



Outline

Case study 1 “Mechoff”

Design of manufacturing systems – Job Shop

- Introduction
- Input data
- Top management’s questions

MECHOFF - *introduction*

- MECHOFF is a small company operating in the field of **mechanical components** for industrial **air conditioning** systems
- Founded **30 years** ago
- It has **30 operators** working on the shop floor
- The main **customers** of MECHOFF are producers of **industrial air conditioning systems**.
- **Quality** is the main strength of MECHOFF, as perceived by its Customers.



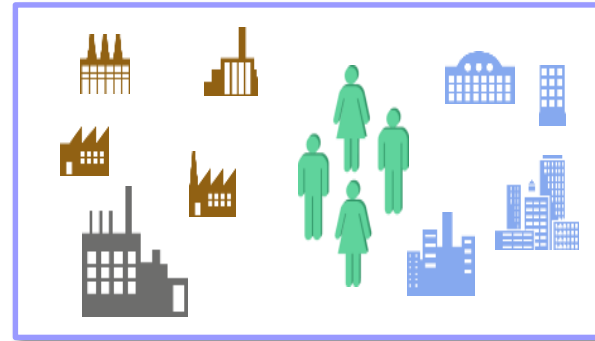
MECHOFF - *introduction*

- Concern: the company is not achieving the same efficiency rate **improvement** as it was during the first years from its foundation.
- The profitability of the company is not at risk, though the **slow decline** in **internal performance** is considered an alarm signal that could result in more relevant problems in the future.



MECHOFF - *introduction*

- Problems may be due to the more and more frequent **outsourcing** (cheapest solution some years ago when demand increased).
- At the beginning, outsourcing was used in extreme situations, three times in a quarter.
- Nowadays **milling** and **grinding** of SP product family are outsourced without even making a short check on internal capacity.



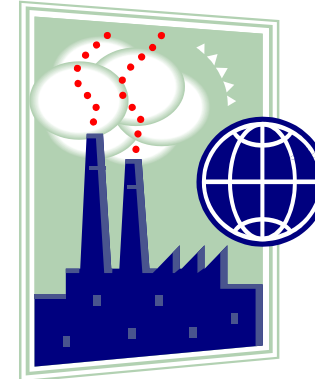
MECHOFF - *introduction*

- The production of a component cannot be assigned only to **one sub-supplier**.
- Therefore **reliability of sourcing**, guaranteeing a high and stable quality level has become more and more **difficult**.
- Moreover, when high volumes are required, some sub-suppliers cannot **deliver on time**
- MECHOFF must revise its **plans** accordingly, in order to satisfy its customer needs.



MECHOFF - *introduction*

- Demand of **SP family products is growing**
- The company is interested in accepting the order of a **new customer** to produce a new product that can be added to the same family.
- If this order were accepted, the yearly volume required would be **2000 units** for the first **two years**.
- MECHOFF top management would be interested in knowing in which way the company could **satisfy the demand internally**.



MECHOFF - *introduction*

- Is it possible to meet demand without buying any new machines (just varying the **number of shifts**)?
- Or is it necessary to buy **new machines (how many)**?
- **Space** is not a constraint because an eventual new expansion of the manufacturing plant was taken into account in the design of layout.



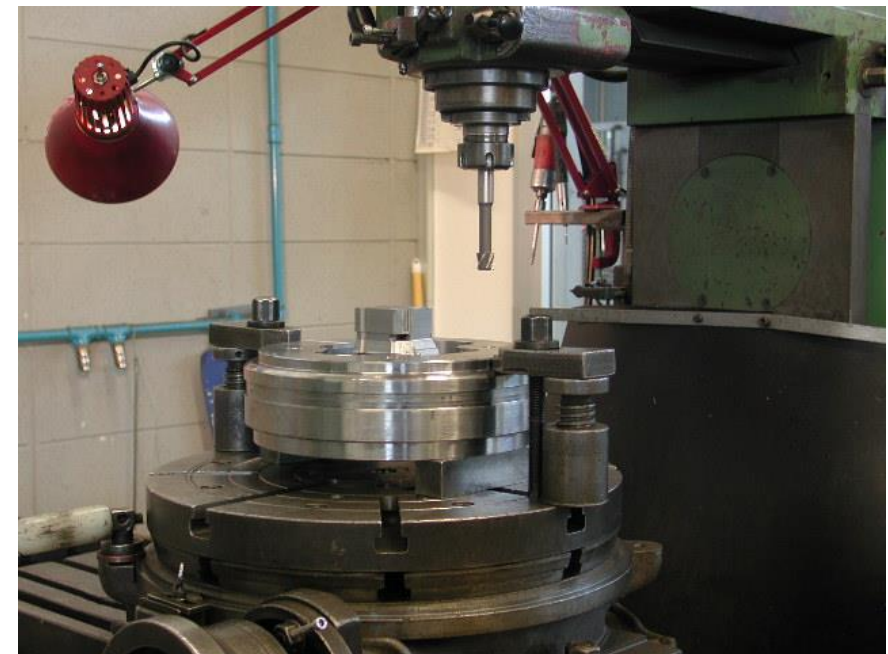
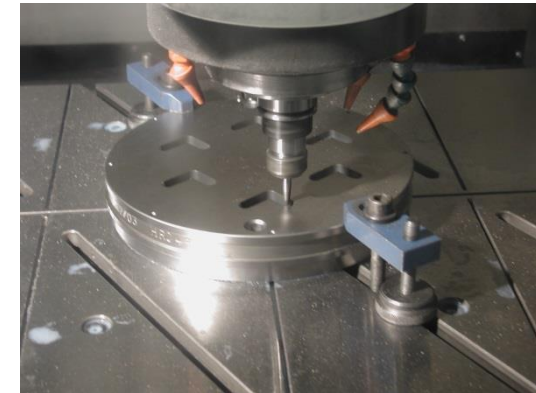
MECHOFF - *input data*

