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PPU231
OEE & Production disturbance management

Five main tasks - Project

1. Maintenance Policy Selection using RCM

    a) RCM proposition
    b) Advantages / disadvantages

Maintenance policy using RCM

2. Priority-based Maintenance

    a) Production capacity
    b) Prioritisation of reactive maintenance
    c) From reactive to proactive maintenance

Priority-based maintenance

3. Production service improvements and disturbance management
    a) Comparing OEE and acive periods
    b) Maximizing OEE
    c) Other factors impacting OEE

OEE and disturbance mgmt.

4. Design of a Production Service System

5. Evaluation of product design changes on production performance & Circular economy solutions

WS1 & WS2

To reflect… Task 2

How can you estimate the expected production? What methods can you use?

	Cycle time (sec)	Set-up time (sec)	MTBF (min)	MTTR (min)	PM interval (hours)	PM time (hours)	Scrap rate
Cutter 1	240	600	100	15	60	2	1%
Cutter 2	240	600	130	17	60	2	1%
Welding 1	300	420	130	16	40	3	--
Welding 2	300	420	180	20	40	3	--
Painting 1	60	120	500	10	150	1	--
Painting 2	60	120	650	15	150	1	--
Painting 3	120	120	360	12	150	1	--
Drying 1	120	0	600	15	100	1	--
Drying 2	120	0	660	13	100	1	--
Drying 3	120	0	560	11	100	1	--
Sticker	120	240	800	10	200	2	---
Heat 1	100	0	--	--	100	5	1%
Heat 2	100	0	--	--	100	5	1%
Qual. insp.	120	0	--	--	--	--	4%

How could you introduce some variability? Maybe a sensibility analysis?

Do you think the system will perform like this? Can you make other assumptions?

Task 5.A

Design change	Cutter 1&2	Welding 1&2	Heat treatment 1	Heat treatment 2	Painting 1-3	Drying 1-3	Stickers
7005 T6 material	Increase CT 1%, Decrease MTBF 5%	Increase CT 1%, Decrease MTBF 5%, Increase MTTR 5%	Increase CT 1%	Increase CT 1%			
7075 T6 material	Increase CT 3%, Decrease MTBF 5%, Increase MTTR 5%	Increase CT 3%, Decrease MTBF 10%, Increase MTTR 10%	Increase CT 2%	Increase CT 2%			
Head angle		Increase CT 1%, Decrease MTBF 5%, Increase MTTR 5%			Decrease MTBF 5%		
Chainstay length							Increase CT 1%
Stand over height							Increase CT 1%
Reach							Increase CT 1%
Bottom bracket height							Increase CT 1%
Bottom bracket type	Increase CT 2%, Decrease MTBF 5%,			Increase CT 1%	Increase CT 1%	Decrease MTBF 2%	

Change from product A to product B / from product B to product A: 6 hours – you should decide on the size of the batch

Task 5.A

Easier to motivate your evaluation report if:

Step 1. You can compare your max. production capacity considering the information presented in the table (previous slide) – one design change at the time, and a combination of those.

Step 2. Reflect about other impacts (than those presented on the table in the previous slide) of the changes in the production system – You can use the results of WS1 as support

Step 3: Find the individual and/or combination of design changes with lower impact on production performance.

Step 4: Construct an evaluation report (send to adriana.ito@chalmers.se and directly to your corresponding product group) until 26/Feb.

- Maximum 1 A4-page (take inspiration from Lean A3 sheet)
- Descriptions of the change in performance of individual machines caused by design changes (from step 1 and step 2)
- A set of recommendations for how to minimize the negative impact of product changes on production system performance

Important dates

- WS2 - Thursday, 2021.02.25, 09.00-11.00 (mandatory participation!)
- Evaluation of design changes - Friday, 2021.02.26 (send it to my email adriana.ito@chalmers.se
- Upload the draft report - Thursday, 2021.03.04 at 23.55 – upload in Canvas
- Upload the Power-Point presentation slides at Canvas before 2021.03.10 at 23.55.
- Upload the written opposition at Canvas before 2021.03.10 at 23.55.
- Upload the final report at Canvas before 2021.03.19 at 23.55.

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OEE & Production disturbance management

In this lecture…

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LO4: Interpret, describe and evaluate Production and Product Service Systems;

LO6: Differentiate, select and develop actions to improve production systems or products during the whole life-cycle.

Agenda

- OEE
- Disturbance management
- Disturbance data
- Design of PSS
- Some reflections about task 3 & 4

Agenda

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- **OEE**
- **Disturbance management**
- **Disturbance data**
- **Design of PSS**
- **Some reflections about task 3 & 4**

OEE

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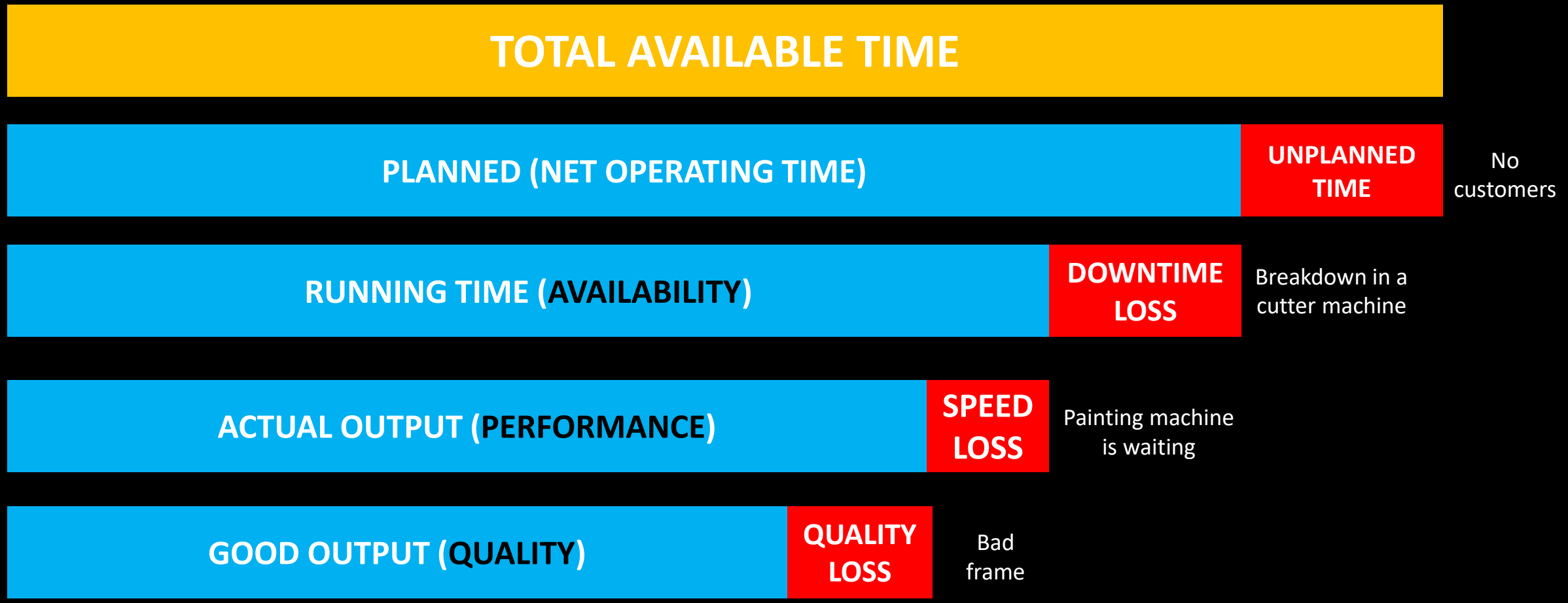
Overall equipment effectiveness (OEE) is a measure of how well a manufacturing operation is utilized compared to its full potential, during the periods when it is scheduled to run.

OEE


TOTAL AVAILABLE TIME
PLANNED (NET OPERATING TIME)
UNPLANNED TIME
No customers
RUNNING TIME (AVAILABILITY)
DOWNTIME LOSS
Breakdown in a cutter machine
ACTUAL OUTPUT (PERFORMANCE)
SPEED LOSS
Painting machine is waiting
GOOD OUTPUT (QUALITY)
QUALITY LOSS
Bad frame

OEE

Original OEE definition (Nakajima)

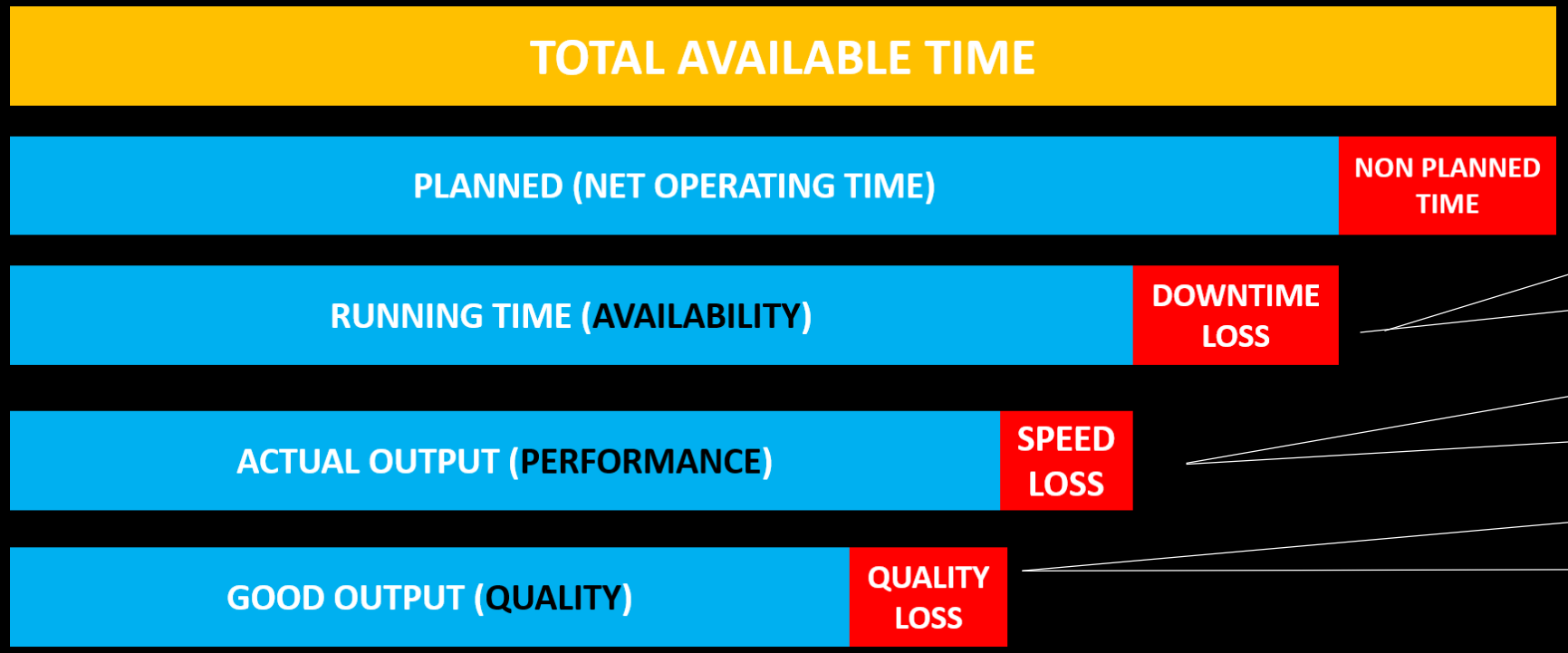
Availability
=
Available production time / Planned production time

Performance
=
(Ideal cycle time * Number of products produced) / Planned production time

Quality
=
(Number of products produced – Scrap) / Number of products produced

OEE = Availability * Performance * Quality

OEE – six big losses



1) Breakdowns
2) Setup/adjustment
3) Idling/minor stops
4) Speed
5) Defects / rework
6) Start-up losses

DUE TO DISTURBANCES WE COMPROMISED ~50% OF OUR CAPACITIES.

We could be twice as more efficient!

What does that mean?

