

WHITEPAPER



**BLAST PAST
BOTTLENECKS WITH
CONSTRAINT BASED
SCHEDULING**

Blast Past Bottlenecks with Constraint Based Scheduling

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The maximum output of many manufacturing operations is determined primarily by their market. The company can sell only a percentage of the products that the manufacturing plant can produce. Some manufacturing operations, however, have internal limits or constraints on production that are more restrictive than market forces, and more restrictive than the maximum capacity of the rest of the plant. This may be more common in industries that face seasonality or other types of lumpy demand, where demand peaks at a certain time of year or at a certain point in a business cycle.

It is for precisely these situations that the discipline of constraint-based scheduling (CBS) was developed. As a business discipline, CBS requires a viable definition of the constraint or problem that limits production, and the development of algorithms and methodologies to maximize production given the constraint in question.

Computer applications have long been employed by production schedulers, and the complex and mathematically-driven nature of CBS means that software functionality is an almost essential tool to leverage CBS in your plant or enterprise. Specifically, CBS is a tool for discrete manufacturers who need to manage bottlenecks in their capacity in order to maximize throughputs. Oftentimes, this constraint consists of a machine tool, packaging machine or other piece of equipment that has a more limited throughput capacity than the rest of the plant. Sometimes a particular class of labor is limited in supply, forming a bottleneck in a manufacturing, engineering or assembly process. Other constraints can be work centers or availability of materials.

CBS should be of interest not only to manufacturing professionals, but sales and customer services executives as well. CBS can allow you, when taking a customer order, to give that customer a very accurate delivery date, given your constraints. Honesty and the ability to keep your promises go a long way to ensuring customer satisfaction.

In this white paper, we'll help you fully understand CBS and describe how an enterprise application like enterprise resources planning (ERP) software can deliver CBS functionality.

Who needs CBS?

Any number of manufacturers may have one part of their operations that have less immediate capacity than the rest of the plant and could benefit from CBS. The natural question to ask is why these manufacturers don't expand capacity in that area. In most cases, it makes more fiscal sense to maximize the return on an existing investment in hard assets like machine tools or soft assets like personnel than it does to make additional investments. A machine tool might cost millions of dollars and take months if not years to put in place. Additional soft resources like design engineers, skilled machinists or welders may be expensive and require long lead times of their own. After all, in any organization there may be a few individuals whose skills, due to long experience, are hard to duplicate. Because people are obviously harder to duplicate than machine tools, it might not be possible to immediately hire someone who can turn around certain tasks as quickly or as accurately as those currently on staff. In the C-suite, decisions on capital expenditures and hiring need to be made based on the growth projections for the company rather than transitory capacity needs. This is why, in many cases when resources within a plant become constraints, it makes more sense to aggressively manage the throughput than it does to increase capacity.

This means planners need to queue work accordingly to make sure a vital constrained resource is never starved. Moreover, work must be planned so that resources that come after the constrained resources in the value chain do not become overwhelmed. Through CBS, it is possible to not only maximize a constrained resource, but to reduce work-in-progress throughout a plant simply by maximizing plant capacity.

CBS does help a manufacturer get the biggest bang for the each buck invested in constrained resources. If, after implementing CBS, a manufacturer gets to the point of overloading the constrained resource all over again, then it might make sense to expand capacity. But that is never the first choice, so really, any company with a constrained resource should seriously consider CBS. Some companies in the food industry should consider CBS for the simple reason that it can help them sequence parts or batches in order to produce products that have had no contact with allergens including nuts.

Some companies, even though they have constrained resources, need to hold off before implementing CBS. An enterprise application is only as good as the data it contains and the processes that it automates. If a company's processes and routing are not accurately reflected in its automated environment, and if information on tools, work

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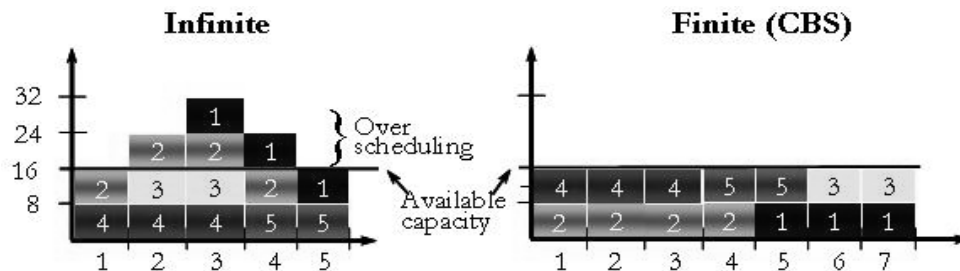
centers or laborers are not current or accurate, trying to engage CBS functionality could bring the entire company to a screeching halt. CBS requires correct routings that reflect steps in the right order, and good data on whether steps can be parallel or whether they need to be sequential. If your processes are not well-planned and if your data is incorrect, you will only automate the creation of a bad schedule.

