Outline

Case study 2 “Mechoff”

Design of manufacturing systems – Cellular Manufacturing

- Introduction
- Input data
- Top management’s questions

MECHOFF cells - ***introduction***

- MECHOFF is a small company operating in the field of **mechanical components** for industrial **air conditioning** systems.

- Demand of **SP family products is growing**.

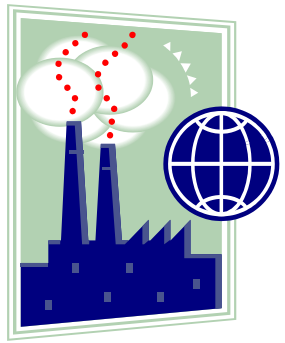
- The company is interested in accepting the order of a **new customer** to produce a new product that can be added to the same family.

- 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 cells - ***introduction***

After checking the best solution to re-insource milling and grinding processes by keeping a Job Shop configuration of the plant, further considerations can be made:



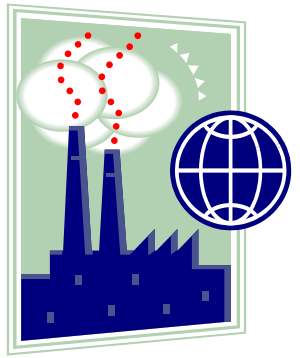
1. one of the main goals of the company is to reach **stable quality;**

2. another concern of the company is the achievement of **shorter lead times;**

3. **similar technological routings are required** in order to produce many products.

MECHOFF cells - ***introduction***

Cellular manufacturing may be beneficial for these issues:



1. **Stable quality:** quality may be more stable for many reasons (work organization, product routings, …)

2. **Shorter lead times:** there is expectation for less WIP than in Job Shop

3. **Similar technological routings:** it is the right condition for a cellular manufacturing to be designed, by creating product families with similar technological routings to be performed in the cells.

MECHOFF cells - ***introduction***

- Is it possible to meet the demand with **manufacturing cells**?

If yes, some questions to be answered may be:

- How many **machines** do I need?
- How many **fixtures** do I need?

MECHOFF cells - ***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 cells - ***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 0.96.
- 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 cells - ***input data***

- Information about **working time** and **set up time** of different **components** on different **machines** are respectively in Table 2 and 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 including 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.

- Note that there is an expectation of **setup time reduction**, with respect to the Job Shop case: product families are similar and universal fixtures could be designed as a result of a standardization project.

MECHOFF cells - ***input data***

Assumption:

For fixtures and tools there are two storage policies:

1. there is a centralized warehouse to stock the non standard tools and fixtures (re-used as existent job shop tools, tools for trials, …);

2. a small warehouse in each manufacturing cell is present for those fixtures that are standardized (universal fixtures, at least for the same product family).

MECHOFF cells - *input data*

Working time (hrs/unit)

	M1	M2	M3	M4	M5
PZ1	0,55	1,25	0	0	0
PZ2	0,25	0	0,5	0,2	0
PZ3	0,4	0,5	0	0,65	0
PZ4	0,4	0	1,25	0,35	0
DI1	0,2	0,2	0	0,15	0,5
DI2	0,2	0,4	0	0,14	1
DI3	0,3	0	0	0,17	0,7
DI4	0	1	0	0,25	0,2
DI5	0,2	0	0	0,2	0
RO1	0	0	0,4	0	0,5
RO2	0	0	0,3	0	0,95
RO3	0	0	1	0	0,98
RO4	0	0	0,2	0	1,05
RO5	0	0	0,5	0	0,65
SP1	0,5	0,3	0	0	1,2
SP2	0,45	0,5	0	0	0,8
SP3	0,3	0,2	0	0	0,9
SP4	0,6	0,8	0	0	1,5

MECHOFF cells - ***input data***

Setup time (hrs/batch) – for the job-shop configuration

	M1	M2	M3	M4	M5
PZ1	3	3	0	0	0
PZ2	1,5	0	3	2	0
PZ3	2	3	0	2,5	0
PZ4	2	0	5,5	3	0
DI1	2	1,5	0	2	1
DI2	1,5	1	0	3	0,5
DI3	1,5	0	0	2	1
DI4	0	2	0	2	0,5
DI5	1	0	0	3	0
RO1	0	0	1	0	2,5
RO2	0	0	2	0	3
RO3	0	0	1	0	2,5
RO4	0	0	2,2	0	3
RO5	0	0	2	0	4
SP1	1,5	0,5	0	0	2
SP2	1	1	0	0	1,5
SP3	1,2	1,5	0	0	1
SP4	2	2	0	0	2

MECHOFF cells - ***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

MECHOFF cells - ***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 **3.5%**, this value can be used also for the SP family.

MECHOFF cells - ***input data***

Code	Yearly demand (units/year)	Number of batches per year (batches/year) – for the job shop configuration
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 cells - ***input data***

- **Machine lifetime indicator** (m_i)=0.05
- **Scheduling efficiency**: 0.85 (i.e. to take into account the hours that could be lost because of difficulties in management)
- **Maintenance coefficient** (for fixture dimensioning) is: 0.98

PS Please make the reasonable assumptions in case of missing data

MECHOFF cells - ***input data (comparison)***

Data	Job Shop	Cells	Comment
Scrap rate	4%	3.5%	Higher quality in the case of cells
Human coefficient	94%	96%	In the cells the space is optimized and the worker has less time waste when attending the machines
Setup times	High	Low	Due to universal fixture assumption for the product families
N. Batches / year	Low	High	Thanks to the lower set up times, smaller lots can be considered as lot sizing policy, in order to have different advantages, such as an expected reduction of WIP in the system (favourable for shorter lead time)
Scheduling efficiency	80%	85%	Easier management

MECHOFF cells - ***Top Management's questions***

- Is it possible to meet the demand with **manufacturing cells**?

If yes, some questions to be answered may be:

- How many **machines** do I need?
- How many **fixtures** do I need?