webindustries

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Cost Minimization Through Manufacturing Scheduling

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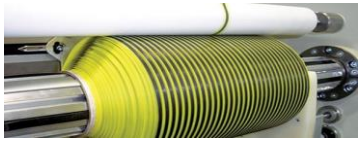
Overview

- Suwanee facility dedicated to precision slitting of carbon fiber composite materials
- Used in the construction of aircraft
- Subject to strict regulations due to the nature of the aerospace industry



Spool of carbon fiber composite material

System

Arrival

- Web Industries' customer is also the supplier

Freezer

- Temperature sensitive material
- Time out of the freezer must be tracked

Thawing

- Materials must thaw for at least 36 hours

Slitting

- Machine Processing times are highly variable

Packaging

- Materials are refrozen after packaging

Exceed out time incident: material surpasses the maximum out time and must be sent for testing.

Opportunity

Minimize cost through improved scheduling

Unplanned Downtime

- Processing times are highly variable.
- When processing times vary, Web Industries incurs costs due to down time and out time.
- Recalculate pull times to balance the trade-off.

Planned Downtime

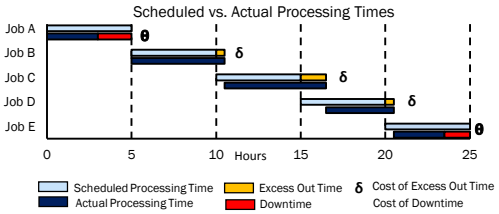
- Switching between work orders requires a set-up.
- Currently ordered by earliest due date.
- Order jobs to minimize set-up costs while maintaining on-time job completion.

Reducing Unplanned Downtime

Objective: Calculate new pull intervals (p*) to minimize cost by balancing the trade off between downtime and out time.

Quantifying Costs

X: Random variable of processing time with distribution F
p: Allotted processing time



$$Total\ Cost = \theta \sum_i Downtime_i + \delta \sum_i Out\ Time_i$$

Newsvendor Formulation

p* is calculated for each of the 12 distributions

Value of Tardiness

$$\delta = \frac{\$15{,}000}{72-36-E[X]\ Hours}$$

Value of Earliness

θ = $300 / Hour

$$p^* = F^{-1}\left(\frac{\delta}{\theta+\delta}\right)$$

Value

Yearly Impact of Unplanned Downtime

320 Hours of Downtime
↓31%
100 Hours Reduced

250 Hours of Downtime Reduced Per Year
$900 Opportunity Cost Per Hour
$225,000 Annual Economic Impact

1,326 Hours of Setups in 2018
−1,176 Hours Scheduled by Constraint Program
150 Hours Reduced

Yearly Impact of Planned Downtime

Multifunctional Scheduling Tool

Inputs

1. List of work orders with due dates.
2. Cost of *out time* (**δ**)
3. Cost of *downtime* (**θ**)

Outputs

1. Order of jobs
2. Required set-ups
3. Scheduled pull time of each job

Reducing Planned Downtime

Objective: Formulate a constraint program that minimizes the length of set-ups required between work orders.

Formulation

1. **Parameters**
   P_i = processing time of job i
   C_{ij} = time penalty of going from job i to job j
   D_i = due date of job I
2. **Decision Variables**
   B_i = start time of job i
   E_i = end time of job i
   $A_{ij} = \begin{cases} 1 & \text{if transitioning from job i to j} \\ 0 & \text{otherwise} \end{cases}$
3. **Objective: minimize makespan**
   min[(max(E$_i$)]
4. **Constraints:**
   Subject to setup matrix and system constraints.

Ordered Schedule that:
1. Minimizes Makespan
2. Minimizes Set-up Time

Results