performance of your factory in the first 50 days of operations, and draw an operational plan for the next 335 days. What decisions are you going to make? In which order? When? How will you coordinate your actions among team members? This write-up is meant to serve as a preparation for the simulation run, and as such, you may leave out minute details. In crafting the strategy, you may want to consider the following decisions that will become relevant during the run: contract selection; lot size; purchase and sale of equipment; raw material reorder point and order quantity; borrowing and repayment of loans (after day 100).

### Summary Report (post-simulation):

After the simulation, you should hand in a write-up that summarizes (1) the actions you took during the 5 real days you had access to the factory and (2) in retrospect what could have done in order to improve performance. For example, did certain areas turn out to be more or less important than expected? How did your understanding of the interplay between decisions change? Show analysis to justify your conclusions to demonstrate your understanding of the concepts and frameworks seen in class, and your ability to use them critically to manage a process. You may use the pre-simulation Action Plan as the template for this report; overlaps are allowed, but you should revise your previous analyses (if any) and discussions if changes have been made. Your team's grade will be based mainly on this Summary Report, and as such, you should ensure that the report is as comprehensive as possible. The summary cannot exceed 4 pages in length, (double-spaced, 12-font) plus up to 2 pages of exhibits.

## Submission Guidelines

- Submission of Action Plan is due at **5 pm EST, Sunday February 15**. This coincides with the time when the simulation starts. Submission of Summary Report is due at **5 pm EST, Friday Feb 27**, one week after conclusion of the simulation exercise.
- Submit both Action Plan and Summary Report write-ups **electronically via Canvas**. To do this, go to the Assignment menu in Canvas and click on either "Littlefield Action Plan" or "Littlefield Summary Report," then click on the button "Submit Assignment." Upload write-ups in Word document formats. One student from your team should submit each write-up on behalf of other teammates. In each write-up, clearly mark the following items: (1) Littlefield team name (as registered on the Littlefield website); (2) names of all team members.