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LOUISE MAYNARD-ATEM

I recently had the pleasure of meeting Max Moullin, director of the Public Sector Scorecard Research Centre, and he gave me a great idea for a series of articles entitled 'My First Project', where people are various stages of the O.R. career talk about the first pieces of work they did on entering the field.

I've talked at length about my experiences thus far in government so now I'd like to hand the floor over to you. Tell me in your own words about your first project: who were you working for and when; what was the problem; how did you solve it; was it successful and; would you approach it the same way today?

Please send your responses to me by email (LMaynardAtem@live.co.uk) and include a recent photo that I can print alongside the article.

I've managed to convince our fine editor to be my guniea-pig for this piece (thanks John and apologies for the very short notice), and I think you'll find it's a great insight into how linear programming can be used in a practical setting, as well as some of the limitations that have been overcome in order to advance the field of O.R.

My First Project – John Crocker

The situation was that the old Scunthorpe Richard Thomas and Baldwins iron works, locally known as Redbourn, was capable of generating a significant proportion of its electricity needs. What it could not make, it bought in from the grid through the Central Electricity Generating Board (CEGB) and when it made too much, it was able to sell the surplus back to the CEGB. The prices were dependent on the time of day – each day was divided into five zones, each charged at a different rate.

The plant needed a certain amount of low pressure (LP) steam to operate some of the machinery, however, it was more practical to produce medium and high pressure (MP and HP) steam produced by boilers burning oil, coke oven (CO) gas or a mixture of CO and blast furnace (BF) gas. Changing from gas to oil was a messy and unpleasant job but oil was expensive whilst the gas was by-products of the processes to convert iron ore into pig iron. There was a 'waste heat' boiler but this was really more trouble than it was worth.

Water used to make the steam needs to be as pure as is reasonably practical. In fact, most of the water used is recycled as 'condensate' and, as it turned out, was often the limiting factor in terms of how much steam and hence electricity could be generated. The steam from the HP boilers was passed through one of the two HP turbines and then mixed with the MP steam to pass through one of the three MP turbines coming out at around the required pressure for use on the plant. The equipment was quite efficient although it had probably been in use for several decades.

The primary task was to determine how much electricity should be generated at any given time. The secondary task was to produce a timetable of when to switch the boilers over from gas to oil and when to add BF gas.

The method that had been chosen by one of my predecessors was linear programming. Strictly speaking, it should have been non-linear programming as several of the relationships were of a non-linear nature however, it had been decided that over the range we were interested in, these could be approximated by piece-wise linear expressions. In order to describe this scenario, over seventy [linear] equations and constraints were required.

Today this would be regarded as a rather trivial problem. Once set up, it would be a simple matter of entering the constants into a package such as LINDO and waiting at most a few seconds for the results. In 1970, the only computer available was a Honeywell 200 which had a massive 8K of memory. There were also no software packages available at this time so the model had to be written in FORTRAN – the only 'high' level language for which we had a compiler. The memory constraint meant that the largest array that could be fitted into the machine leaving sufficient available to actually perform some elementary row and column operations was 18 by 20. Unfortunately, it is not generally possible to solve a 70 by 70 LP by solving sixteen 18 by 18 LPs so the first thing that had to be done was to create a whole new set of [18] variables which were extremely clever combinations of the original 70. Fortunately, my predecessor had done this and had, in fact, got the program working. It took less than a day to compile and less than a week to run and collate the results.

My first task was to maintain and run this model as required (generally whenever there was a significant change in the price of oil and/or electricity). I had hoped to run the original on our new ICL 1904 but external factors caused the problem to go away. Incidentally, that was the only time in over 40 years as an O.R. practitioner that I got involved professionally in linear programming. This was also by no means the only time that I got given the task of taking over someone else's project.

Problem Page

Thank you to all of those who've sent in responses to last month's problem page, and thank you for your feedback, apparently puzzle #2 was slightly more challenging than the first, which was my intention. I look forward to reading your solutions this month, let me know if you find it easier or more difficult. As usual, answers in an email (LMaynardAtem@live.co.uk) with your workings included and best of luck!

Puzzle #3 – Choose Your Crew

	Skills			
Name	Fishing	Sailing	Navigation	Salary
Amy	2	5	4	$1,000
Bill	1	1	2	$1,100
Carl	1	4	3	$800
Dan	5	2	2	$1,300
Eva	4	1	1	$1,300
Fred	3	2	5	$1,400
Greg	1	3	4	$1,400
Henry	3	1	3	$1,000
Ida	4	2	4	$700

Table 1

Successfully navigating the waters during sea voyages is a challenging task. A captain's most important decision is selecting the right crew for the voyage. A mix of different skill sets is required to sail the ship efficiently, navigate to the destination, and fish for food along the way.

Table 1 shows a list of crew members that are available for you to hire for the voyage. Each crew member demands a salary for the voyage and has different skill levels of Fishing, Sailing, and Navigation.

In order for your journey to be successful, you must have a cumulative skill of 15 or more in each of the three skill categories from all of your chosen crew members. You may choose as many crew members as you like.

Question: What is the minimum achievable cost for the voyage?

<OR>