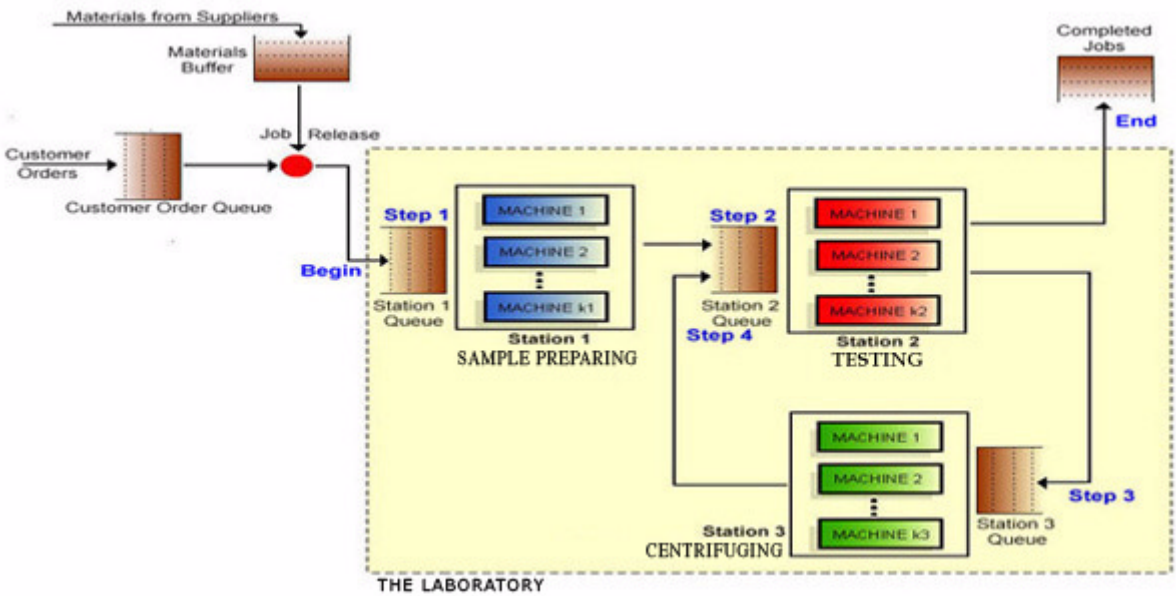
Columbia Business School

Managing Reponsiveness with Perishable Supplies at Littlefield Labs

Introduction

Littlefield Laboratories is a state-of-the-art highly automated lab that tests blood samples. Samples are tested using a test kit that is disposed after testing one sample. These kits are procured from a single supplier and stored in the materials buffer. The testing process consists of four steps carried out at 3 stations called **sample preparing**, **testing** and **centrifuging**. The blood samples arrive from hospitals and clinics as customer orders. The first step consists of matching each sample with one test kit from the buffer (the combination is referred to as a job), filling test tubes with blood and preparing for the testing process. This is done at the sample preparing station. The job then moves to the testing station where basic tests are conducted on the blood sample in step 2. In the third step, the sample is centrifuged to extract plasma and blood cells. Finally, the job moves back to the testing station for additional testing in step 4. All samples go through additional testing and then the results are sent to the customer.

All the stations consist of automated machines that perform the operations. You may purchase additional machines during the assignment. You can purchase one of any type of machine for $80,000. You can also sell any machine at a retirement price of $10,000, provided there is at least one other machine left at that station. The operators are paid a fixed salary, and increasing the number of machines at a station does not require any increase in the number of operators.



You may also change the way the queue of jobs at the Tester is sequenced. Specifically, you can choose between (1) first-in-first-out (FIFO); (2) priority to all jobs waiting for step 2; or (3) priority to all jobs waiting for step 4.

Customer orders arrive randomly at the lab. Each order is for one sample. Customer orders are only accepted when the total number of orders in the lab is less than 100.

Test kits are purchased from a single supplier every seven days and cost $600 per kit. The test kits have a shelf life of 1 week. One week after a shipment of kits is received any kits remaining in inventory are disposed and more kits are ordered. The number of kits ordered is the order-up-to level plus the number of backlogged customer orders, if any, waiting for kits. If the lab has sufficient cash to pay for the order, the new kits arrive immediately. Otherwise no kits are ordered at all and there will be no kits in stock for the next seven days. You may change the order-up-to level at any time.