- Less resource utilization
- Less rework
- Higher safety
- Higher costumer satisfaction
- …

Agenda

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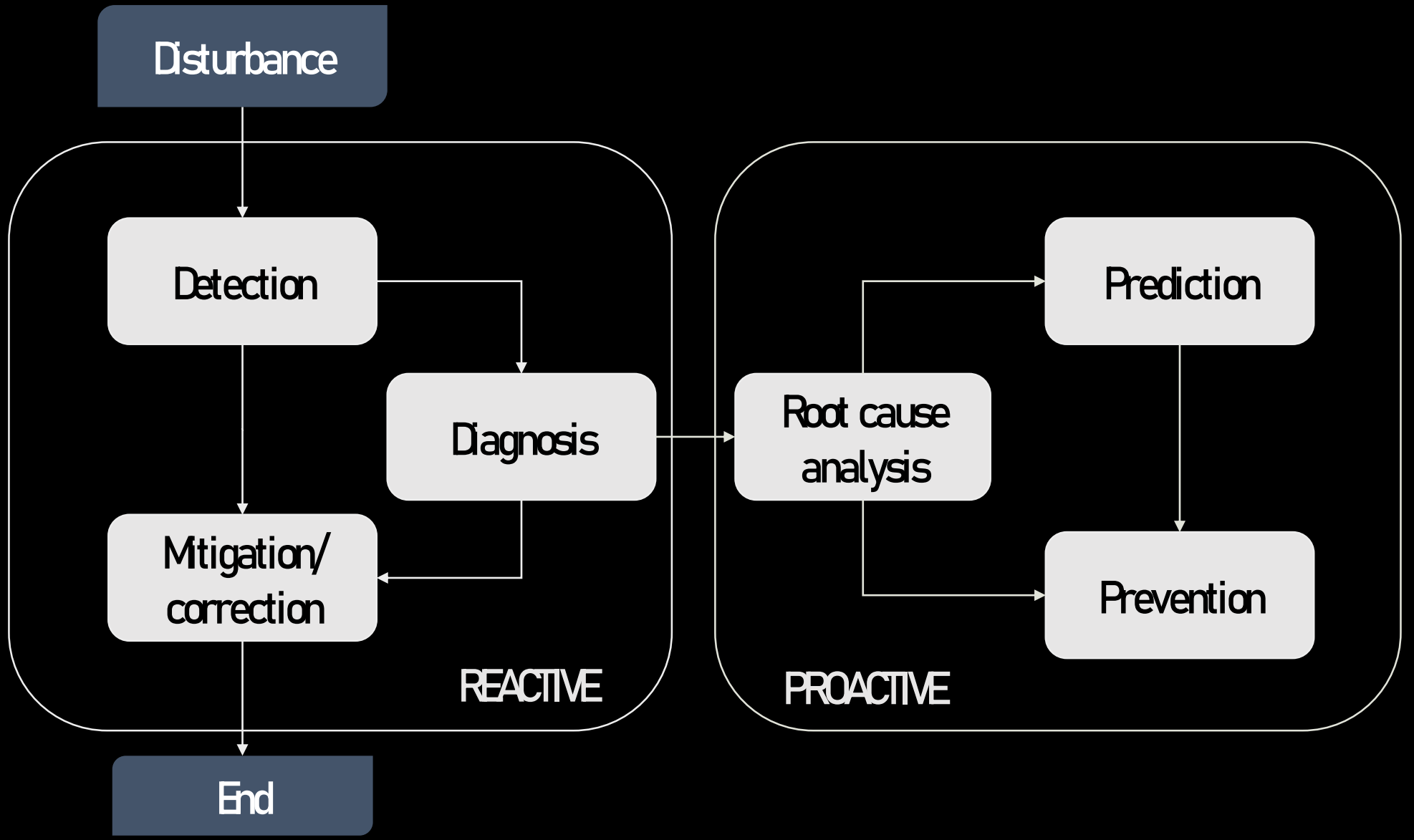
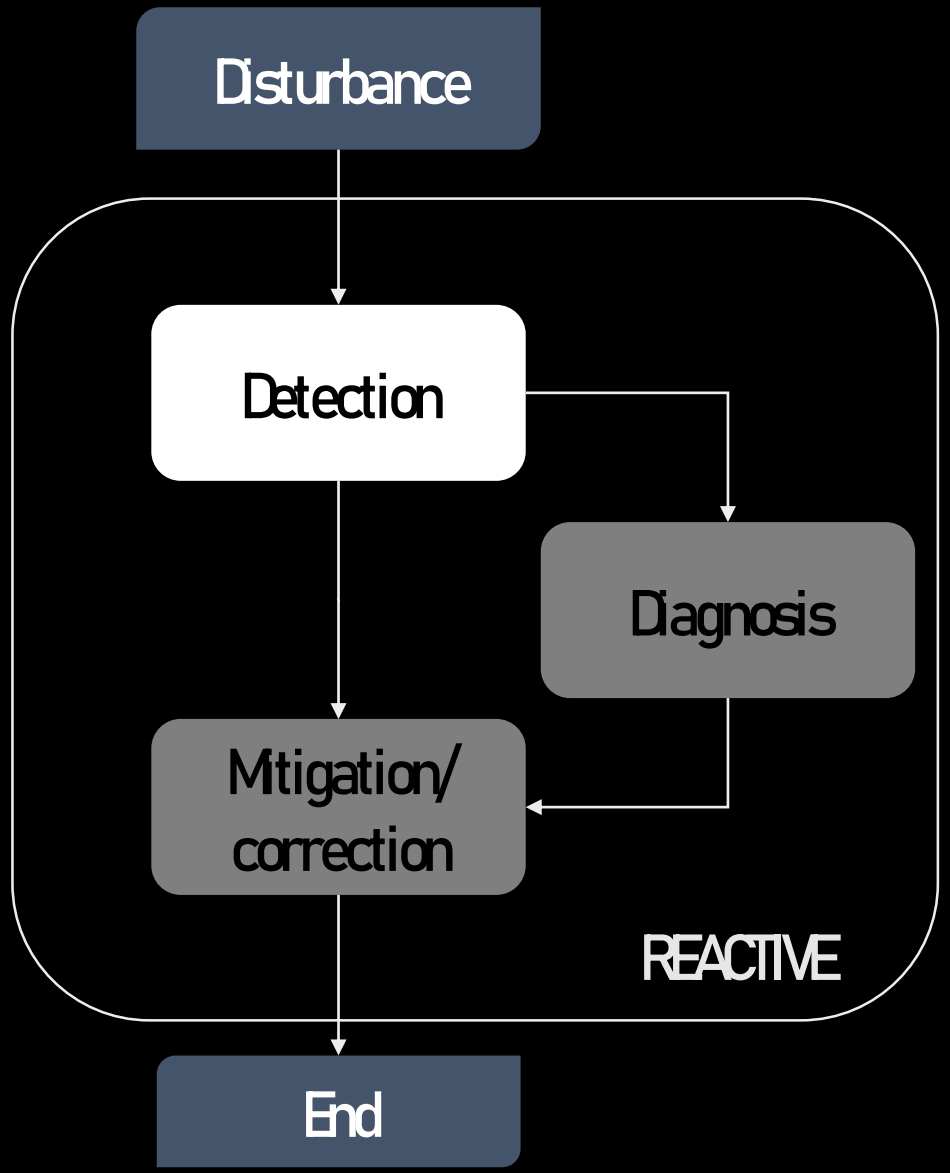
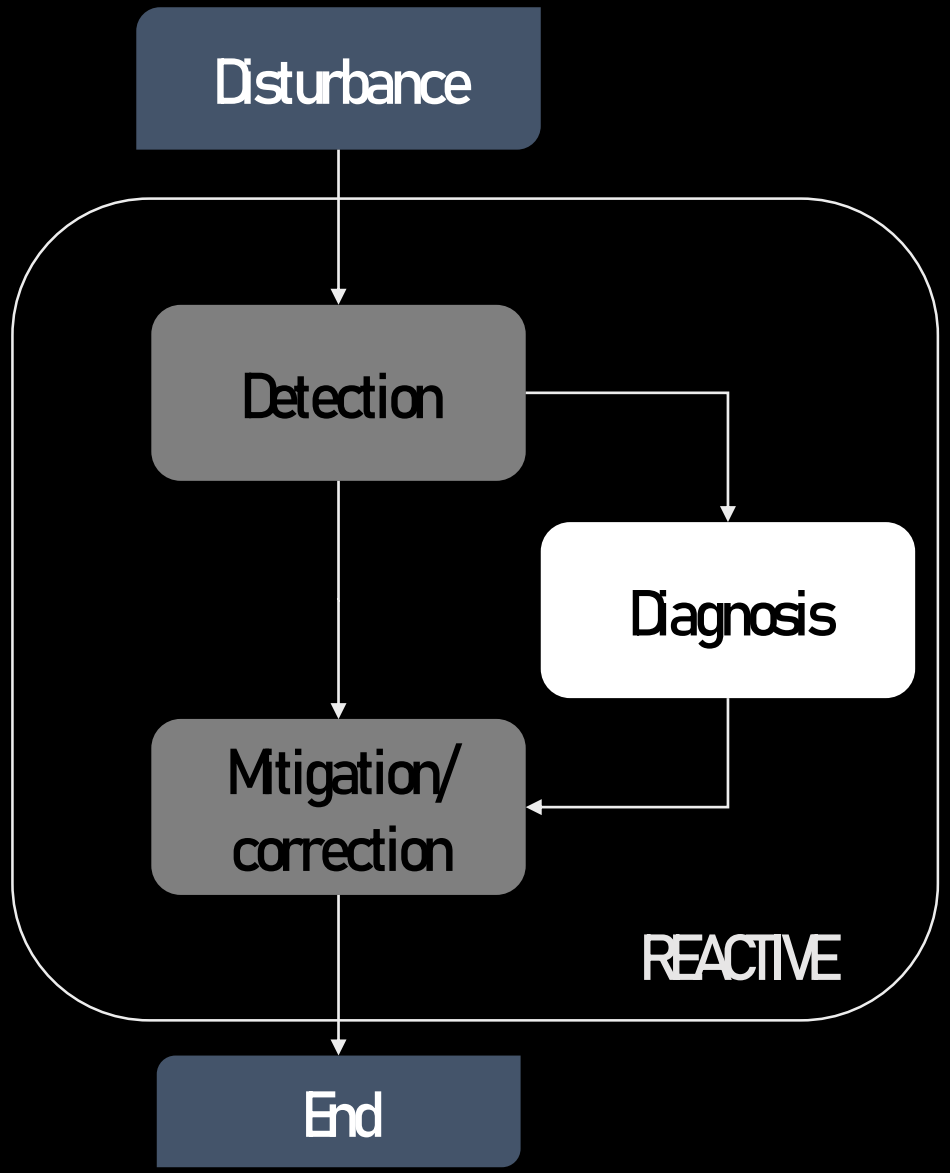
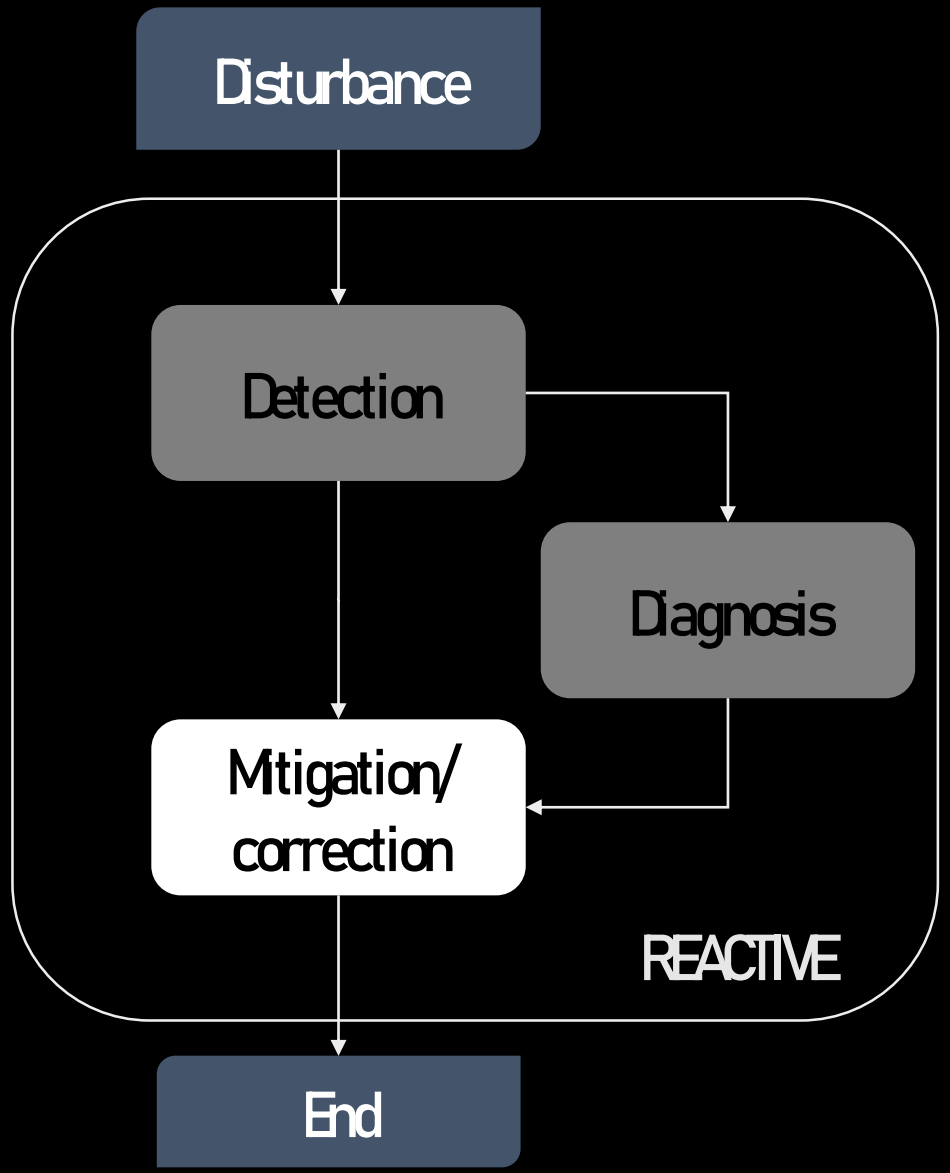
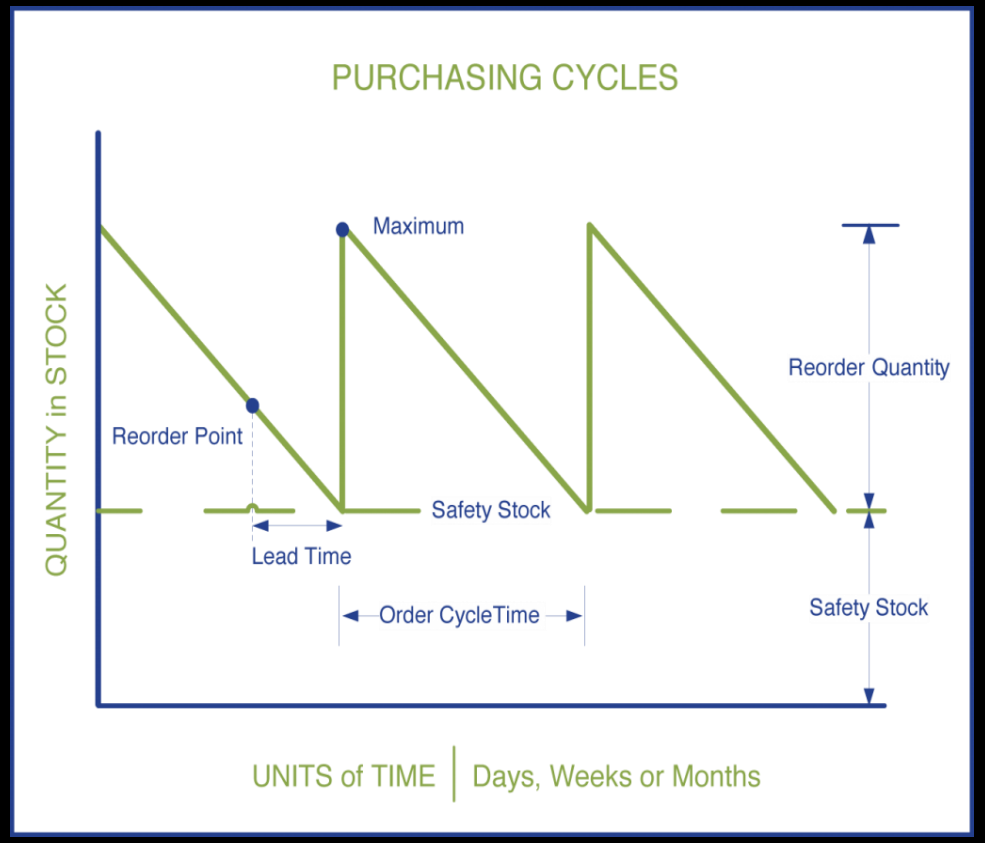
- OEE
- **Disturbance management**
- Disturbance data
- Design of PSS
- Some reflections about task 3 & 4