	Type of machine	Number of machines (WS) currently available
M1	Universal miller	2
M2	Drilling machine	5
M3	Machining center	8
M4	Lathe	2
M5	Face grinder	12

MECHOFF - *introduction*



Working stations



MECHOFF - *introduction*



Working stations



MECHOFF - *input data*

- **Drilling department** is not well saturated since, usually, only 4 out of 5 machines regularly work. Therefore it is common opinion that the available capacity is enough also for the new products.

MECHOFF - *input data*

- Information about **working time** and **set up time** of different **components** on different **machines** are respectively in Table 2 and Table 3.
- **Working times** and **set up times** for the **new products** have been **estimated** by the production manager based on similar pieces which are currently manufactured.
- **Set up times include:**
 - upload of working programme
 - picking of the correct tool from the tool warehouse
 - fitting
 - machine cleaning

Set up times are included all the activities that are needed to prepare the machine to work a batch of products. The set up is always done when the machine is not working, therefore production is stopped.

MECHOFF - *input data*

Working time (hrs/unit)

	M1	M2	M3	M4	M5
PZ1	0.55	1.25			
PZ2	0.25		0.5	0.2	
PZ3	0.4	0.5		0.65	
PZ4	0.4		1.25	0.35	
DI1	0.2	0.2		0.15	0.5
DI2	0.2	0.4		0.14	1
DI3	0.3			0.17	0.7
DI4		1		0.25	0.2
DI5	0.2			0.2	
RO1			0.4		0.5
RO2			0.3		0.95
RO3			1		0.98
RO4			0.2		1.05
RO5			0.5		0.65
SP1	0.5	0.3			1.2
SP2	0.45	0.5			0.8
SP3	0.3	0.2			0.9
SP4	0.6	0.8			1.5

MECHOFF - *input data*

Setup time (hrs/batch)

	M1	M2	M3	M4	M5
PZ1	3	3			
PZ2	1.5		3	2	
PZ3	2	3		2.5	
PZ4	2		5.5	3	
DI1	2	1.5		2	1
DI2	1.5	1		3	0.5
DI3	1.5			2	1
DI4		2		2	0.5
DI5	1			3	
RO1			1		2.5
RO2			2		3
RO3			1		2.5
RO4			2.2		3
RO5			2		4
SP1	1.5	0.5			2
SP2	1	1			1.5
SP3	1.2	1.5			1
SP4	2	2			2

MECHOFF - *input data*

- According to a rough analysis it has been evaluated that the availability of machines is 0.95.
- The **human coefficient** has been fixed to 0.94.
- The **reference mix** is given by the 3 product **families** that are manufactured internally (**PZ**, **DI** and **RO**) and by the new family **SP**.

MECHOFF - *input data*

Working hours and shifts

- **5 working days** a week (i.e. **220 days/year**)
- All departments work for **2 shifts/day**
- Each shift is **7.5h** long
- **Overtime**: no more than **2 hours a day** and no more than **8 hours on Saturday** (as agreed with Trade Unions).

PS

The top management wants all departments to work the same number of shifts in order to make management easier and to avoid the presence of WIP that would cumulate among departments.

MECHOFF - *input data*

- All the data that can be useful to find the best solution to **increase production capacity** have been collected.
- **Yearly demand** for all components and the **number of batches** that are dispatched every year are shown on next table.
- The average **scrap rate** is **4%**, this value can be used also for the SP family.
- **Labour cost** is 13.50 €/h for an Operator working on first shift, 14.50 €/h on the second shift, 15.50 €/h on the third shift (OT is 21 €/h).

MECHOFF - *input data*

Code	Yearly demand (units/year)	Number of batches per year (batches/year)
PZ1	500	10
PZ2	500	12
PZ3	500	18
PZ4	500	9
DI1	2500	40
DI2	3400	40
DI3	6250	30
DI4	5000	25
DI5	500	15
RO1	8000	30
RO2	500	5
RO3	6500	20
RO4	500	10
RO5	10000	50
SP1	5000	25
SP2	7000	35
SP3	2600	13
SP4	2000	20

MECHOFF - *input data*

	M1	M2	M3	M4	M5
Machine cost (€/machine)	150000	300000	200000	250000	250000

- **Machine lifetime indicator** (m_i)=0.05
- **Scheduling efficiency**: 0.8 (i.e. to take into account the hours that could be lost because of difficulties in management)

PS

Please make the reasonable assumptions in case of missing data

MECHOFF - *Top Management's questions*

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