



# Variability in Supply Chain Planning

Nico Vandaele, GSK Research Chair, KU Leuven PICS Belgium

SAS Forum, in Cooperation with PICS Belgium October 9, 2014

### Agenda



#### 15.00 – 15.50 – NYO Alatus

#### Embracing the variability in your supply chain planning

- 15.00 15.10 Academic overview by Prof. Nico Vandaele
- 15.10 15.25 Pharmaceutical case 1 by Carl Verhamme
- 15.25 15.40 Discrete case 2 by Kris Lieckens
- 15.40 15.45 Today's reality by Prof. Nico Vandaele
- 15.45 15.50 Q&A
- 15:50 16.20 Break
- 16.20 17.10 Daan Voets and Jos Polfliet, SAS

Best practices in using sensor data

to increase performance and reliability

### **Planning Performance History**





**KU LEUVEN** 



#### Note:

#### Slides from Carl Verhamme for SAS Forum – October 2014





### **Pharmaceutical Co.**



FlowBalancer used as <u>Improvement</u> and <u>Benchmarking</u> tool besides a planning tool.



**<u>Value Stream Mapping</u>** (VSM) as a starting point during an implementation











### **Capsules**

### **Current VSM**



### **Analytical Model - overview**



- Identify:
  - Productmix
  - Routings
  - Resources (equipment / people)







- Increase of demand
- Installation of an additional shift

Improvement
Set-up reduction on the bottleneck
Increase MTTF
Reduction of variability
Optimisation of the batchsize