CBS and ERP

When it comes to CBS functionality within an ERP package, what we are really talking about is an online, integrated, in-memory scheduling engine. This engine will work

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in conjunction with shop order functionality resident in a software application and will handle finite scheduling. By finite scheduling, what we mean is that CBS will do live planning, taking into consideration present load and capacity. To accomplish this, a CBS module will use different optimizing methods like “least slack and “as late as possible.” Finite scheduling is distinguishable from infinite loading, which in fact allows you to exceed available capacity while finite scheduling plans only within the constraints of available capacity.



When a shop order is created within the ERP package, a routing is used to create and plan the operations list. With infinite planning, operations are created and planned considering only the gross capacity available, and with no regard to existing orders. When an ERP package has been configured for CBS, it is routed to a CBS server which calculates start and finish times for the operations with consideration to existing orders and capacity. When the shop order is executed, CBS updates the information regarding operations and sends the results back to the server.

CBS-enabled applications can operate in a number of different modes. For instance, through predictive scheduling, the system can create an optimal schedule for a given set of orders, while through reactive scheduling it can be made to adjust a schedule as changes ensue without losing flexibility of that schedule. Through interactive scheduling, a CBS module can allow you to manually plan operations on a Gantt chart.

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CBS functionality within an ERP solution also ought to work in a multiple-site environment. Let's say you need to calculate a delivery date based on a multi-site, multi-level analysis of material as well as capacity throughout your whole supply chain. CBS should allow you to plan given all the sites in your supply chain and the actual work scheduled for each of those work centers. Manually or automatically, you should be able to schedule work and immediately give your customer a realistic idea of when their order will be completed.

In selecting a solution to deliver CBS, there are a number of system prerequisites that you need to look for. First of all, it is hard to deliver CBS entirely with a stand-alone system like a best-of-breed manufacturing execution system (MES). In fact, the more an enterprise application integrates various business disciplines, the more powerful it will be in terms of delivering CBS. This means that if an application suite offers functionality cobbled together from different products it has purchased, it may be harder to use that suite to deliver good CBS functionality. This is because a number of business variables that reside in non-manufacturing functionality of a system can affect capacity. For instance, IFS Applications offers tight integration between CBS functionality and maintenance and enterprise asset management (EAM) functionality. Scheduled maintenance or other activities that affect capacity are reflected in CBS scheduling capabilities. IFS Applications will also allow for reduced capacity due to vacations and sick time logged by employees. So it is difficult, for obvious reasons, for CBS to be completely separate from other business functions that also affect capacity.

Moreover, for many companies, CBS may be desirable during times of peak demand but unnecessary at other times. Ideally, it should be simple to turn CBS on and off through a simple check box.

Just the beginning

Apart from the immediately apparent capacity management benefits of CBS, there are a number of less-obvious analytical capabilities. CBS functionality typically allows you to conduct predictive analyses of what would happen if certain changes are made to an optimized schedule. So if a plant manager is pressured by a particular account executive to prioritize an order on behalf of a customer, that plant manager can produce

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excellent data on how many other orders would be late as a result. Furthermore, CBS functionality can provide predictive analyses on the effect of added capacity in the plant. So before going out and purchasing that additional machine tool, it is possible to see if that will truly deliver an increase in capacity or if it will simply result in a bottleneck further downstream in your manufacturing processes.

Like any piece of functionality within an enterprise application, CBS is a topic that could be the subject of a lifetime of learning. Using CBS within your enterprise does not require a doctoral degree, but does require some homework on the scheduling functionality of your ERP tool. If you have stayed with us this far, you have already gained a pretty fair understanding of CBS. As you learn more about CBS, here are a few other acronyms are likely to encounter.

- CBS** – You already know this one! Constraint Based Scheduling
- EPST** - Earliest Possible Start Time
- LPST** - Latest Possible Start Time
- ASAP**- As Soon As Possible
- ALAP** - As Late As Possible
- JIT**- Just-In-Time
- FCFS** - First Come First Served
- EDD** - Earliest Due Date
- WIP** – Work In Process

You can learn a lot more about CBS by attending training courses offered by professional groups like APICS, and by reading up on the topic. But for most manufacturing executives, the best time spent on CBS will be devoted to mastering the CBS functionality of an enterprise application used within the enterprise.

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About IFS

IFS, the global enterprise applications company, provides solutions that enable organizations to respond quickly to market changes, allowing resources to be used in a more agile way to achieve better business performance and competitive advantage.

IFS was founded in 1983 and now has 2,600 employees worldwide. IFS has pioneered component-based enterprise resources planning (ERP) software with IFS Applications™, now in its seventh generation. IFS' component architecture provides solutions that are easier to implement, run, and upgrade. IFS Applications is available in 54 countries, in 20 languages.

IFS Applications provides extended ERP functionality, including supply chain management (SCM); enterprise asset management (EAM); maintenance, repair, and overhaul (MRO); product lifecycle management (PLM); customer relationship management (CRM); and corporate performance management (CPM) capabilities.

IFS has over 500,000 users across seven key vertical sectors: aerospace & defense, automotive, high-tech, industrial manufacturing, process industries, construction & facilities management, and utilities & telecom. IFS also provides a cross-industry solution for retail & wholesale distribution.

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