ISE 140 Spring 2021   Term Project

You are to work in teams of 4 (some groups have 5 members)

Due Date: <mark>5/12</mark>
Deliverables
ONE zipped folder uploaded on canvas with
    a. report (doc or docx format),
    b. **ALL** supporting documents used in the report as separate appendix
        - documents include excel spreadsheets with computations,
        - simulation model development (e.g. promodel or flex sim),
        - journal papers used
        - etc….
    c. weekly journal

PROBLEM

The Vikings Division, a subsidiary of AK Enterprise, is headquartered in Pleasanton, CA. The company produces a variety of nutritional products, including adult medical nutrition supplements and pediatric infant formulas, as well as ancillary equipment. Vikings Products especially focuses on producing five main products, namely Product 1, 2, 3, 4 and 5. These products are sold directly to various distributors and wholesalers.

Five years ago, when their patent was valid, there were no competitors making similar products. It was because of that Vikings Products had their patent and not many companies are interested in producing nutritional products. However, their patent expired, while at the same time more company jumped into producing similar products due to sharply increased demand in recent years.

The demand for the five products varies depending on the type. Some of the products have seasonal demand while others experience more of a steady demand. However, the demand for all product types has some fluctuation from week to week. Table 1 shows the demand of each product for the last 20 weeks. The 5 products are composed of four sub-products, i.e. sub-product 1, 2, 3, and 4. Bill of Materials for each product is given to Table 2.

The firm has lost their profit over several years, and they decided to look into the system deeply. They had a poor history of meeting their demand on time. They consistently had demand backordered. Furthermore, there was very little cost containment in the production facility. They maintained high work-in-process (WIP) inventory leading to long production cycle times. The high cycle times and WIP were a result of many factors including manufacturing the wrong production quantities of the different product types (i.e., little forecasting was done), poor utilization of the machines, running inappropriate lot sizes, and using no formal scheduling methodology.

This was the environment that Vikings Products Division operated under for years. The firm could not continue operating in this manner and continue to remain in business since their profit has been falling down. Mr. John Smith, an industrial engineering manager at the company, was asked to spend a considerable amount of time repairing the relationship with the customers, using some of her training in scientific management to reduce the cost and cycle times of the production facility.

One of Mr. Smith's first goals was to establish a formal method for forecasting the demand, planning the production based on BOM and capacity, and scheduling the production of the different product types. To aid her in these efforts, Mr. Smith hired part-time industrial engineers to collect cost information and production data on the manufacturing facility including performing time standards. Table 3(a) and Table

3(b) summarize production/sub-product costs and the backorder cost per unit per period for each type. The backorder cost reflects the penalty that Vikings Products will incur if they do not meet the demand on time. The result of the remaining data analysis is summarized in Tables 4 - 8 including:
- Bill of Materials for each product (Table 2). Note that there are five products and each product has different BOM of sub-products.
- Routings of each sub-product type (Table 4). Note that there are seven stations and each sub-product type visits each station in a different order.
- Number of machines at each station (Table 5).
- Processing time per unit in minutes for each sub-product type at each station (Table 6).
- Setup time per lot in minutes for each sub-product type at each station (Table 7). A setup is incurred only when each product type first comes into a station.
- Frequency and the time of downtime in minutes for each station (Table 8).

Mr. Smith was pleased with this data summary. He then instructed the part-time engineers to prepare a report outlining a suggested forecasting, planning and capacity, and scheduling methodology for Vikings Products Division. **The report is limited to ten pages of main text** (single spaced, 12-point font Times New Roman, and 1 inch margins). **The appendices are not included in the 10 page limit.**
The report must address the following requirements in each module.