### **Simulations: Demand**

Scenario	Simulation Parameter	BaseCase	Simulated	% Difference	Criteria	Bead IM	Bead ER	Capsules	Packaging	Shipping	Total
Scenario 0	Base Case				WIP	570.210	734.328	0.442	0.192	11051.933	
					Cycle Time	32.90	47.04	11.85	5.15	30.12	127.05
					Throughput	17.330	15.612	0.037	0.037		
					Utilization	88%	88%	59%	68%		88%
Scenario 1	Increase demand in finis	shed product	s by 5%		WIP	801.501	1099.701	0.469	0.214	11051.933	
	10% is too much for the	e bead			Cycle Time	44.04	67.08	11.98	5.46	30.12	158.69
					Throughput	18.200	16.393	0.039	0.039		
					Utilization	93%	93%	62%	71%		93%
					Diffence WIP	231.291	365.373	0.027	0.022	0.000	
					Difference Cycle Time	11.14	20.05	0.14	0.31	0.00	31.64
					Difference Throughput	0.870	0.761	0.002	0.002		
					Difference Utilization	5%	5%	3%	3%		5%
					% WIP	40.56%	49.76%	6.20%	11.29%		
					% Cycle Time	33.87%	42.62%	1.16%	5.98%		24.90%
					% Throughput	5.02%	5.00%	5.09%	5.09%		
					% Utilization	5.68%	5.68%	5.08%	4.41%		5.68%
					-	-				-	
Scenario	Simulation Parameter	BaseCase	Simulated	% Differen	c Criteria	Bead IM	Bead ER	Capsules	Packaging	Shipping	Total
Scenario Scenario 0	Simulation Parameter Base Case	BaseCase	Simulated	% Differen	c Criteria WIP	Bead IM 570.210	Bead ER 734.328	Capsules 0.442	Packaging 0.192	Shipping 11051.933	Total
Scenario Scenario 0	Simulation Parameter Base Case	BaseCase	Simulated	% Differen	Criteria WIP	Bead IM 570.210	Bead ER 734.328 47.04	Capsules 0.442 11.85	Packaging 0.192 5.15	Shipping 11051.933 30.12	Total 127.05
Scenario Scenario 0	Simulation Parameter Base Case	BaseCase	Simulated	% Differen	Criteria WIP	Bead IM 570.210	Bead ER 734.328 47.04 15.612	Capsules 0.442 11.85 0.037	Packaging 0.192 5.15 0.037	Shipping 11051.933 30.12	Total 127.05
Scenario Scenario 0	Simulation Parameter Base Case	BaseCase	Simulated	% Differen	Criteria WIP	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88%	Capsules 0.442 11.85 0.037 59%	Packaging 0.192 5.15 0.037 68%	Shipping 11051.933 30.12	Total 127.05 88%
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated	% Differen	Criteria WIP	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328	Capsules 0.442 11.85 0.037 59% 0.442	Packaging 2 0.192 5 5.15 0.037 68% 2 0.318	Shipping 11051.933 30.12 11051.933	Total 127.05 88%
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated	% Differen	Criteria WIP 6 of demand	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328 47.04	Capsules 0.442 11.85 0.037 59% 0.442 11.85	Packaging 2 0.192 5 5.15 0.037 68% 2 0.318 5 8.53	Shipping 11051.933 30.12 11051.933 30.12	Total 127.05 88% 130.42
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated	% Differen	Criteria WIP 6 of demand	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328 47.04 15.612	Capsules 0.442 0.037 0.037 0.442 0.042 0.442 11.85 0.037	Packaging 0.192 5.15 0.037 68% 0.318 5.853 0.037	Shipping 11051.933 30.12 11051.933 30.12	Total 127.05 88% 130.42
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated ncreas	% Different Se of 5% es the 9	Criteria WIP 6 of demand Cycle Time by	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328 47.04 15.612 88%	Capsules 0.442 0.037 0.037 0.037 0.442 0.442 0.037 0.037 0.59%	Packaging 2 0.192 5 5.15 0.037 68% 2 0.318 5 8.53 0.037 87%	Shipping 11051.933 30.12 11051.933 30.12	Total 127.05 88% 130.42 88%
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated ncreas	% Different Se of 5% es the 9	Criteria WIP 6 of demand Cycle Time by	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328 47.04 15.612 88% 0.000	Capsules 0.442 11.85 0.037 59% 0.442 11.85 0.037 0.037 59% 0.000	Packaging 2 0.192 5 5.15 0.037 68% 2 0.318 5 8.53 0.037 87% 0 0.126	Shipping 11051.933 30.12 11051.933 30.12 0.000	Total 127.05 88% 130.42 88%
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated ncreas	% Different se of 5% es the 0 31 d	6 Criteria WIP 6 of demand Cycle Time by ays	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328 47.04 15.612 88% 0.000 0.000	Capsules 0.442 11.85 0.037 59% 0.442 11.85 0.037 0.442 11.85 0.037 59% 0.000 0.000 0.000	Packaging 2 0.192 5 5.15 0.037 68% 2 0.318 5 8.53 0.037 87% 0 0.126 0 3.38	Shipping 11051.933 30.12 11051.933 30.12 0.000 0.000	Total 127.05 88% 130.42 88% 3.38
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated	% Different se of 5% es the 0 31 d	Criteria WIP 6 of demand Cycle Time by ays	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328 47.04 15.612 88% 0.000 0.000 0.000	Capsules 0.442 11.85 0.037 59% 0.442 11.85 0.042 11.85 0.037 59% 0.000 0.000 0.000 0.000	Packaging 2 0.192 5 5.15 0.037 68% 2 0.318 5 8.53 0.037 87% 0 0.126 0 3.38 0 0.000	Shipping 11051.933 30.12 11051.933 30.12 0.000 0.000	Total 127.05 88% 130.42 88% 3.38
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated	% Different se of 5% es the 0 31 d	Criteria WIP 6 of demand Cycle Time by ays	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328 47.04 15.612 88% 0.000 0.000 0.000 0.000 0%	Capsules 0.442 11.85 0.037 59% 0.042 11.85 0.037 59% 0.0037 59% 0.000 0.000 0.000 0.000 0.000 0.000	Packaging 2 0.192 5 5.15 0.037 68% 2 0.318 5 8.53 0.037 87% 0 0.126 0 3.38 0 0.000 19%	Shipping 11051.933 30.12 11051.933 30.12 0.000 0.000	Total 127.05 88% 130.42 88% 3.38 0%
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated	% Different Se of 5% es the 9 31 d	Criteria WIP O of demand Cycle Time by ays	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328 47.04 15.612 88% 0.000 0.000 0.000 0% 0.00%	Capsules 0.442 11.85 0.037 59% 0.042 11.85 0.042 11.85 0.037 59% 0.000 0.000 0.000 0.000 0.000 0.00%	Packaging 2 0.192 5 5.15 0.037 68% 2 0.318 5 8.53 0.037 87% 0 0.126 0 3.38 0 0.000 19% 5 65.56%	Shipping 11051.933 30.12 11051.933 30.12 0.000 0.000	Total 127.05 88% 130.42 88% 3.38 0%
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated	% Different Se of 5% es the 31 d	Criteria WIP O of demand Cycle Time by ays	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328 47.04 15.612 88% 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	Capsules 3 0.442 4 11.85 2 0.037 5 59% 3 0.442 4 11.85 2 0.037 5 9% 0 0.000 0 0.000 0 0.000 0 0.00% 0 0.00% 0 0.00%	Packaging 0.192 0.037 0.037 0.8% 0.037 0.318 0.037 0.7% 0.0126 0.126 0.3.38 0.000 19% 0.5.56% 0.5.53%	Shipping 11051.933 30.12 11051.933 30.12 0.000 0.000	Total 127.05 88% 130.42 88% 3.38 0% 2.66%
Scenario Scenario 0 Scenario 2	Simulation Parameter Base Case Reduce available ho	BaseCase	Simulated	% Different se of 5% es the 31 d	o Criteria WIP O of demand Cycle Time by ays	Bead IM 570.210	Bead ER 734.328 47.04 15.612 88% 734.328 47.04 15.612 88% 0.000 0.000 0.000 0.00% 0.00% 0.00% 0.00%	Capsules 3 0.442 4 11.85 2 0.037 5 59% 3 0.442 4 11.85 2 0.037 5 59% 0 0.007 0 0.000 0 0.007 0 0.00% 0 0.00% 0 0.00% 0 0.00%	Packaging 2 0.192 5 5.15 0.037 68% 2 0.318 5 8.53 0.037 87% 0 0.126 0 3.38 0 0.000 19% 65.56% 65.53% 0.00%	Shipping 11051.933 30.12 11051.933 30.12 0.000 0.000	Total 127.05 88% 130.42 88% 3.38 0% 2.66%





