MASSACHUSETTS INSTITUTE OF TECHNOLOGY

15.761 Introduction to Operations Management

Spring 2011

COURSE SYLLABUS

Course Website	http://stellar.mit.edu/S/course/15/sp11/15.761/index.html
Delivery Team	
Professors:	Itai Ashlagi, E62-577, iashlagi@mit.edu
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Class hours:	(A) MW 10-11:30am, E62-223 (Levi)
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Office hours:	TH 3-4pm in E62-677 and by appointment (Ashlagi).
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Teaching Assistants:	Rajan Prasanna, (A), rprasa@mit.edu)
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Course Objective

To provide students with concepts, techniques and tools that will enable them to design, analyze and improve core strategic operational capabilities of the firm. It covers a broad range of application domains and industries such as high-tech, financial services, insurance, automotive, health care, retail, fashion, manufacturing and more. Special emphasis will be given to the effects of uncertainty in business decision making, and to the interplay between high-level financial objectives and operational capabilities. In particular, some of the topics covered include: process analysis, re-engineering and innovation, flow diagrams, capacity analysis and ROI, cycle time analysis, inventory management, delayed postponement, production control, supply chain coordination, risk pooling, quality management, revenue management…The course will include lectures, many case studies, as well as guest lecturers. A special feature of the course are the simulation games that are played by the students and provide hands-on demonstration of some of the central concepts. We believe that the course will provide a competitive edge in almost every post graduate career path.

The course relies on a combination of case discussions, lectures, readings, and assignments. To pursue the course objective most effectively, you will have to:

1. Prepare the assigned cases, readings, exercises, and discuss them in class;
2. Prepare a written analysis of two cases;
3. Prepare a two page review of the book *The Goal* by E. Goldratt; and
4. Engage in three managerial simulation exercises and prepare related written reports.

Course Material

The required course material includes:

- The 15.761 course packet. Course packets are available at CopyTech, E52-045
- E.M. Goldratt and J. Cox, *The Goal: A Process of Ongoing Improvement*, North River Press, Second Revised Edition, 1992. (Available at the Coop).
- G. Cachon and C. Terwiesch, *Matching Supply with Demand: An Introduction to Operations Management*, McGraw-Hill Irwin, 2009. (Available at the Coop). This will be referred to in the following as "MSD"

Academic Integrity

Our general policy for this class is that when preparing cases and assignments you should not receive any related input from anyone who has already participated in a faculty-lead discussion of the same material, be it at Sloan or another school. In addition, you should work alone when preparing graded individual assignments, and when preparing graded team assignments your discussions should be strictly limited to the members of your team. When preparing any graded assignment you may *not* consult or use material not already included in the course packet or posted on the course webpage, unless this has been explicitly authorized by the instructor. In particular, using material from previous editions of this course is strictly prohibited. Also, no individual may be listed as a co-author of a team assignment unless that person has contributed to the work submitted in a substantial manner. Each member of the team is fully responsible for ensuring that each submitted assignment is done according to the expected professional standards and the academic integrity policy.

The academic integrity policy of this course will be enforced, and any violators would expose themselves to the most serious consequences. In addition, you will be held personally responsible for confronting and reporting any violations that would come to your attention. Finally, if at any point during the course you believe that you may be violating this academic integrity policy, or if its implications in your particular situation are not completely clear, you should immediately contact the instructor.

Note that this policy implies in particular that you should:

- Never ask for/obtain/use hints or material relative to an assignment from any student or alumni who has already taken the class;
- Never perform a search on the internet to find information relative to a graded assignment.

Team and individual work

- Students are required to form teams of at most 3 (this is a strict constraint). The students will work in their teams in preparing the two case analyses as well as playing the simulation games (see below). In team assignments the students are allowed to discuss the assignment only with their team members. (For more details see the Academic Integrity section above.)
- We allow forming teams among different sections, but in such case your assignments will be due the earliest day among the sections.
- In individual assignments you should not consult any other student including your team members.

Professional Standards and other Important Miscellaneous

- We ask that you please put a name card in front of you in every class.
- As per the school policy, please refrain from using laptops, notebooks, cell-phones and any other electronic devices during class.
- Attendance: There are only 24 class sessions in this course. We consider this the minimum required to cover the essentials of operations management. As per the school policy, job interviews are not a legitimate reason to miss a class. Students having more than two such

absences would risk reduction in their participation and overall grade in the course. It is difficult to receive a passing grade in 15.761 without regular attendance. A Student who is going to miss a class should notify the TA of the section prior to class.

- Lateness: As per the school's new policy we will not allow late shows to the class. Once the class discussion starts the TA will put a sign ``class in session" on the classroom's doors. Please refrain from entering the class if the sign is on the door upon your arrival.
- Please be prepared for every class. It is your responsibility to inform the instructor by email several hours before class if for any reason you have not been able to prepare adequately.
- For communications about registration status issues, swap and wait lists, attendance and absences from class, please email the TA for your section. For any issue concerning access to course material (course packet, textbooks, readings), please email the course administrator (apiccolo@mit.edu). For any other communication related to the course, please send an email to both the professor and the TA for your section (unless it is of a highly personal/confidential nature, in which case you should email the professor only).

Grading and Assignments

The grading of 15.761 will be based on the following weights:

Class Participation (individual)	20%
Case Analyses (team)	30% (15% each)
Homework Assignments (individual)	10% (5% each)
Goal Book Report (individual)	10%
Simulations (team)	30% (20% Littlefield, 10% Retailer)

Class Participation (individual)

Class participation will be determined on the basis of your comments in each class session. Some of the criteria that we will use to judge effective class participation include:

1. Is the participant a good listener?
2. Is the participant concise and articulate?
3. Are the points made relevant to the current discussion? Are they linked to the comments of others?
4. Do the comments show clear evidence of appropriate and insightful analysis of the case?
5. Is there a willingness to participate?

Case Analyses (team)

These two papers should contain your answers to the specific preparation questions for the two corresponding cases that are provided later in this document. In preparing these assignments, please adhere to the following guidelines:

1. Work in teams of at most three students (see above). This is a firm constraint, no exceptions.
2. Written assignments are to be turned in at the beginning of class for your section, in the classroom, on the day they are due. If the team consists of members of several sections, the assignment should be turned in at the beginning of the earlier one).
3. Hand in one paper copy of the case write-up for each group (email attachments will not be accepted).
4. Each student should have a personal copy of his/her team write-up for the corresponding class discussion.
5. Case analysis assignments must be less than 4 pages in length (excluding appendices) and use text fonts no smaller than 12.
6. Every graph or table/spreadsheet showing the results of computations must be accompanied by both a clear description of what all numbers shown represent qualitatively, and an exhaustive explanation of how they are computed, including a statement of all the relevant mathematical formulas or algorithms. Please do not submit a table copied from a spreadsheet assuming that the instructors will try to figure out by themselves how the numbers it shows are calculated – they won't.

Homework Assignments (individual)

There will be two short homework assignments that will aim to test your grasp of some of the quantitative material taught in the course:

1. The assignments should be done individually and submitted at the beginning of the class where there are due.
2. Homework assignments should be 1 page of text font no smaller than 12.

The Goal Book Report (individual)

Each student in the class should individually prepare and turn in a report of at most 2 pages containing answers to the following questions:

1. What are the methods described in *The Goal* for identifying a bottleneck?
2. After bottlenecks have been identified, what are the concrete factory floor-level actions described in the book for improving overall system performance?
3. Relate the notions of *statistical fluctuations* and *dependent events* mentioned in the book to concepts covered during the course. Also explain and relate to course concepts the statement made by Jonah that a factory "balanced with demand" will soon experience bankruptcy.

4. Several times in the book, lot sizes are reduced in order to decrease cycle time. What are the limits to this strategy?
5. When designing an operational process from scratch, which process step(s) should be the bottleneck(s)?
6. Leaving writing style and other delivery issues aside (e.g. romance novel format), what substantial critiques would you make about the part of this book pertaining to the management of business operations?

Factory Simulation Exercises (team)

As part of your team of at most three students, you will get to manage a virtual factory in two separate web-based simulation exercises. The goal of this assignment is to let you adapt and apply concepts from the first half of the class in a managerial situation; it will also give you a chance to formalize your own decision models and test their relevance and effectiveness.

The first exercise involves a reduced set of managerial decisions and is designed to help your team create its decision models before the full version of the game is played as part of the second exercise. After that second simulation is over, each team will turn in a written report of at most 4 pages (excluding appendices) about this final exercise which should contain your answers to the following questions[1]:

1. How did you forecast demand? For what decisions in the game did you find it most useful to have a demand forecast available? A posteriori, were you happy with your demand forecasting technique and would you use the same one if the game was to start over again?
2. What models and/or considerations did you use to decide how many machines of each type to buy initially? Later on during the simulation, how did you decide how many more machines to buy or sell? A posteriori, were you happy with your capacity decision process and would you use the same one if the game was to start over again? If not, define precisely how you would make capacity decisions for another potential run of the simulation.
3. How did you decide on the parameters of your (R,Q) inventory replenishment policy? How did you update these parameters over time? A posteriori, were you happy with your inventory model and would you use the same one if the game was to start over again? If not, define precisely how you would set inventory replenishment parameters decisions for another potential run of the simulation.
4. How did you decide initially and later in the game what type of contract to go after? A posteriori, were you happy with your method/model for quoting lead-times and would you use the same one if the game was to start over again? If not, define precisely how you would choose which contract type to use for another potential run of the simulation.

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[1] IMPORTANT: Whenever asked for what you would do for another potential run of the simulation, you should not just state that you would use a better strategy relying on some analysis or model, but instead actually provide that analysis and/or implement that model so you can describe it in detail in your report. For example, only stating "If the game started again we would use a better model taking X into account." will not receive any credit unless you define that better model explicitly and show exactly how it takes X into account.

5. Describe your factory's performance during the simulation, both in absolute and relative terms, and provide an interpretation. Is there anything not already mentioned in any of your previous answers which you would do in order to improve your performance if you were to play the game a second time?
6. What are the most important lessons you learned or insights you gained from playing this simulation game?

Retailer Pricing Simulation Exercise (team)

Your team's goal in this assignment is to develop a generic markdown pricing strategy for a retailer seeking to maximize revenue when selling some inventory over a limited time period. The required simulation software (retailer.zip) can be downloaded from the course website and executed from any windows-based computer. In addition, the game folder contains some historical sales data (retail.xls) on which you can perform statistical analyses. You can start playing the game as early as you want during the course, but we recommend that you give yourself at least a week before the assignment is due in order to develop and test your strategy. A couple of days before that due date, you will receive an email containing some random seed numbers (a computer code which determines the random scenario you will be facing) on which you should apply the strategy you will have developed by then.

Your team's assignment for this simulation exercise consists of a report of at most 4 pages (including the computer printouts) containing your answers to the following questions:

1. Provide a detailed description of the strategy you have developed for making price markdown decisions during the game. This description should be generic, i.e. it should enable the reader to apply your strategy exactly in any instance of the game.
2. What is the rationale underlying the strategy you described in the previous question, i.e. why do you think it is a good strategy?
3. Provide a commented example of the application of your strategy to the first of the five runs generated under the "Compete" mode with the first random seed provided.
4. Provide a printout of both the detailed and summarized outcomes of the application of your pricing strategy to the five runs obtained with each of the two random seeds provided. How much revenue have you generated in total?

COURSE SCHEDULE AT-A-GLANCE

Day	Date	Contents	Required-Readings	Textbook Coverage	Optional readings	Assignments	Sim
Wed/Thu	2/3-Feb	Course Introduction		2.2-3,3.1			
Mon/Tue	7/8-Feb	Case: Burger King + McDonald's	Production Processes	2.6	Types of Processes		
Wed/Thu	9/10-Feb	Lecture: Capacity	Wait-in-Line Blues	3.2-5,7.1-9			
Mon/Tue	14/15-Feb	Case: Webvan			A Bombay Lunch Box		
Wed/Thu	16/17-Feb	Case: American Express Travel				Short individual HW	
Wed/Thu	23/24-Feb	Case: PATA	PATA Video			Case write-up	
Mon/Tue	28-Feb/1-Mar	Lecture: Process-Re Engineering + CVS	Reengineering Work				
Wed/Thu	2/3-Mar	Case: Toyota		9.8,10.1-10	Decoding the DNA of TPS		
Mon/Tue	7/8-Mar	Lecture: Inventory 1		2.4-5, 6.4-5, 11.1-7			
Wed/Thu	9/10-Mar	Lecture: Inventory 2		13,14.1-3			
Mon/Tue	28/29-Mar	Case: Obermeyer		12	Rocket Science Retailing	Case write-up	
Wed/Thu	30/31-Mar	Case: HP Deskjet				Short individual HW	
Mon/Tue	4/5-Apr	Lecture: Production Control and SC Design	Dell (Automate)		ERP Technology Note		
Wed/Thu	6/7-Apr	Case: Mark and Spencer vs. Zara	Zara Video		Fast, Global & Enrepr.	Goal report	
Mon/Tue	11/12-Ap	Case: HP vs. Dell	Dell Video				
Wed/Thu	13/14-Apr	Case: Barilla		16	Made to Measure		
Wed/Thu	20/21-Apr	Lecture: Quality	Hank Kolb	9.1-6	Berwick, What is Sigma 6?		
Mon/Tue	25/26-Apr	Case: Break.com					
Wed/Thu	27/28-Apr	Lecture: Revenue Management 1	Varian				
Mon/Tue	2/3-May	Lecture: Revenue Management 2	Neetessine Shumsky	15.1-15.3			
Wed/Thu	4/5-May	Case: TNG				Retailer report	
Mon/Tue	9/10-May	Case: Video Vault		16.3-16.5			
Wed/Thu	11/12-May	Course Wrap-up				Simulation report	

Note: Sections B and C will not have class on February 1. Section A will not have class on Feb 22. Instead there will be a guest lecture that will be scheduled on an 11.30-1 slot for all the sections. Exact date TBD

SCHEDULE OF TUTORIALS AND TA OFFICE HOURS

Day	Date	Contents
Thu/Fri	3/4-Feb	Simulation Game
Thu/Fri	10/11-Feb	Capacity 1
Thu/Fri	17/18-Feb	Capacity 2
Thu/Fri	3/4-Mar	Inventory 1
Thu/Fri	10/11-Mar	Inventory 2
Thu/Fri	31-Mar/1 - Apr	Replenishment
Thu	7/8-Apr	Simulation Game
Fri	5/6-May	Revenue Management

Note: There will be 2 tutorials of identical content during every week listed above.