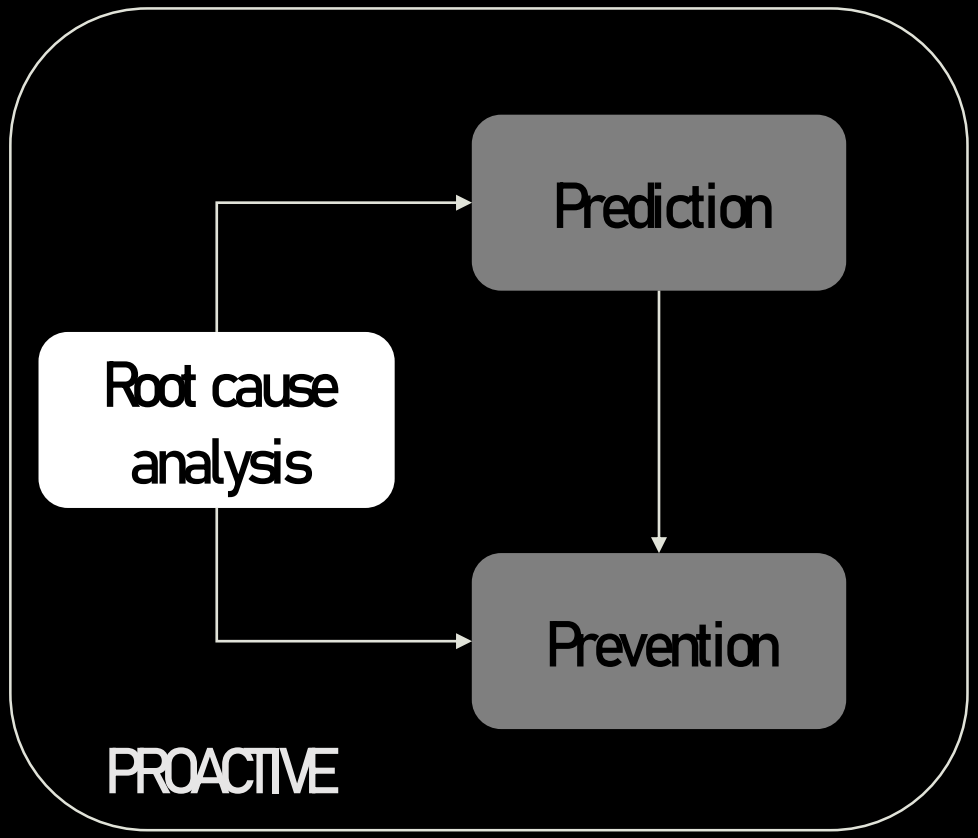

Disturbance
Detection
Diagnosis
Mtigation/
correction
REACTIVE
End
Root cause
analysis
Prediction
Prevention
PROACTIVE