### **Simulations: Capacity (extra shift)**

Scenario	Simulation Parameter BaseCase Simulated % Differen	ic Criteria	Bead IM	Bead ER	Capsules	Packaging	Shipping	Total
Scenario 0	Base Case	WIP	570.210	734.328	0.442	0.192	11051.933	
		Cycle Time	32.90	47.04	11.85	5.15	30.12	127.05
		Throughput	17.330	15.612	0.037	0.037		
		Utilization	88%	88%	59%	68%		88%
Scenario 4	Increase 50% for hours available for the bead	WIP	350.6649	378.38	0.442	0.1922	11051.933	
	(additional shift)	Cycle Time	20.2307	24.2366	11.8461	5.152	30.11799	91.58339
		Throughput	17.2333	15.61	0.0373	0.0373		
		Utilization	58%	58%	59%	68%		68%
		Diffence WIP	-219.5451	-355.9481	0	0	0	
		Difference Cycle Time	-12.67	-22.80	0.00	0.00	0.00	-35.47
		Difference Throughput	0.0033	-0.0021	0	0		
		Difference Utilization	-30.00%	-30.00%	0.00%	0.00%		-20.00%
		% WIP	-38.50%	-48.47%	0.00%	0.00%		
		% Cycle Time	-38.50%	-48.47%	0.00%	0.00%		-27.91%
		% Throughput	0.02%	-0.01%	0.00%	0.00%		
			\$4.09%	-34.09%	0.00%	0.00%		-22.73%
	Cycle Time <mark>reduce</mark> if extra shift on k instal	s by 35 days oottleneck is led						