DETAILED COURSE SCHEDULE AND ASSIGNMENT QUESTIONS

(This version: January 16, 2008)

Lecture: Introduction and Class Overview **Wednesday, February 2 (Thursday, Feb 3)**

Readings: COURSE SYLLABUS (THIS DOCUMENT)

MSD Cover: 2.2-3, 3.1

Simulation Exercise

Live from **Sunday, February 6 at 5pm** until **Sunday, February 6 at 9pm**

Readings: LITTLEFIELD TECHNOLOGIES: OVERVIEW (posted on Stellar)
MANAGING CAPACITY AND LEAD-TIME AT LITTLEFIELD TECHNOLOGIES (posted on Stellar)

NOTE 1: In order to familiarize yourself with the simulation game interface, analyze early demand data and plan your strategy for the game, you can access your factory as early as **Friday, February 4 at 2 pm** using the following URL:
http://lab.responsive.net/lt/mit/entry.html
You will then receive additional customer orders and gain the ability to manage your factory (using the same URL as above) during the respective 'Live' periods.

NOTE 2: Experience demonstrates that **advance planning** and **sound use of quantitative models blending physical and financial considerations** provide key competitive advantages in this game.

McDonald's and Burger King Cases Monday, February 7 (Tuesday, February 8)

Readings: PRODUCTION PROCESSES
TYPES OF PROCESSES

MSD Cover: 2.6

Case: Students with last names beginning with A-L work on the BURGER KING CORPORATION case and skim the MCDONALD'S CORPORATION case; students M-Z work on the MCDONALD'S CORPORATION case and skim the BURGER KING CORPORATION case.

Questions:

1. Draw a process flow diagram showing the major process steps, inventories and flows for hamburger production in your case.
2. For the case you read, analyze the peak hourly capacity and peak hourly demand for burger patties. Can they produce enough burgers?

Lecture: Capacity Wednesday, February 9 (Thursday, February 10)

Readings: PRESCRIPTION FOR THE WAITING-IN-LINE BLUES: ENTERTAIN, ENLIGHTEN AND ENGAGE

MSD Cover: 3.2-5, 7.1-9

Webvan Case Monday, February 14 (Tuesday, February 15)

Readings: A BOMBAY LUNCHBOX (AVAILABLE FROM STELLAR)

Case: WEBVAN: GROCERIES ON THE INTERNET

Questions:

1. Describe Webvan's logistic and delivery system. What are the aspects of Webvan's operation which you think are most challenging to manage?
2. Compare the net operating margin of a Webvan Distribution Center against that of an equivalent number of traditional supermarkets (from exhibits 2 and 6). Compared to a traditional supermarket, what are the major costs Webvan can hope to save? What major additional costs will be incurred by Webvan?
3. Assume that (i) each van can deliver 5000 orders per year; (ii) 10% of customer orders require 2 deliveries instead of one; (iii) customer delivery orders are spread out uniformly between 1pm and 10pm; and (iv) the annual cost per van is $60,000. What would be the annual cost to Webvan of a home delivery fleet sized to meet its demand under these assumptions? Instead of assumption (iii) above, suppose now that 40% of delivery orders fall between 1-6pm, and 60% between 6-10pm. What is the annual home delivery fleet cost now?
4. More generally, what are the features of Webvan's home delivery operation which most sensitively affect the company's net margin? In retrospect, what would you have done differently?

American Express Travel Case Wednesday, February 16 (Thursday, February 17)

Case: AMERICAN EXPRESS TRAVEL

Questions:

1. Given the nature of the BTC business, what are some specific issues Sullivan might focus on to improve profits at American Express Travel?
2. Decide on a staffing level for the Indianapolis BTC so as that wait times are no more than a minute on average. Assume that calls last 5 minutes. How does your recommendation compare with the 'linear' staffing rule in use? (Use the data in Exhibit 3)

3. Assuming that net costs are 5% of revenues, what are the potential dollar savings for the Indianapolis BTC if wait times acceptable wait times were relaxed to 1.5 minutes? What are the cost benefits to wrapping up calls in 2.5 minutes? (Use the data in Exhibits 3 and 2)
4. Discuss the merits and demerits of Sullivan's centralized BTC idea. Assume that net costs are 5% of revenues and base your recommendations on the data in Exhibit 1.

PATA Wednesday, February 23 (Thursday, February 24)

Case: MASSACHUSETTS GENERAL HOSPITAL: PRE-ADMISSION TESTING AREA

GRADED CASE WRITE-UP DUE AT THE BEGINNING OF CLASS

Questions:

1. Construct a process flow diagram of the PATA visit from a patient's perspective. Calculate the capacity and utilization rate at each step in the process.

2. Use capacity analysis tools (build-up diagrams or/and queuing) to decide if and where there is a bottleneck in the clinic. If a bottleneck does indeed exist, how long do patients wait as a result of the bottleneck? (As an approximation, assume that all appointment slots were filled and patients arrived on time.)

3. Evaluate the three Task Force diagnoses - not enough time between appointments, not enough rooms, not enough physicians. Are these diagnoses valid? If so, are they primary contributors to long patient wait times? Why or why not?

4. What factors contribute to variability in PATA process flow and what control, if any, does the clinic have to eliminate it?

5. What changes would you recommend to improve PATA?

Process Re-Enginerring + CVS Monday, February 28 (Tuesday, March 1)

NOTE:

Readings: REENGINEERING WORK: DON'T AUTOMATE, OBLITERATE

Case: PHARMACY SERVICE IMPROVEMENT AT CVS (A) AND (B)

Questions:

1. What changes do you recommend to CVS's existing pharmacy fulfillment process? What IT changes, if any, are required to implement your changes.
2. How can you be sure that the new process you propose will be an improvement over the existing one? How can you be sure it will not make things *worse*?

3. What groups, if any, are like to have problems with your proposed solution? How will you deal with their objections?
4. How will you ensure that there is no backsliding – that there still won't be wooden boxes in use six months from now? How can technology be used to prevent or inhibit backsliding?
5. Does PSI represent a significant opportunity for CVS? Would improving customer service be of significant financial benefit to the company?
6. What percent of pharmacy detectors from CVS in 2000 were light versus heavy users?

Toyota Case Wednesday, March 2 (Thursday, March 3)

Readings: DECODING THE DNA OF THE TOYOTA PRODUCTION SYSTEM

MSD Cover: 9.8, 10.1-10

Case: TOYOTA MOTOR MANUFACTURING, USA INC.

Questions:

1. What are the principles and components of the Toyota Production System?
2. As Doug Friesen, what would you do to address the seat problem? Where would you focus your attention and solution efforts? What options exist? What would you recommend? Why?
3. Where, if at all, does the current routine for handling defective seats deviate from the principles of the Toyota Production System?
4. What are the underlying causes of the problems facing Doug Friesen?

Lecture: Inventory 1 Monday, March 7 (Tuesday, March 8)

MSD Cover: 2.4-5, 6.4-5, 11.1-7

Lecture: Inventory 2 Wednesday, March 9 (Thursday, March 10)

MSD Cover: 13, 14.1-3

Sport Obermeyer Case Monday, March 28 (Tuesday, March 29)

Readings: ROCKET SCIENCE RETAILING IS ALMOST HERE: ARE YOU READY?

GRADED CASE WRITE-UP DUE AT THE BEGINNING OF CLASS

MSD Cover: 12

Case: SPORT OBERMEYER, LTD.

Questions:

1. Using the sample data given in Exhibit 10, make a quantitative recommendation for how many units of each style Wally should make during the initial phase of production. Assume that all of the ten styles in the sample problem are made in Hong Kong (minimum order quantity 600 units per style, provided any quantity of a style is ordered), and that Wally's initial production commitment must be at least 10,000 units because of capacity constraints later in the season.
   WARNING: THERE IS NO 'RIGHT' ANSWER HERE. THE MODELS WE HAVE LOOKED AT WILL NOT COVER ALL YOUR BASES ON THIS PROBLEM. BE QUANTITATIVE BUT CREATIVE; IMAGINE IT'S YOUR COMPANY ON THE LINE.
2. What operational changes would you recommend to Wally to improve performance?

Hewlett-Packard Case Wednesday, March 30 (Thursday. March 31)

Case: HEWLETT-PACKARD: DESKJET PRINTER SUPPLY CHAIN (A)

Questions:

1. What are the main causes of the inventory/service crisis described in the case?
2. Build and describe an Excel model to recommend quantitative target inventory levels under HP's current supply chain design for the 6 European options assuming a weekly (periodic review) replenishment and a 98% service level (k=2.054) for the following two scenarios: (i) 5-week sea shipment lead-time; (ii) 3-day air shipment lead-time. Evaluate the total supply-chain inventory levels (safety stock, cycle stock, pipeline stock) that will result from the weekly inventory replenishment targets that you recommend for these options.
3. Assuming a 20% gross margin and average selling price of $660 for each printer, inventory holding costs of 50% per year, sea transportation costs of $1 per printer (lead-time 5 weeks) and air transportation costs of $11 per printer (lead-time is 3 days), compute the total supply chain cost (inventory and transportation) for the two scenarios you analyzed in the previous question.
4. Modify the model you built for the previous question in order to quantify the financial impact of localizing HP's Deskjet Printers in Europe instead of Vancouver.
5. What changes would you recommend for HP's supply chain operation and design?

Simulation Exercise
Live from **Sunday, April 10 at 5:00pm** until **Friday, April 15 at 5:00pm**

Readings: LITTLEFIELD TECHNOLOGIES: OVERVIEW (posted on Stellar)
MANAGING CAPACITY, INVENTORY AND LEAD-TIME AT LITTLEFIELD TECHNOLOGIES (posted on Stellar)

NOTE 1: In order to familiarize yourself with the simulation game interface, analyze early demand data and plan your strategy for the game, you can access your factory as early as **April 1 at noon** using the following URL:

http://lab.responsive.net/lt/mit/entry.html

You will then receive additional customer orders and gain the ability to manage your factory using the same URL as above) during the respective 'Live' periods.

NOTE 2: Experience demonstrates that **advance planning** and **sound use of quantitative models blending physical and financial considerations** provide key competitive advantages in this game.

NOTE 3: The simulation report for your group must be submitted in at the beginning of the last class in the course on **Wednesday, May 11 (Thursday, May 12).** See the detailed description of that assignment at the beginning of the syllabus.

Lecture: Production Control and SC Design Monday, April 4 (Tuesday, April 5)

Note: THE GOAL: A PROCESS OF ONGOING IMPROVEMENT
BOOK REPORT DUE AT THE BEGINNING OF CLASS

Readings: AUTOMATE OR DIE (DELL)
ERP TECHNOLOGY NOTE

Zara Vs. Marks & Spencer Case Wednesday, April 6 (Thursday, April 7)

Video: ZARA'S BUSINESS MODEL OVERVIEW (DOWNLOAD FROM STELLAR & WATCH BEFORE CLASS SESSION)

Readings: FAST, GLOBAL AND ENTREPRENEURIAL: SUPPLY CHAIN MANAGEMENT, HONG-KONG STYLE

MSD Cover: 10

Case: MARKS & SPENCER'S AND ZARA: PROCESS COMPETITION IN THE TEXTILE APPAREL INDUSTRY

Questions:

1. What are the key differences between M&S and Zara from a customer standpoint?
2. Draw the entire supply chain of each company, and also describe the key steps and information sources of their respective design process.
3. How can a buyer at M&S optimize the production order decision under the current supply chain and lead-times? How do buyers make the same decision for Zara?
4. What are the relative benefits of Inditex and Zara's business models?

HP vs. Dell Monday, April 11 (Tuesday, April 12)

Readings: THE PRIMACY OF CHAINS CAPABILITY CHAINS MAKE A BUSINESS

ARTICLE POSTED ON THE COURSE WEBSITE

Case: THE POWER OF VIRTUAL INTEGRATION: AN INTERVIEW WITH DELL'S COMPUTERS MICHAEL DELL

Questions:

1. Compare the supply chains structure of Dell and HP.
2. Where and what types of inventory each company holds in its supply chain?
3. What would be the major capacity planning issues in each of the supply chains?
4. What coordination mechanism each company is using?

Barilla Case Wednesday, April 13 (Thursday, April 14)

Readings: MADE TO MEASURE: INVISIBLE SUPPLIER HAS PENNEY'S SHIRTS ALL BUTTONED UP

MSD Cover: 16

Case: BARILLA SPA (A)

Questions:

1. What problem was JITD designed to solve? What are its underlying causes?
2. What are the key components of JITD? How is it supposed to correct or mitigate the problem you described in 1.?
3. How can Barilla implement this program?

Lecture: Quality Wednesday, April 20 (Thursday, April 21)

Readings: STATISTICAL PROCESS CONTROL: CONTROLLING VARIATION IN HEALTH CARE
WHAT IS 6 SIGMA?

MSD Cover: 9.1-6

Case: HANK KOLB, DIRECTOR, QUALITY ASSURANCE

Questions:

1. What are the causes of the quality problems on the Greasex line?
2. What should Hank Kolb do?

Break.com Monday, April 25 (Tuesday, April 26)

Case: Break.com

1. Flowchart the information supply chain in the online advertising industry. What is Break.com's value proposition?
2. What challenges does Break.com face in managing its display advertising contracts? Assuming that all contracts are identical and indivisible, with a $6.5 CPM and 10% make-good underdelivery penalty, determine how many impressions Break.com should contract on for its homepage during the second quarter of 2008.
3. How might Break.com implement revenue management, namely uses price differentiation? Based on Exhibits 6 and 7, determine which advertising contracts are the most attractive to Break.com.
4. What are the implementation challenges and risks associated with revenue management in the online display advertising industry?