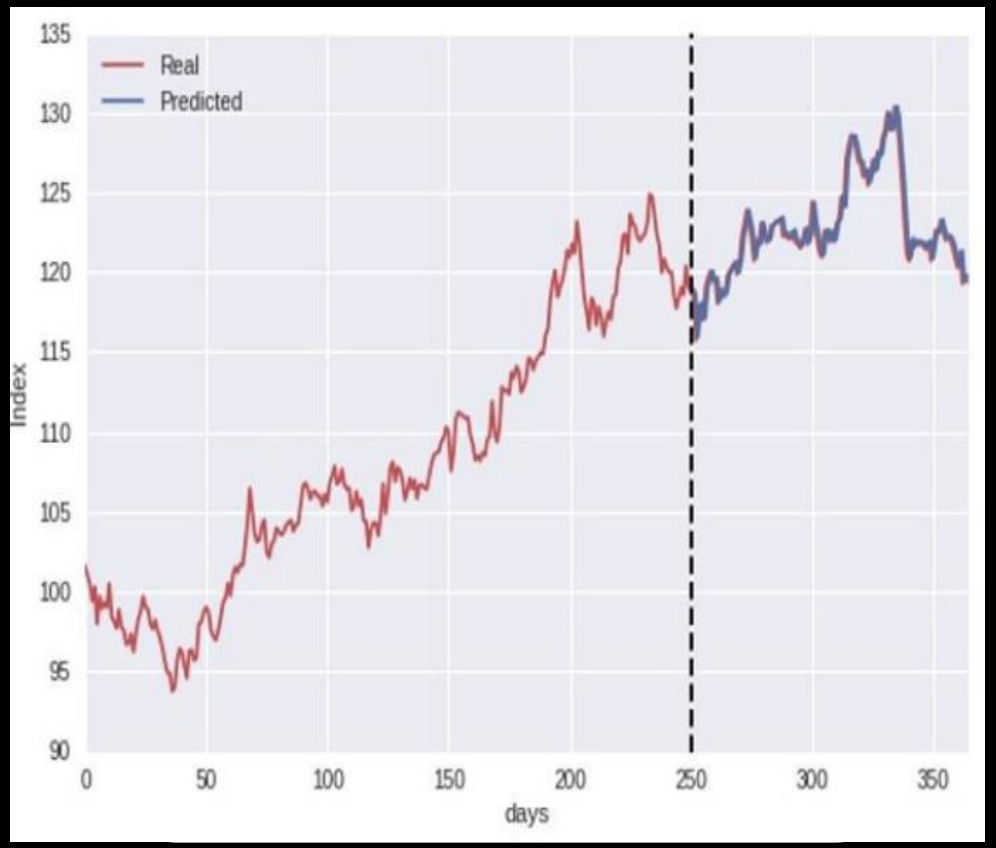

Disturbance
Detection
Diagnosis
Mtigation/
correction
REACTIVE
End

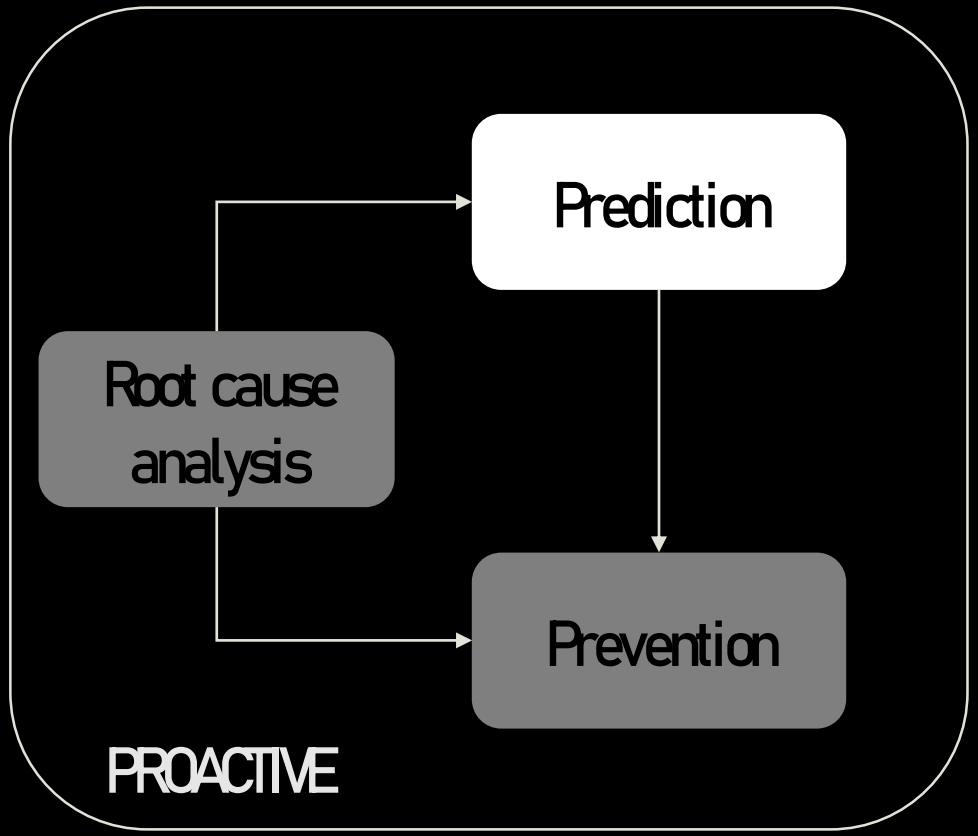

Disturbance
Detection
Diagnosis
Mtigation/
correction
REACTIVE
End

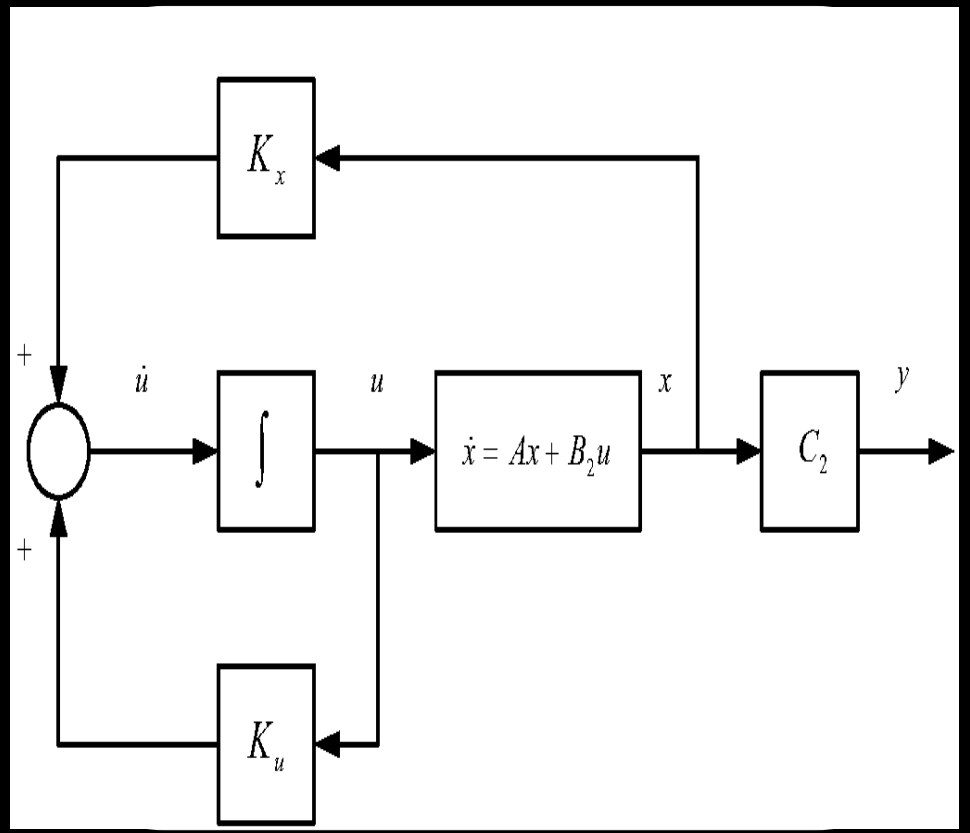

Disturbance
Detection
Diagnosis
Mtigation/
correction
REACTIVE
End

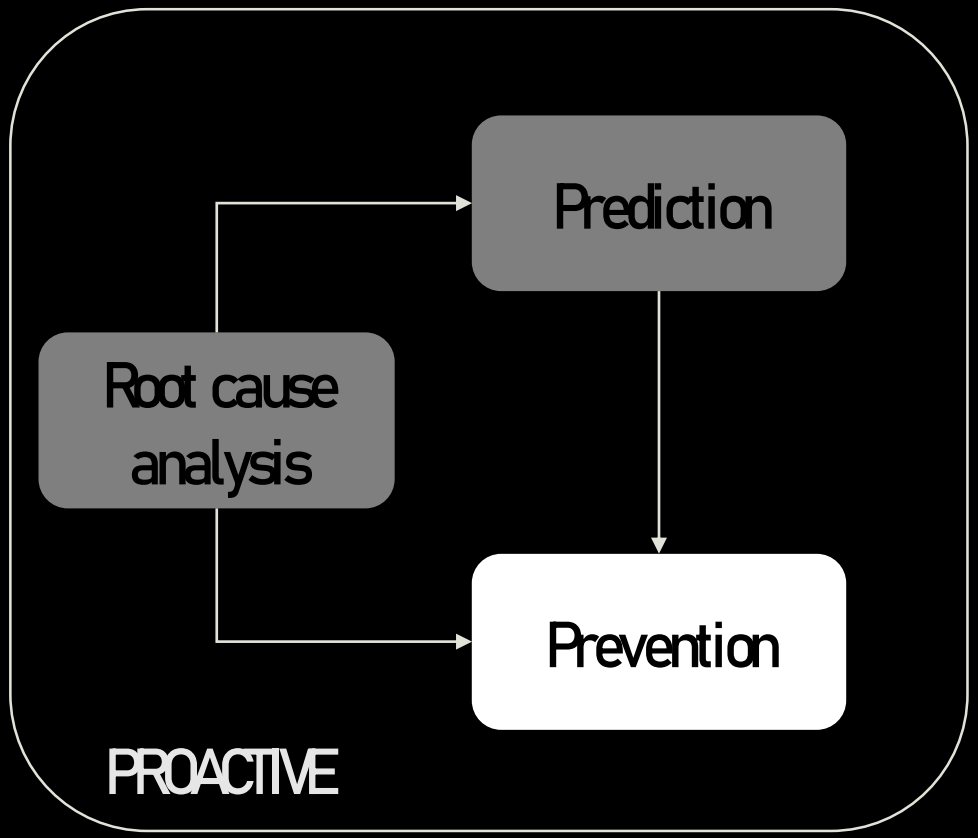

PURCHASING CYCLES
QUANTITY in STOCK
Maximum
Reorder Quantity
Reorder Point
Safety Stock
Lead Time
Order CycleTime
Safety Stock
UNITS of TIME
Days, Weeks or Months


Prediction
Root cause analysis
Prevention
PROACTIVE

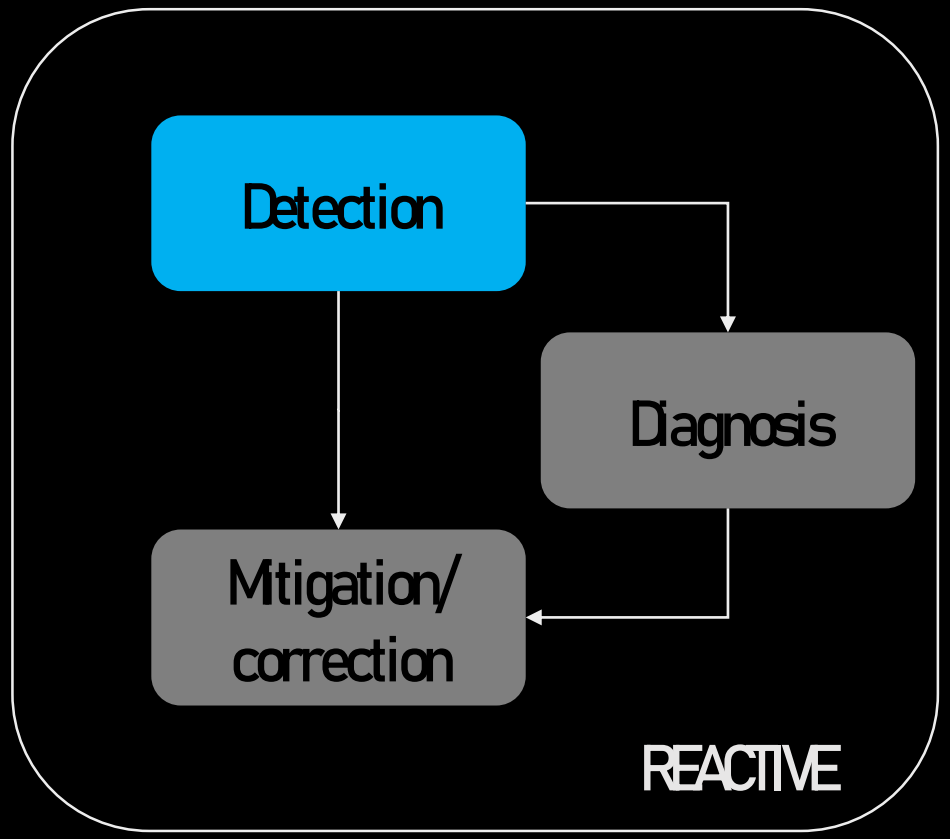

Real
Predicted
Index
days
135
130
125
120
115
110
105
100
95
90
0
50
100
150
200
250
300
350


Prediction
Root cause analysis
Prevention
PROACTIVE


K_x
+
$\dot{u}$
$\int$
u
$\dot{x} = Ax + B_2u$
x
C_2
y
+
K_u

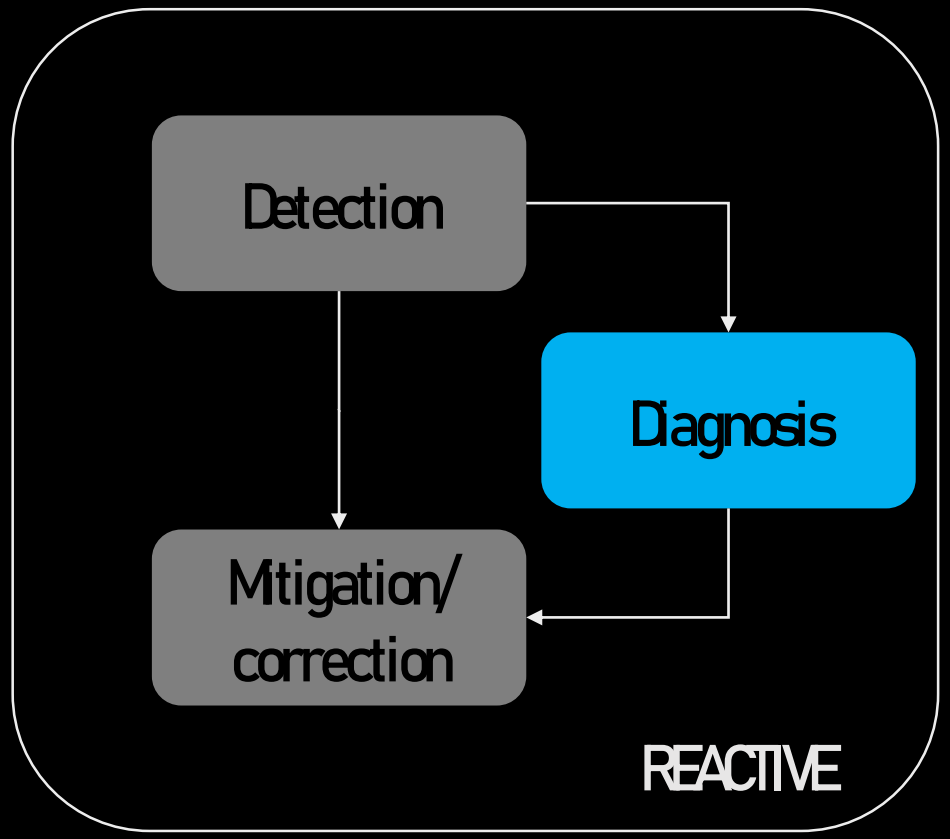

Prediction
Root cause analysis
Prevention
PROACTIVE

HOW CAN TECHNOLOGY HELP?
RESULTS FROM LITERATURE REVIEW

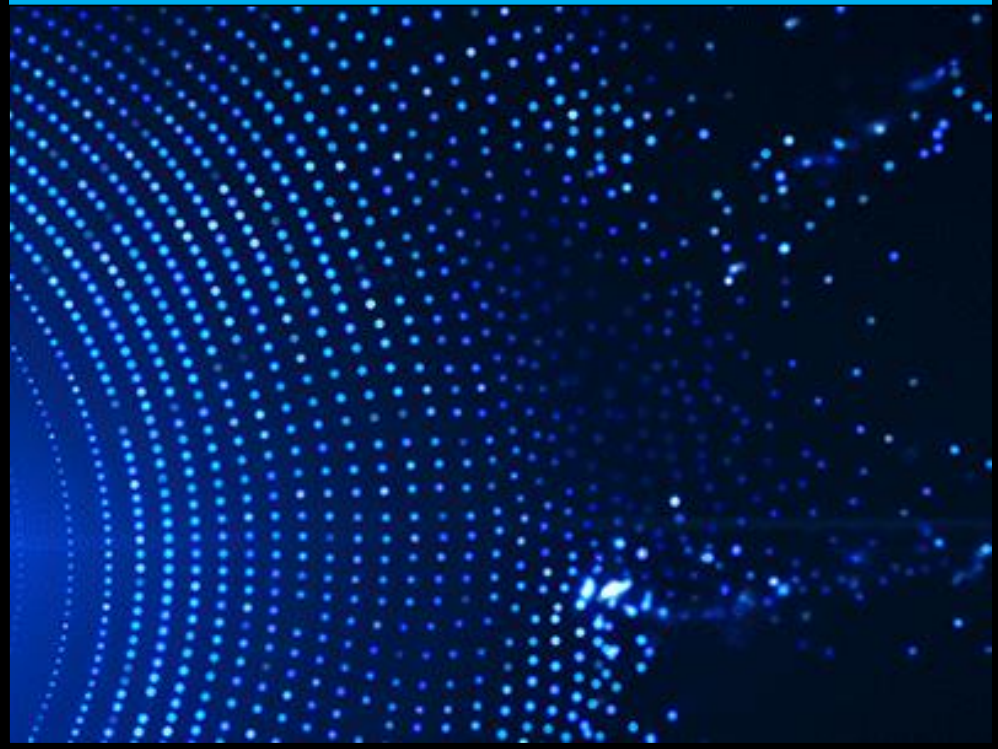


SMART SENSORS +
SMART DEVICES

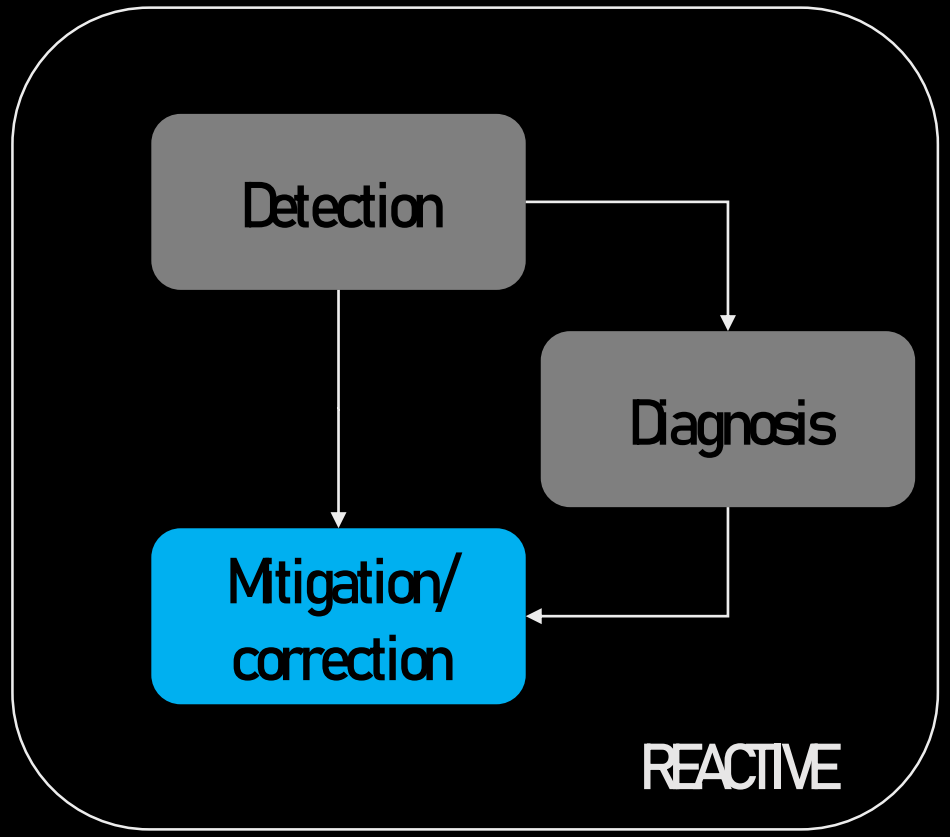
HOW CAN TECHNOLOGY HELP?
RESULTS FROM LITERATURE REVIEW