### **Simulations: Utilization (setup, yield)**

Scenario	Simulation Parameter Bas	eCase Simulated % Differer	nc Criteria	Bead IM	Bead ER	Capsules	Packaging	Shipping	Total
Scenario 0	Base Case		WIP	570.210	734.328	0.442	0.192	11051.933	
			Cycle Time	32.90	47.04	11.85	5.15	30.12	127.05
			Throughput	17.330	15.612	0.037	0.037		
			Utilization	88%	88%	59%	68%		88%
Scenario 5	Increase yield in bead 10%,	up to 90% in IM, ER	WIP	568.7222	852.8764	0.442	0.1922	11051.933	6
			Cycle Time	32.0113	48.5593	11.8461	5.152	30.12	127.68669
			Throughput	17.3333	17.5636	0.0373	0.0373		
			Utilization	88%	88%	0.59	0.68		88%
	(					0	0	0	
						0.00	0.00	0.00	0.64
						0	0		
						0%	0%		0%
		Sot Up rodu	uction from 6	to 1 on		0.00%	0.00%		
		Set up red		10 4 01		0.00%	0.00%		0.50%
		Battlanack	vaducas cv	clo tin		0.00%	0.00%		
		Domeneck	equices cy			0.00%	0.00%		0.00%
Scenario	Simulation Parameter Ba	h	v 14 dave			Capsules	Packaging	Shipping	Total
Scenario Scenario 0	Simulation Parameter Ba Base Case	b	y 14 days			Capsules 0.442	Packaging 0.192	Shipping 11051.933	Total
Scenario Scenario 0	Simulation Parameter Ba Base Case	b	y 14 days			Capsules 0.442 11.85	Packaging 0.192 5.15	Shipping 11051.933 30.12	Total 127.05
Scenario Scenario 0	Simulation Parameter Ba Base Case	b	y 14 days			Capsules 0.442 11.85 0.037	Packaging 0.192 5.15 0.037	Shipping 11051.933 30.12	Total 127.05
Scenario Scenario 0	Simulation Parameter Ba Base Case	b	oy 14 days			Capsules 0.442 11.85 0.037 59%	Packaging 0.192 5.15 0.037 68%	Shipping 11051.933 30.12	Total 127.05 88%
Scenario Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		oy 14 days	100.0000		Capsules 0.442 11.85 0.037 59% 0.442	Packaging 0.192 5.15 0.037 68% 0.1922	Shipping 11051.933 30.12 11051.933	Total 127.05 88%
Scenario Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		y 14 days	27.885	38.1286	Capsules 0.442 11.85 0.037 59% 0.442 11.8461	Packaging 0.192 5.15 0.037 68% 0.1922 5.152	Shipping 11051.933 30.12 11051.933 30.12	Total 127.05 88% 113.12969
Scenario Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		y 14 days	27.885	38.1286 15.6121	Capsules 0.442 11.85 0.037 59% 0.442 11.8461 0.0373	Packaging 0.192 5.15 0.037 68% 0.1922 5.152 0.0373	Shipping 11051.933 30.12 11051.933 30.12	Total 127.05 88% 113.12969
Scenario Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		y 14 days Oy 14 days	27.885 17.3333 84%	38.1286 15.6121 84%	Capsules 0.442 11.85 0.037 59% 0.442 11.8461 0.0373 59%	Packaging 0.192 5.15 0.037 68% 0.1922 5.152 0.0373 68%	Shipping 11051.933 30.12 11051.933 30.12	Total 127.05 88% 113.12969 84%
Scenario Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		y 14 days y 14 days Cycle Time Throughput Utilization Diffence WIP	27.885 17.3333 84% -86.8705	38.1286 15.6121 84% -139.0608	Capsules 0.442 11.85 0.037 59% 0.442 11.8461 0.0373 59% 0	Packaging 0.192 5.15 0.037 68% 0.1922 5.152 0.0373 68% 0	Shipping 11051.933 30.12 11051.933 30.12	Total 127.05 88% 113.12969 84%
Scenario 0 Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		Cycle Time Throughput Utilization Diffence WIP Difference Cycle Time	27.885 17.3333 84% -86.8705 -5.01	38.1286 15.6121 84% -139.0608 -8.91	Capsules 0.442 11.85 0.037 59% 0.442 11.8461 0.0373 59% 0 0.000	Packaging 0.192 5.15 0.037 68% 0.1922 5.152 0.0373 68% 0 0.00	Shipping 11051.933 30.12 11051.933 30.12 0 0.00	Total 127.05 88% 113.12969 84% -13.92
Scenario 0 Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		Cycle Time Throughput Utilization Diffence WIP Difference Cycle Time Difference Throughput	27.885 17.3333 84% -86.8705 -5.01 0.0033	38.1286 15.6121 84% -139.0608 -8.91 0	Capsules 0.442 11.85 0.037 59% 0.442 11.8461 0.0373 59% 0 0.000 0.000 0	Packaging 0.192 5.15 0.037 68% 0.1922 5.152 0.0373 68% 0 0.000 0.00	Shipping 11051.933 30.12 11051.933 30.12 0 0.00	Total 127.05 88% 113.12969 84% -13.92
Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		Cycle Time Throughput Utilization Difference WIP Difference Cycle Time Difference Throughput Difference Utilization	27.885 17.3333 84% -86.8705 -5.01 0.0033 -4%	38.1286 15.6121 84% -139.0608 -8.91 0 -4%	Capsules 0.442 11.85 0.037 59% 0.442 11.8461 0.0373 59% 0 0.00 0.00 0 0%	Packaging 0.192 5.15 0.037 68% 0.1922 5.152 0.0373 68% 0 0.00 0 0.00 0 0%	Shipping 11051.933 30.12 11051.933 30.12 0 0.00	Total 127.05 88% 113.12969 84% -13.92 -4%
Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		y 14 days Cycle Time Throughput Utilization Diffence WIP Difference Cycle Time Difference Throughput Difference Utilization % WIP	27.885 17.3333 84% -86.8705 -5.01 0.0033 -4% -15.23%	38.1286 15.6121 84% -139.0608 -8.91 0 -4% -18.94%	Capsules 0.442 11.85 0.037 59% 0.442 11.8461 0.0373 59% 0 0 0.000 0 0%	Packaging 0.192 5.15 0.037 68% 0.1922 5.152 0.0373 68% 0 0.0373 68% 0 0.000 0 0%	Shipping 11051.933 30.12 11051.933 30.12 0 0.0	Total 127.05 88% 113.12969 84% -13.92 -4%
Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		y 14 days Cycle Time Throughput Utilization Difference WIP Difference Cycle Time Difference Utilization % WIP % Cycle Time	27.885 17.3333 84% -86.8705 -5.01 0.0033 -4% -15.23% -15.24%	38.1286 15.6121 84% -139.0608 -8.91 0 -4% -18.94% -18.94%	Capsules 0.442 11.85 0.037 59% 0.442 11.8461 0.0373 59% 0 0.007 0 0% 0.00% 0.00%	Packaging 0.192 5.15 0.037 68% 0.1922 5.152 0.0373 68% 0 0.0373 68% 0.0373 68% 0.00% 0.00%	Shipping 11051.933 30.12 11051.933 30.12 0 0.0	Total 127.05 88% 113.12969 84% -13.92 -4% -10.96%
Scenario 0 Scenario 6	Simulation Parameter Ba Base Case Setup reduction in bead fro		y 14 days Cycle Time Throughput Utilization Difference VIP Difference Cycle Time Difference Utilization % WIP % Cycle Time % Throughput	27.885 17.3333 84% -86.8705 -5.01 0.0033 -4% -15.23% -15.24% 0.02%	38.1286 15.6121 84% -139.0608 -8.91 0 -4% -18.94% -18.94% 0.00%	Capsules 0.442 11.85 0.037 59% 0.442 11.8461 0.0373 59% 0 0.007 0.00% 0.00% 0.00%	Packaging 0.192 5.15 0.037 68% 0.1922 5.152 0.0373 68% 0 0.0373 68% 0.007 0 0.00% 0.00% 0.00%	Shipping 11051.933 30.12 11051.933 30.12 0 0.0	Total 127.05 88% 113.12969 84% -13.92 -4% -10.96%





