Uncertainty based capacity planning

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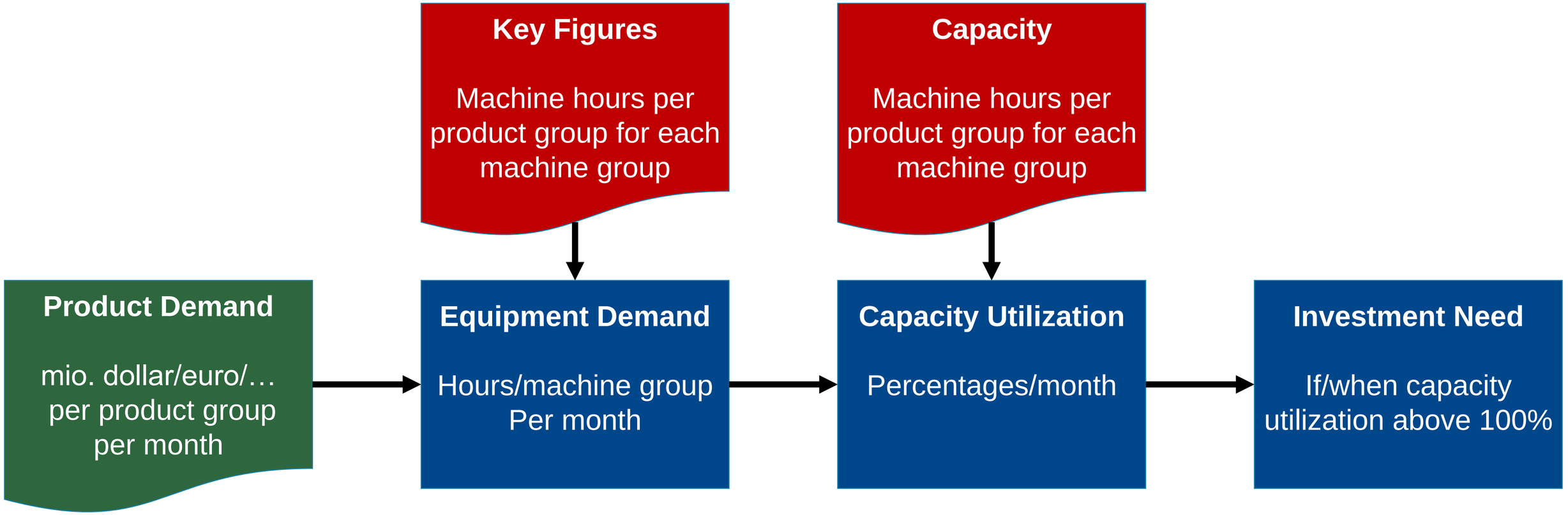
#RISKAWARENESSWEEK2020

RISK AWARENESS WEEK 2020

Agenda

1. Capacity planning in brief
2. Grouping products and machines
3. Data analytics
4. Modelling and simulation
5. Address the outcome
6. Further improvements
7. Conclusions
8. Who am I talking

Capacity planning in brief



Capacity planning in brief

	A	B	C	D	E	F	G	H	I	J	K
1	**Demand Survey (hours)**										
2											
3	**Equipment X**	**Jan**	**Feb**	**Mar**	**Apr**	**Maj**	**Jun**	**Jul**	**Aug**	**Sep**	**Okt**
4	Product A	2.400	2.880	3.120	3.600	3.360	3.120	2.880	3.120	3.360	3.840
5	Product B	2.200	2.090	1.980	1.760	1.650	1.320	1.540	1.650	1.980	2.200
6	Product C	0	0	0	0	0	0	0	0	0	0
7	Product D	20.000	20.500	20.000	19.500	20.000	20.500	20.000	19.500	19.000	21.000
8	Product E	1.500	2.400	4.500	3.000	2.400	2.100	2.100	1.800	2.400	3.600
9	**Standard Demand**	**26.100**	**27.870**	**29.600**	**27.860**	**27.410**	**27.040**	**26.520**	**26.070**	**26.740**	**30.640**
10	No of machines	54	54	54	54	54	54	54	54	54	54
11	Hrs/machine	720	720	720	720	720	720	720	720	720	720
12	Standard Capacity	38.760	38.760	38.760	38.760	38.760	38.760	38.760	38.760	38.760	38.760
13	**Standard Capacity Load**	**67%**	**72%**	**76%**	**72%**	**71%**	**70%**	**68%**	**67%**	**69%**	**79%**