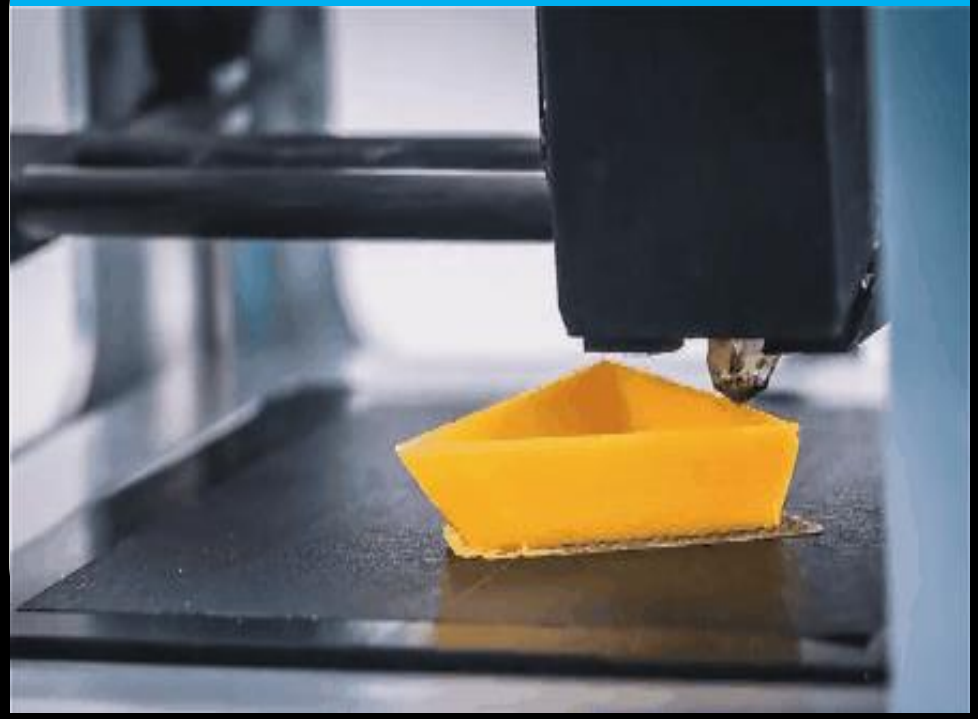
BIG DATA +
DATA ANALYTICS



HOW CAN TECHNOLOGY HELP?
RESULTS FROM LITERATURE REVIEW



3D PRINTING +
AUGMENTED REALITY



HOW CAN TECHNOLOGY HELP?
RESULTS FROM LITERATURE REVIEW

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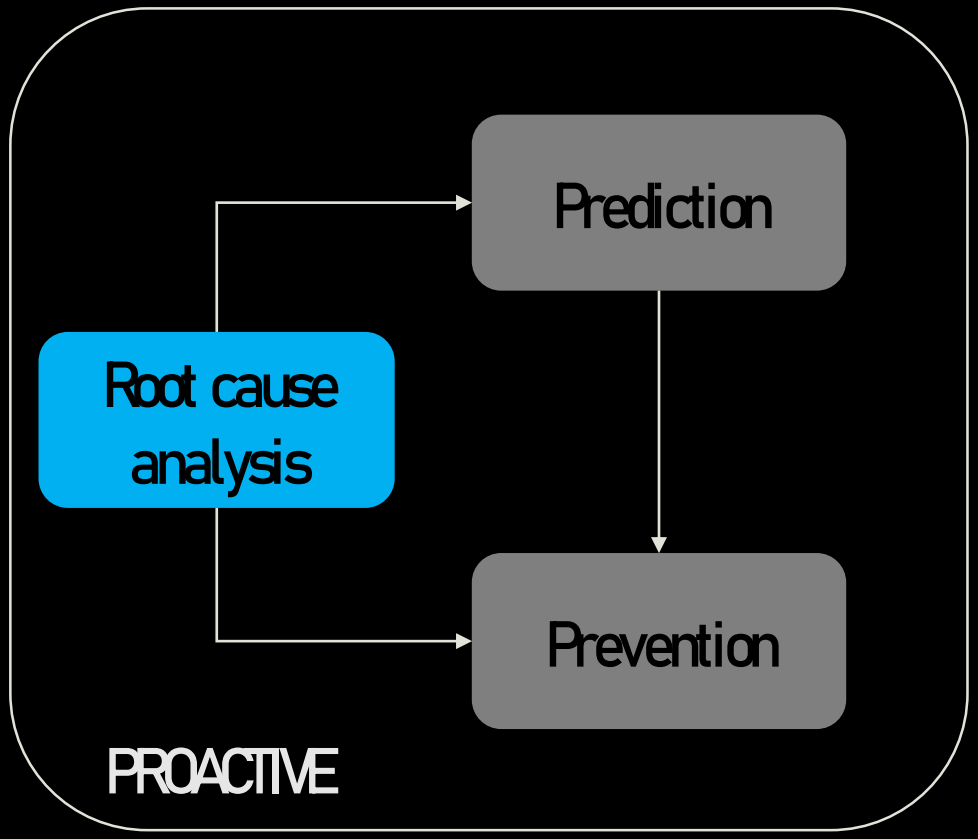
CLOUD TECHNOLOGIES



HOW CAN TECHNOLOGY HELP?
RESULTS FROM LITERATURE REVIEW

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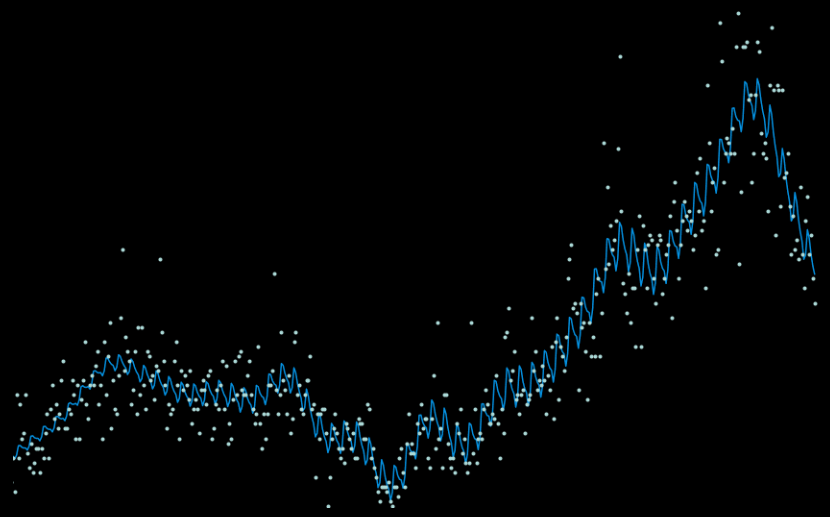
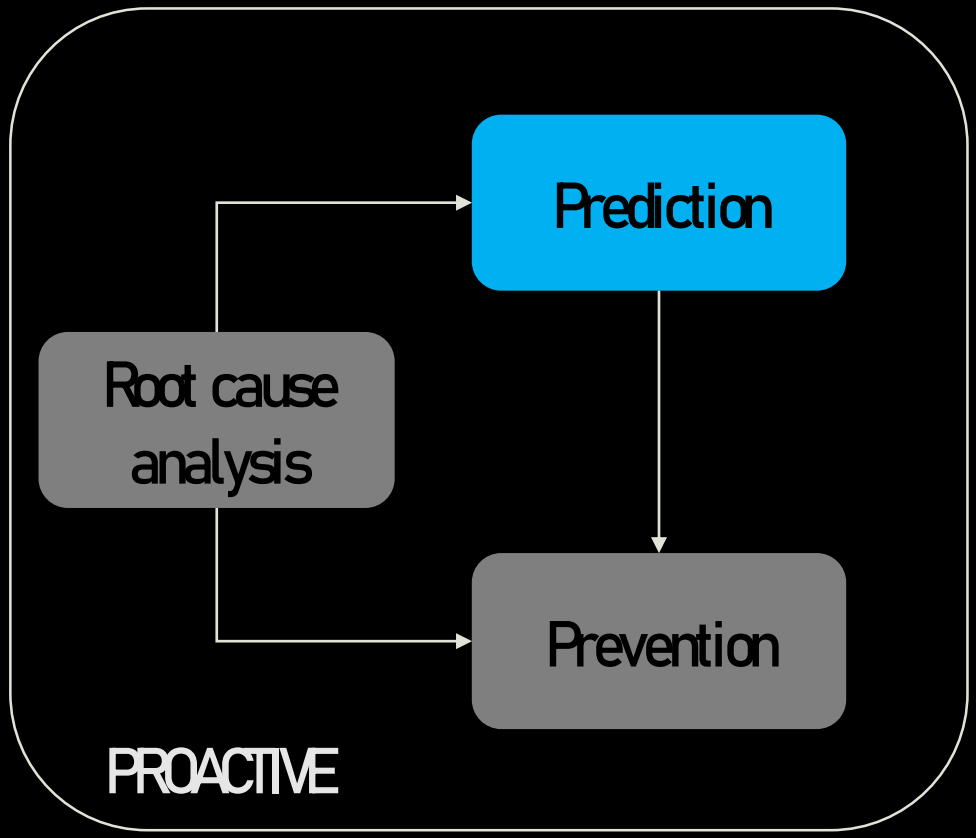
DATA
ANALYTICS