### **Simulations: Batch Size**

Scenario 2	Reduce available hours per day for packaging 20%	WIP	570.210	734.328	0.442	0.318	11051.933	
		Cycle Time	32.90	47.04	11.85	8.53	30.12	130.42
		Throughput	17.330	15.612	0.037	0.037		
		Utilization	88%	88%	59%	87%		88%
Scenario 11	Reduce available hours per day for packaging 20%	WIP	570.21	734.3281	0.442	0.2528	11051.933	
	Batch size in packaging from 5 to 7 for 10 mg	Cycle Time	32.8969	47.0359	11.8461	6.7768	30.12	128.67369
	Batch size in packaging from 10 to 12 for 20 mg	Throughput	17.33	15.6121	0.0373	0.0373		
	Batch size in packaging from 5 to 7 for 30 mg	Utilization	88%	88%	59%	79%		88%
		Diffence WIP	0	0	0	-0.0654	0	
		Difference Cycle Time	0.00	0.00	0.00	-1.75	0.00	-1.75
		Difference Throughput	0	0	0	0		
		Difference Utilization	0%	0%	0%	-8%		0%
		% WIP	0.00%	0.00%	0.00%	-20.55%		
		% Cycle Time	0.00%	0.00%	0.00%	-20.53%		-1.34%
		% Throughput	0.00%	0.00%	0.00%	0.00%		
		% Utilization	0.00%	0.00%	0.00%	-9.20%		0.00%



Reduction of available time can be compensated by increase of Batch Size The optimal Batch Size is 1.7 Mio (10mg) vs current Batch of 0.5 Mio



