Operations Research, Spring 2018 (106-2)
Case Assignment 1

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1 The story

Mikasa sits in her office looking outside the window. After she retired from the army, she went to Hsinchu, Taiwan to work in a semiconductor manufacturing company, IEDO. As she is smart, strong, diligent, and able to pay full attention on what she is working on, she finished all the assigned jobs perfectly. These perfect records lead her to the current position, the head of the Operations Research department. She has been promoted to this position for two weeks.

Her eyes are still as beautiful as before. However, she is worrying about something. Multiple customers order multiple products, which may be produced at multiple factories. As the head of the OR team, Mikasa now is responsible for assigning manufacturing tasks to multiple factories owned by the company. She finds that the new job is really challenging, as there are many factors to consider. Moreover, the objective is somewhat defined ambiguously. The previous head, Eren, cannot manage this job in a good way. Mikasa needs to protect Eren again.[1]

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[1]Though the problem is motivated by a real problem faced by a real company, it has been modified to fit the need of this course. In particular, the problem has been simplified by taking away a lot of factors to be considered in practice. Technical details that are domain-specific about semiconductor manufacturing are also removed. Though this makes the problem somewhat abstract, this allows one to work on it without having knowledge in semiconductor manufacturing. Nevertheless, please still try to see the connection between the problem presented here and the real-world business.

2 The problem

Mikasa now needs to plan for IEDO's production processes for the next week. Her task is described as follows.

Six customers, all big companies, place orders to IEDO. Each order contains a set of products and the associated order quantities. Each customer may place more than one orders. For confidentiality reasons, customers' names must be hided. Therefore, they will be called customers 1, 2, ..., and 6. IEDO currently produces twelve kinds of products, labeled as products 1, 2, ..., 12. The spreadsheet *Orders* records the current ten orders placed by the six customers. The numbers therein are the order quantities of each item. For example, order 1, placed by customer 1, requires 2000 units of item 4, 3000 units of item 5, etc. The sheet also records the price to collect upon completing that order. For example, if all the ordered items are delivered to customer 1, customer 1 will pay IEDO \$5,500.[2] As long as any single unit of an ordered item is not delivered, IEDO gets nothing.

IEDO owns eight fabs. As different fabs are constructed at different times, they have different capacities and different production rates. The spreadsheet *Fabs* records the current eight fabs, their capacities, and their production rates with respect to all items. For example, fab 1 in total has 840 machine hours as its capacity for the next week. To produce item 1 in fab 1, IEDO must spend 1 hour to produce 10 units. If that 1 hour is spent on producing item 2, IEDO will only get 5 units. Suppose fab 1 is asked to produce items 4 and 5 for order 1, it needs to allocate $\frac{2000}{10} + \frac{3000}{5} = 800$ hours on this task. There will be only $840 - 800 = 40$ hours remaining for other production tasks. Due to technology limits, fab 1 is unable to produce items 10 to 12.

Obviously, sometimes an order cannot be completed by one single fab. For example, order 1 cannot be completed by fab 1 because item 10, required in order 1, cannot be produced in fab 1. If an order is split and be completed by multiple fabs, there will be multiple deliveries to a customer. The shipping costs and compensation for bothering the customer together form order splitting costs. The spreadsheet *Splitting* records the splitting cost of each customer per splitting. For example, suppose order 1, which is placed by customer 1, is completed by three fabs, IEDO must pay $\$1000 \times 2 = \$2000$ as the order splitting cost. The profit of completing order 1 is thus only $\$5500 - \$2000 = \$3500$.

Mikasa's team is responsible for assigning orders to fabs and how to allocate the

[2]All these numbers have been normalized to keep the real information confidential.

capacity of each fab to the assigned orders. While ensuring that each fab's assigned tasks do not exceed its capacity limitation, the main objective is to earn as much profit (sales revenue minus splitting cost) as possible. As the head of the OR team, Mikasa knows that she must somehow guide her teammates to come up with a way to do the planning. As the same problem will occur again and again,[3] Mikasa really wants to have a systematic way for doing this.

3 Your tasks

Use whatever method you like, make a suggestion to Mikasa about how to allocate machine hours to orders and items for each fab. Make your proposal by completing three things: an executive summary for the COO (chief operations manager), a production plan for fabs, and a description of your method for Mikasa.

1. (20 points) Write down a summary of your proposed allocation in your report. In the report, do not repeat the detailed machine hour allocation that is already included in the spreadsheet. Instead, write an executive summary by summarizing relevant information (order allocation, order completion, order splitting, fab capacity utilization, etc.) that the COO of your company would be interested to know. Of course, you should calculate and report your final profit. In short, summarize the *outcome* of your production plan in Part 2, but DO NOT include the detailed plan here. ***Limit this part to be no longer than one A4 page.***

   The points you earn in this part depends on the relevance, clearness, and easiness-to-read of your executive summary.

2. (40 points) Write down your detailed allocation by filling in numbers into the spreadsheet *OR106-2_case01_studentAnswer.xlsx*. In that spreadsheet, you may modify only the values contained in those green cells. ***Do not modify anything else.*** If you fail to follow this rule so that your submission cannot be graded automatically, you get no point in this part.

   Try to earn as much profit as possible. The points you earn in this part is $40(\frac{z}{z^*})$, where z is your profit and z^* is the maximum attainable profit.

[3] If we allow IEDO to keep inventories for future demands, the planning problems for all future weeks will become interdependent. To make our lives easier, let's assume that this is not allowed.

3. (40 points) Describe the method you design for Mikasa's problem. 20 points will be based on the logic of your method. Please note that Mikasa's problem may become *larger*, i.e., with more customers, orders, and items, in the future. The values of parameters may also become different. Your method will also be graded by considering its extendability. Finally, please explain your method in an easy-to-understand way. 20 points will be based on your presentation. ***Limit this part to be no longer than two A4 pages.***

4 Submission rules

- **Teams.** Students should form teams to work on this case study. Each team should have three to five students. Each team should make only one submission.
- **Things to submit.** Please submit an MS Excel spreadsheet (for Problem 2 above) and a PDF file (for Problem 1 and 3 above). Limit your report to six pages, including everything. Include the student IDs and names of all team members in both files.
- **Where to submit.** Please submit both files to NTU COOL.
- **Deadline.** The deadline of this assignment (for both the report and files) is 2:00 pm, March 5, 2018. Works submitted between 2:00 pm and 3:00 pm will get 10 points deducted as a penalty. Submissions later than 3pm will not be accepted.