HOW CAN TECHNOLOGY HELP?
RESULTS FROM LITERATURE REVIEW

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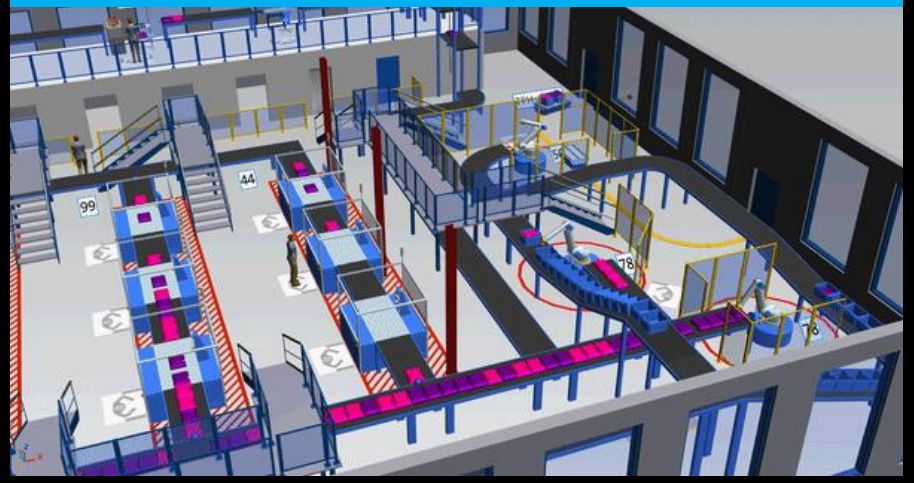
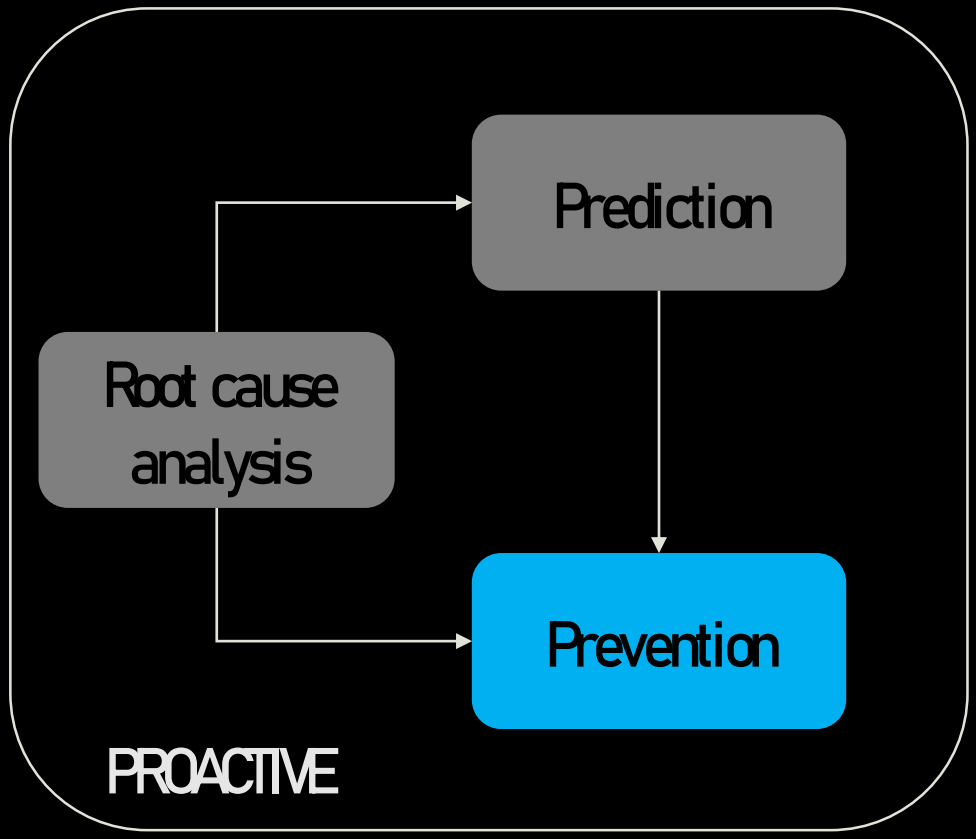
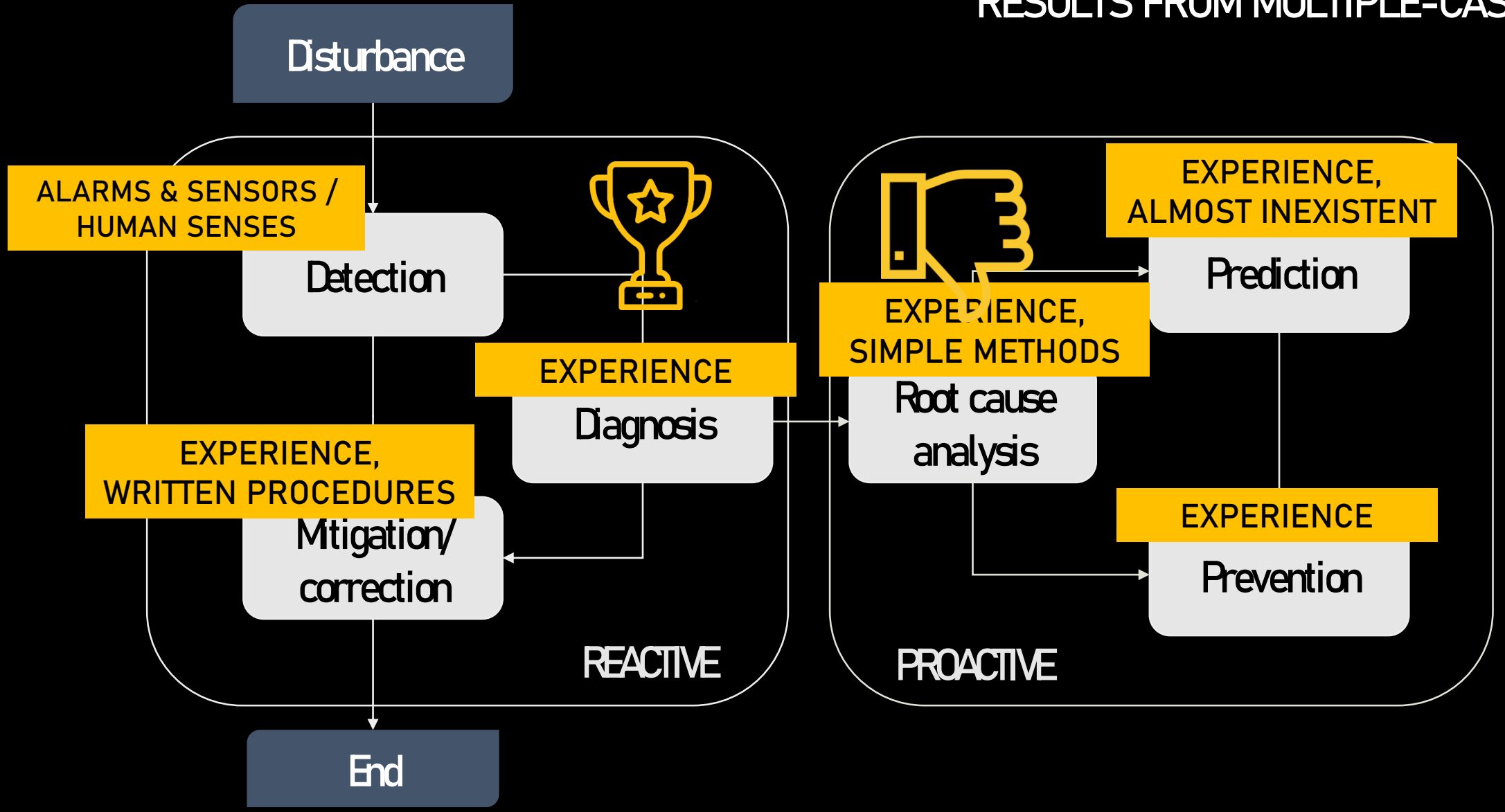
SIMULATION





HOW ARE COMPANIES DOING?
RESULTS FROM MULTIPLE-CASE STUDY



21 FACTORS

Failure of software	Media error	Cleaning	Preventive maintenance
Equipment failure	Shortage of staff	Reprogramming	Tool change
Speed loss	Stop in the line	Planning error	Time for change
Incidents	Lack of material Waiting for product	Work meeting	Set up
Scrap / quality problems	Failure of peripheral	Pause / Break	Adjustment
			Human error

(**Bokrantz, J., Skoogh, A., Ylipää, T., & Stahre, J. (2016).** Handling of production disturbances in the manufacturing industry. *Journal of Manufacturing Technology Management*, *27*(8), 1054–1075.)

Agenda

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OEE

Disturbance management

Disturbance data

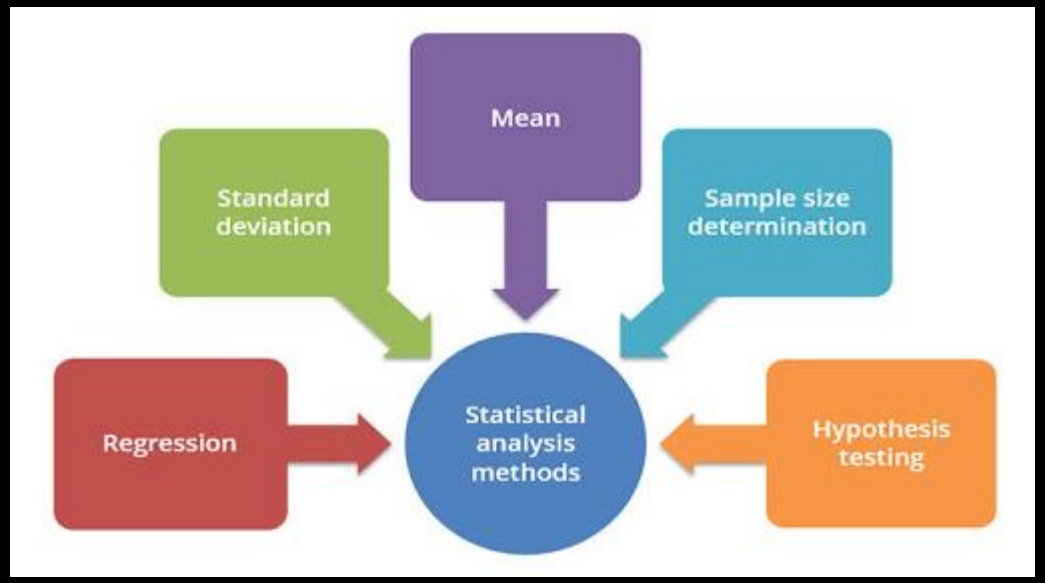
Design of PSS

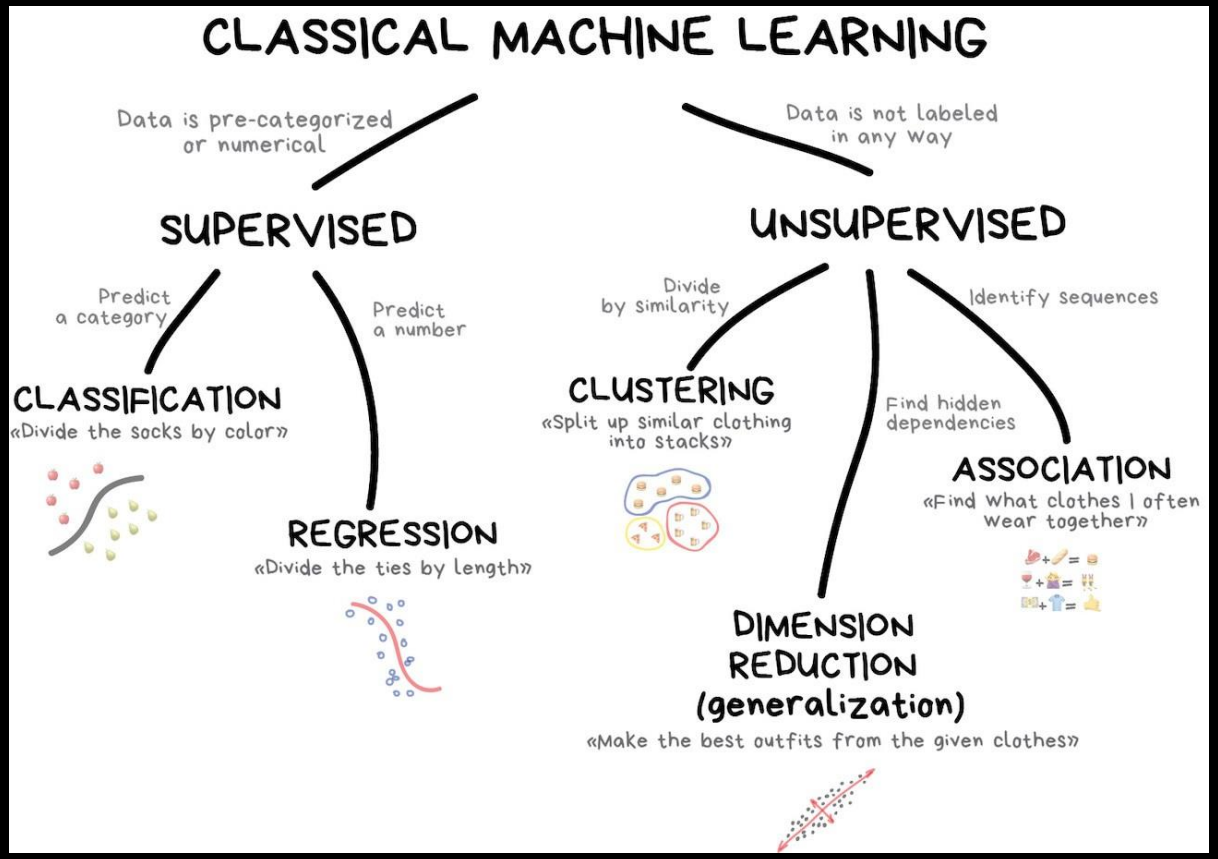
Some reflections about task 3 & 4

When we are analysing disturbance data…

- Methods based on statistical models
- Methods based on machine learning / AI

(https://vas3k.com/blog/machine_learning/)



