
Using TOC for Integrated Resource Scheduling (IRS) in MRO environments

The problem

Often in complex MRO environments there are three basic operations going on:

- **Project management:** The scheduling of the phases, activities and tasks to conduct an overhaul or upgrade of an asset is managed through the use of project management planning and scheduling techniques – most commonly the Critical Path method. The Critical Path method does not explicitly take into account resource contention and does not intrinsically deal with variability in execution of the plan.
- **Manufacturing:** The job shop which does the manufacturing operations associated with MRO often will work according to MRPII and will struggle to integrate its manufacturing schedules with the master project schedules for the assets being managed. The result is often missed due dates, high levels of work in progress and excessive expediting.
- **Supply Chain and materials management:** It is the job of the materials management people to ensure that they have the right stock in the right place at the right time. The problem is though that often they have a competing goal to maintain inventory at lowest possible levels and this means that spares and parts are not available to the shop floor when called for by the master project schedule. Delays on materials can cause huge losses from underutilisation of the asset in question.

The challenge

The Holy Grail of good MRO scheduling is to integrate resource scheduling across the three major functions described above in such a way that the flow of the MRO project is disrupted to the least extent possible by bottlenecks caused by non-availability of resources – be they people, materials or plant and machinery.

A solution

By combining the proven scheduling methods of TOC:

- **Critical Chain** project management
- **TOC Replenishment** supply chain management
- **Drum Buffer Rope** manufacturing

with the TOC system performance metrics and the logical Thinking Process tools, the result is a powerful means of releasing capacity of both the asset being overhauled and the MRO crews.

ISRAEL AIRCRAFT INDUSTRY

The Israeli Aircraft Industry employs about 15,000 people. A major function is to maintain Jumbo Jets used in Passenger service. A particular type of maintenance, called 'type D,' normally takes 46 days in the industry. The penalty for non-performance to schedule is very steep...\$60,000 per day, because the airlines need the planes back into scheduled service. The company had been paying up to \$ 25 million per year in penalties. A letter from the manager to Dr. Goldratt (included on <http://www.Goldratt.com>) notes, "...we succeeded to drop our average Turn Around Time per Aircraft Visit from three months to two weeks and to increase our order backlog from two months to one year."

NAVAL AIR DEPOT AT CHERRY POINT, NC

The air depot is a large and complex repair and overhaul aerospace activity. They perform in-depth scheduled and unscheduled maintenance on a variety of naval aircraft, engines and components. The annual revenue is \$650 million and they employ 4,500 people.

They have considerably complex bills of material and routing process. Master Scheduling tasks for repair often considered as projects or job shop environment with substantial variability.

The prototype aircraft selected for proof of concept was the H-46 helicopter. Collaboration with Vector Strategies using our TOC based critical chain scheduling techniques yielded truly impressive results. Over a 2-month period the **amount of aircraft in flow was reduced from 26 to 14**. This first step was crucial; maintaining 14 aircraft in flow matched their available capacity to the customers demand. The system transformed from a push system to a pull system. The clean and strip supervisor Mark Meno remarked, "Pull work through don't push it."

The average turnaround time, due in part to an aging fleet of aircraft, was approaching 225 days. **Within 4 months of implementing the Vector Strategies approach the turnaround time was reduced to 132 days**. This remarkable improvement was accomplished without hiring any additional people. In fact the overtime was now considerably lower than before.

There was a quantifiable improvement of the already high quality product being produced. The amount of rework was reduced and the feedback from customers showed a demonstrable increase in satisfaction. Jerry Frontera, local union steward commented, "**Your approach really works, grievances are down and people doing the work are feeling good.**"

UNITED STATES MARINE CORPS MATERIAL COMMAND

The mission of the Materiel Command is to provide the highest level of materiel readiness to the United States Marine Corps. They have two maintenance centres that perform depot level repair on their track and wheeled vehicles. The operating forces send vehicles to the centres when depot maintenance and repairs are required and issued a replacement if assets are available.

The maintenance centres are a critical link in the readiness supply chain and have reputations for being very responsive. Similar to private business their customers demand quick turnarounds and competitive prices. Pressure to meet promised schedules is becoming greater. Many of the leading edge best business practices have been implemented and a powerful ERP is in place. But, it is not enough.

A prototype effort cut the cycle time in half within three months. Variation in their processes has been dramatically reduced. The prototype team leader Joe Frisone remarked, "Since we started using TOC, this is the first time we haven't been hit by the end of month bow wave."

They are now committed to implementing TOC throughout both maintenance centres as quickly as possible.

According to Col. Rivers, the commander of the maintenance centre at Barstow, "TOC creates a production planning activity that is detailed and comprehensive. The result is improved use of resources and better scheduling and production flow across cost work centres."

PEARL HARBOUR NAVAL SHIPYARD

A unique approach to managing submarine maintenance projects is bringing positive results at the Pearl Harbour Naval Shipyard and Intermediate Maintenance Facility (NS&IMF).

The shipyard's Fleet Maintenance Availability Project for Submarines (FMB) is using critical chain project management to improve schedule and performance on submarine availabilities.

For years, critical path project management has been the standard for Navy shipyards and industry as a whole. In the critical path process, a schedule is developed that allots enough time for jobs so that they, and consequently the project, will finish on time with a 90 percent probability.

In critical chain project management, the duration of jobs is shortened so that half of the time they will finish late. The time that has been cut from these jobs is placed in buffers in certain strategic points of the schedule.

“It’s a change in the way we execute and plan work,” said Cmdr. Kent Kettell, Assistant Operations Officer for FMB. “It minimizes chaos and fire fighting.”

Although at face value, the idea of deliberately starting a project late seems counterproductive, critical chain management actually helps the shipyard meet or beat project end dates. In critical path management, even if a job finishes early, the next job in line doesn’t begin immediately because it’s either still scheduled to start at the original date or a resource isn’t available. Critical chain schedules encourage a “relay race” behaviour, where workers finish a job as quickly as possible and, without delay, pass the baton to others on the next job. The intention is to capture gains in schedule and pass them on.

Since critical chain project management was implemented last year, FMB has improved its schedule performance, finishing its last 13 availabilities on time. The average number of jobs done per upkeep has also risen while lowering the number of man-hours required.

Metrics comparing performance in fiscal year 2002 before and after the inception of critical chain project management show 11 percent more jobs done per upkeep while using five percent less man-hours. There was also a 13 percent increase in job completions. All of this was accomplished while the average length of availabilities was reduced 5.6 days.

Shipyard workers see and feel the results. “I’ve seen the difference,” said Roxanne Bataya, a shipfitter supervisor. “We aren’t bouncing around like before.”

Shipfitter Richard Donald agreed. “It seems like we do less jobs at one time. It’s more organized.”