IEOR 240: Optimization Analytics

Case Study 1

Due: 11:59PM, October 18 (Tuesday), 2022

1 General

The task is to formulate and solve, as a linear program, the Case: Calgary Desk Company".

2 Report

- The report should contain sections on formulation, solution and discussion.
- In your formulation, please define all variables clearly, state the units that you use, and justify briefly all constraints and the objective function. Make reasonable assumptions wherever necessary, but be sure to state them clearly and show the justifications.
- After solving the problem, present the optimal solution clearly in non-technical terms. It is advisable to use tables, summaries and graphs when applicable. It should be presented in a way that is understandable to management personnel that have no training in Operations Research. The output from AMPL should be included in an appendix with brief explanations.
- Do a few sensitivity analysis for parameters in the problem. The sensitivity analysis should contain different types of parameters. Justify why is interesting from a management point of view to perform those analysis for the parameters you have chosen.

3 Group

For the case study and report you can work in teams of up to **five** students that could belong for different class sections. All reports will be graded with the same level of rigorousness independently of the number of students in the group. Each member of a team is required to understand every part of the project, but all team members will receive the same grade.

4 Submission

Each team should submit **one** report on bcourses by 11:59PM, October 18 (Tuesday). No late submission will be allowed. As a suggestion, you may submit the report at least half an hour before the deadline. You can also update your report after the first submission.

CASE 1: Calgary Desk Company

It is August and the Calgary Desk Company (CALDESCO) of Calgary, Alberta, is about to plan the production schedule for its entire line of desks for September. CALDESCO is a well-established manufacturer. Due to an internal policy of production quotas (which will be detailed later), it has been able to sell all desks manufactured in a particular month. This, in turn, has given the company reliable estimates of the unit profit contributed by each desk model and style.

The Desks

CALDESCO manufactures a student size desk (24 in. × 42 in.), a standard size desk (30 in. × 60 in.), and an executive size desk (42 in. × 72 in.) in each of the three lines: (1) economy, (2) basic pine, and (3) hand-crafted pine.

The economy line uses aluminum for the drawers and base and a simulated pine-laminated 1-inch particle board top. Although the basic pine desk use 1½-inch pine sheets instead of particle board, they are manufactured on the same production line as the tops of the economy line models. Because its drawers and base are made of wood, however, a different production line is required for this process.

Hand-crafted desks have solid pine tops that are constructed by craftsmen independent of any production line. This desk line uses the same drawers and base (and hence the same production line for this process) as the basic pine desk line. Hand-crafted desks are assembled and refinished by hand.

Production

Production Line 1 is used to manufacture the aluminum drawers and base for the economy models; production line 2 is used to manufacture the tops for the economy and basic models. There are two production lines 3, which are used to manufacture drawers and bases for the basic and hand-crafted lines. (Two lines are necessary to meet production targets.)

The production times available on the three production lines are summarized on the Excel spreadsheet below. The time requirements (in minutes) per desk for the three different types of production lines, the finishing and assembly times, and the time required to hand-craft certain models are also summarized on the spreadsheet.

Labor

CALDESCO currently employs a workforce of 30 craftsmen, but due to vacations, illnesses, etc., CALDESCO expects to have only an an average of 80% of its craftsmen available throughout the month. Each available craftsman works 160 hours per month. The expected total labor availability, which is also given on the spreadsheet is:

(.80) * (30 craftsmen) * (160 hours/craftsmen) * (60 minutes/hour) = 230,400 worker-minutes.

Each craftsman in CALDESCO's shop is capable of doing all the tasks required to make any model desk; including running of the manufacturing lines, assembling the product, or performing the detailed operations necessary to produce the hand-crafted models.

Two craftsmen are required for each production line, but only a single craftsman is needed for hand crafting and for assembly and finishing. Thus the total amount of man-minutes required to produce a desk = 2 × (the total production line time) + (hand crafting time) + (assembly/finishing time).

Materials Requirements

As detailed earlier, the economy desks use aluminum and laminated particle board, whereas the basic and hand-crafted models use real pine. The amounts of aluminum, particle board, and 1½-inch thick pine sheets (in square feet) required to produce each style of desk are summarized on the spreadsheet along with the September availability of aluminum, particle board, and pine sheets.

Company Policy/Quotas

CALDESCO has been able to sell all the desks it produces and to maintain its profit margins in part by adhering to a set of in-house quotas. These maximum and minimum quotas for desk production are given on the spreadsheet.

CALDESCO will meet all outstanding orders for September. These are also summarized on the spreadsheet.

Profit Contribution

The unit profits, which have been determined for each style of desk, are also summarized on the spreadsheet.

The Report

Prepare a report recommending a production schedule to CALDESCO for September. In your report, analyze your results, detail the amount of each resource needed if your recommendation is implemented, and discuss any real-life factors that might be considered that have not been addressed in this problem summary nor listed on the spreadsheet. Include some appropriate "what-if" analyses. Your report should give a complete description/analysis of your final recommendation complete with tables, charts, graphs, etc. The complete model and the computer printouts are to be included in appendices.

	A	B	C	D	E	F	G	H	I	J	K	L
1	CALDESCO--SEPTEMBER											
2												
3	PROFIT, ORDERS, MATERIALS (SQ.FT.), PRODUCTION TIME (MIN) PER DESK											
4												
5	LINE	SIZE	PROFIT	SEPT. ORDERS	ALUMINUM	PARTICLE BOARD	PINE SHEETS	LINE 1 TIME	LINE 2 TIME	LINE 3 TIME	ASSEM./ FINISHING	HAND-CRAFTING
6	ECONOMY	STUDENT	20	750	14	8		1.5	1		10	
7		STANDARD	30	1500	24	15		2.0	1		11	
8		EXECUTIVE	40	100	30	24		2.5	1		12	
9	BASIC	STUDENT	50	400			22		1	3	15	
10		STANDARD	80	1500			40		1	4	18	
11		EXECUTIVE	125	100			55		1	5	20	
12	HAND-	STUDENT	100	25			25			3	20	50
13	CRAFTED	STANDARD	250	150			45			4	25	60
14		EXECUTIVE	325	50			60			5	30	70
15												
16												
17	RESOURCE AVAILABILITY FOR SEPTEMBER											
18												
19	LABOR(MAN-MINUTES)			230400								
20	ALUMINUM (SQ.FT.)			65000								
21	PARTICLE BOARD(SQ.FT.)			60000								
22	PINE SHEETS(SQ.FT.)			175000								
23	PRODUCTION LINE 1 (MIN.)			9600								
24	PRODUCTION LINE 2 (MIN.)			9600								
25	PRODUCTION LINE 3 (MIN.)			19200								
26												
27	PRODUCTION QUOTAS (OF TOTAL PRODUCTION)											
28												
29		MIN %	MAX %									
30	ECONOMY	20	50									
31	BASIC	40	60									
32	HAND-CR.	10	20									
33	STUDENT	20	35									
34	STANDARD	40	70									
35	EXECUTIVE	5	15									