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Can You Make an Extra $1Million in Annual Profits by Better Scheduling of Your Resources?

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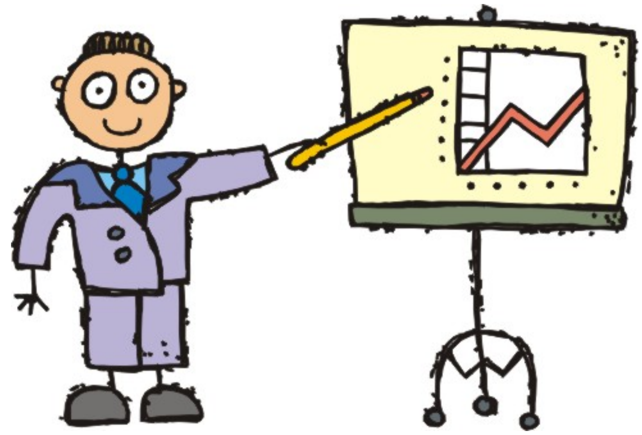
Introduction



This paper is about using available technologies such as artificial intelligence, computer–based simulation, distributed real–time computing, wireless mobile computers, barcode and RFID tracking to improve the operational efficiencies of operations such as factories, warehouses, food processors, repair depots, mineral extractors, chemical laboratories and biotechnology organizations.

If we simply stand and watch, we can observe how much time people waste waiting for other people or equipment to finish some operation or waiting for materials or some other resources to become available. We can formalize this by performing a raw capacity analysis. In this, we add–up all the time demands on classes of resources (such as types of equipment and labor classes of employees) of necessary work for customer orders over a specific time period (such as a month) and divide by the hours that the resources are available. The results are often shocking!

In one very busy, well run and hard working organization, we recently computed raw capacities of around 30%. This implies that there is a tremendous opportunity to significantly increase throughput at no increased cost for people and equipment. What are the raw capacity numbers for your operation?

It is well–recognized, in many management case–studies from the early Hawthorne experiments in industrial engineering to today's Kaisen events, that it is possible to increase performance by 10% or more by simply by paying attention to an operation and how it functions. The problem is how to sustain the gains once management is no longer focusing significant attention on the operation. Unfortunately people quickly return to their old inefficient ways unless management has a way to ensure that they maintain their new level of performance.

This paper is a about how to achieve sustainable gains in performance through the use of computer technology. It does not eliminate the need for excellence in management but rather gives managers at all levels in an organization the tools they need to ensure that their operations are running efficiently with minimum wastage of expensive resources.

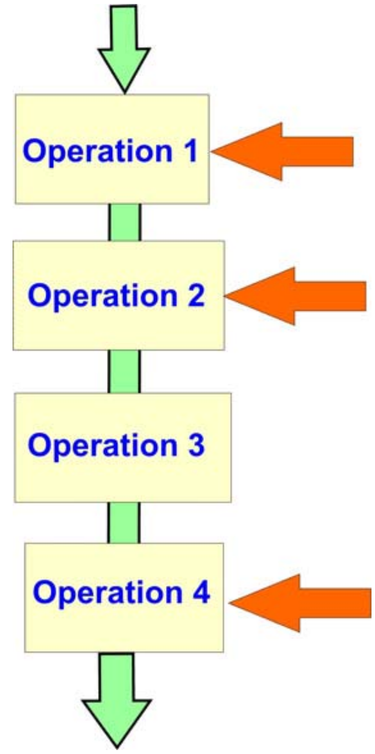
Increasing Profits

Let us consider an operation with $24 Million in annual sales and monthly operating expenses for people and equipment of $1Million (including all operating overhead). If we can achieve a sustainable improvement of 10% in the utilization of people and equipment resources then this implies that we can:

- Cut operating costs by $100,000 per month without impacting sales, or
- Increase sales by $200,000 without increasing operating costs.

Either way, this translates to over $1Million in increased pre–tax profits per year.