The current pricing contract is as follows. Results sent within the quoted lead time of 1 week earns $750. If an order is still in the lab 1 week after it arrived, then a lateness penalty is incurred. Specifically, the total revenue for an order linearly decreases from $750 for a 1-week lead time to $0 for the maximum lead time of 2 weeks. Orders that take longer than 2 weeks to fill generate no revenue at all even though they must be completed.

Customers are willing to pay a premium for a contract with shorter lead times. Specifically, customers will pay $1000 for completed orders if the lab will commit to a quoted lead time of 1 day, with the payment decreasing linearly to zero at 3 days. Customers will also pay $1250 for a promised lead time of 0.5 days, decreasing to $0 at 0.75 days. You may change between contracts at any time but once a contract is assigned to particular customer order, that order's contract cannot be changed.

You will have some cash on hand when the assignment begins. This amount is depleted by buying machines and by buying test kits from the supplier. The revenue earned from filled orders increases 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 over which you have no control, such as salaries, rent, utilities, etc. are ignored. To reduce the chance of bankruptcy, you are not allowed to purchase a machine if the resulting cash balance would be too low to purchase an order of kits equal to the order-up-to level.

The winning team is the team with the most cash at the end of the game. You can compare the cash status of your team to other teams by clicking on the "Overall Standing" button on the bottom of the web page.

Registering your team

Before the first assignment begins, you will need to create and register your team. Come up with a team name consisting only of lower-case letters (no punctuation) and a team password. Your instructor will give you the address for the registration web page. The web page is shown at the top of the next page.

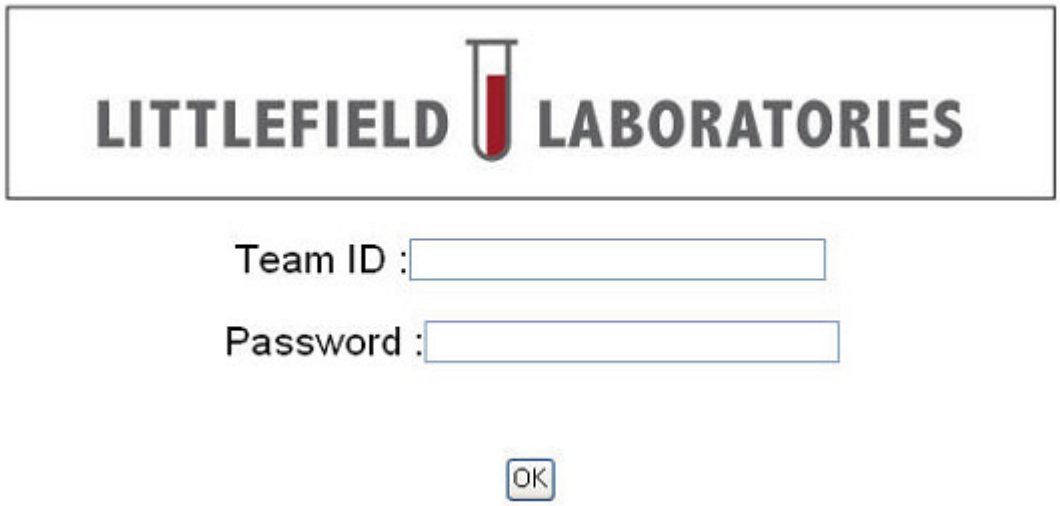
On the registration page, you will first have to enter the code given in class. Once you have entered the code, you will be asked for the team name and the password that you came up with. Finally, you will be asked for the names of each of the team members. After you submit this information from the web page, your team will be registered. Later, if you

decide to change you team name, password, or members before the assignment begins, you can simply return to the registration page, enter the same team name and password you entered the first time, and then make your changes. To completely remove your team, delete all of the team members' names and save the resulting team. You will not be able to make any changes to your team after the assignment begins.

Accessing your laboratory

When the assignment begins, you can access your lab from the entry web page using the team name and password that you previously registered. Your instructor will give you the address for the entry web page. The entry web page is shown below.