We do not seem to need further equipment…

… Yet, simulations will show a 36% likelihood of missing ability to meet demand

Capacity planning issues

- Demand based on elaborate and detailed forecasting process
- Capacity requirements based on ERP system
- We have tons of data at our disposal
- Data are known to be uncertain

Yet

- Forecasts and capacity profiles are based on single point estimates
- Uncertainties are (subsequently) handled through experience based maximum utilization

Effective, uncertainty based decision making is not applied/leveraged

Improvement of capacity planning

Aspiration

- Calculate and leverage a (more) valid profile for capacity utilization and investments

Strategy

- Analyse and recognize known uncertainties
- Set and apply targets for delivery service
- Model using Monte Carlo simulation
- Calculate relevant capacity profile and investment needs

Data analytics

You have tons of data

- Planned/forecasts and actual sales figures
- Capacity demand key figures
- Equipment uptime/capacity figures

Calculate/analyse uncertainty profiles

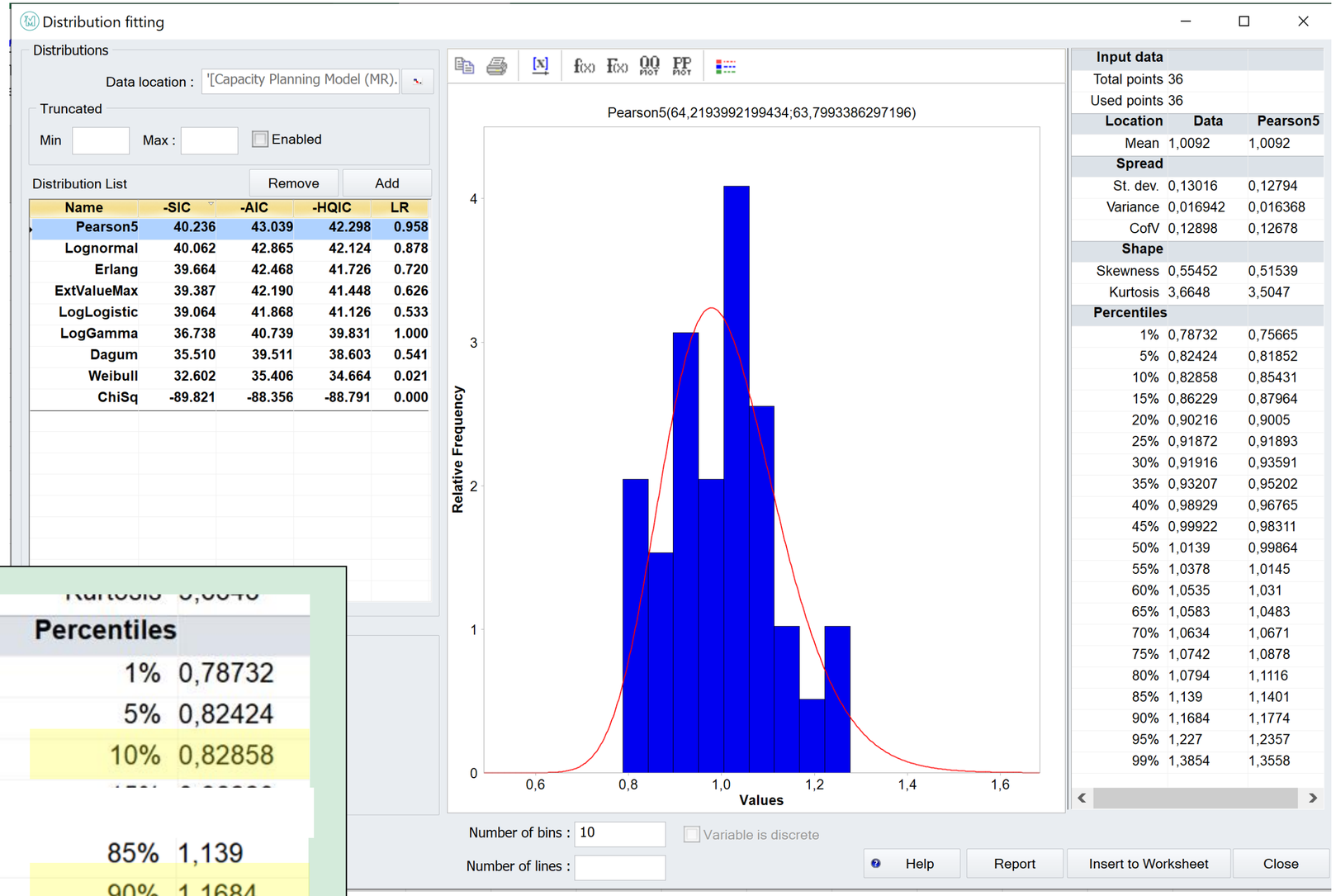
- Based on known data
- Leverage a Planned/Actual factor