Lecture: Revenue Management 1 Wednesday, April 27 (Thursday, April 28)

Readings: VARIAN

Lecture: Revenue Management 2 Monday, May 2 (Tuesday, May 3)

Readings: NETESSINE AND SHUMSKY

MSD Cover: 15.1-3

Transportation National Group Case Wednesday, May 4 (Thursday, May 5)

Case: TRANSPORTATION NATIONAL GROUP (TNG)

NOTE : **RETAILER REPORT DUE AT THE BEGINNING OF CLASS**

Questions:

1. Characterize TNG's business in terms of its cost structure, its customers and markets and it relationship to its parent corporation. Considering this characterization, what do you see as the key management challenges TNG faces?
2. What is your assessment of TNG's current lease performance measures and controls, especially its use of ROI measures?

3. How might TNG implement revenue management? What ideas or approaches seem most viable in a business like this?
4. Based on the data for the Yakima branch, what is the potential revenue opportunity at this location from optimally controlling the availability of leases of various durations? (You may want to use a linear program (Solver) analysis to answer this question.)
5. If TNG wanted to implement revenue management, what recommendations would you make going forward and how would you prioritize your recommendations?

Video Vault Case Monday, May 9 (Tuesday, May 10)

MSD Cover: 16.3-16.5

Case: VIDEO VAULT

Questions:

1. How do Blockbuster and Video Vault compete?
2. If you were managing Video Vault in 2002, how many VHS copies of A.I. and Zoolander would you purchase under the traditional wholesale price contract? (assume no special VHS package deal, a shelf life of 12 weeks, a purchase price of $40, an average sell-off price of $6 per copy and a rental price of $4)
3. As Video Vault, how many VHS copies of A.I. and Zoolander would you purchase under a revenue sharing agreement? (assume an upfront fee of $7 and a 50% revenue share)
4. What are the pros and cons of revenue sharing for the studios and the retailers? Should Video Vault sign up with Rentrak?

Course Wrap-Up Wednesday, May 11 (Thursday, May 12)

NOTE : **LITTLEFIELD SIMULATION REPORT DUE AT THE BEGINNING OF CLASS**

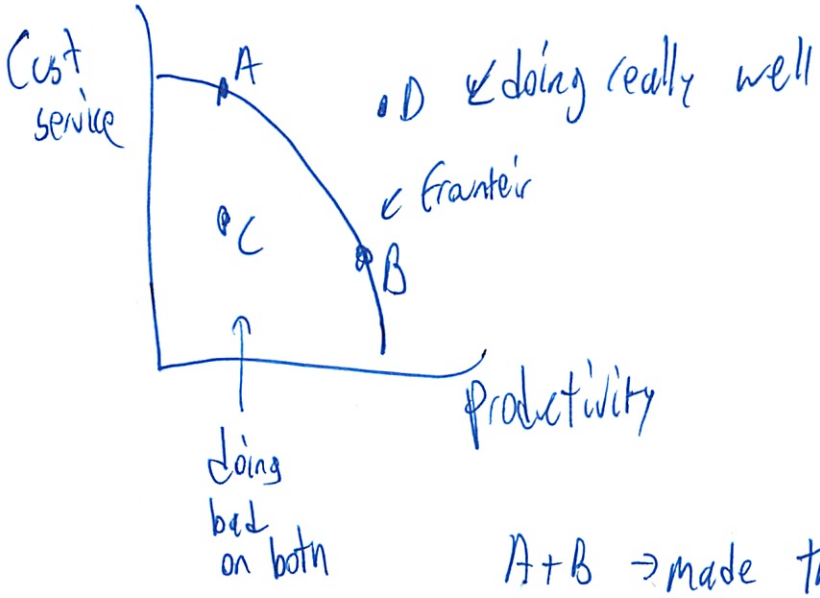
Matching Supply w/ Demand Reading

2/1

- real cases
- analytical, but not too technical
  - lots of greek letters
- really about the title
- how much to make?

- real world economy has frictions
- profit is usually small % of revenue
- quantative models + forcasting (good, I want to learn)

Call center must balance trade off
Cheap labor $ vs cust service



A+B ⇒ made the tradeoff

(2)

Chap 2

Need to plan ahead to create supply
- can't conjure up instantly

Need to look at how biz processes actually work

Steps → activities if adds value

Gantt chart
(like project management!)
19th century!

Critical path
- activities that if delayed would ~~push back~~ delay completion

But lots of people want treatment at a hospital
- So process not project

Supplies = process resources

Also some procedures take diff lenghts of time
- so flooded w/ work at some times, starved at other times

2.2 3 Measures

- process like black box

(3)

Deal in "flow units"
- 1 patient, car, etc

Some inventory in process at any point in time

flow time - time to get thrugh process

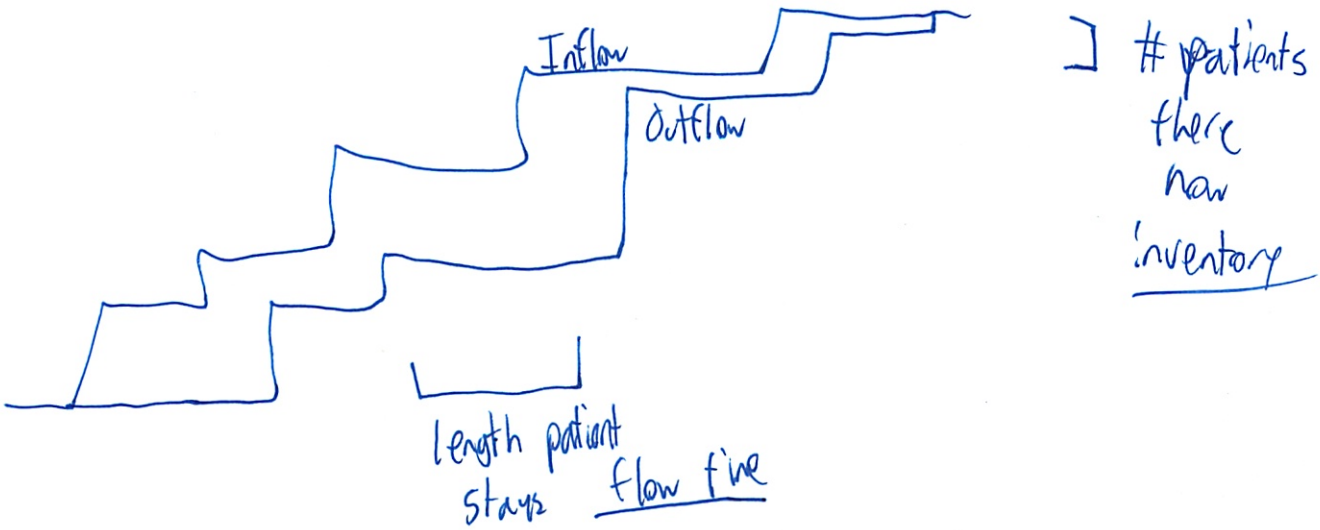
flow rate / thraghput rate = # flow units / time unit
- max = capacity

If process is capacity constrained → extra output could be sold

Shorter flow times help match supply + demand

Lower inventory req. less capital too
↳ lower inv is better!

Why do these inventories exist??
- can't just look at snapshot in time



(4)

Compute avg inventory

↳ find inv at each time interval and avg (# intervals)

Compute flow rate

↳ find each patients' stay lenght + avg (# patients)

Littles' Law	Avg Inv = Avg flow rate vs Avg Flow time

- proof complex

(would be interested in seeing to get better at proofs)

Useful to find third metric when know two

Should always hold

2.4 Inv Turns + Costs

- measure inventory in $ so can compare
  - flow unit = a $1 bill
  - flow rate = COGS / time period
  - flow time = $\frac{\text{Inv \$}}{\text{flow rate}}$ = ~~Inventory Turns~~
- avg item spends that many days on the shelf
  - well various shelves

inv turns = $\frac{1}{\text{flow time}}$

Inventory also has holding costs

- can become obsolete
- perish
- theft / shrinkage
- storage space + overhead (heat, security, etc)
- ↑ wait times ↓ quality

Per unit inv costs = Avg inv costs / Avg inv turns ← holding cost per year, hard to calc

↑ percent of COGS

Firms w/ low inv turnover often have high margins w/ small profit margins - this can add up quick

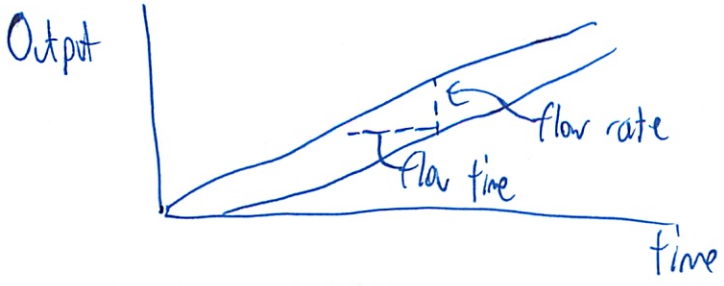
2.5 Five Reasons to Hold Inv

- need to look at process in detail

1. Pipeline Inv

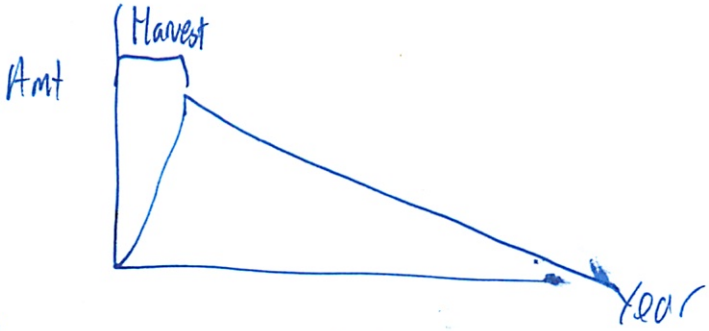
- still have critical path time
- must have some work in progress

Inv = Flow rate * flow time



(6)

2. Seasonal Inv

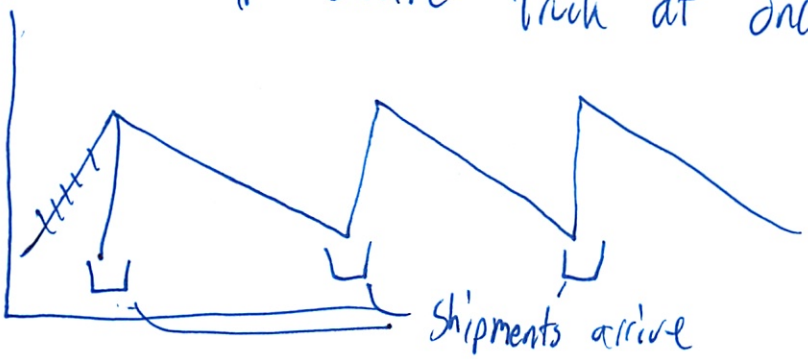


- Capacity rigid
- Variable demand
- build up inventory so have more constant production
- or ~~Can~~ supplies come all at once (harvest) and ~~you~~ use it over production for next year

3. Cycle Inv

- Can't instantly ship goods
- Cheapest to ship entire truck at once, not just in time

Concept 2 really this

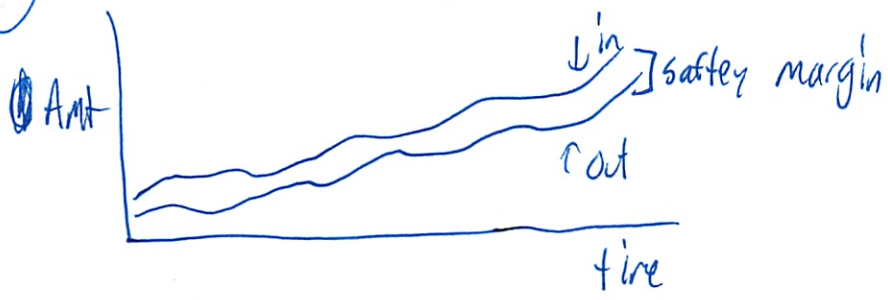


4. Decoupling Inv/Buffers

- build in buffers
- Can absorb variations in flow rates for each operation

5. Safty Inv

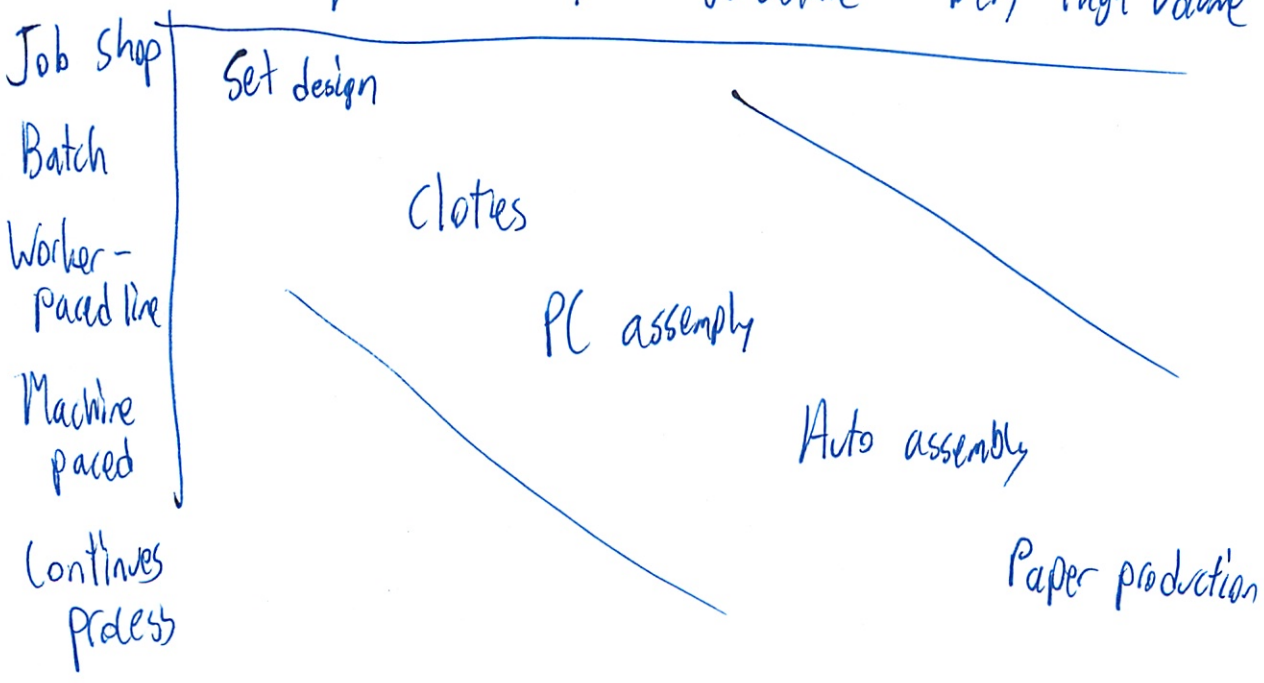
- Stochastic demand
  L= difference b/w predicted demand + realized demand
- forcasts not perfect
- Unless errors free



