12.3 Factory planning 1

An engineering factory makes seven products (PROD 1 to PROD 7) on the following machines: four grinders, two vertical drills, three horizontal drills, one borer and one planer. Each product yields a certain contribution to profit (defined as £/unit selling price minus cost of raw materials). These quantities (in £/unit) together with the unit production times (hours) required on each process are given below. A dash indicates that a product does not require a process.

	PROD 1	PROD 2	PROD 3	PROD 4	PROD 5	PROD 6	PROD 7
Contribution to profit	10	6	8	4	11	9	3
Grinding	0.5	0.7	-	-	0.3	0.2	0.5
Vertical drilling	0.1	0.2	-	0.3	-	0.6	-
Horizontal drilling	0.2	-	0.8	-	-	-	0.6
Boring	0.05	0.03	-	0.07	0.1	-	0.08
Planing	-	-	0.01	-	0.05	-	0.05

In the present month (January) and the five subsequent months, certain machines will be down for maintenance. These machines will be as follows:

January	1 Grinder
February	2 Horizontal drills
March	1 Borer
April	1 Vertical drill
May	1 Grinder and 1 Vertical drill
June	1 Planer and 1 Horizontal drill

There are marketing limitations on each product in each month. These are given in the following table:

	1	2	3	4	5	6	7
January	500	1000	300	300	800	200	100
February	600	500	200	0	400	300	150
March	300	600	0	0	500	400	100
April	200	300	400	500	200	0	100
May	0	100	500	100	1000	300	0
June	500	500	100	300	1100	500	60

It is possible to store up to 100 of each product at a time at a cost of £0.5 per unit per month. There are no stocks at present, but it is desired to have a stock of 50 of each type of product at the end of June.

The factory works a six days a week with two shifts of 8 h each day.

No sequencing problems need to be considered.

When and what should the factory make in order to maximise the total profit? Recommend any price increases and the value of acquiring any new machines.

N.B. It may be assumed that each month consists of only 24 working days.

This problem, and the subsequent problem, is based on a larger model built for the Cornish engineering company of Holman Brothers (which no longer exists).

12.4 Factory planning 2

Instead of stipulating when each machine is down for maintenance in the factory planning problem, it is desired to find the best month for each machine to be down.

Each machine must be down for maintenance in one month of the six apart from the grinding machines, only two of which need be down in any six months.

Extend the model to allow it to make these extra decisions. How much is the extra flexibility of allowing down times to be chosen worth?

From H. P. Williams, "Model Building in Mathematical Programming",
Wiley, 5th edition, 2013