	A	B	C	D
1	**Data analytics example**			
2	**Product A Sales**			
3				
4	**Month**	**P Planned**	**A Actual**	**A/P Factor**
5	Jan	100	82	0,82
6	Feb	120	99	0,83
7	Mar	130	140	1,07
8	Apr	150	133	0,89
9	May	140	130	0,93
10	Jun	130	135	1,04
11	Jul	120	117	0,98
12	Aug	130	129	0,99
13	Sep	140	147	1,05
14	Oct.	160	169	1,05
15	Nov	180	190	1,06
16	Dec	200	216	1,08
17	Jan	105	128	1,22

Data analytics

Select simulation distribution

- Vose/ModelRisk and @Risk have tool to do this effectively
- Just pick the best fit unless you have insights to select others
- Discuss approach and outcome with planning team
- Accept that uncertainties may be bigger than what is generally expected



Modelling demand

F12 =VoseTriangle($B$12;$C$12;$D$12)*F4

	A	B	C	D	E	F	G	H	I
1	**Sales**								
2						**Sales Value mUSD**			
3	**Planned Sales**					Jan	Feb	Mar	Apr
4	Product A					100	120	130	150
5	Product B					200	190	180	160
6	Product C					60	80	100	120
7	Product D					400	410	400	390
8	Product E					50	80	150	100
9	**Total Planned Sales**					**810**	**880**	**960**	**920**
10		**Definition of uncertainty**							
11	**Simulated Sales**	Min	ML	Max					
12	Product A	70%	100%	130%		97	114	132	173
13	Product B	80%	100%	110%		216	204	154	134
14	Product C	50%	100%	150%		61	82	101	100
15	Product D	90%	100%	120%		451	379	333	464
16	Product E	25%	100%	200%		47	86	167	88
17	**Total Simulated Sales**					**873**	**866**	**888**	**960**
18									

Modelling key figures

	A	B	C	D	E	F	G	H	I	J
1	**Capacity Needs**									
2						**Equipment**				
3	**Capacity need hours/mUSD**		**X**			**Y**			**Z**	
4		Min	ML	Max	Min	ML	Max	Min	ML	Max
5	Product A	23	24	26	20	22	25	11	13	16
6	Product B	10	11	13	15	16	18	22	30	35
7	Product C				4	5	7	30	42	50
8	Product D	40	50	75	20	22	25	30	33	34
9	Product E	25	30	40	23	25	28	40	48	52
10										
11										

… and equipment downtime

	A	B	C	D	E	F	G	H	I	J
13	**Capacity Risk Profile**							**X**	**Y**	**Z**
14	Average Breakdowns/month							5	6	10
15	Breakdown Duration/hours			Min				5	1	8
16				Exp				24	10	48
17				Max				96	24	150

Modelling equipment demand profile

Demand Survey (hours)											Delivery certainty		90%
Equipment X	**Jan**	**Feb**	**Mar**	**Apr**	**Maj**	**Jun**	**Jul**	**Aug**	**Sep**	**Okt**	**Nov**	**Dec**	**YEAR**
Product A	2.201	2.6									5.008	4.747	41.105
Product B	2.629	2.2								2	2.064	3.481	26.569
Product C	0	0	0		0	0	0	0	0	0	0	0	0
Product D	29.225	20.874	19.120	22.981	28.490	20.339	21.477	14.663	23.614	20.496	20.489	28.446	270.214
Product E	1.359	2.781	5.134	2.449	2.570	2.034	1.870	2.401	2.285	4.605	5.648	5.353	38.488
Simulated Demand	**35.414**	**28.562**	**29.684**	**31.273**	**35.424**	**27.398**	**27.895**	**22.919**	**31.361**	**31.208**	**33.208**	**42.027**	**376.376**
No of machines	54	54											3
Hrs/machine	720	720											0
Breakdown hours	257	269	373	555	145	246	82	204	21	393	426	251	3.222
Simulated Capacity	**38.623**	**38.611**	**38.507**	**38.325**	**38.735**	**38.634**	**38.798**	**38.676**	**38.859**	**38.487**	**38.454**	**38.629**	**463.338**
Utilization/Load	92%	74%	77%	82%	91%	71%	72%	59%	81%	81%	86%	109%	81%
90th Percentile Load	**88%**	**93%**	**97%**	**92%**	**91%**	**90%**	**89%**	**87%**	**88%**	**101%**	**107%**	**113%**	**84%**
Non delivery risk	**1%**	**3%**	**6%**	**2**	**2%**	**3%**	**2%**	**1%**	**1%**	**11%**	**22%**	**36%**	**36%**

