

IE375 Fall 2020 Assignment: Case 2
Due: November 24, Tuesday, Strict due time: 23:00

Information on the Assigned Cases:

- 1) Each Case is 10%.
- 2) Each Case will be worked with groups of 2 students. If you prefer, you can solve your case alone, but it is not recommended.
- 3) Case 1 is an assignment for only section 01. Hence you cannot have groups of students who are coming from different sections.
- 4) Case requires a lot of computations. Hence, you need to be efficient in computations. Sometimes, a similar computation is required to be utilized for different parts – you are strongly encouraged to use a spreadsheet or a computer program for computations. Please report the program code and all the formulas you have used. DO NOT simply submit the output.
- 5) Make sure that you review course material before you start. Cite sources used if any.
- 6) Make sure that you present your results in such a way that you show your understanding of the solution approach as well as the solution. Your report should reflect your knowledge and ideas so that somebody else (your peers, your superiors) can understand and work on it for further needs.

Academic Dishonesty (taken from IE375 Course Information): You are not allowed to communicate with other groups, but instead you can contact the TA for your questions. The communication among the group members is essential and expected for the success of the outcome. Any violation of the above understanding will result in measures outlined in the student rules and regulations.

Submission Information: Please send your solution as a pdf file to Izzet Egemen Elver (egemen.elver@bilkent.edu.tr)

What is expected? How to study?

To answer the questions, make sure that you understand the course materials as well as the reading materials from the textbook. Make sure that you understand each case question and present your answers clearly. Questions are numeric and hence you have chances of making computational errors. To avoid the possibility of receiving no partial grade, present all the formulas you are using and explain how you are proceeding with computations. If you use a computer code for your computations, report the code and explain how you are implementing the formulas clearly. Make sure that you present your findings clearly and neatly.

Grading

Grading will follow the following weights:

- Part A:** Production Planning 30%
- Part B:** Material Ordering Policy 40%
- Part C:** Automation of Production 30%

Coco's Toys

Coco Toys Company is in Orlando with single headquarter and has been serving different customers all around the US since 1985. It has a single manufacturing plant with two stock houses, one for the raw material storage and one for storing the finished products. CT is producing three different kind of toys: cars, dolls and legos. The material CT uses to produce its toys are plastic and metal screws. Manufacturing process consists of two operations: shaping and assembly. Plastic is used for shaping and metal screws are used for assembly. After the production is finished the painting operations starts with special paints that are not harmful for child health. The monthly demand rate for each toy is assumed to be deterministic and given as follows:

Toy	Monthly Demand (units)
Car	6000
Doll	5500
Lego	3600

Part A: Production Planning

Coco's Toys has 90 workers. 40 workers are working in shaping operations, 30 workers are working in assembly operations and 20 workers are working in painting operations. Regular working time is 8 hours for each worker and assume there are 20 working days in a month. CT is comfortable with asking its workers to work overtime but must pay overtime fee, also there is a legal limitation on overtime working hours which is at most 5 hours per worker per month. Assume that in overtime hours, each worker can perform each operation. Since CT is extremely strict about the quality of its products, it does not allow subcontracting and wants to produce all the demand in the house on time (no backorders are allowed). For the holding cost, 2% monthly interest rate is applied to the cost of producing one unit of a toy in a regular working hour. CT's production planning team has provided you with the following information about operation times and costs.

Toy	Required Shaping Time (hours)	Required Assembly time (hours)	Required Painting time (hours)	Cost of producing one unit in regular time	Cost of producing one unit in overtime
Car	0.5	0.4	0.3	7	9.1
Doll	0.4	0.4	0.2	5	6.5
Lego	0.3	-	0.1	3	3.9

I) Formulate an Aggregate Production Plan for 12 months as an LP for Coco's Toys if the aim is to minimize total cost without any backorders. (Assume starting and ending inventory level is zero)

II) What is the allowable percentage of increase in demand such that the available workforce can still satisfy the demand without subcontracting?

Part B: Material Ordering Policy

Since offshoring is more economical, CT has an agreement with three different suppliers from China to get the required materials for its toys. As a drawback, the lead times of the raw materials are approximated to be 6 weeks for each supplier (assume 48 weeks in a year). According to the contract with the suppliers you are given the following data.

	Fixed Ordering Cost (\$)	Unit Cost (\$)	Holding Cost (\$ per year)
Supplier 1 (Plastic)	10000	20 (per kg)	2.3 (per kg)
Supplier 2 (Metal)	12500	30 (per box)	3.4 (per box)
Supplier 3 (Paint)	13000	15 (per kg)	1.6 (per kg)

According to production department, the required amount of raw materials for each toy are as follows:

	Required Plastic/Unit (kg)	Required Metal Screw/ Unit (box)	Required Paint/ Unit (kg)
Car	0.8	0.3	0.06
Doll	0.7	0.25	0.05
Lego	0.5	-	0.03

I) As a company policy, CT chooses to give orders only at the beginning of the months so that coordination among items will be possible. Taking the base time as 1 month, apply Powers-of-Two policy and calculate average total cost for each material for each of the following cycle times -1 month, 2 months, 4 months, 8 months, and 16 months. Determine the optimal cycle length and the reorder point for each of the materials.

II) If there is another supplier which will be able to supply all the ordered materials in a single delivery in 3 weeks with \$30000 fixed ordering cost and 25, 32, 18 units costs for plastic, metal and paint respectively, calculate the optimal cycle length (cycle length is continuous not powers-of-two as there is no need for further coordination with a single supplier) and the associated average total cost (holding cost rate is the same). Compared to the results you found in Part I, do you think it is better to make an agreement with this supplier?

Part C: Automation of Production

Coco's Toys has realized that overtime is needed because the workforce is not adequate to satisfy all the demand in regular time. So, the company has decided to automize some part of its production and leased a new machine for \$50000/year including purchase and maintenance cost. The machine will carry out all shaping, assembly, and painting operations. There will still be workers to satisfy the remaining part of the demand and some workers will be devoted to the machine.

CT is planning to use a rotational cycle policy so there will be only one production run for each toy in every cycle. Setup costs are proportional to the setup time and approximated to be \$120/hour. Assume that the machine will work for 2400 hours in a year. In the following table, you are given relevant data about the production details of the machine.

	Annual Production Rate	Setup Time (hours)	Unit Cost (\$)
Car	100000	2.4	11
Doll	100000	3.2	8
Lego	200000	1.5	5

- I)** According to the annual production rate of the machine, at most what proportion of the demand can be satisfied from the machine? (The proportion must be same for each toy.)
- II)** If CT wants the machine to be used for only for half of the total demand, calculate the optimal cycle length and the lot sizes.
- III)** According to the values you found in Part II, calculate the associated setup and holding cost.
- IV)** Calculate the uptime and determine the proportion of the time that the machine is idle.
- V)** There will be 6 workers devoted to the machine and they will be working all the time that the machine is up. If for those workers CT will pay \$10/hour, calculate the total cost of production with the machine.