Forecasting
1. For each product type, Suggest a forecasting methodology *(based on the models discussed in class)* and provide forecasts for the next five weeks. In order to validate your methodology, Mr. Smith requires that it must generate a Mean Absolute Deviation (MAD) no greater than those given in Table 1 when applied to the last ten most recent weeks. In other words, the first ten weeks are used to make a forecast model, and the recent ten weeks are used to validate the forecast model.
2. Additionally, suggest two forecasting methods *(based on your research which have to be different form the ones discussed in class)* that might be appropriate for the given data set. This implies that your group will have to review literature **published in journal papers** and identify two that might be appropriate for this situation. ***You are expected to explain why these methods are suitable***. ***Select one of the methods, use the data and develop the forecast for the next five weeks.*** Please cite the journal paper using MLA or APA format used for reference.

Planning
Develop a production plan for the next five weeks to meet the forecasted demand that minimizes the total production costs. You need to attempt (**at a minimum**) a level and chase production strategy for each product. Assume there are 480 manufacturing minutes in a day, 5 manufacturing days in a week and 52 working weeks in a year. Provide the total cost of your plan for the next five weeks and for each product type state the production quantity, the ending inventory, the number of units backordered, workers needed, and undertime in each week if applied. (Ending inventory and back orders must be zero at the period 25. Exceptions: level policies for product 3 and product 4 may have some ending inventory at the period 25.)

Also develop a MRP record for all the products and sub-products based on the given BOM to produce the forecasted demand. Refer to the tables in Appendix A. Then, create a MPS for the four sub-products based on those MRP records. **With the MPS record of sub-products, perform a capacity plan to determine the number of machines you will need for your production plans and provide the total cost for the plan.** Do not forget to subtract down time from available hours. In considering downtime, each week is supposed to have non-stop 2400 minutes long. Also, assume beginning inventory equals zero.
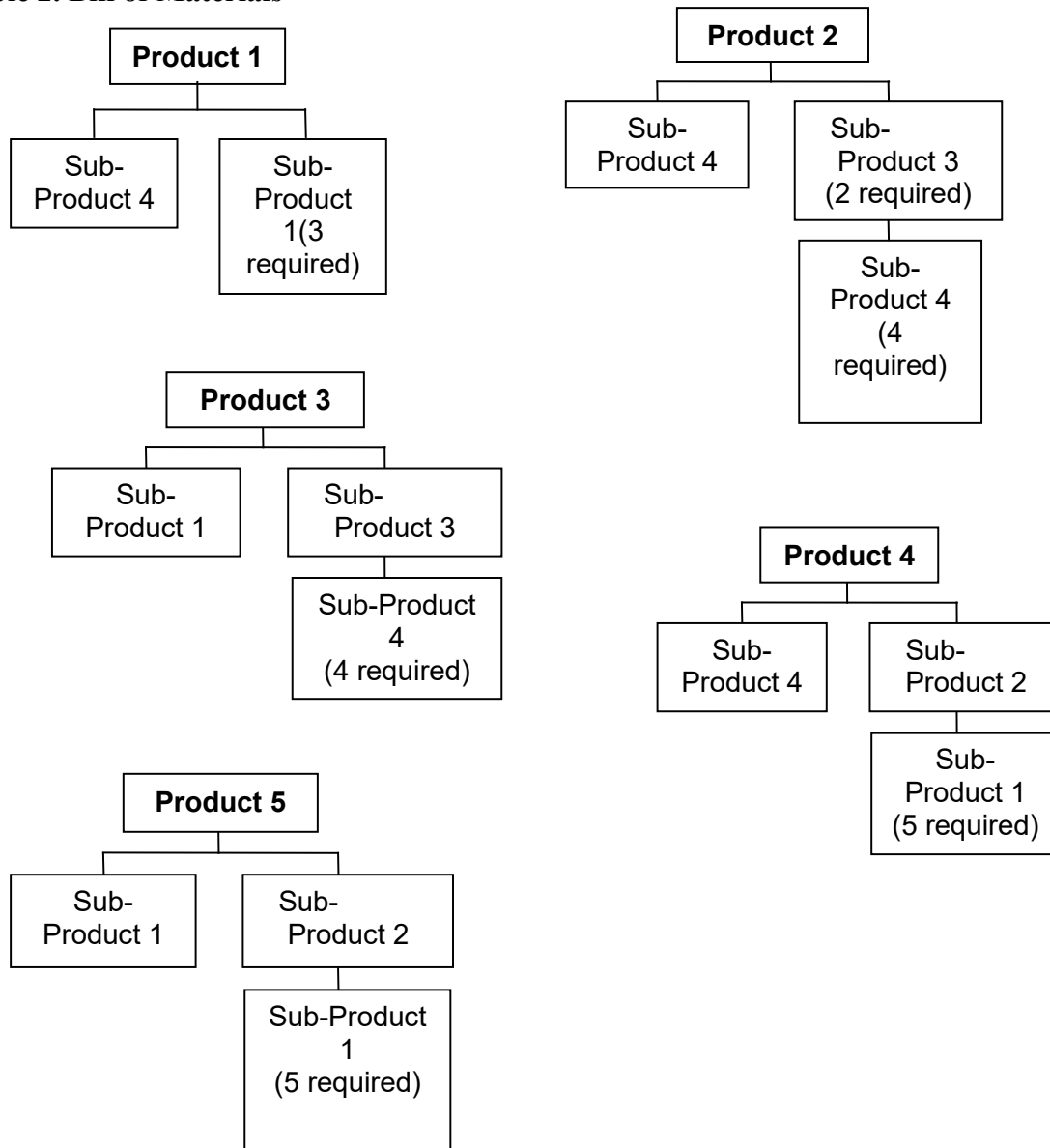
Scheduling