Management by Simulation (MBS)



At the core of the technology needed to achieve these sustainable gains is the technique of Management by Simulation (MBS). MBS starts with the current state of operations. Then it simulates how work should flow though operations, using “best practices” rules. From this it develops the data needed to schedule operations and also generates the expected results data against which people’s performance can be measured.

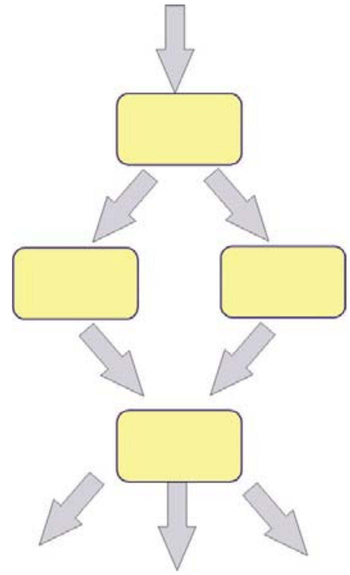
Work is broken down into specific jobs that are considered to be a sequence of steps called a route. Each step of a route may require people, equipment and material resources. Jobs are typically broken down into batches that are queued up at a work center until the people, equipment, and material resources needed to perform the job step are available. Once the resources are available, the job step takes a certain amount of time and then the job/batch is sent to the next operation.

MBS simulates the flow of jobs though the work centers specified by their routes. At each work center, there is a potential conflict for the resources needed to carry out the job step. The resolution of this conflict is performed by Artificial–Intelligence Expert–Systems rules that mimic the "best practices" decision making by human managers.

Examples of the rules–based decisions about resources may include:

- Give highest priority to rush jobs
- Give priority to those jobs closest to wanted date, taking into account the estimated time for subsequent job steps.
- Make sure that required minimum and maximum times from the last job step are met.
- Make sure that people have the required skills to perform the job step.
- Use the fastest available machine
- Make sure that the materials will be available when needed.

A MBS system, like that available from BellHawk Systems, can simulate a week or more of operations in a few minutes of computer time. In doing this it takes into account:



- Availability of people by shift, including the effects of holidays and vacations and weekends.
- Availability of equipment, including the effect of preventive maintenance.
- Availability of materials, either from planned deliveries or to be produced by other jobs.

As a result, MBS predicts:

- When jobs will be completed
- A daily schedule of activities for people and machines
- When materials will be needed
- Backlogs of work for each work center and operation
- Availability of resources that are not assigned to jobs for certain periods of time.

As the allocation of resources to jobs is based upon best–practices rules established by managers and supervisors (more on this later) the schedule produced should represent an efficient allocation of resources to get the work performed. The resultant schedule may, however, not be acceptable due to late deliveries or too great a backlog of customer orders.

With a MBS system, a manager can then play what–if games to improve the allocation of resources. Some examples include:

- Shifting working hours or the use of overtime.
- Moving people from one work–center to another. This can be done manually or by allowing the system to automatically re–allocate people from one work center to another when needed.
- Expediting the delivery of materials.
- Changing the preventive maintenance schedules on equipment.

When changes are made, then the simulation is re–run to predict the outcome of the management decisions. Note that this is very different from an optimizing scheduler in which all the resource allocation decisions are made according to an optimization algorithm (which typically use a time–slotted linear–programming algorithm). With MBS, we are simply trying to predict the outcomes of management decision making, using management's rules. This usually results in schedules that are intuitively understandable by managers, supervisors, and workers and thus more likely to be followed than some abstract schedule that may, theoretically, be more highly optimized than the schedule produced by a MBS system. More importantly, a MBS schedule may take into account the manager's general knowledge about factors such as the start of deer–hunting season that negatively impact availability of resources in certain parts of the country.

A MBS schedule can be run to produce:

- Daily detailed work schedules for people and equipment
- Weekly work schedules for people and preventive maintenance schedules for machines
- Predictions of customer delivery dates
- Required delivery dates of materials from vendors
- Long range forecasts of shipments, backlogs and material requirements based on a mix of actual customer orders and sales forecasts

MBS can be used for both short term scheduling and long–range resource planning.