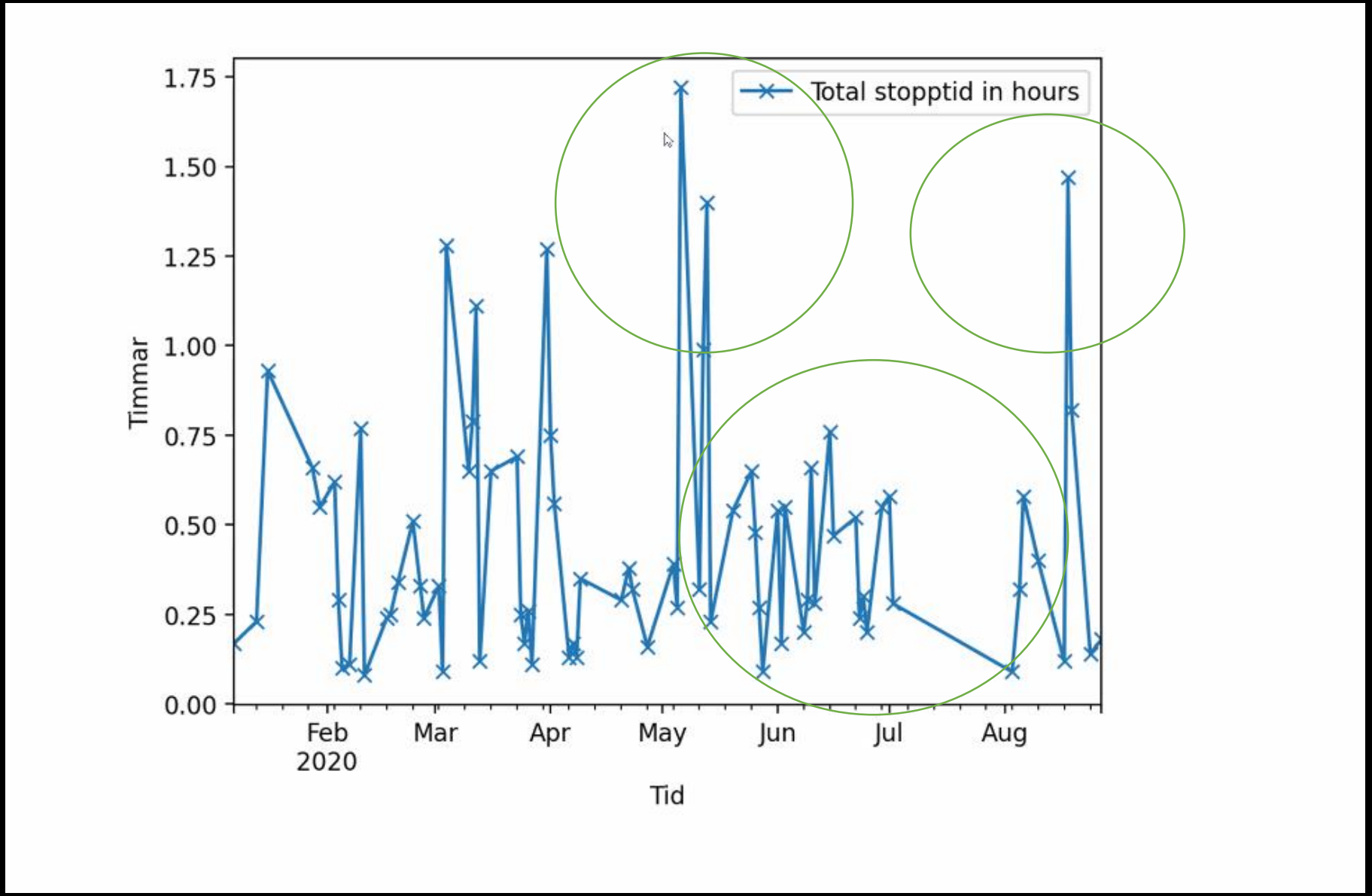


When we are analysing disturbance data…

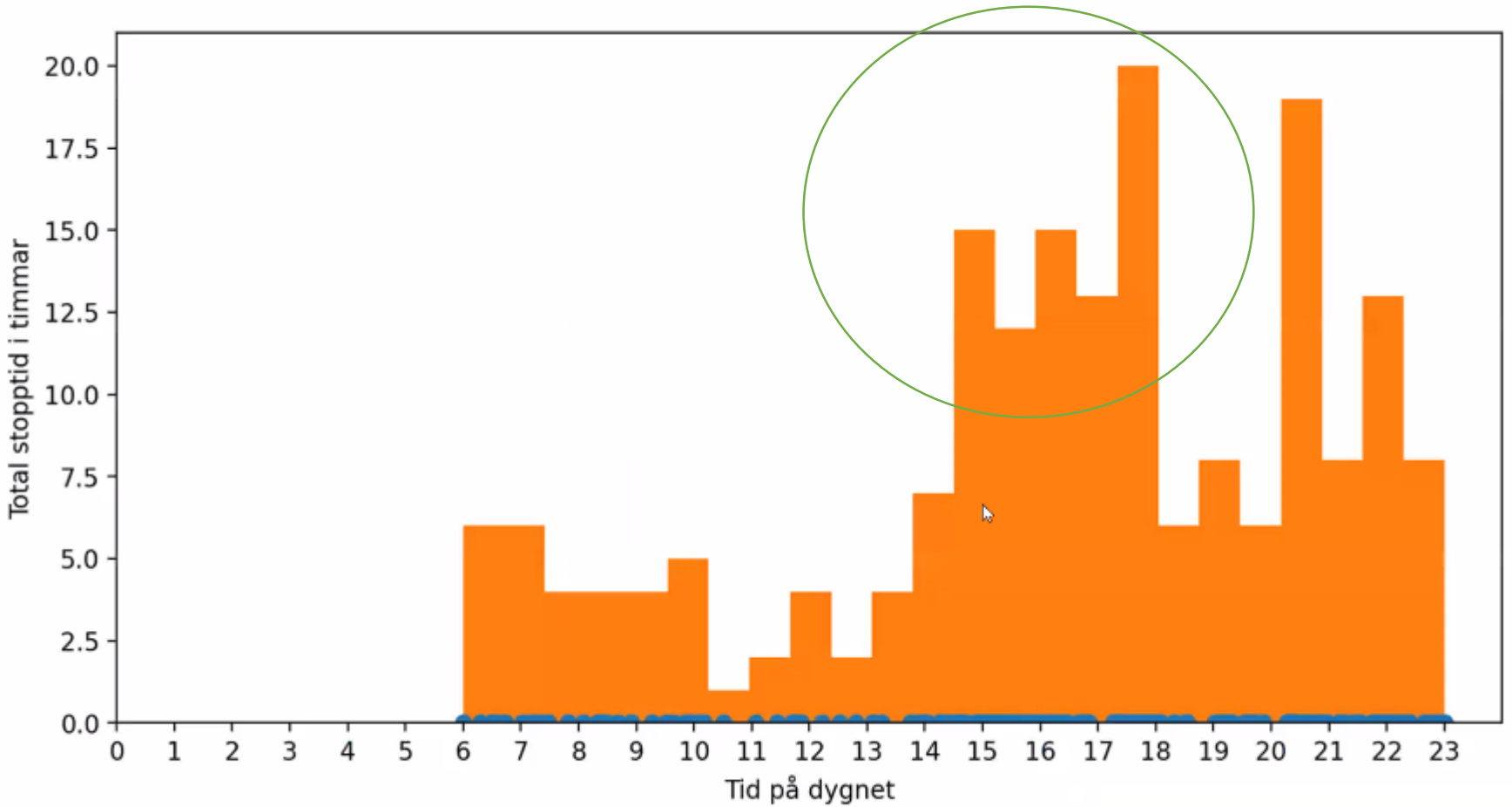
Questions
What disturbances have longer duration?
What are the most frequent disturbances?
When do the disturbances usually occur?
How are the disturbance varying? (SD)
Is there any correlation among disturbances?
……..

There are many ways to analyse the data, be creative!

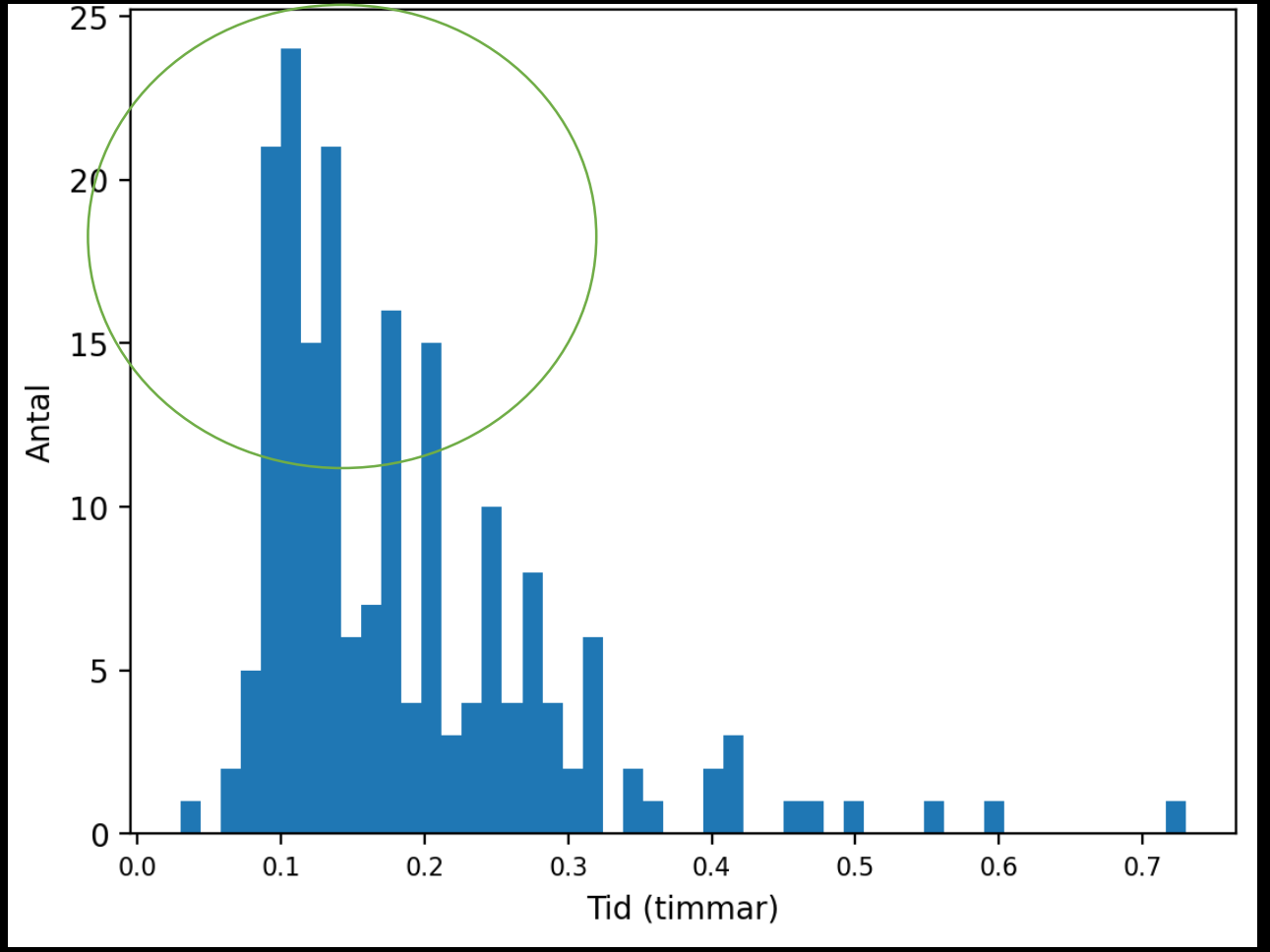
Time series


Total stopptid in hours
Timmar
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Feb
2020
Mar
Apr
May
Jun
Jul
Aug
Tid