(I realize now that many of those "fad" manufacturing methods - are just this in practice
There is a reason each business can't use it

2.6 Product - Process Matrix

- Some processes manual, others automated
- becomes more automated as volume increases



Similar processes have similar problems

First Lecture 2/3

15.761 Introduction to Operations Management

Assistant Professor Itai Ashlagi
Operations Management Group,
MIT Sloan School of Management

iashlagi@mit.edu
http://web.mit.edu/iashlagi/www

Announcements

- There are recitations this week (focus on simulation game)
- First simulation game is coming soon (Sunday, Feb 6, 2-6.30 pm).
- Please form a team of at most 3 and enroll to the game website (for details see the syllabus)

Itai Ashlagi - Bio

- B.A. in Mathematics and Computer Science, Haifa University, Israel (99)
- Team Leader in a start-up company in Israel (99-02)
- M.Sc and PhD in Operations Research, Technion, Israel (08)
- Post-Doctorate at Harvard Business School (08-10)
- Research: Market and mechanism design, auctions (e.g. adwords), Kidney exchange, matching problems, game theory, competition
- Experience in industry: Collaboration with Alliance Paired Donation (kidney exchange)

Course Staff

- Teaching Assistants:
  - Section A: Rajan Prasanna, rprasa@mit.edu
  - Section B: Puneet Newaskar, puneet@mit.edu
  - Section C: Kanaka Pattabiraman, kanakap@mit.edu
- Administrative Assistant:
  - Anna Piccolo, apiccolo@mit.edu, x3- 6605

Class Outline

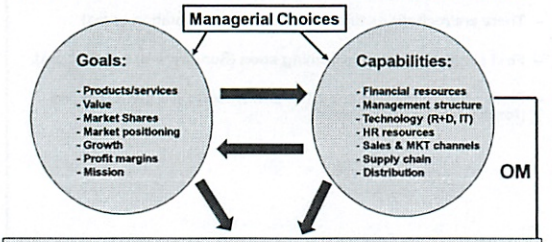
- Class Introduction: Concepts & Outline
- Organization
  - Material
  - Assignments/Grading

What is OM? Execution View

OM = The Strategy of Execution!

= From 2D to 3D!

Strategy = Develop Goals & Capabilities

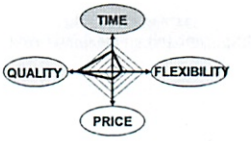


System Design and Operations (= Supply/Value Chain):

Organizations, people, technology, processes, information and resources involved in creating products/services and moving them to customers

Operational Strategy Definition

- Added Value (Good or Service?)
- Strategic Positioning



Competing with Operations

DELL vs. hp COMPAQ

TOYOTA vs. Ford

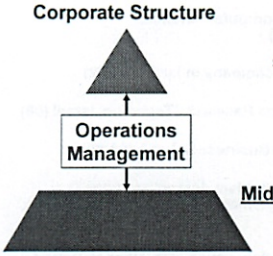
amazon.com. vs. BARNES&NOBLE www.bn.com

southwest.com jetBlue vs. UNITED AmericanAirlines

ZARA vs. GAP celio*

Operations within the Firm

Corporate Structure



Top Management speaks the language of *MONEY*

Operations Management

Mid-Mgt., Associates, Workers speak the language of *THINGS*

OM merges physical and financial analyses, and requires great care to people issues!

Career Paths

BOEING Microsoft intel. massport

Johnson&Johnson southwest.com

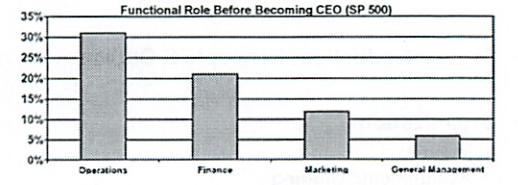
amazon.com. United Technologies Lucent Technologies

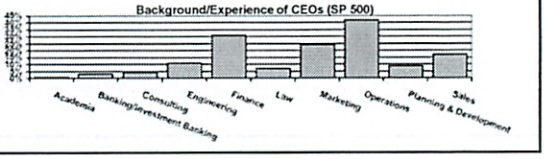
ATKEARNEY An EDS company DELL

McKinsey&Company

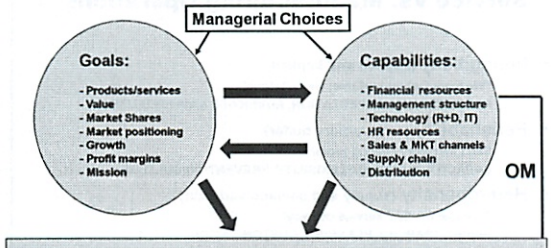
Career Paths

SpencerStuart 2008





Strategy = Develop Goals & Capabilities

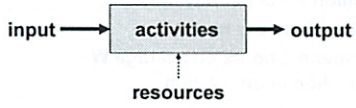


System Design and Operations (= Supply/Value Chain):

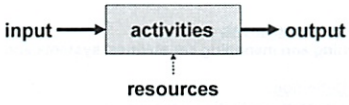
Organizations, people, technology, processes, information and resources involved in creating products/services and moving them to customers

OM Definition (2): The Process View

- *Operations Management* is the activity of designing and managing processes in order to achieve results of value to the various stakeholders of an enterprise
- A *Process* is a set of coordinated activities relying on various resources to transform inputs into outputs



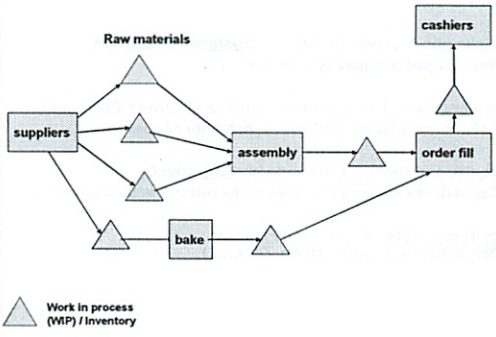
Process Architecture



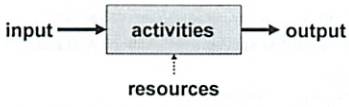
1. Technology
2. Physical Flow
3. Information Flow
4. Coordination Mechanisms

} Process Flow Diagram

Au Bon Pain



Process Performance

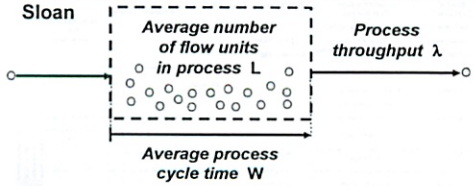


1. Efficiency: output / input
2. Quality: of output
3. Capacity: maximum throughput = output production rate
4. Cycle Time: time elapsed from input to output
5. Flexibility: volume and product

Process Physics: Little's Law

If you can't measure it, you can't manage it.

- 300 new MBA's/Year x 2 Years MBA = 600 students in Sloan



- Conservation of Flow (equilibrium):

$$L = \lambda \times W$$

Little's Law

How many servers facebook needs?

Server capacity – 500 users
Users – 480 million
240 million visits per day
10 million visits per hour λ
Users spend 2 hours on average W
L – 20 million in the system
40,000 servers

$L = \lambda \times W$

Service Vs. Manufacturing Operations

- Intangibility (Explicit and Implicit)
  - "We manufacture perfume; we sell Hope"
  - PERCEPTION Vs. EXPECTATION, ADVERTISE & MATERIALIZE
- Perishability (no inventory buffer)
  - Can't inventory seating room!
  - CAPACITY PLANNING/FLEXIBILITY, PREVENTION/CULTURE
- Heterogeneity (supply and demand variability)
  - Consider medical service delivery!
  - HIRING, TRAINING, PLANNING, CUSTOMIZATION
- Simultaneity (of production and consumption)
  - No safety nets for quality problems…
  - HIRING, TRAINING, HR, PLANNING, CONCURRENT ENGINEERING

Course Goals

1. Use Scientific Approach to Analyze Business Operations:
   (flow-diagrams, capacity analysis,…)
2. Understand Basic Laws of the `Physics' of Business Operations:
   (Role of uncertainty, Little's law, behavior of queues,…)
3. Recognize and Understand Fundamental Tradeoffs:
   (Capacity-inventory-service level, inventory-transportation,…)
4. Learn from Success Stories and Failures:
   (Dell, Webvan, Toyota, Barilla, Zara,…..)

Class 1 Wrap-Up

1. Operations Management:
   designing and managing capabilities, systems and processes
2. Process Definition:
   input + output + activities + resources
3. Process Performance:
   efficiency + quality + capacity + cycle time + flexibility
4. Little's Law: $L = \lambda \times W$
5. Operational Strategy Definition:
   quality + price + time + flexibility

Course Outline

	Day	Date	Contents	Required Readings	Textbook Coverage	Optional readings	Assignments	Sim
Process, capacity analysis	Wed/Thu	2/3 Feb	Course Introduction		2.2-3,3.1			
	Mon/Tue	7/8 Feb	Case: Burger King - McDonald's	Production Processes	2.4	Types of Processes		
	Wed/Thu	9/10 Feb	Lecture: Capacity	Waiting Line Blues	3.2-5,7.3-9			
	Mon/Tue	14/15 Feb	Case: Webvan			A Boundary Lunch Box		
	Wed/Thu	16/17 Feb	Case: American Express Travel				Short individual HW	
	Wed/Thu	23/24 Feb	Case: PATA	PATA Video			Case writeup	
Process re-engineering	Mon/Tue	28 Feb/1 Mar	Lecture: Process Re Engineering - CVS	Reengineering Work				
	Wed/Thu	2/3 Mar	Case: Toyota		9.8,10.3,10	Decoding the DNA of TPS		
Inventory Control	Mon/Tue	7/8 Mar	Lecture: Inventory1		2.4.5, 8.4.5, 11.5-7			
	Wed/Thu	9/10 Mar	Lecture: Inventory2		12.3,4.3.3			
	Mon/Tue	28/29 Mar	Case: Obermeyer		11	Rocket Science Retailing	Case writeup	
	Wed/Thu	30/31 Mar	Case: HP Deskjet				Short individual HW	
Supply Chain Production Management	Mon/Tue	4/5 Apr	Lecture: Production Control and SC Design	Dell (Automatic)		ERP Technology Note		
	Wed/Thu	6/7 Apr	Case: Marks and Spencer vs. Zara	Zara Video		Fast, Global & Entrepr.	Goal report	
	Mon/Tue	11/12 Apr	Case: HP vs. Dell	Dell Video				
	Wed/Thu	13/14 Apr	Case: Barilla		16	Made in Measure Berwick, What is Sigma 47		
	Wed/Thu	20/21 Apr	Lecture: Quality	Hank Kolb	9.3-6			
Revenue Management	Mon/Tue	25/26 Apr	Case: Brook.com					
	Wed/Thu	27/28 Apr	Lecture: Revenue Management	Varian				
	Mon/Tue	2/3 May	Lecture: Revenue Management	Netzwine Shemsky	15.1-15.3			
	Wed/Thu	4/5 May	Case: TNG				Retailer report	
	Mon/Tue	9/10 May	Case: Video Vault		16.3-16.5			
	Wed/Thu	11/12 May	Course Wrap-up				Simulation report	

Organization

- Course website: http://stellar.mit.edu/S/course/15/p11/15.761/index.html
  (like DMD the website is split between sections A, B and C)
- Course Materials:
  - Course Packet (Cases and Readings)
  - *The Goal: A Process of Ongoing Improvement*, E. Goldratt and J. Cox
  - *Matching Supply with Demand*, G. Cachon and C. Terwiesch
- Grading

Class participation	20%	individual
Goal book review	10%	individual
Homework assignments	10%	individual
2 Case analyses	30%	in teams of at most 3
Simulation game & report	30%	in teams of at most 3

- Professional Standards
- Office Hours: Professor W 2-3 in E62-562 & appointments

15.761 First Lecture

Simulation game ~~Fri~~ Feb 6 2-6:30pm

Recitation to review

Instructor: Itai Ashlagi
- Isreal
- fairly new professor

Game theory tools to study markets
- incentives
- ad words research
- kidney exchange

Operations management

- matching supply w/ demand
- efficently organize materials
- improving within constraints
- * strategy of execution

---

have limited capabilities + resources
have certain goals
- profit
- social
- etc

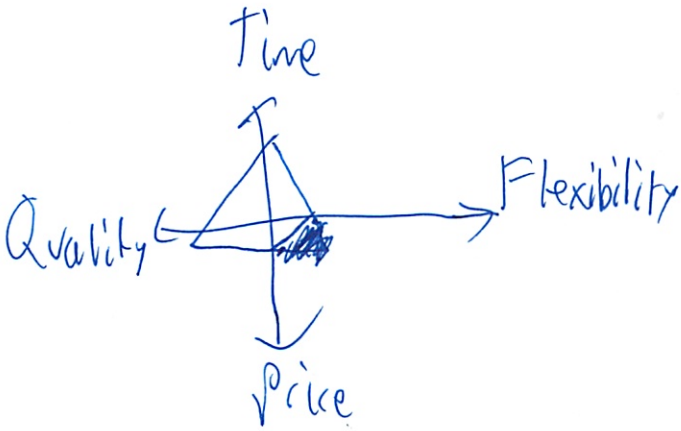
Build an operation w/ these resources to meet goals

(2)

Where is OM?

