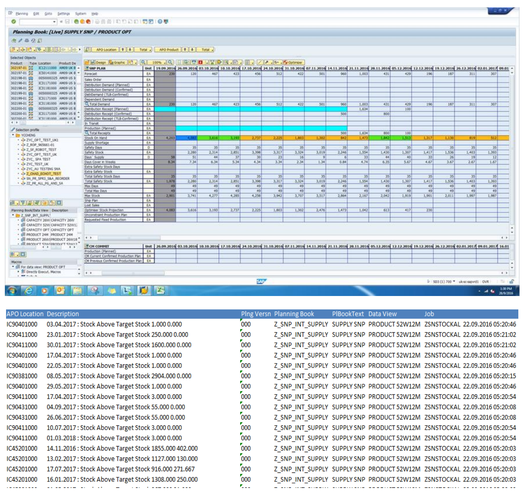
DYSON REPLENISHMENT PROCESS (part I)

Department of Industrial Systems Engineering and Management
IE3100R/IE3100M Systems Design Project | Group 16

Group Members: Titus Ong | Felix Fernando | Kevin Christian | Ren Xiao Kai | Sheena Low | Shi Lei | Song Shuang | Zhang Xian
NUS Supervisors: A/P Ng Kien Ming | A/P Ng Tsan Sheng, Adam Industrial Supervisor: Mr. Laurent Derien

PROJECT OVERVIEW: To improve the efficiency and decisions of capacity swaps between SKUs during the manual Extended Period Horizon (EPH)

1. BACKGROUND



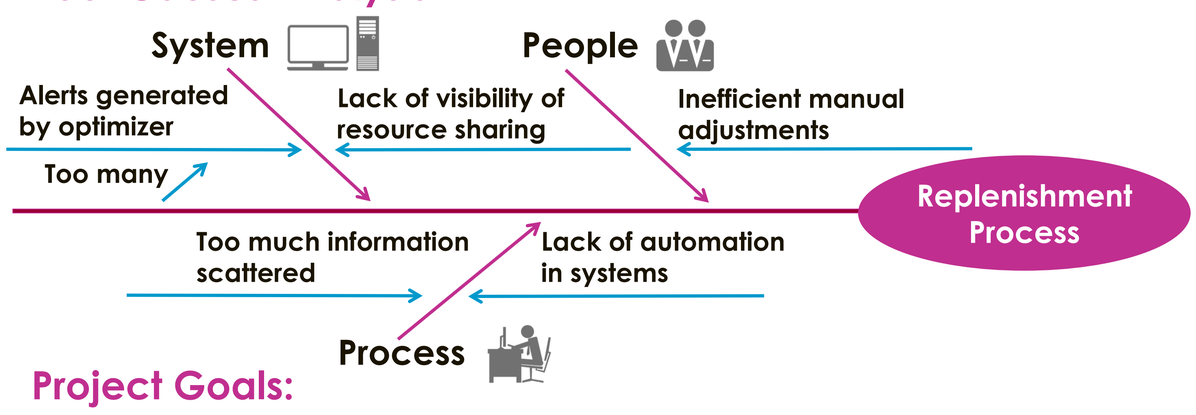
- After an SAP optimizer run, planners receive a planned production (PP) which determines the quantity to produce for each market and SKU.
- During the EPH, it does not make changes to the PP for the first 12 weeks.
- Supply planners will manually address shortages alerts during the EPH.
- Most alerts are not resolved before the PP is committed in that week.

2. OBSERVATIONS

Bottlenecks / Opportunities

- Some shortages can't be resolved as resources are at full capacity
- Capacity swaps between SKU are practiced as the production plan in the EPH is not optimized
- Current method of capacity swaps is slow and not systematic

Root Causes Analysis



Project Goals:

- To reduce the time taken to make a decision and to optimize the capacity swaps between SKU

3. METHODOLOGY

- Create a visualization tool for resource families (SKUs sharing the same resources) to help planners to determine the family quickly
- Have a tool to process all required information and propose optimum capacity swaps

  -Extract data from optimizer logs automatically using VBA
  -Formulate linear optimization model to minimize delay penalty cost and Backorders.

- Test the model with real data from the SAP optimizer to compare results

Optimization Model

Objective function:

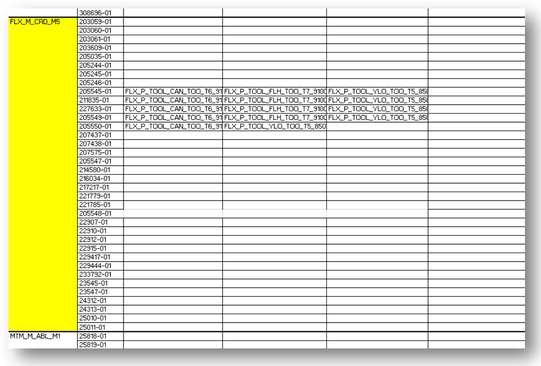
$\min \Sigma\Sigma\ a_i \min\{0, I_{it} - SS_{it}\} + b_i * \min\{0, I_{it}\}$

