# IEOR 240: Optimization Analytics

Case Study 1

**Due: 11:59PM, October 20, 2023**

## 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 software 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 four to six 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 20. 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.

在问题阐述部分，请清晰地定义所有变量，明确指出使用的单位，并简要说明所有约束条件和目标函数的合理性。在必要时可以进行合理的假设，但务必明确陈述并展示理由。

在解决问题后，以非技术性的术语清晰地呈现最优解决方案。建议在适用时使用表格、摘要和图表。应以一种容易理解的方式呈现，适用于没有运筹学培训的管理人员。软件生成的输出应包含在附录中，并附有简要解释。

针对问题中的参数进行一些敏感性分析。敏感性分析应包括不同类型的参数。解释为什么从管理的角度来看执行这些参数的分析是有趣的，以及您选择的参数进行分析的理由。

# 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.

# 案例1:卡尔加里办公桌公司

现在是八月，卡尔加里的卡尔加里办公桌公司(ICALDESCO)。由于生产配额的内部政策(将在稍后详细说明)，CALDESCO是一家成熟的制造商。它已经能够销售在特定月份生产的所有办公桌，这反过来又使公司对每种办公桌型号和风格所贡献的单位利润有了可靠的估计

## 课桌

CALDESCO生产学生尺寸的书桌(24英寸× 42英寸)。x60英寸)，以及一个行政尺寸的桌子(42英寸。× 72英寸)，每一种都有:(1)经济舱。(2)基本松木，(3)手工松木。

经济线的抽屉和底座使用铝材，并使用模拟松木层压的i英寸刨花板顶部，虽然基本款松木办公桌使用1%英寸的松木片代替刨花板，但它们与经济线型号的顶部在同一条生产线上生产。不过，因为它的抽屉和底座都是用木头做的，所以这道工序需要不同的生产线。

手工制作的桌子有坚实的松木台面，由独立于任何生产线的工匠建造。这条桌线使用了与基本的松木桌线相同的抽屉和底座(因此在这个过程中使用了相同的生产线)。手工制作的桌子是手工组装和修补的

## 生产

1号生产线用于生产经济型车型的铝制抽屉和底座;2号生产线用于生产经济型和基础型的顶部。3号生产线2条，用于生产基础款和手工款的抽屉和底座(满足生产指标需要2条生产线)

三条生产线的可用生产时间汇总在下面的Excel电子表格中。三种不同类型生产线的每台时间要求(以分钟为单位)，精加工和装配时间，以及手工制作某些型号所需的时间也总结在电子表格上。

## 劳动

CALDESCO目前雇用了30名工匠，但由于假期，疾病等原因，CALDESCO预计整个月平均只有80%的工匠可用。每个可用的工匠每月工作160个小时。预期的总劳动力可用性，也在电子表格中给出

I 80)(30个工匠)。1160 hourseraftsmen)。(60分钟/小时= 230400工人分钟

CALDESCOs车间的每个工匠都能够完成制作任何模型桌所需的所有任务，包括生产线的运行;组装产品或执行生产手工制作模型所需的详细操作

每条生产线需要两名工匠，但手工制作和组装整理只需要一名工匠，因此生产一张桌子所需的总人工分钟数为2 ×(生产线总时间)+(手工制作时间)+(组装/整理时间)。

## 材料的要求

如前所述，经济型办公桌使用铝材和层压刨花板，而基本型和手工制作的型号则使用真正的松木。生产每种类型的桌子所需的铝、刨花板和1%2英寸厚松木板(以平方英尺为单位)的数量，连同9月份铝的可用性，都汇总在电子表格中。刨花板和松木板

## 公司政策/配额

CALDESCO能够销售其生产的所有办公桌，并通过坚持一套内部配额来维持其利润率。这些办公桌生产的最高和最低配额都列在电子表格上

CALDESCO将满足9月份所有未完成的订单的误码率。这些也总结在电子表格上

## 利润贡献

每一款办公桌的单位利润也被汇总在电子表格上

## 这份报告

准备一份报告，向CALDESCO推荐9月份的生产计划。在你的报告中。分析你的结果，详细说明如果你的建议被实施，每种资源所需的数量，并讨论任何可能被认为没有在这个问题摘要中解决的现实因素，也没有在电子表格中列出。包括一些适当的“假设”分析。你的报告应该对你的最终推荐给出一个完整的描述/分析，包括表格、图表、图形等。完整的模型和计算机打印结果应包括在附录中。

| | 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 | | | | | | | | | |