Develop a scheduling methodology that minimizes the cycle time to satisfy the first week's production plan. The scheduling methodology must state the dispatching rule at each station, and the lot size for each sub-product type. If you decide to change the plan or add machines in order to reduce the cycle time, then the total cost given by the planning department must be adjusted to reflect these changes. *You must provide some justification as to why your scheduling methodology minimizes the cycle time.* Assume that all the orders for the week arrive at the beginning of the week. All products must be produced before the end of the week (that is, makespan must be less than the available working time in a week). *I encourage you to use a simulation software such as ProModel for the scheduling*.

Table 1. Historical Demand

History Horizon	product 1	product 2	product 3	product 4	product 5
1	140	145	100	18	55
2	155	164	82	22	46
3	145	178	70	25	58
4	152	200	55	27	37
5	155	215	110	32	32
6	145	205	85	35	48
7	147	170	74	39	67
8	135	142	62	41	68
9	137	119	115	43	52
10	140	147	88	47	42
11	120	162	78	53	32
12	150	180	67	55	43
13	161	199	121	58	37
14	143	220	93	60	61
15	149	208	84	64	45
16	140	175	71	66	48
17	142	140	128	69	53
18	157	121	99	72	38
19	148	146	89	75	57
20	144	160	77	79	40
MAD Tolerance	**10**	**10**	**10**	**10**	**10**

Table 2. Bill of Materials

Product 1
- Sub-Product 4
- Sub-Product 1(3 required)

Product 2
- Sub-Product 4
- Sub-Product 3 (2 required)
  - Sub-Product 4 (4 required)

Product 3
- Sub-Product 1
- Sub-Product 3
  - Sub-Product 4 (4 required)

Product 4
- Sub-Product 4
- Sub-Product 2
  - Sub-Product 1 (5 required)

Product 5
- Sub-Product 1
- Sub-Product 2
  - Sub-Product 1 (5 required)

Table 3(a). Cost Information of Products

	Product 1	Product 2	Product 3	Product 4	Product 5
Regular Cost ($/unit)	100	80	25	150	200
Holding ($/unit/week)	15	12	11.5	20	18.5
Backorder ($/unit/week)	25	18	10	50	75

Undertime cost is $2/min
Hiring cost is $12,000/person
Layoff cost is $25,000/person
No overtime or subcontracting allowed
Beginning inventory is zero
Regular production units per worker is 30.
Initial Workforce is 10 workers

Table 3(b). Cost Information of Sub-Products

	Sub-Product 1	Sub-Product 2	Sub-Product 3	Sub-Product 4
Regular Cost ($/unit)	7	25	22	12