- manufacturing
- call center
- restaraunt
- retail
- Server farms
- airlines
- advertisement
  - esp online
- inventory
- hospitals

What is your strategic positioning



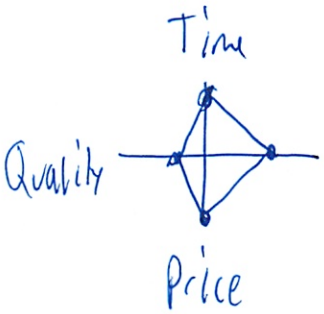
decide where to place yourself

Time vs timing

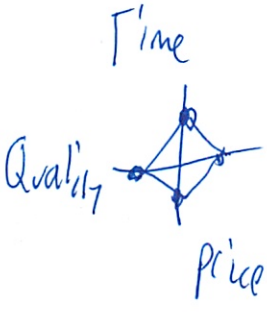
(3)

3 examples w/ food

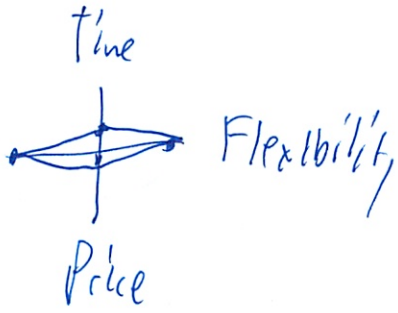
Food Trucks



Au Bon Pain

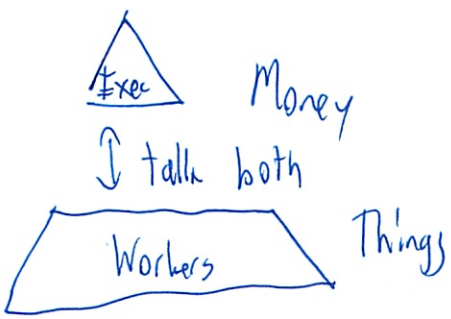


Legal's



flexible - can they change what they are offering
to match cust needs
↑ size of menu
↑ do things change day to day
meet customers needs
can meet a varying cust demand

Companies compete w/ operations
Left - have good ops

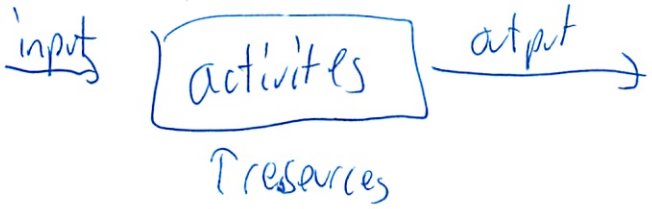


(4)

Many CEOs wee operations role

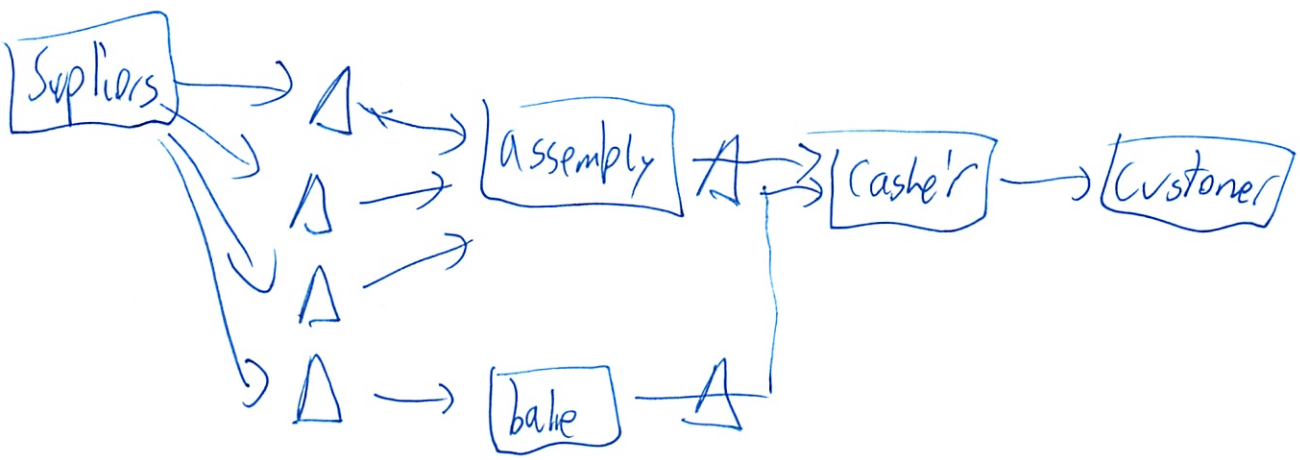
Have operations backgrand

Most basic tools ; processes



(young prof - first time teaching)
(presentation not very organized)

△ = WIP/Inventory
- buffers waiting for next step



(5)

Things to Watch

1. Efficiency — output/input
2. Quality — of output
3. Capacity — max throughput
4. Cycle Time — time in out
5. Flexibility — volume + product

Little's Law

$$L = \lambda \times W$$

- L: avg queue length
- λ: arrival/throughput rate
- W: Avg waiting time of cycle

Cust arrive → [in progress] → finished work

300 new MBA/year × 2 year edu = 600 MBA students at any one time

- Very robust law
- things can be stocastic

(6)

How many servers FB needs?

Need max time, not avg time

(he is abstracting this too much)

Server capacity 500 users

10 million visits per hr

Users spend 2 hrs on avg

So 20 million on at once

$L = \lambda \times W$

20 million = 10million x 2

- time of day

Peak is important

Service vs Manuf Operations

- tangable goods
- tangable easy to measure
- can return goods
- perisability

(7)

Sell something don't have it anymore
↳ Simultaneity
no inventory
production and consumption at same time
but still capacity to manage

Course Goals

1. Sci approch to analyze biz ops
2. Basic "phisics" of biz ops
3. Fundemental Tradeoffs
4. Sucess Stories + Failures

Check to make sure CVS case appears in course pack

MIT Sloan School of Management — Prof. Ashlagi/Levi
15.761 Introduction to Operations Management — Spring 2011

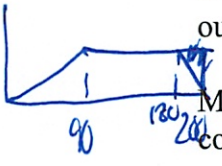
Littlefield Technology Simulation Exercise

First Assignment Description

Background

In early March, Littlefield Technologies (LT) opened its first and only factory to produce its newly developed Digital Satellite System (DSS) receivers. LT mainly sells to retailers and small manufacturers using the DSS's in more complex products. LT charges a premium and competes by promising to ship a receiver within 48 hours of receiving the order, or the customer will receive a rebate based on the delay.

The product life cycle of many high-tech electronic products is short, and the DSS receiver is no exception. After 200 days of operation, the plant will cease producing the DSS receiver, retool the factory, and scrap any old tools. In the initial months, demand is expected to grow at a roughly linear rate, stabilizing after about 3 months (90-110 simulated days). The release of the next generation product (which will be manufactured in another facility using a different process) is scheduled after exactly 180 days of production on the current version. At that point, it is expected that demand on the current version will progressively collapse down to zero. Although orders arrive randomly to LT, the marketing department expects that, on average, demand will follow the trends outlined above.



Management's main concern is managing the capacity of the factory in response to the complex demand pattern predicted. Delays resulting from insufficient capacity would undermine LT's promised lead times and ultimately force LT to turn away orders.

Assignment

how much of a rebate?

It is now early March, and after 20 (simulated) days of operation LT is starting to fear that a few of their receivers may be soon delivered after their due dates given the increase in demand. In response, management has installed a high-powered operations team (you) to manage the factory's capacity. For the next 180 simulated days (which will correspond to 5 real days) you must buy or sell machines to maximize the factory's overall cash position. Currently there are 10 board stuffing machines, 15 testers, and 10 tuning machines. Machines of all types cost $2,000,000. The retirement price of all machines is negligible. 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.

just capital, not opex

You may also change the way testing is scheduled. Currently, jobs at the tester are scheduled First-In-First-Out (FIFO), but you can give priority status either to the initial tests or the slightly longer final tests.

Orders for receivers arrive in batches of 60, and currently each order travels through the factory in one lot of 60 kits. However, you may divide each order of 60 kits into 2 lots of 30 receivers, 3 lots of 20 receivers, 5 lots of 12 receivers, or 10 lots of 6 receivers. Each lot travels independently through the factory, but the order is not shipped until all the lots that make up the order are completed. The manufacturing step on each machine consists of a complex combination of automated and manual tasks such as loading the group of boards and setting up fixtures. Your shop-floor supervisor has recently completed the following processing time estimates:

Processing Time (hours):

Step	Station	Set-up time (per lot)	Operation time (per unit)
1	1	0	0.2
2	2	0	0.1
3	3	1	0.05
4	2	0	0.15

In addition, very little variability was observed around the processing times indicated above for process steps 2 and 4, so that they can be considered deterministic for practical purposes. Process step 3, which is performed on station 3 (tuning), is more labor-intensive, so that the corresponding processing times exhibit more variability and their distribution seems roughly exponential (coefficient of variation equal to 1). The same is true for process step 1 which requires a fair amount of manual labor.

According to the service contract management has agreed to, jobs completed within 48 hours earn $25,000. Late jobs incur a revenue penalty of $25,000 per day (prorated by fractions of a day), so that jobs that take longer than 72 hours to complete earn no revenue.

You may change the lot size by clicking on the "Customer Order Queue" icon and then clicking on "edit data." You can buy, sell, or change scheduling at machines by clicking on the icon corresponding to the machine type.

Fortunately, you do not have to worry about managing procurement of raw materials; LT has collocated suppliers so that having raw materials on hand is rarely a concern.

The balance on your bank account earns interest (compounded every simulated day) at a compounded rate of 10% per year. You will be allowed to take loans should you need them. The interest on the loan accumulates at 20% of the loan value compounded annually. You begin with $10,000,000.

Plus machines?

When the assignment begins, there will already be 20 days of history available for your review. The simulator will run for an additional 180 real days corresponding to 4 hours of simulation time (you only gain access to the simulation after 20 simulated days have elapsed however).

After this simulation is over, you can check the status of your factory, but the factory will no longer be running.

Dates for Simulator Access

All students must form a team of at most three members (strict constraint) and register their team by February 3, 10 pm. Please use the following link (please remember to keep track of your team username and password):

http://quick.responsive.net/lt/mit/start.html

(Use the code 'go' to register.)

Access to your factory will be granted on Friday February 4, 2011 at 2 pm, when you will be able to observe the data from the first 20 days and plan your strategy, but not to make any changes. The simulation will resume on Feb 6th, Sunday at 2 pm, at which time you will manage and control your factory. It will end 4.5 hours later at 6.30 pm.

Once the simulator has started on February 4, students can access their factories from

http://quick.responsive.net/lt/mit/entry.html

(Use your username and password.)

Report

This is the first of two web based simulation projects and you will be submitting a joint report on the two simulations at the end of the semester; see the class syllabus for details.

have not learned anything
is this a baseline report?

So what are the variables in play here?

key: how many machines to order

demand guess demand

match orders in time

capital very expensive + sunk

Little Field Simulation
Recitation

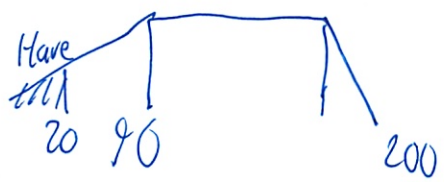
Not easy, Spend some time on
Need to check in real time

How long in each station
Total time does order take
Won't say how to optimize

Have 20 days of data
- need to analyze to estimate # of orders

Run a regression
- mean, st dev

Given pattern of demand



But will increase

Some day by day fluctuation

Is main problem

(2)

Small misestimates can quickly grow in problem

Premium is 25,000

More complex optimization than bear

Have $ in the bank as well

- marginal revenue

(I don't have the tech/math skills for that)

Want to use new data to adjust estimates

No API

- the sloan students laughed
- TA: if you have a lot of time on hand

Can make changes as you run

How set up staffing?

- Order
- now FIFO

Can change it throughout simulation

Have to do write up

(3)

Stocastic - predictable

2 stations

Other 2 are RV

- need to model RV

Need to allocate 2 * 4 steps based on lenght it takes

Default

1, 3 10 machines

2, 4 15 machines

Ratios: everytime I add machine 1, need some fraction —

Calc base throughput

2-3 hrs

Can have queues - can see it

Diagram of Factory

- can click on each station

(course 6 people would be much better than at this)

Need Flash

each team gets same demand pattern

(4)

Big thing is capacity

- Need to est demand
- Update estimate as you go

Then 2/4 swap

Loan + interest

~~After that~~

At start need to build up cash

Can't sell machines

Live Fi at noon

Lesson: Demand is unpredictable

What is the st dev

(kinda did this stuff - not confident though)

Don't order upfront - not ~~doing~~ making $ in biz

How much do you care about making a spike

Ask: How much will I lose by not making this capacity decision?

(5)

Intrest ~~upfront~~ at start gets compounded a lot

Regression: how best can I fit line through
- what is the R^2
just do straight line regression

Nice descripts of what you can decide, etc

Have baseline # precalculated

Organize who can change spreadsheet

Station count - add to count

Lot size
- obvious
- do math
- set up time
- but faster cycle time if have enough capacity

Inv carrying cost - just lost interest

Should have a little excess capacity

Set up time for each batch
- also don't do too small batches

I always think about why ~~do this~~ game dev did this

(6)

What are they trying to teach

Interface sucks

Can prioritize 2 and 4
- (but why?)

Can tune if critical to ship

But can keep fixed

Y axis completed jobs is in days
- want under 2

Job arrivals is what to watch

17.761 Conf Call

lot size
- calculate me

logger pro
- calcs regression

predict where it is going go

what is the peak machines
- how fast

interest ~ $3,000 day

2 st devs above peak
65-67 jobs

st dev ~ 5 again

5 I should call

$1,000/day on loan for $2 million

Variance

Queuing time
- how to model
- but usually no queue

(2)

Will get through 1 faster
- is that speed greater than ~~station~~ step 3 penalty?