### Capsules



### **Results**



Reduction of FG inventory by 30 days→ 6,5 Mio\$ in working capital





8,4% reduction in operational costs









# FlowBalancer

# A stochastic and analytical planning tool @ job shops

Powered by







### Agenda

- Flow system approach
- Planning challenges



- Reason and solution for these challenges: ERP vs ARP
- Software integration with examples
- Results from practice





### **Flow System Approach**







### Flow System Approach @ Job Shops



Gives your Performance Wings

# Planning Challenges @ Job Shops

#### Uniform, consistent and advanced decision support tool

Monthly sales & operations meeting

- Capacity-Demand Analysis
- Lot sizingImprove d
- Improve delivery performance
- Quickly calculate the impact of decisions during the meeting
- User friendly interface and powerful visualizations
- Integration with ERP system

Yearly/quarterly process flow design and engineering

- Simulation of new products
- Simulation of new layouts





# Planning Challenges @ Job Shops

#### Stochastic nature of the manufacturing system



- Seasonality
- Product mix changes
- 🏺 Phasing-in/out



**Supply** 

- Alternative routings, outsourcing, ...
- Lot sizes, inventory levels
- 🏺 🛛 Breakdowns, scrap
- Unreliable delivery of raw material/ finished good,...





# Planning Challenges @ Job Shops

#### Job Shop

#### **Decision Problem**

#### Demand Meeting

- Needs vs Supply
- Multiple functions
- Separate tools

#### Complex

- Interdependent
- Various goals
- Intuition

#### Data Warehousing

Nyo

#### **Decision Support**

- Analytical S&OP
  - System Approach
  - Different views, same world
  - One shared database
- Modeling
  - Flow Theory
  - Performance measures
  - Software implementation
  - Data Discipline





# S&OP Approach @ Job Shops

#### **ERP: DETERMINISTIC AND STATIC PLANNING**



#### FLOWBALANCER: STOCHASTIC AND DYNAMIC PLANNING



### **ERP @ Job Shops**



### **ERP @ Job Shops**



### **ARP** @ Job Shops





Gives your Performance Wings

### **ARP** @ Job Shops

If our standard is a quoted lead time to deliver within 50 hours, our customers will have a service level of 90 %



### **ARP** @ Job Shops



# Software Integration @ Job Shops



nvo alatus

Gives your Performance Wings



### **Dashboard - Scenario 1**







### **Resource Under/Overcapacity**





Scenario: Use more/less shifts-overtime



### **Product Volumes**



Scenario: Assign volume Period 1+3 to Period 2





### **Product Lead Times**



Scenario: Use alternative routing more





### **Product Lead Times**



Scenario: Use alternative routing more



### **Positioning FlowBalancer**



Gives your Performance Wings

### **Benefits @ Dana Corporation**



- Productivity: +27%
- Manufacturing lead time: -50 to -60%
- Inventory turns: from 3.5 to 6
- Workforce: +41%
- Sales/FTE: +66%
- Operating costs: more than -10%

**S&OP process: 85%** of all the improvements with *mid term* planning **Detailed scheduling**: the remaining 15% with *short term* planning





### **Benefits @ Atlas Copco Airtec**

- 2000 2012
  Implementation and further development at
  Atlas Copco,
  Continental Tyres
  Baxter
  JNJ
  GSK
  UCB
- Better data quality in ERP system
- Objective and consistent decision tool
- Setimate impact of a S&OP decision on KPIs
- Accurate due date promising
- Dynamic lead time offsets, up to twice as large than used so far

Better customer service & Better delivery performance





# **Questions?**





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We explicitly include the stochastic nature of the production system to allow for variability and disruptions. The mathematical expressions for the expected lead time and lead time variance depend on lot sizes. This enables the plant to minimize lead time and thus optimize lot sizes for all parts simultaneously.



If given lead times are unacceptable, adjustments are made to the capacity structure, unloading overloaded equipment or selecting alternative routings. The queuing model responds quickly to these requests, a main reason it has worked.

#### Rony Cremmery Former Supply Chain Director @ Spicer-Off Highway, Dana Corp

By using these models, our organization has gained insight into non-evident impact factors like uncertainty, variability and stochasticity. This has enabled us to quantify their influence on lead times and associated costs.

#### Noel Janssens Supply Chain Manager Portable Energy Spare Parts, Atlas Copco Airpower NV

**KU LEUVEN**