Undertime cost $2/min
Buy machine cost $4,500/machine
Resale machine cost $2,250/machine

No overtime or subcontracting allowed

Holding cost based on ending inventory

Table 4. Routings

Sub-Product Type	Route
1	1, 2, 3, 4, 5, 6, 7
2	1, 5, 4, 3, 2, 6, 5
3	7, 3, 5, 2, 1
4	4, 2, 7, 5, 6

Table 5. Number of Machines

Station	Number of Machines
1	10
2	20
3	10
4	15
5	15
6	20
7	5

Table 6. Processing Times (minutes per unit)

Station	Sub-Product 1	Sub-Product 2	Sub-Product 3	Sub-Product 4
1	20	19	13	0
2	9	22	18	8
3	14	18	21	0
4	21	7	0	12
5	15	15	16	16
6	11	11	0	15
7	18	0	3	10

Table 7. Setup Times (minutes per lot)

Station	Sub-Product 1	Sub-Product 2	Sub-Product 3	Sub-Product 4
1	200	190	80	0
2	130	215	160	130
3	210	85	65	0
4	95	155	0	60
5	70	125	120	75
6	110	75	0	125
7	150	0	125	270

Table 8. Downtime (minutes per machine)

Work Center	Time Between Failures	Repair Time
1	240	25
2	240	25
3	180	30
4	180	20
5	180	25
6	240	15
7	240	25

Appendix. MRP records

Sub-product 3	Period				
	21	22	23	24	25
Gross requirements					
Scheduled receipt					
PAB / 200					
Net requirements					
Planned order receipt					
Planned order release					
Q=Fixed 2 periods; LT=1; SS=25					

Sub-product 1	Period				
	21	22	23	24	25
Gross requirements					
Scheduled receipt					
PAB / 450					
Net requirements					
Planned order receipt					
Planned order release					
Q=1000; LT=1; SS=100					

Sub-product 2	Period				
	21	22	23	24	25
Gross requirements					
Scheduled receipt					
PAB / 150					
Net requirements					
Planned order receipt					
Planned order release					
Q=200; LT=0; SS=0					

Sub-product 4	Period				
	21	22	23	24	25
Gross requirements					
Scheduled receipt					
PAB / 650					
Net requirements					
Planned order receipt					
Planned order release					
Q=L4L; LT=1; SS=50					

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Write the REPORT USING APA 7 format

I recommend using the following format while writing your report

Section	Topic	Comments
	Executive Summary	Limit to 300 words
1.0	Introduction - Background - Problem Statement - Objective	Answer the Who, what, when, why
2.0	Methods & Procedures	
	Overall general plan and then specifics for - Forecasting, - Planning - Materials Requirement Planning - Capacity Planning - Simulation and Scheduling	This is very similar to instructions. In this section explain, the process that you will follow to obtain the results (based on the results) Provide the procedure - What is it? - If specific tool is to be used, why is it useful? (Think about your objective) - How do you use it? - How do you apply it? **You should not state any results in this section**.
3.0	Results	Present the result here - What did you learn from applying the procedure stated in section 2
4.0	Conclusions and recommendations	**State the main conclusions from your analysis**, and provide recommendations based on your analysis.
	References	**Ensure that they are cited in the main report**
	Appendices: A - Z	**Ensure that they are cited in the main report** Examples: Raw Data, Excel files, simulation model development, Weekly Journal

Tables and Figures
- Use same font size as main text
- Table legends and figure legends go above the body of the table and are left aligned
- All tables and figures need to be referred in the main text

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Weekly Journal Format <mark>(limit to 1 page per week)</mark>

Week_____   date: _____

1. Goals for this week (beginning of the week)

2. Responsibility Matrix

Task	Responsibility	Date Allocated	Due date	Completed (Y/N)	completion date (If late)	Signature

Comments

3. Goals achieved this week (end of the week)

To do:

1.

2.

3.

4.

5.