Theory of Constraints Scheduling

APICS PDM

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Bottlenecks

- Bottlenecks typically have less capacity then the proceeding and following operations
- Limit the output of an organization
- Managers should focus on identifying and eliminating them

Eliminating bottlenecks:

- Increase capacity at the bottleneck
- Cross train and insure maximum utilization at the bottleneck
- Develop alternate procedures or routings
- Move inspection to before the bottleneck
- Schedule to match the capacity of the bottleneck

“The Goal”

- By Eliyahu Goldratt in 1984 –20th Printing and Third revision 2004
- Considered the founding work in the field of TOC
- Alex Rogo relied on his mentor Jonah
- Introduced the concept of “herbies”
- The Goldratt Institute issue certifications called Jonah

Theory of Constraints

- The Theory of Constraints Goal is to maximize flow through the entire system
- Emphasizes balancing flow
- Improve performance of bottleneck:
  - Determine what is constraining the operation
  - Exploit the constraint
  - Subordinate everything to the constraint
  - Determine how to overcome the constraint
  - Repeat the process for the next constraint

Theory if Constraints Metrics

- Throughput – the rate at which the system generates money through sales
- Physical assets – the total system investment
  - Inventory
  - Buildings and land
  - Plant and equipment
- Operating expense – money the system spends to convert inventory into throughput

Priority Rules for Dispatching Jobs

- FCFS - first come, first served
- SPT - shortest processing time
- EDD - earliest due date
- LPD – longest processing time
- CR - Critical ratio
- Rush - emergency

Critical Ratio

- Computed by dividing the time remaining until the due date by the work remaining
- If the Critical Ratio is less than one, the job is behind schedule

$$CR = \frac{\text{Time Remaining}}{\text{Workdays Remaining}}$$

Drum Buffer Rope

- Drum is the schedule as it sets the pace of production
- The buffer is a small amount of inventory in front of the bottleneck operation to minimize idle time at the bottleneck
- The rope is the synchronizing of the sequence of operations to ensure the effective use of the bottleneck operation
- The goal of DBR is to maximize output and shorten lead times while the minimizing the inventory needed

Delta Airlines

- 2005 Filed for Bankruptcy
- Recovery Plan:
  - Tech Operations Group revenues $ 270 Million
    - +20% revenue, + 20% turnaround time
  - No capital investment
  - No increase in labor

Key Elements of the Plan

- Use the system constraint to set the drumbeat
  - Repair and support shops
- Manage queue “first in-first out”
- Delay assembly until all parts are available
- Synchronize parallel activities with CMM
- Limit expediting by rule set
- Use flexibility to respond to variation
- Adopt a doctrine of accountability

DBR at Delta

- Rope was set at 15 days: 5 days of work content plus 10 days buffer time
- Orders to be processed by FIFO
- Any jobs in shop longer than 10 days are labeled “red”
- Red labeled jobs go to the front of the queue
- Expedited parts are marked Green and limited to 20 at any one time (.2%)

Prioritization Rules

1. all parts with green expedite tags,
2. red items in order of due date,
3. all other items in “first in, first out” order.

The Results

- In one year, the repair and support shops **decreased turnaround times on parts by 40 percent, increased throughput by 18 percent, and cut WIP levels in half.**
- In addition, Delta was able to increase the total engine maintenance workload from customers outside of Delta Airlines by 33 percent.
- As for the bottom line, not only did Delta's Tech Ops Group meet its 2006 revenue goal of $270 million, but the company also **exceeded that goal by $42 million**