Utilization
10 ~80 station 2 peak 15 jobs
15 ~50 12 jobs

station 1 same

10 station 3 ~~80~~ 38% 15 jobs

---

target 80% on the mean
31 hrs max now

---

ratios now

jobs/machine

machine 1 15:10 80% 1.5
2 15:15 80% 1
3 15:10 38%
40:10 80% 4

Need 62 machines
making $

(3)

erroring on side of caution

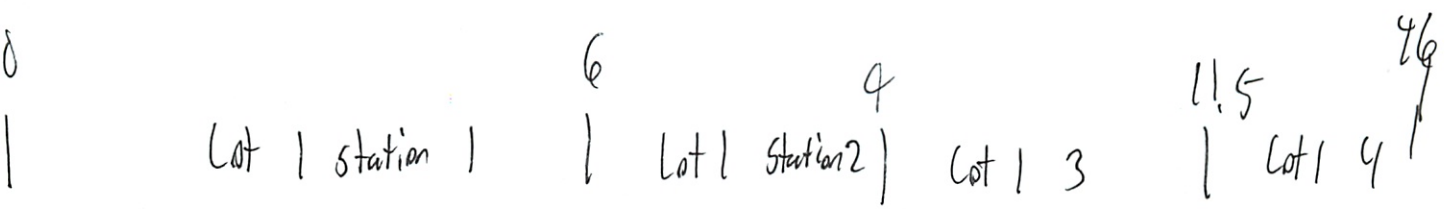
doing calcs on what it is now 1/60 lot

Guessing too much

Call over

(long day, tired)

Need to come up with queing lots formula

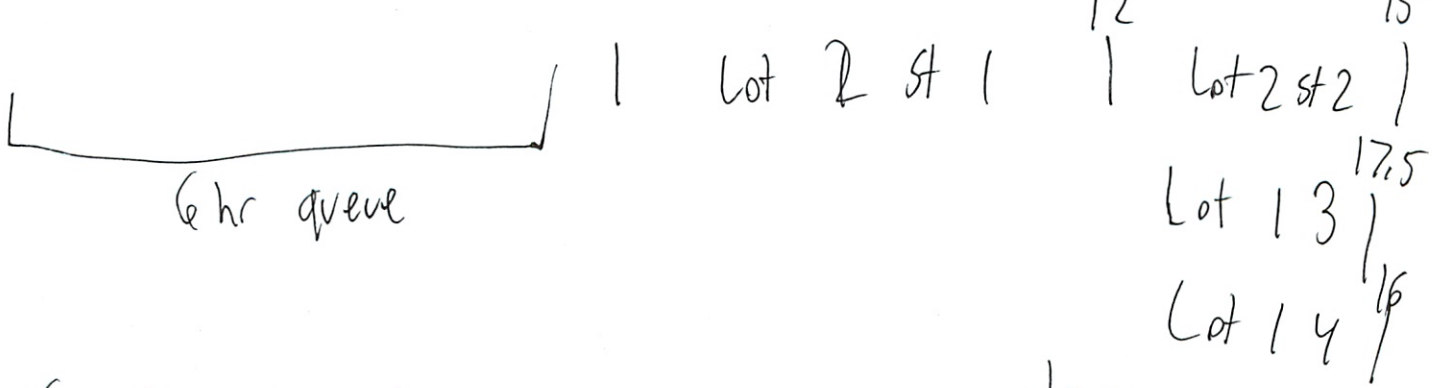


assuming sep machines

but multiple machines

So lot size each step difficult

- when starts bunching



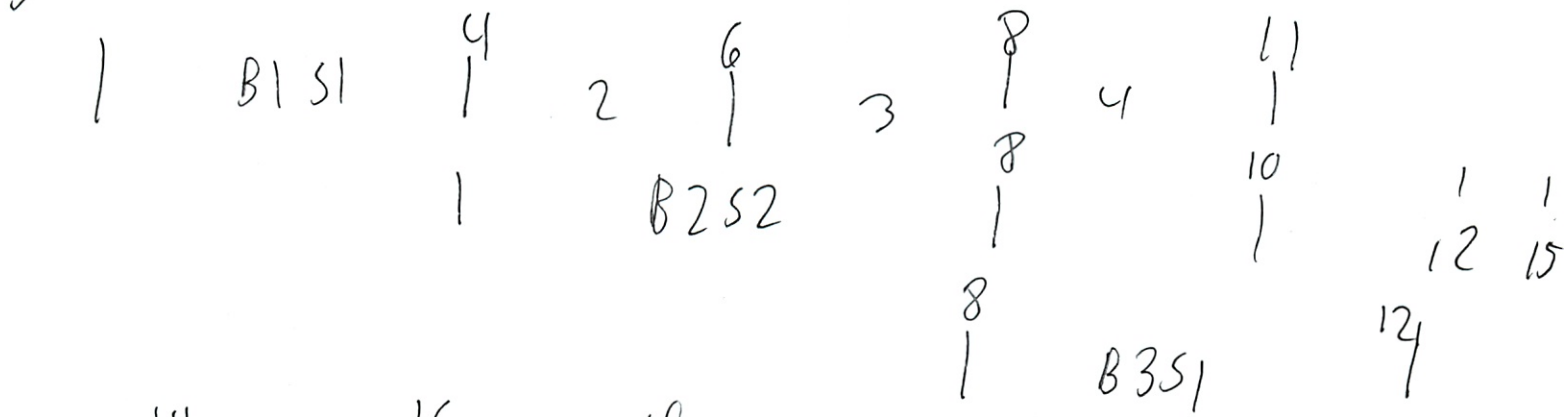
So time till last done = 22 hrs

But depends how many machines!

(4)

Must be better ways to solve

Depends if have spare machines - where stuff is waiting



1 Station 1
2 station 2
1 Station 3
↑ this is what I set

Call again

With 1 machines what is best to 48

Tradeoff 2 machines 16 / lot
1 22 /

Take up

(5)

Chr is delay factor

-slowest function

Doing a lot every 6 hrs/set of machine

lot half a job

job every 12 hrs w/ 121 machine

10 jobs every 12 hrs 10 20 10

want 65 jobs 90 ~~78~~ hrs

w/ just 5 bumping machines

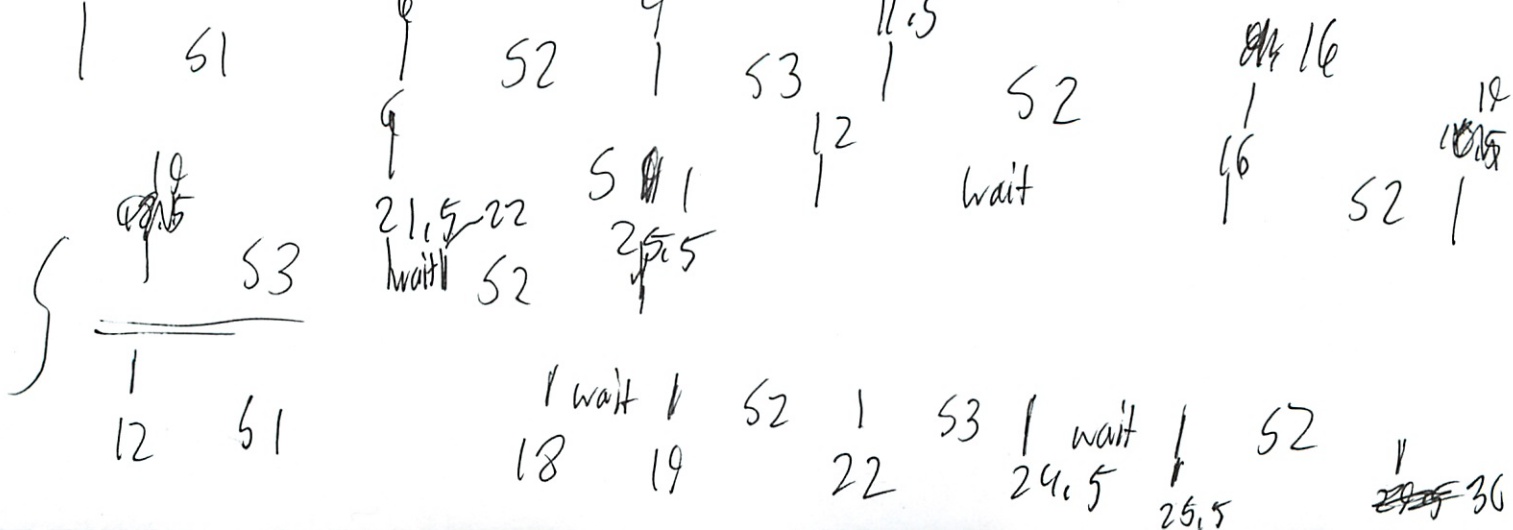
Variance

(I feel elegant solution - wish to find)

---

end call

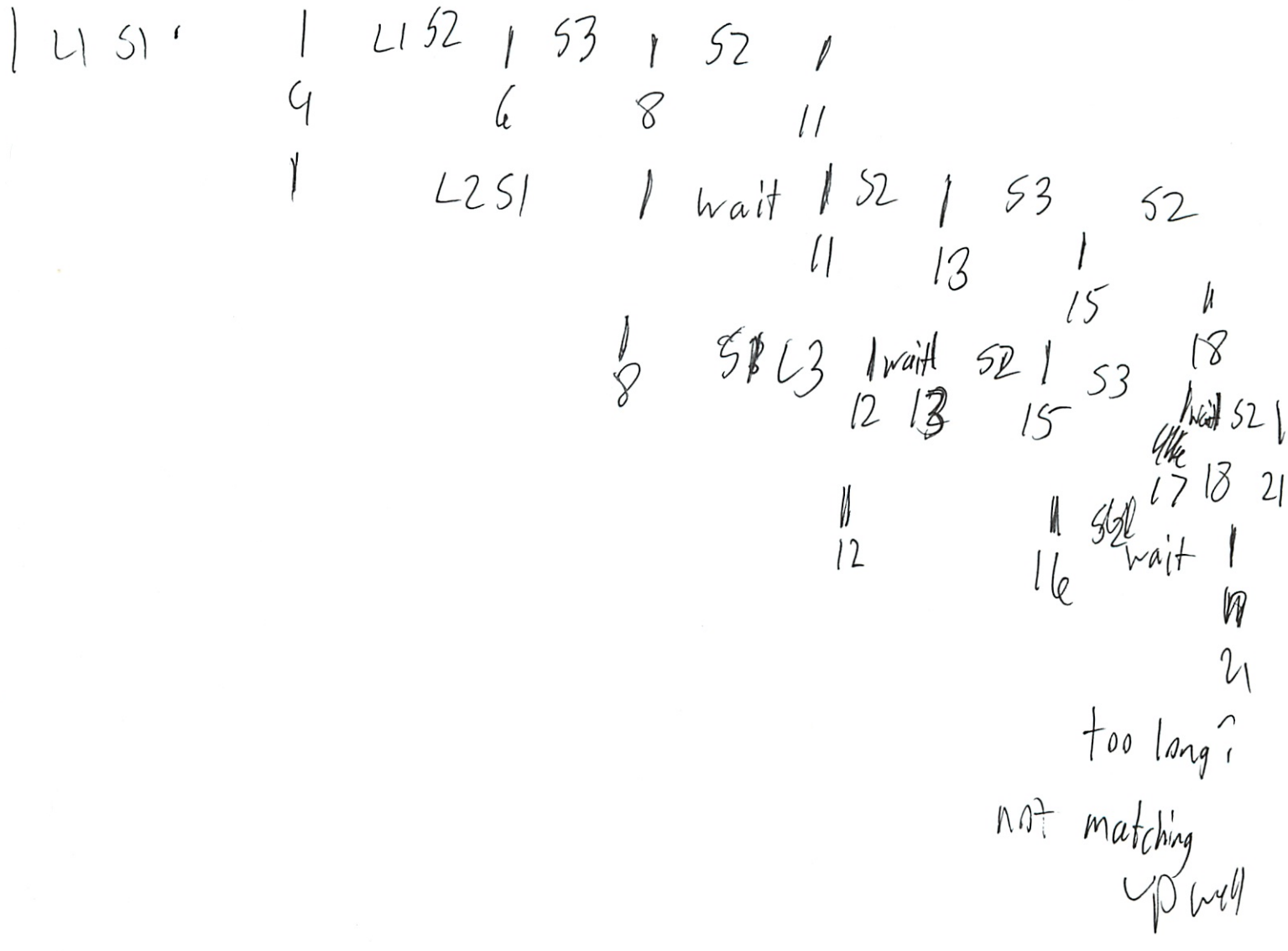
50 | 11 for 2 lots



(6) S1 18 | Wait 24 | S2 30

does not fit well in w/ 2
but did not exactly calculate

||| for 3 lots



(7) 111 for 5 lots

cab

Just pick a lot size
+ guess + check
Report matters

Hard to do at scale — 15 is diff
How do 1.5

So just guess

1 at 60 is 1 per order

So intuition and work from there

3/20 - median
best at 121

20	24	10	15	5
20 jobs every	12 hrs	20	30	10
40	24	20	30	10
60	24	30	40	15
70	24	35	45	15

ratios don't apply w/ this fire

(8)

(Very un scientific)

(I wish I had more science)

Pay back loan

1:45 talk

15.761 Sim Doing

2/6

- #2:01 still not open
(recorded thoughts in skype chat)

NSD Chap 3

process capacity important
need to analize the details
and simplify so important for a manager

3.1 Process flow diagram

first look at engineering diagrams
but does not show us how iron ore moves through process
So look at pictures of iron ore at each step of process
define process boundries of the right detail
- for what we are currently looking at

□ - process activities
- adds value

△ - buffers

→ flow

Can omit ~~cheap~~ non limiting or cheap steps
(book makes silly comment about U-shape)
Or can superimpose process over engineering map

3.2 Bottlenecks, Capacity, Flow

Big Q: How much can be processed in 1 day?