When a MBS system is run, it starts with the actual current state of the operation(s) being scheduled. In this way the schedule reflects a prediction into the future from the current actual state rather than picking up from where the last schedule predicted the state would be.

This is very useful in that it enables a MBS system to be run at any time and take into account:

- Late–breaking rush jobs
- Machine breakdowns
- People calling–in sick or being injured on the job
- Changes to customer orders
- Delays in delivery of materials.

The MBS system will then generate a new schedule, taking these changes into account, which may be very different from the prior schedule.

Performance Monitoring

A schedule produced by a MBS system reflects what is achievable, using the best–practices rules built into the scheduling system, the available resources, and management's best judgment as to how to deploy these resources. It is of little use if no one follows the schedule or management is unable to judge how well people and equipment performed relative to the schedule.

It is critically important that a MBS system be used in conjunction with a job, labor, material, and machine tracking system to measure performance against the schedule. This enables management to have the controls to measure and motivate people to follow the schedule and to meet the productivity goals established by the schedule.

It is this comparison of scheduled versus actual performance that enables management to ensure that the 10% or more productivity gains achievable though improved scheduling are sustained. Without it, people will use the schedules as guidelines but will quickly slip–back to their old pace with many production employees working at the slowest pace at which they will retain their jobs.

With a comparison of a MBS schedule and actual performance a manager can quickly determine:

- Which employees are not meeting production targets and need retraining or replacing.
- Which equipment is not producing to its rated throughput.
- Which supervisors are not able to motivate their people to meet production goals.
- Key employees who consistently exceed goals and should be rewarded.

For a description of how to use technologies such as barcode tracking, RFID, and wireless mobile computing to monitor jobs, labor, materials, and equipment, please see "Materials Tracking Handbook", by Dr. Peter Green, BellHawk Systems Corporation, April 2005, available on www.BellHawk.com.

Developing the Rules

A critical part of the implementation of a MBS is the implementation of the rules. This is done by the implementation team in collaboration with the managers, supervisors, and key employees who are responsible for operations. This typically takes place in a number of stages:

1. Identification of operations that are performed and what resources are needed to carry out these operations.
2. Identification of people skills. This may be in the form of a skills–matrix that identifies what activities each employee is trained to perform and how well they can perform these activities.
3. Identification of equipment characteristics that differentiate one machine from another and also those characteristics that enable machines to be substituted for one another.
4. Identification of route steps for standard jobs, including identification of the people skills, equipment capabilities, and quantities of materials needed.
5. Establishment of standard people and equipment times needed to carry out operations. If an organization does not have good historic data, it may be necessary to run a tracking system for a few months to develop this data.
6. Development of expected lead times for materials ordering or production. This enables a MBS to use these expectations as part of its decision rules.
7. Development of rules for resource allocation. This is probably the most critical part of rules development and calls for the most discussions as there are often many special cases.
8. Development of rules for forming batches as well as for forming run groups of like jobs steps performed on a single machine at the same time.

9. Development of rules for special routings. Some of these may be statistical in nature, such as that a certain percentage of products need rework, which places an additional work burden on people and possibly equipment.

Usually the starting point is the current way things are done but it is essential to move beyond this, if true productivity gains are to be achieved. The development of the rules gives everyone an opportunity to reengineer job functions and work operations to improve efficiency. Note that all the work flow reengineering should come from within and not be externally imposed. Otherwise people feel that their jobs may be threatened and then they fail to cooperate. In my experience it is much better to let people do their own re–engineering while focusing on how to best achieve a set of rules that represents achievable best practices in work flow.

The goal is to develop a set of rules that reflect practical best practices that everyone believes are achievable. Then these will be used by MBS to set the performance standards by which everyone is measured.

Some Contentious Issues

Some of the issues that lead to much discussion are:

1. "People are power". Letting a MBS system allocate resources across departmental boundaries, in a flexible schedule scheme, may result in some managers feeling threatened.

