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### Intelligent scheduling software, December 2001

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#### application report

## Intelligent scheduling software

Douglas James

Efficient scheduling is a key driver for profit

Many job shops have a key piece of equipment that is rarely, if ever, mentioned in Industrial Laser Solutions—it is a well-worn "white board." Allocation of customers' work to machines and time slots is scheduled here; it's well worn because it gets updated every hour or so with new information.

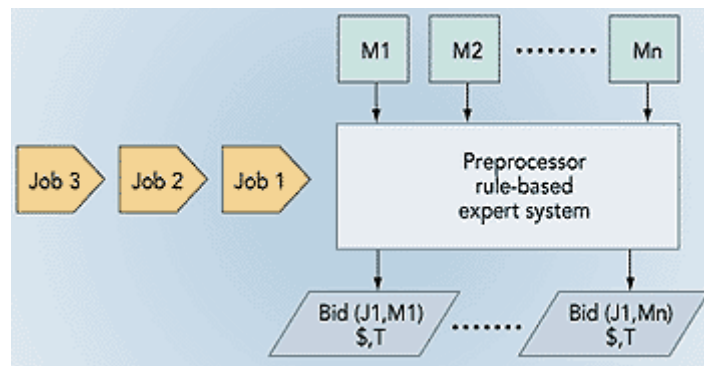
In a job shop where expensive machines use the flexibility of software tooling and high-quality rapid laser processing to allow fast turnaround, short-run jobs, scheduling is critical.

Consider the scheduling goals of a typical job shop:

- Meet due dates—keep your promises
- Minimize the average flow time (waiting time + process time) through the shop—allowing fast turnaround for quoting
- Achieve high machine utilization, or maximize output in a given time period
- Provide accurate job status information—allows you to accept additional work with due-date commitment
- Reduce setup times
- Minimize production costs

These multiple goals, coupled with a random arrival of work, ensure a high degree of complexity in organizing and optimizing operations.

You can easily estimate your current utilization by comparing actual revenue to



Jobs arrive at the shop (typically random) and are preprocessed by Juggler using a rule-based Expert System. For each job it compares job requirements (other than time-dependent data) with the attributes of each machine and generates a list of the machines that could perform this job. It also calculates the relative speed (and cost) of each machine for this particular job using a model of laser processing that takes into account material, thickness, focal spot and machine contouring speed. These bids are passed to the optimization engine together with the time-based constraints of the job.

maximum possible revenue (or use the calculator at [www.jambalaya.ca](http://www.jambalaya.ca)). Utilization can be affected by many factors. An in-house operation producing standard parts with good future requirement visibility can have a high utilization, whereas a true job shop, with a large number of customers, little forward visibility and fast turnaround service may have a utilization of less than 40 percent. Whatever your answer, it is interesting to question whether this is the best that your shop could do—the opportunity to push, say, 10 percent more work through a shop would be attractive.

### Scheduling complexity

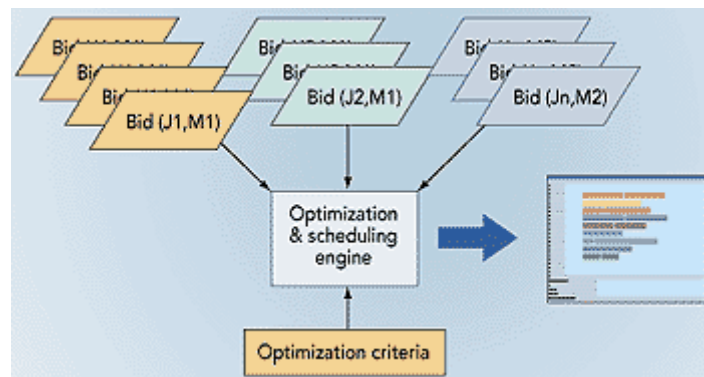
Scheduling is complex because it exhibits explosive growth as the number of jobs or machines increases.

Each job has a number of requirements or constraints—it will have an earliest start date/time, priority, due date, setup time, process duration (which may vary between machines), laser power, type of laser (CO<sub>2</sub> or Nd:YAG), pulse characteristics, beam quality, lens focal length, process gas, table dimensions and accuracy. The various machines in the shop have attributes that may or may not match a job's requirements and so, if the job can be done, it can be allocated to one of the shop's viable machines.

For a shop with two or three machines, placing a small number of jobs on the white board may not be too difficult, particularly if the shop is running well below capacity or promised due dates are long. But the profitability of the shop requires that the capacity utilization is as high as possible, and extending due dates removes one of the key attractions of laser processing—the ability to give fast turnaround.

As the number of jobs increases, finding any solution becomes increasingly difficult without the aid of specialized software; finding the optimum solution—minimizing the number of late jobs, maximizing the throughput, minimizing the cost, or minimizing the number of lens changes—requires the use of intelligent software.

The software must recognize that new jobs arrive, are processed and disappear from the schedule, machines break down and so on. So it must be able to dynamically reschedule on demand and reflect changes while finding the best solution in real time. It must operate at a process level so that it knows which machines are capable of performing the task and how long it will take on each.



**The optimization engine produces an optimum schedule from the job bids, their time-based constraints and details of the optimization goals.**

Whereas there are a number of "Enterprise Resource Planning" software packages for job shops that include scheduling as one of their modules, Juggler by Jambalaya is a dedicated decision support scheduling system specifically designed for job shops using laser processing. It recognizes process-specific elements of the jobs and machines, handles the dynamic nature of the schedule, has a built-in cost model for consumables and spare parts, allows scheduling of maintenance, and produces optimum schedules against a number of criteria, including cost, throughput and lens changes.

Juggler always looks for a solution that satisfies all due dates, and only if that is possible will it attempt to optimize for minimum production costs or maximum output,

as selected by the user. In other cases, Juggler will find the solutions that minimize lateness before attempting to optimize other parameters. Recently, optimization that minimizes the number of lens changes has been added to Juggler.

### **Benefits**

Increasing the utilization of expensive machines can translate directly into enhanced profits. Having good visibility when making promises of delivery to customers and the ability to tighten your turnaround time can assist in obtaining orders. Real-time rescheduling when machines breakdown can present you with options on how to mitigate the impact on your customers. Clear visualization of the requirements and constraints of jobs and the attributes of machines can aid rapid decisions in production meetings. In difficult economic times, it can aid by minimizing the cost of jobs, determining optimum shift structures, or allocating work to fewer machines.

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