=Sales!I15*VoseTriangle(Capacity!$B8;Capacity!$C8;Capacity!$D8)

=VosePoisson(Capacity!$C$14)*VoseTriangle(Capacity!$C$15;Capacity!$C$16;Capacity!$C$17)

=VoseSimPercentile(E14;$N$1)

=VoseSimProbability(L14;1)

Address the outcome

Demand Survey (hours)											Delivery certainty		90%
Equipment X	**Jan**	**Feb**	**Mar**	**Apr**	**Maj**	**Jun**	**Jul**	**Aug**	**Sep**	**Okt**	**Nov**	**Dec**	**YEAR**
Product A	2.904	2.561	2.788	2.893	3.320	2.633	2.598	2.868	4.144	4.207	5.112	5.639	41.668
Product B	2.242	2.097	2.067	2.059	1.839	1.374	1.872	1.613	1.901	2.054	2.322	3.705	25.144
Product C	0	0	0	0	0	0	0	0	0	0	0	0	0
Product D	19.034	17.609	23.220	28.816	15.284	21.865	17.256	18.015	18.018	27.713	28.622	24.532	259.983
Product E	1.909	3.304	4.765	2.899	2.882	1.953	2.093	1.520	2.519	3.930	4.638	7.004	39.417
Simulated Demand	**26.089**	**25.570**	**32.840**	**36.667**	**23.325**	**27.825**	**23.819**	**24.016**	**26.582**	**37.905**	**40.694**	**40.880**	**366.212**
No of machines	54	54	54	54	54	54	54	54	54	55	59	62	662
Hrs/machine	720	720	720	720	720	720	720	720	720	720	720	720	8.640
Breakdown hours	490	495	355	269	328	118	355	212	7	620	232	68	3.649
Simulated Capacity	**38.390**	**38.385**	**38.525**	**38.611**	**38.552**	**38.762**	**38.525**	**38.668**	**73**	**38.980**	**42.248**	**44.572**	**472.991**
Utilization/Load	68%	67%	85%	95%	61%	72%	62%	6	69%	97%	96%	92%	77%
90th Percentile Load	**88%**	**93%**	**96%**	**92%**	**91%**	**91%**	**88%**		**88%**	**99%**	**98%**	**98%**	**82%**
Non delivery risk	**1%**	**3%**	**6%**	**2%**	**3%**	**2%**	1		**1%**	**8%**	**8%**	**7%**	**8%**

It appears we do need to invest in Equipment type X to be 90% certain to be able to meet demand

Further improvements

- **Embed inventory profile to enable levelling supply**
  - Opening stock
  - Inventory levels and policies to avoid investments
- **Differentiate between delivery service levels**
  - What needs to be e.g. 90%, what needs to be e.g. 80%
  - What can we deliver on the remainder
- **Embed risks and opportunities**
- **Analyse/embed correlations**

Be a valuable partner to the planning team

Conclusions

- Capacity planning is a vital decision process used in most industrial companies
- Still it is often very elaborately leading to an extremely detailed single point estimate
- Oddly enough … It does NOT show investment needs directly

- As risk manager, you are the expert on uncertainties
- Leverage data analytics and Monte Carlo simulation to help the planning team
- Give them tools and understanding … not results

- Liaise and collaborate – let the planning team win
- The purpose is to leverage intelligent risk taking

- Do not worry – the organisation will know your contribution

Who am I talking about this

- 13 years as LEGO Group manufacturing capacity planner
- 13 years in other LEGO Group functions including
  - IT
  - Strategic Planning
  - Finance
  - Product Development
- 10 years as LEGO Group head of Strategic Risk Management
- 3 years as independent consultant at AKTUS
- I can be reached at hl@aktus.dk