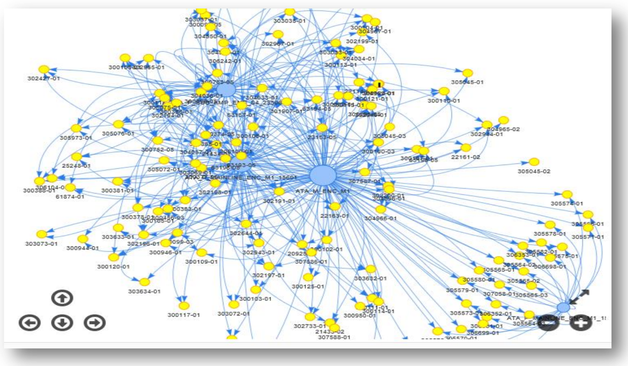
Constraints	Remarks
$I_{imt} = I_{im(t-1)} + R_{imt} - D_{imt}$	Stock on hand at time t for market m product i, for t ≥ 1
$R_{imt} = P_{imt} + C_{imt}$	Total receipts = Planned receipts + Confirmed receipts
λtime $\Sigma\frac{x_{ijmt}}{m_{ij}} = P_{imt}\ \forall i\ \forall t$	Total planned receipts = Total units of production
$R_{imt} \geq C_{imt}$	Total receipts are smaller than confirmed receipts
$\Sigma xijmt \leq Mjt \quad \forall j\ \forall t$	Total time used is limit to resource capacity
$SS_{imt} = \Sigma D_{imk}$	Aggregated demand

Variables	Definitions
SS_{imt}	Safety stock at time t
I_{imt}	Stock on hand at time t for product I
R_{imt}	Total receipts at time t for product I
D_{imt}	Forecasted demand at time t for product I
P_{imt}	Total planned receipts at time t for product I
C_{imt}	Total confirmed receipts at time t for product I
a_i	Below safety stock penalty cost for product I
b_i	Delayed demand penalty cost for product I
m_{ij}	Amount of resource j needed for product I
M_{jt}	Resource capacity of resource j at time t
x_{jimt}	Unit of production for market m product i resource j at time t

4. SOLUTIONS

Visualization Tool

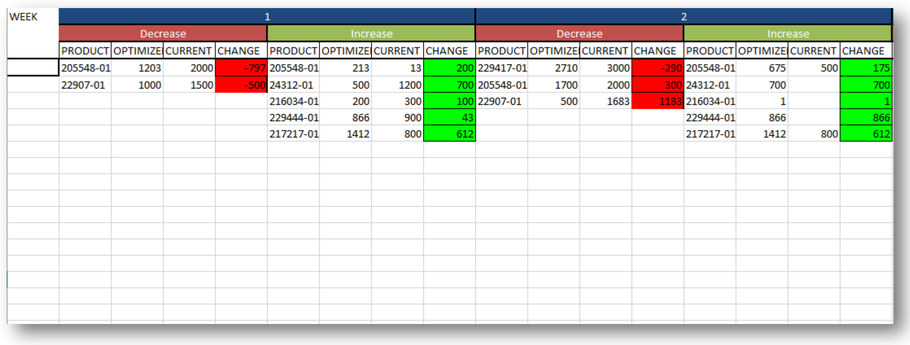




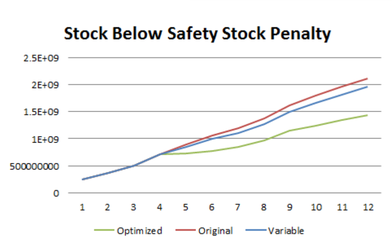
- Quick reference for planner to determine which Family to refer to in the EPH Planner (below)
- The second graph displays resources (blue nodes) and products (yellow nodes) using Alteryx. Senior management can identify potential long term capacity constraints and adjust sub-contracting strategies.

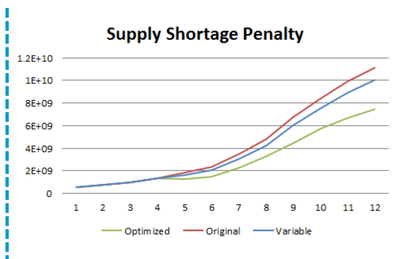
EPH Planner

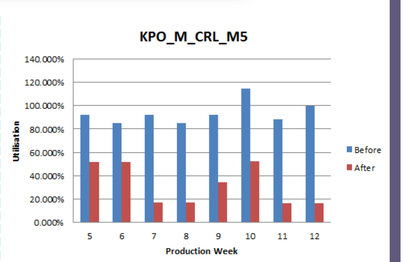
- User interface displaying the proposed number of units to decrease or increase for SKUs for each bucket
- A dynamic tool for planners to communicate their changes to other planners as well as to monitor effects of the change done
- Interactive dashboards created for resource management and planning showing penalty costs and utilization of resource(s)



WEEK	1								2							
	Decrease				Increase				Decrease				Increase			
	PRODUCT	OPTIMIZE	CURRENT	CHANGE	PRODUCT	OPTIMIZE	CURRENT	CHANGE	PRODUCT	OPTIMIZE	CURRENT	CHANGE	PRODUCT	OPTIMIZE	CURRENT	CHANGE
	205548-01	1203	2000	-797	205548-01	213	13	200	229417-01	2710	3000	-290	205548-01	675	500	175
	22907-01	1000	1500	-500	24312-01	500	1200	700	205548-01	1700	2000	300	24312-01	700		700
					216034-01	200	300	100	22907-01	500	1683	1183	216034-01	1		1
					229444-01	866	900	43					229444-01	866		866
					217217-01	1412	800	612					217217-01	1412	800	612







5. EVALUATION

Value Added

Before

- Slow and inefficient decisions in capacity swaps
- Lack of visibility in resource and product interdependencies

After

- Quicker visibility of network between resource and products

1 min → 5 s

- Optimized decisions in capacity swaps

1 by 1 comparison → 450 SKUs simultaneous

- Decrease in expected number of shortages

Future Directions

- This optimization model serves as a prototype, which can be further defined and developed by Dyson's software engineers.
- The tool could be integrated with the current SAP APO system to have a smoother workflow.
- Training should be conducted to embed this tool into the current replenishment process