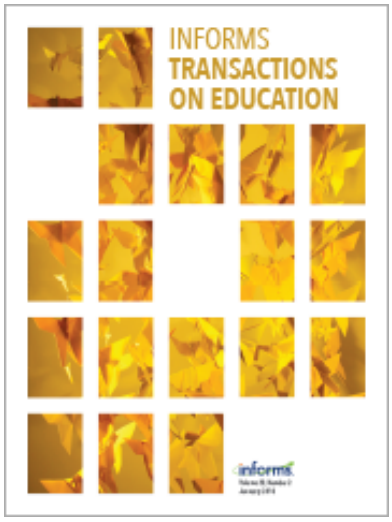

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Michael Francis Gorman

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Case

Junko's Giant Print Shop Job Assignment Problem

Michael Francis Gorman[a]

[a] Department of Management Information Systems, Operations and Analytics, University of Dayton School of Business, Dayton, Ohio 45419
Contact: michael.gorman@udayton.edu, https://orcid.org/0000-0003-1295-8147 (MFG)

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Jimmie Junko runs Junko's Giant Print Shop, which provides on-request custom print services for its customers. Although the print industry has been shrinking in recent years at a rate of more than 2% per year, as of 2021, it still comprises about $75 billion in the United States (IBIS World 2021). That contraction has challenged Jimmie to be more efficient at allocating jobs to his various presses and has confronted him with downsizing challenges. In short, it is more important than ever for Jimmie to be efficient with how he assigns jobs to presses.

Jimmie has a wide range of printing capabilities, but his most challenging line is the traditional paper printing lines that have seen the greatest decline because of the internet. He must be efficient in assigning these jobs to keep his costs down in this extremely competitive market that has considerable overcapacity. Because of the market shrinkage, he is also regularly challenged to downsize at the appropriate time and method: too fast, he may lose work; too slow, and he ends up paying for costly presses that sit idle. He is also faced with union contracts that provide a fixed-week work schedule for each employee (current wage of $40 per hour). Seeing that the industry is in some disarray, the union has become more flexible and open to creatively structuring revised contracts to allow Junko's to stay in business.

One group of presses are particularly challenging for Jimmie to schedule. He has five different industrial-speed presses (for simplicity, named A–E). Each press is slightly different in its specifications, so each one has different costs and time requirements for each print job. In Jimmie's world, there are many attributes of each job, such as the color of ink; the number of colors; one- or two-side printing; and the paper size, thickness, material, finish, and quality that all affect the cost and time of the press required for a print job.

But the most important element to both cost and time of the print job is the number of pages in the customer order or the job size. The runtime (and cost) for a job is the period of time (and cost) that is largely a function of the number of pages. The more printed surfaces, the longer it takes and the higher its paper, ink, and other costs. It is not an exact science on how long a job runs; it varies depending on all of these factors and others, such as paper restocking, unplanned outages, and the like.

Junko's receives orders on an ongoing basis from its customers. At any given time, there is usually a number of jobs ready to print. The marketing team works with Jimmie to prioritize jobs in terms of their due date. Once the jobs for the week are decided, he plans his presses on a weekly basis; each Friday, he takes the chosen jobs and plans how each printer can get them finished for the least cost. Though on-time delivery is an issue, his role is to get as many jobs through the presses as he can to stay ahead of demand. The sequence of the jobs or on which printer they go is not as important as getting them all done each week.

Jimmie's information technology system collects the total pages and time for all jobs. There is a costing system in place at Junko's that applies many rules of thumb from the accounting department to arrive at total press cost for a job (excluding wages). The costs include paper, ink, energy, equipment wear and tear, and paper waste.

For each order, Jimmie must set up the press. Setup includes getting the press ready by stocking the appropriate paper type, ink color, etc. This occurs for all jobs and requires the same effort regardless of how big the job is; it is a fixed cost for each job. Setup is costly because it requires union labor to conduct, and when a press is being set up, it is not producing revenue. In most cases, setup is so expensive that any job is only assigned to a single press to avoid multiple setups and paying that cost twice. It is bad for both cost and capacity to "split" a job.

This challenge is rather common in many production lines with setup and runtime, which occurs in many industries. The big difference from the other industries is that Jimmie does not determine how many pages are in a job. Although soup or autos are produced to stock (or inventory), and thus, the number of flavors or colors is flexible for any single run, Jimmie offers a make-to-order service—that is, he produces specifically the number of pages the customer orders. In order to be competitive and customer friendly, he allows his customers to adjust their order size right up to the time when he starts production. (Usually, the change is within plus or minus 10% of the original order).

These conditions have led to a number of headaches for Jimmie, and he wants your help.

First, he wants to understand cost and time relationship to job size. He wants an estimate of how long a job will take and what it will cost to provide good customer service and earn a reasonable margin. As discussed, there is some uncertainty in both because of varying setup and run times.

Second, Jimmie wants to understand how to best assign print jobs to presses. There are time requirements, capacity conditions (determined by union contracts), and cost considerations. Given a set of jobs, what is the best way to utilize his print capacity and reduce costs?

Third, Jimmie wants to assess the profit and customer service risks of the job assignment plan. Even when he thinks he has a good plan for putting jobs on presses, sometimes he has cost overruns or falls short on capacity because jobs run long, and some must fall into the subsequent week. He wants to evaluate the profit and capacity risk associated with any given plan for putting jobs on his presses so that he knows his plan is profitable and feasible.

Fourth, Jimmie wants to evaluate the sensitivity of a plan to uncertainty. He is wondering if his plan would change if he had more exact run time and cost estimates or if he could better know the eventual job size when making a plan. Because he has so much uncertainty in machine characteristics and job sizes, he is wondering if planning is worthwhile at all. In short, garbage in, garbage out; any plan based on uncertain data might be suspect itself! He wants to know if, despite the uncertainties, his plan is a good one or if it would change with different job sizes or printer speeds.

He is turning to you for help.

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