↳ process capacity

- how much could be produced
- flow rate is ~~[illegible]~~ actual

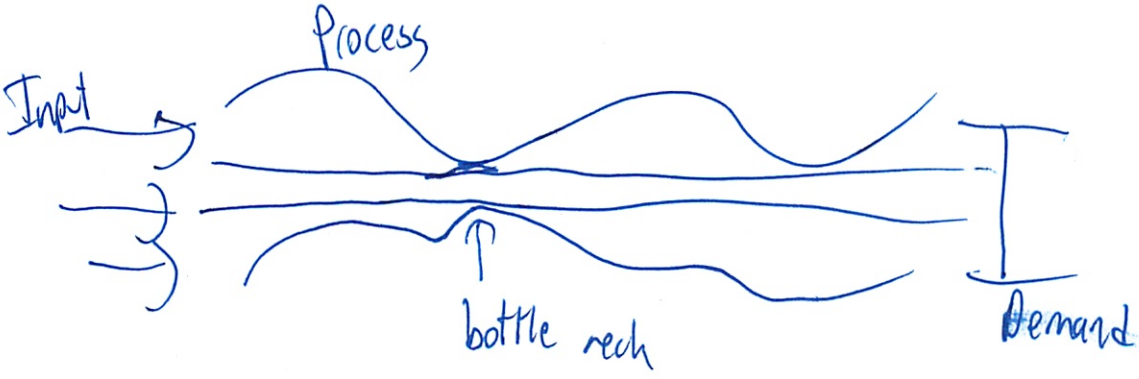
(should have found bottlenecks explicitly in sim)

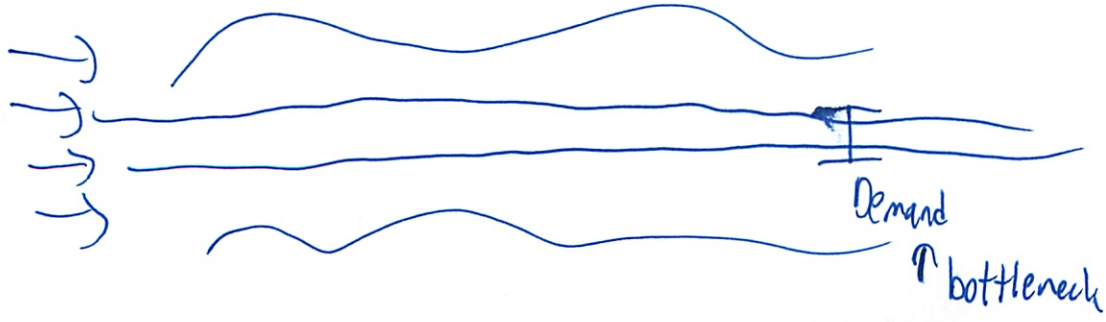
- find individual processes w/ low capacity → bottleneck

Process capacity = min (process 1 capacity, ..., process n capacity)

flow rate = min (ava. input, demand, capacity)

also matters





(3)

Use Littles law to find flow rate
Measure in per-unit-time

3.3 How long to produce a certain amt?

$$\text{Time to fullFill X units} = \frac{X}{\text{Flow rate}}$$

3.4 Process Utilization + Capacity Utilization

- first year Supply capacity > demand

$$\text{Process utilization} = \frac{\text{flow rate}}{\text{Process capacity}}$$

$$\text{Util of resource} = \frac{\text{flow rate}}{\text{Capacity of resource}}$$

- you want to max. profit, not util.

3.5 Workload + Implied Utilization

Util can not > 100%
but how can we know extra demand?

$$\text{implied utilization} = \frac{\text{capacity requested by demand}}{\text{available capacity}}$$

(This textbooks' extra remarks are obvious)

(4)

3.6. Multiple Types of Flow Units

- if breaks up into multiple flows
- or diff types of flow units
  - product mix

- So say the flow is a random product
  - which it is depends on relative probabilites of all flows
- Or can define a flow unit as 1 min of work
  - and track "requested time" at each step
  - instead of apps/hr
- decide which to use
  - both same result

Writing in math way

Max $\{US + V\}$

Subject to $US \leq 10$, $V \leq 5$

$US \leq 10$, $V \leq 3$ immigration

$US + V \leq 10$ luggage handling

Optimal solution

$US + V = 10$

↑ what makeup is random

depends on objective

(still confused on apps/hr vs min/hr approach

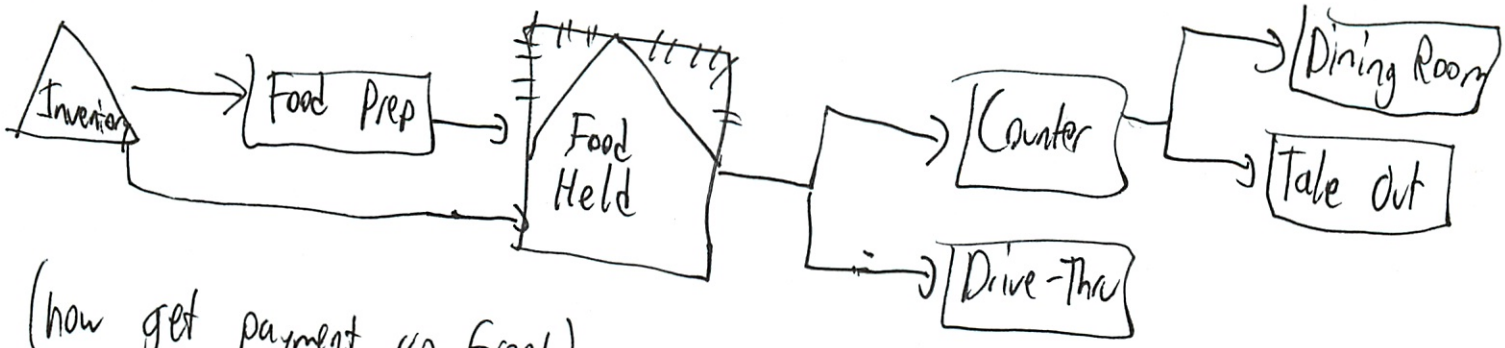
Burger Cases

Q1 Process flow diagram
- steps
- inventories
- flows

for McD

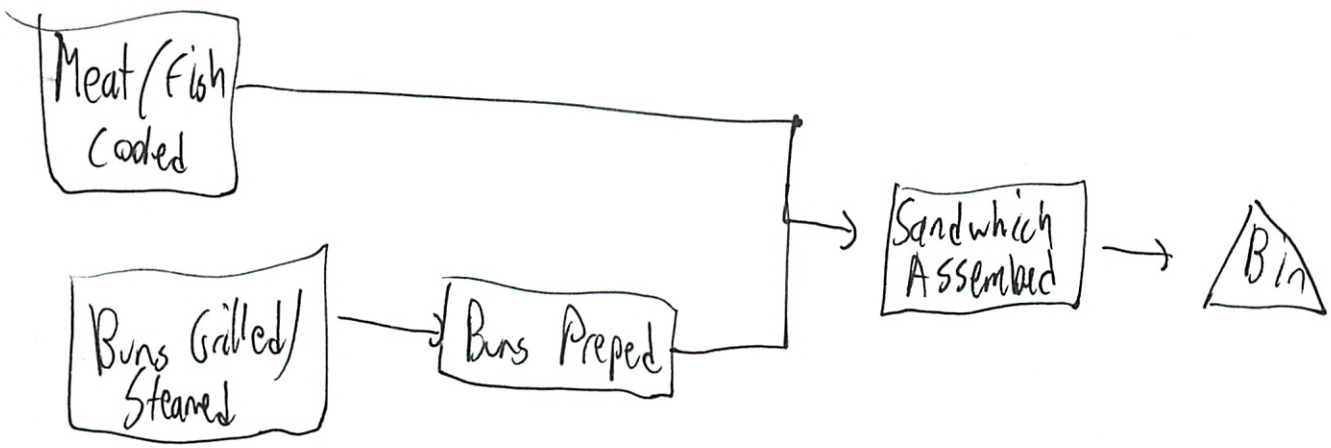
Q2 Find peak hourly capacity / demand

Food flow

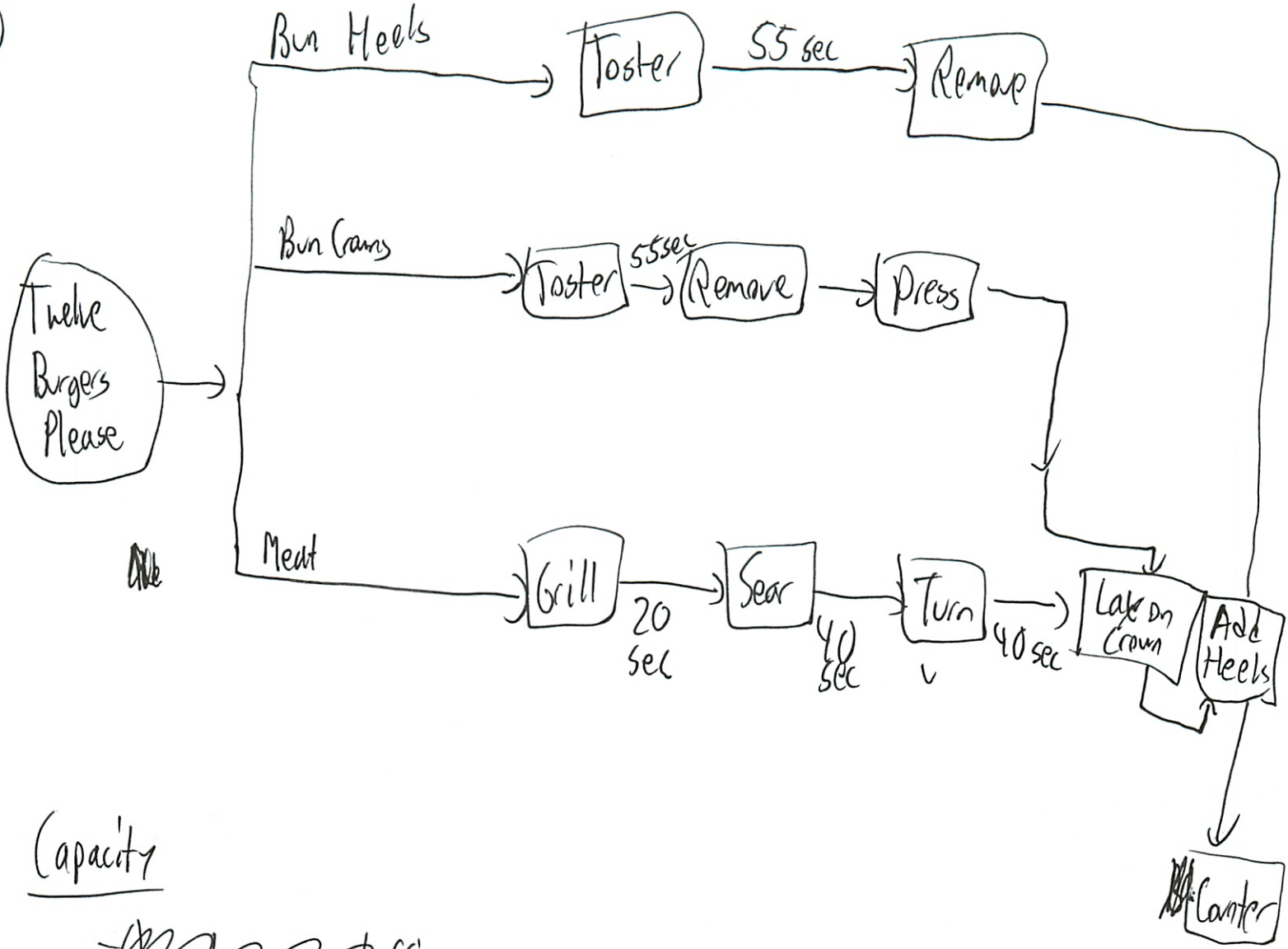


(how get payment up front)

Sandwich prep



(2)



Capacity

~~Depends on staffing~~

- Will do for burgers
- 24 slots on grill
- 100 sec to ~~make~~ cook + make

$$L = \lambda W$$

$$24 = \lambda \cdot (100 + 15)$$

$\lambda =$ ~~[illegible]~~ burgers/min

~~[illegible]~~

12.5%

753 burgers/hr

(3)

Demand

↓ big hour

$600-700 hour was 20-24 burgers

Quarter Pounders

Grill Capacity = 20

Time = 270 + 15 sec

Rate = 4.2 qt lbs/min

Prod = 252 ll /hr

Demand

6-8 in a $600-700 hour

15.761

McD + Bk differences in operation
- strategy

20% Bk customized
- ? more focused on custom?
In 1976 ad - did not make ahead of time
"have it your way"

~~Time~~ ~~Price~~ ~~Quality~~ ~~Flexibility~~

Bk

I don't really agree
I think more the same
time
hours open
experience: clean, type of decor
marketing to kids
(the prof is just not getting that people say their is no diff)
Bk has microphone
MCD has TV screen