2. How much time is really available for work? While most employees work a nominal 8 hour day they spend a significant amount of time in meetings, performing administrative and "housekeeping" duties, and in supervising other employees. The question that has to be settled is how much time in a day, such as 6 hours, is really available for work.

3. How to handle demands for rush jobs. Does a rush job requested by the company CEO have a higher priority than a rush job requested by a company sales representative?

4. Some people work slower than others. How do we set standards? Should these standards take into account quality as well as speed? What about Trainees?

Evolution of the Rules

It is unreasonable to expect that initially managers, supervisors and key employees can come up with a set of rules that is accurate, complete, and reflects best practices. Instead, it is much better to use a RISE (Rapid Incremental Systems Evolution) methodology. In this, an initial set of rules are implemented that are based on initial interviews with operations personnel. Routes and their parameters are established and then the rules are tested against real operational data.

Managers, supervisors, and lead employees review the results of the schedule produced by the MBS system and criticize it. This leads to discovering where the rules are deficient or just plain wrong. Often there are many special cases that were not discovered during the initial knowledge engineering interviews. This process is aided when:

1. The rules are written in an English–like language so that they can be read and understood by operational personnel.

2. A graphic interface is developed so that operations personnel can visualize what is happening in the work flow.

3. The rules can be quickly changed and the simulation quickly re–run to visualize the effects of the changes.

This process of test and evaluation continues until everyone agrees that the predicted schedules represent most–efficient practical schedules. Then the schedules are introduced into production and the performance predicted by the MBS system is compared with the results from a production tracking system such as BellHawk. Initially, it is to be expected that there will be significant discrepancies. Some of these will be due to errors in the rules or the established time standards. Others will require management intervention to deal with employees who are now found to be wanting in performance, equipment that does not work as advertised, and vendors who are late delivering materials.

Once the schedules generated by MBS reflect the performance achievable by production, then these are used to set the standards by which management and employees are measured. It is expected that the operations reengineering that occurs during the rules development phase will result in 10% or more improvement in operational efficiency. By comparing the performance predicted by MBS with that actually achieved, senior management can evaluate managers and supervisors and managers and supervisors can evaluate employees for performance on an ongoing basis. MBS becomes the yardstick by which acceptable performance is measured.

The rules do not become frozen once MBS moves into production. They continue to be evolved as business practices change and the demands on an organization change. Most importantly, a MBS system can be used to predict how an organization will respond to increased demands due to entering a new market segment or decreased demands due to a declining market sector. It can also be used to predict the effect of hiring new employees or buying new equipment or of a layoff or retirement of equipment.

Conclusion

Can the implementation of an MBS system add a million dollars to your bottom line? The answer depends on the nature of your operations and the level of commitment that senior management is willing to put behind the implementation. Organizations are very resistant to change and the implementation of an MBS will typically result in people having less discretionary time during the working day. Employees will have much more of their time structured by the scheduler and may be called upon to carry out a wide variety of tasks during the working day. All of this may make employees uncomfortable in embracing the new methodology but it is essential if they are to retain their jobs in the face of ferocious global competition.

With senior management behind the project, driving for a substantial improvement in bottom line profit and being willing to displace employees who cannot work under the new regime, then the gains can be very worth while. Left to low–level employees to implement, such a project is doomed to failure due to inertia and their need to retain the status quo.

These projects are not quick, painless or inexpensive to implement. Expect to spend between $100,000 and $300,000 on software, hardware, and professional services and to take six months to a year to fully implement the system. But the returns on this investment are very high, with payback times measured in a few months once the system is operational.

Author

Dr Peter Green is President and Chief Systems Architect for BellHawk Systems Corporation. He is an expert in the use of software to track, control, plan and schedule industrial operations. Dr Green holds a BSEE and a Ph.D. in Computer Science from Leeds University in England. Prior to founding BellHawk Systems, Dr. Green was a Professor of Computer Engineering at WPI and a research staff member at MIT. Dr Green has over 30 years experience leading teams in the development of systems for Government, industrial, and commercial clients including many mission–critical web–based, client–server, and distributed peer–to–peer systems.

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