If you are using Windows, then MS Internet Explorer is the recommended browser. You should also have java and javascript enabled and window blocking for the lab web site disabled. These are the defaults on most PC's, so you will only need to worry about your settings if things don't appear to be working right.



Using the simulator

The web-based simulator runs continuously. That is, if you view the site at 10 am on a Monday and then view it again at 11 am on the same day, you will see that some simulated time has elapsed. One hour of real time corresponds to 24 hours of simulated time. You have no control over the simulator's clock. **You may need to wait for a few simulated days to see the effects of your decisions, so constant monitoring is not necessary.**

When you login, your lab's status is automatically updated. Whenever you make a change (like increasing the number of machines), the lab is also updated. To update the lab status otherwise, you must click on the *update* button on the bottom of the web page. In light of the slow speed of the simulator, there will usually be no need for frequent updating.

The web page seen after logging in will have a schematic diagram of the lab floor as seen in the figure on page 1. Clicking on an icon on the schematic will reveal a menu and corresponding data. For example, clicking on a station icon will reveal a menu that gives data about the station, as well as additional buttons that allow you to change the number of machines at the station or view the historical utilization the station. In similar fashion, you can get other information as described in the table on the following page. You will also be able to download the data into text files that can be opened by Microsoft Excel, for further analysis, by clicking on a button below the plots.

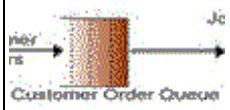
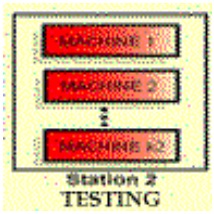
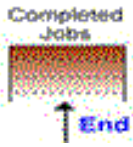
Assignment

In early January Littlefield Labs opened its first and only lab to test samples from surrounding hospitals and clinics. On day 0, the lab started with one of each type of machine type and 15 kits for testing. This left the lab $1 million cash on hand. Customer demand is random, but expected demand will be constant from day 0 to 75, then grow at a constant rate until day 150. Expected demand will be constant again from day 150 to day 315. When the lab's technology is obsoleted at the end of this lifetime, demand seen by the lab will end abruptly and operations will be terminated. At that point all capacity will be useless and thus have no value.

The lab has been running for 52 days, and management has hired a high-powered operations team (you) to manage the capacity, scheduling, purchasing, and contract quotations to maximize the cash generated by the lab over its lifetime. You will have control of the lab from day 52 to day 218. At 1 hour per simulated day, this translates to 6 real days and 22 real hours. At day 218, you lose control of the lab, and the simulation will quickly run another 97 days of simulation. When you lose control of the lab, management expects you to leave the lab parameters set to maximize the lab's cash position when the lab shuts down later on day 315. After the simulation ends on day 315, you can check the status of your lab, but the lab will no longer be running.

Your team should turn in one summary of what actions you took during the time you had access to the lab, why you took those actions, and in retrospect whether you think you did the right thing. Show analysis to justify your conclusions. Your team's grade will be partially based on your performance, but mainly based on your summary. The summary cannot exceed 2 pages in length, and no appendices are allowed.

Icons on the Littlefield Labs web page:

ICON	INFORMATION AVAILABLE	DECISION PARAMETERS
Order Queue: 	• Number of new customer orders by day • Average number of orders waiting for kits by day • Current pricing contract for arriving orders	• Pricing contract
Materials Buffer: 	• Number of kits in the buffer at the beginning of each day, whenever inventory hits zero, and whenever new shipments arrive	• Order-up-to level
Station Queues: 	• Average number of samples waiting to be processed on a station while all the machines in the station are busy, by day	
Stations: 	• Number of machines in each station • Scheduling policy at the Tester • Historical utilization of the station by day (i.e., the average fraction of time a machine was busy at that station during that day, average over all machines)	• Number of machines in each station • Scheduling policy at the Tester
Completed Jobs: 	• Numbers of orders completed by day (by pricing contract) • Average order lead time by day (by pricing contract) • Average revenue per order by day (by pricing contract)	

Sources and uses of cash can be obtained by clicking on the *cash* button below the schematic.

Finally, you can check the overall standing of your team using the *overall standing* button.