(2)

lights

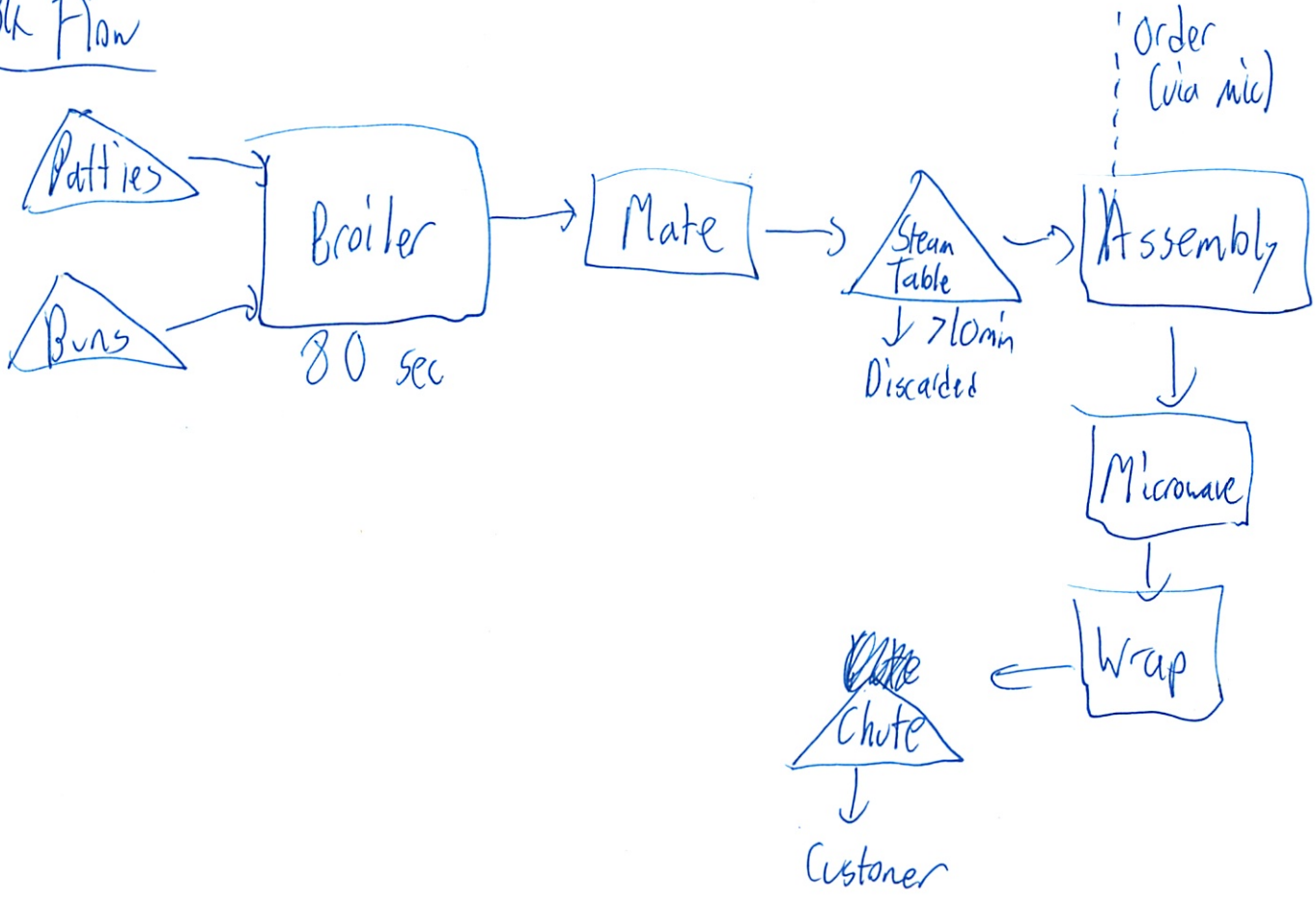
(the prof just does not seem to get it
this is stupid)

McD - manufactures by batches

Bk - belt - continuous chain broiler

making to sales or for inventory

Bk Flow



(silly too much attention to detail that does not matter
- obvious
- no reason to learn)

Have WIP

(3)

Steam table is postponement

So can customize burgers quickly

Broiler - don't need someone watching it

Capacity

200 burgers + 100 whopers = 300 patties/hr

?assembly point - choke point/bottle neck

Grill

12 burgers /80 sec → 540 b/hr

8 ~~burgers~~ /80 sec → 320 wappers/hr
Whoppers

Peak Demand

~~Peak hour = 205 burgers~~

31,227 sandwichs/month

* 1/(52/12)
* 18% ← Friday
* 17.9% ← 12-1PM
* 83.2% ← Burgers

212 burgers/hour

(4)

$$\rho_{utilization} = \frac{\text{peak demand}}{\text{capacity}}$$

$$\rho_{burgers} = \frac{212}{300} \simeq 70\%$$

$$\rho_{whoppers} = \frac{254 \cdot 31.2\%}{100} \simeq 79\%$$

$$\rho_{plain\ burgers} = \frac{254 \cdot 48\%}{200} \simeq 61\%$$

---

target 3 min

Current time 4 min 5 sec

lots of reasons not achieved

Could be all in 5 min the peak

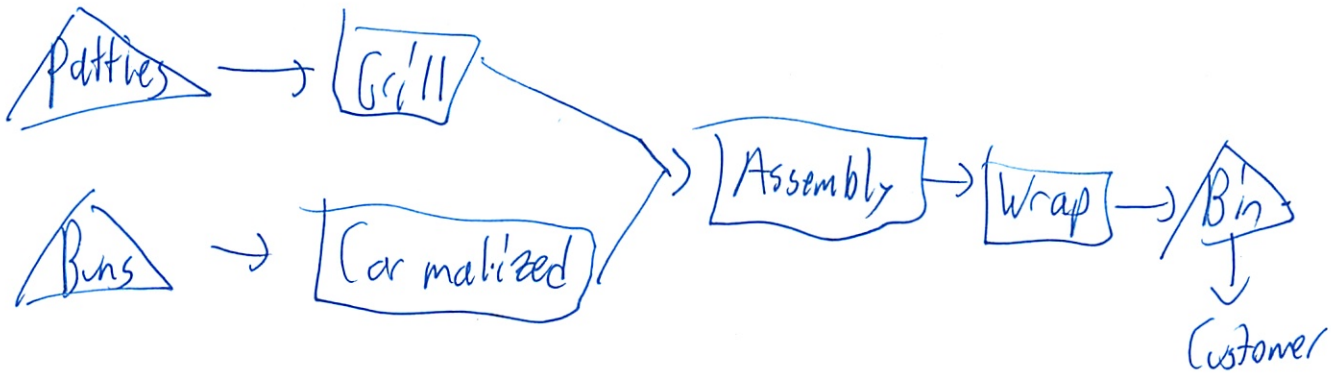
~~Some~~ everything was average

(I don't think it anything to do w/ assembly capacity
- Why managers are so stupid - Fit in the box)

(5)

Now McD

- (this is so boring)



(again I think this is missing stuff)
(both actually operate quite similar - not the view he is presenting)

Confronted him that similar

- main difference: steam table - flexibility
  - broilers continuous

Capacity

(how is this any different)
(largely due to meaning diff)

(6)

Grill

(how can you use usually ??)

24 per batch max (usually)

100 sec + 15 sec clean

$\frac{24}{115} \cdot 3600 = 751$ ~~patties~~ burgers/hr

Could actually do 48

(But prof going w/ 24 - just to show the math)

Quarter Pounders

$\frac{10}{285} \cdot 3600 = 126$ qt lbs/hr

No info on other steps - have buns - clearly higher

So use this as bottle neck

Take the minimum - the quarter pounder

Student: Its a completly diff grill - so treat differently

(why does not prof get this?)

Demand

55,703 sand/month

$\cdot \frac{1}{(52/12)}$

(7)

- 17.8 Friday
- 14.9 12-1

= 341 sandwichs/hr

Burger $341 \cdot .491\ \# + 341 \cdot (2 \cdot 18.8\%) = 247$ ~~Sandwich burgers/hr~~ patties/hr
↑ big mac

Qr lbs $3/4 \cdot .147 = 50.7$ patties/hr

$\rho_{total} = \frac{341}{751} = < 40\%$

Big diff in utilization

I argued can't see difference

Need to look at seconds
- predictable variability
- Unpredictable "

(I talk to long)

- Service level: define carefully — avg
  - % people longer than time

Class 2: McD & BK Cases

1. What is the strategic value positioning of McD and BK?
2. Process Flow Diagrams
3. What are the peak demand and capacity at BK and McD?
4. What are the key operational differences (technology, control, HR, product…) between the BK and McD restaurants?

Strategic Value Positioning

Burger King PFD + Capacity

McDonald's PFD + Capacity

Predictable Vs. Unpredictable Variability

Operational Characteristics

Type	Burger King	McDonald's	Why?

Operational Characteristics

Type	Burger King	McDonald's	Why?

Class 2 Wrap-Up

1. Process (technology, architecture and control) alignment with strategic positioning (flexibility, quality, cost and time)
2. Capacity Utilization, Bottlenecks, Predictable Vs. Unpredictable Variability
3. Production Control, Make-to-Stock Vs. Make-to-Order

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Strategic Value Positioning

Solutions

Burger King PFD + Capacity

McDonald's PFD + Capacity

Predictable Vs. Unpredictable Variability

Predictable Vs. Unpredictable Variability

Sec	# Customers
80	5
90	10
100	12
110	12
120	22
130	12
140	12
150	10
160	5

<u>Customer waiting time statistics</u>:

Average waiting time = 120 sec

However 39% wait longer than 120 sec

Operational Characteristics

Type	Burger King	McDonald's	Why?

Operational Characteristics

Type	Burger King	McDonald's	Why?

Class 2 Wrap-Up

1. Process (technology, architecture and control) alignment with strategic positioning (flexibility, quality, cost and time)

2. Capacity Utilization, Bottlenecks, Predictable Vs. Unpredictable Variability

3. Production Control, Make-to-Stock Vs. Make-to-Order

- Capacity ≠ inventory
- Cost
- time
  - processing time

(Now I appreciate theoretical math much more)

Queue w/ Bursty Arrivals (from slides)

$$A = \begin{cases} \frac{1}{4} & p = \frac{1}{2} \\ \frac{7}{4} & p = \frac{1}{2} \end{cases}$$

$E[A] = 1 = \frac{1}{4} \cdot \frac{1}{2} + \frac{7}{4} \cdot \frac{1}{2}$

$\lambda = 1$ call arrival ~~rate~~ rate

$S = \frac{3}{4}$ service time

$\mu = \frac{4}{3} = \frac{1}{3/4}$ ⊥ service time

$C_A = \frac{\sqrt{E[A^2] - (E[A])^2}}{E[A]} = \frac{\left(\frac{1}{4}\right)^2 \cdot \frac{1}{2} + \left(\frac{7}{4}\right)^2 \cdot \frac{1}{2} - 1}{1} = \frac{3}{4}$

(6.041 is back!) (Need to become refamiliar w/)

$C_S = 0$ deterministic

$L = \frac{(3/4)\sqrt{4} \cdot (3/4)^2}{2 \cdot 1/4} = .63$ avg # jobs in queue

(2)

Avg wait time (Little's Law)

$W = \frac{L}{\lambda} = .63 \text{ minutes} = \frac{.63}{1}$

You decide what the system is

Kendall Bank of America (from slides)

$N = 4$ ATMs

$\lambda = 110$ cust/hr

$S = 2$ min

On average, shald it be 0

- 30 customers / hr / atm · 4 = 120 cust/hr capacity
- so should be good

$\mu = \frac{60}{2} = 30$ cust/hr / atm

(Be clear / study what each variable is)

$\rho = \frac{\lambda}{N\mu} = \frac{110}{4 \cdot 30} = \frac{11}{12}$ Capacity

$L = \frac{\left(\frac{11}{12}\right)^{\sqrt{2 \cdot 5}}}{1 - \frac{11}{12}}$ ... no CA, 6!

↓next pg

(3)

C_A is not given, can't calculate

good estimate = 1

where st dev ≈ expectation

(normal, right)

Empirically good

C_S = 1 estimate as well

$$L = \frac{\left(\frac{11}{12}\right)^{\sqrt{2.5}}}{1 - \frac{11}{12}} \cdot \frac{1+1}{2} = 9.11 \text{ customers}$$

$$W = \frac{L}{\lambda} = \frac{9.11}{110} \approx 5 \text{ min}$$

What can you do?

- add more machines
- reduce job lenght
  - speed up machine
  - people to help
- decrease variability

(4)

What if wanted 2.5_{min} wait time?

- Solve for
- will increase at square exponent relationship

What if doubled ATMs to $N = 8$

$$\rho = \frac{110}{8 \cdot 30} = \frac{11}{24}$$

$$L = \left(\frac{1+1}{2}\right) \cdot \frac{\left(\frac{11}{24}\right)^{\sqrt{18}}}{\left(1 - \frac{11}{24}\right)} = .067 \text{ customers avg in queue}$$

$$W = \frac{L}{\lambda} = 2.2 \text{ sec avg wait time}$$

Very non linear

- exponent very crucial

What if only 1 more $N = 5$

$$\rho = \frac{110}{5 \cdot 30} = \frac{11}{15}$$

$L = \ldots = 1.28$ customers

$W = \frac{L}{\lambda} = .78$ min

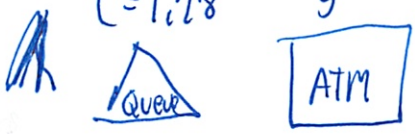
(I want to graph)

(5)

Mistake many managers make

Whole Thing as system

L=1.28 5 lenght



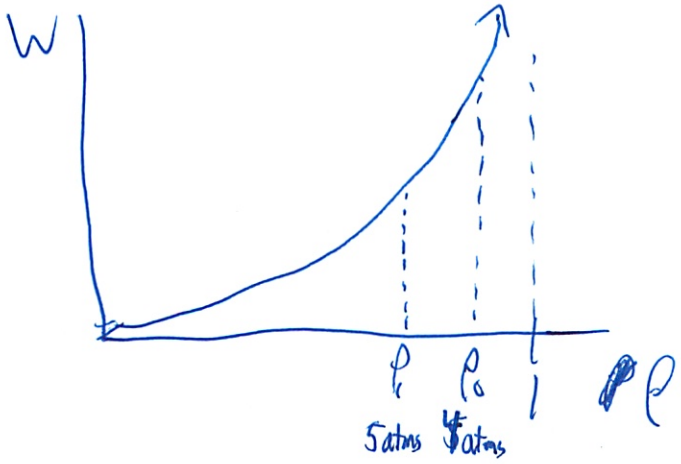
$\hat{L}$ = 6.28

Calc whole thing

- add the averages

1.7 + 2 = 2.7

When ρ goes to 1, L goes to ∞



Diminishing marginal returns from adding ATMs

(Presentation/math not too organized)

(Starting to recognize math "blocks")