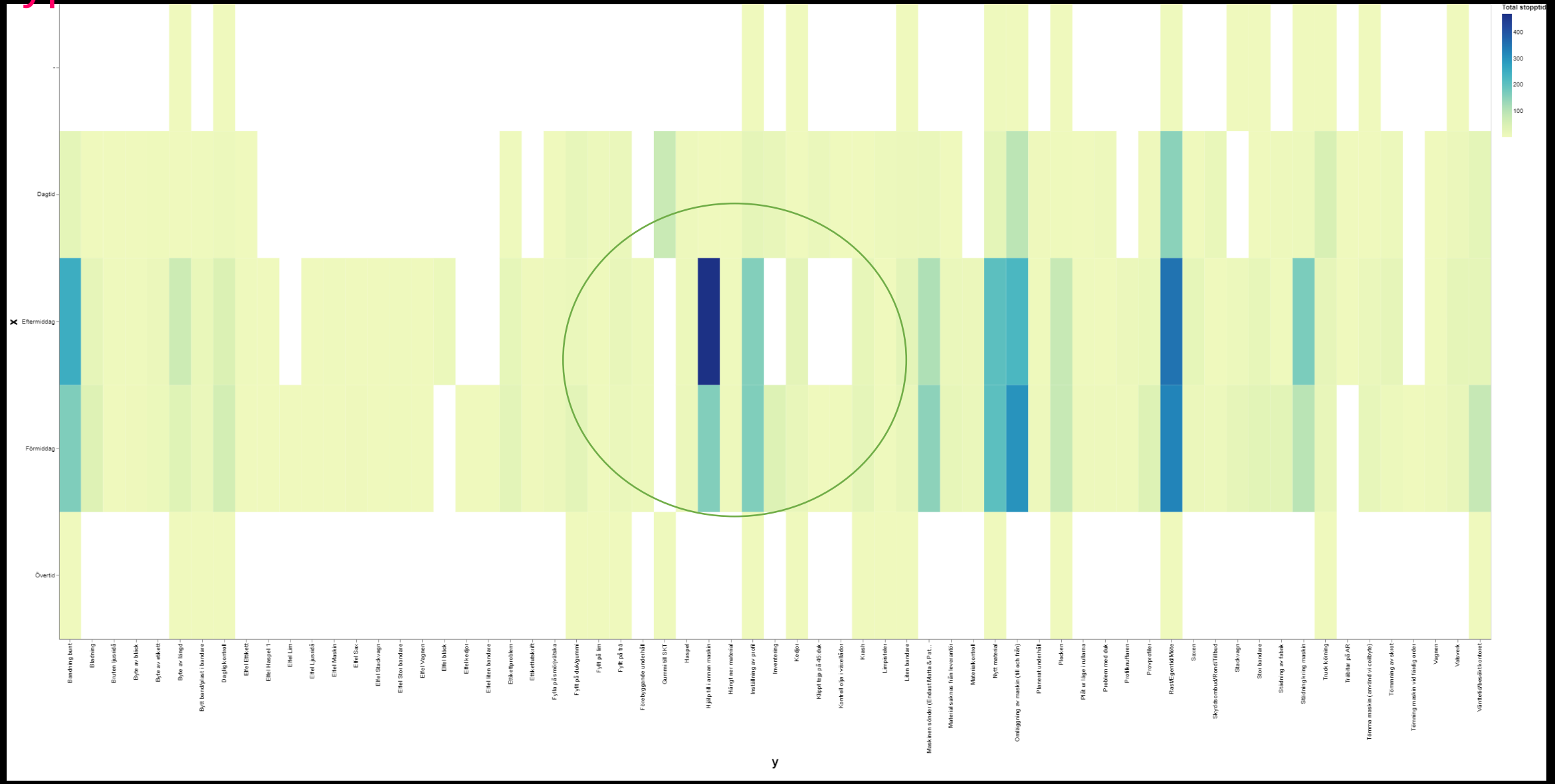
Distribution during the day



Distribution

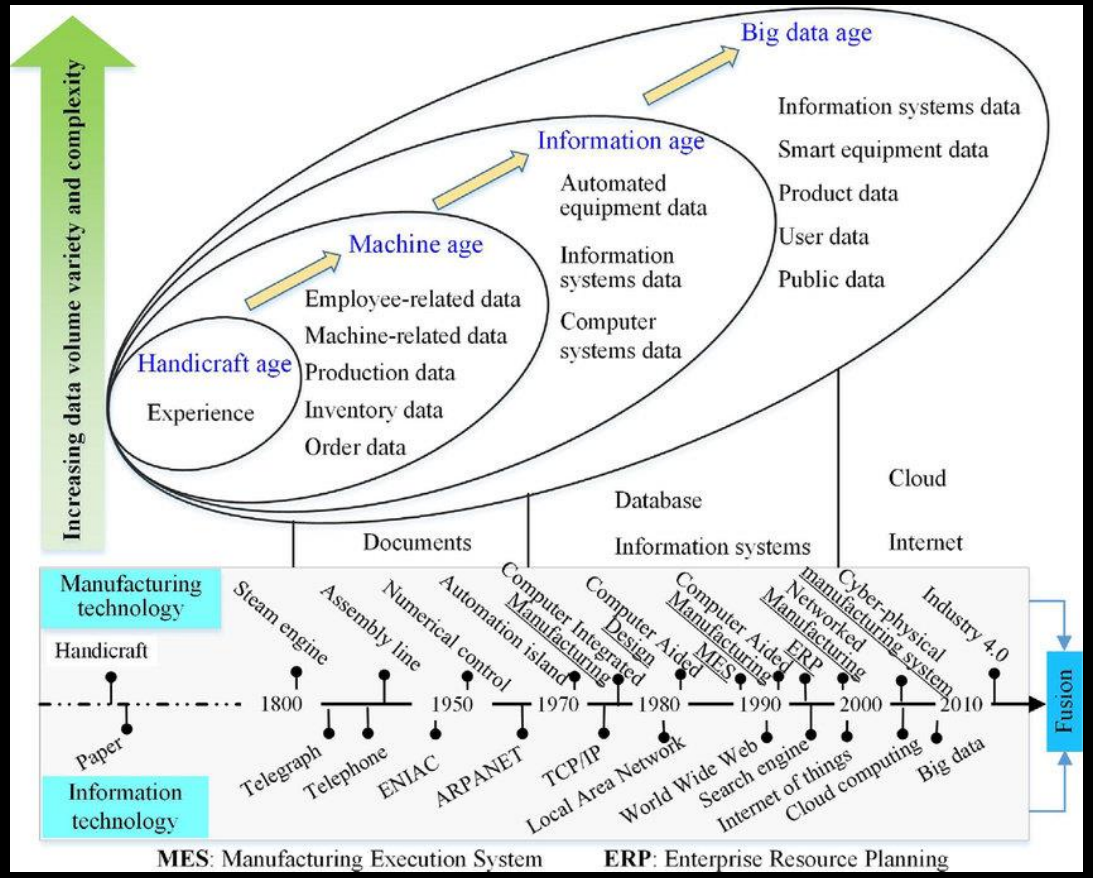


Type of disturbance and shift



Other data set

What other data could be helpful when analysing production disturbances?



Agenda

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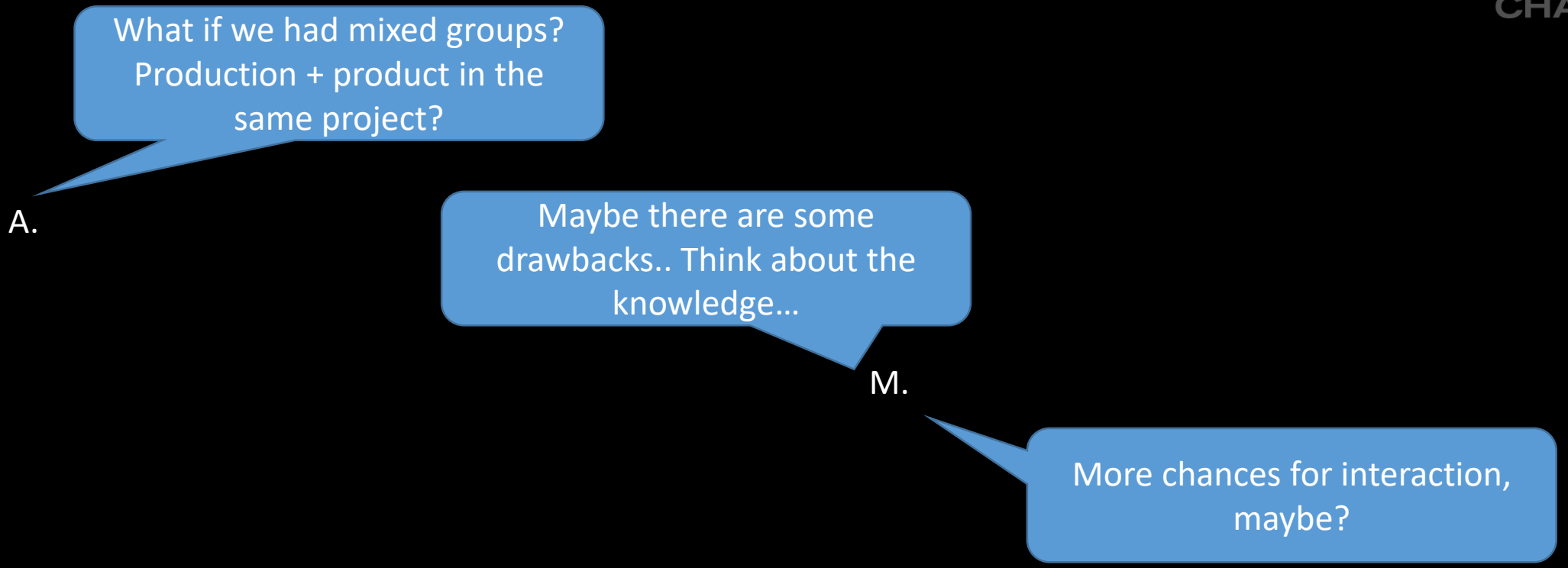
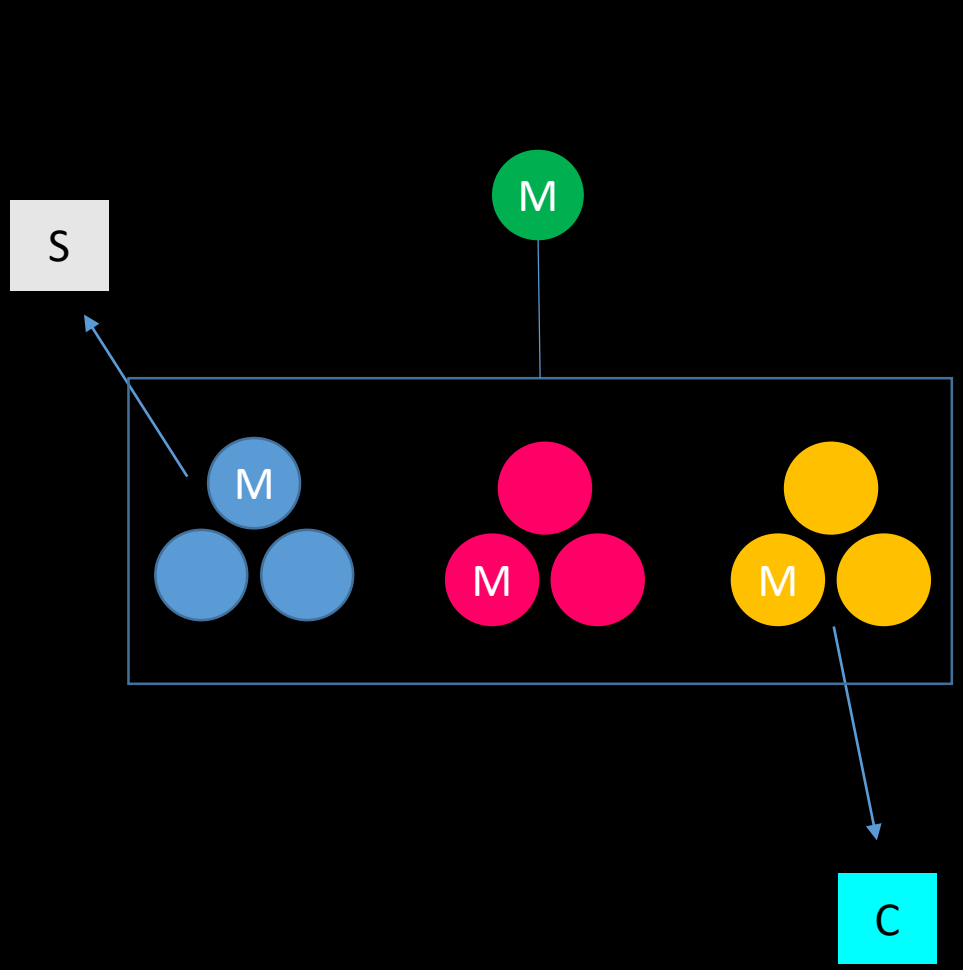
- OEE
- Disturbance management
- Disturbance data
- **Design of PSS**
- Some reflections about task 3 & 4

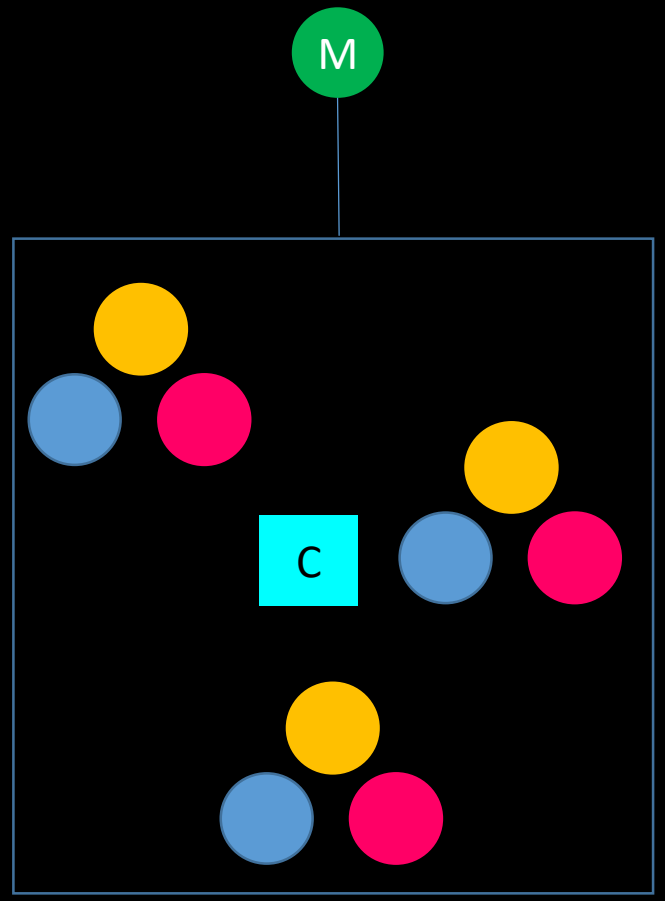
Decision of the project groups

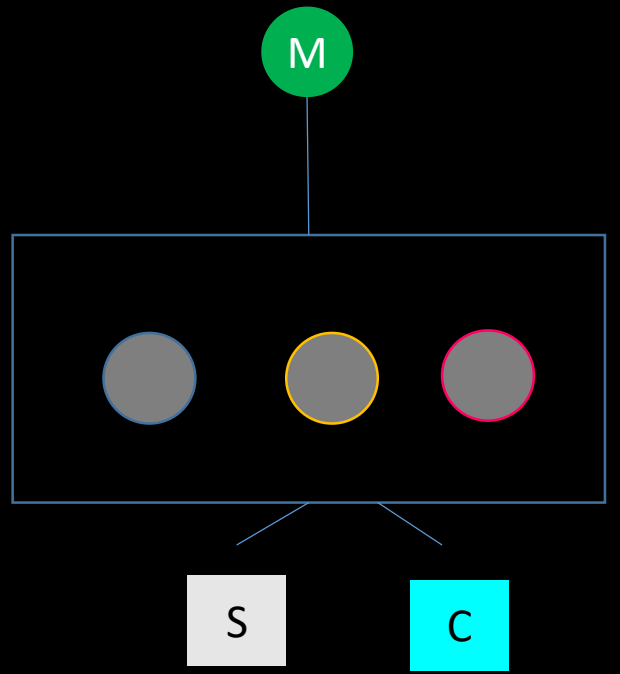


- Do you think your results would be different if you had a product someone from the product member working in your team?
- Finance? Quality? Supply? Logistics? Marketing? Continuous improvement? HR?

Types of organization







Types of organization

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How are companies typically organized?

Do you think there is any influence of the size of the company? What about the type of industry?

Agenda

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- OEE
- Disturbance management
- Disturbance data
- Design of PSS
- **Some reflections about task 3 & 4**

Reflections…

Improvement action	Cost, SEK
SMED	7500
Maintainability project	28000
Component upgrade	22000
Autonomous maintenance	30000
Condition-based maintenance	17500
Change PM program	40000
Educate maintenance technicians	13000
Cycle time reduction project	58000
Maintenance prevention project	35000
New machine	75000
Educate maintenance engineers in data analytics	45000

Where to implement the improvement?

How great is the expected impact in the goals of the entire production line?

How could you implement the improvement? Ex. What does it take to the company to educate maintenance personnel?

Reflections…

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Task 3.C: Other factors impacting OEE

- Make sure you recommend actions that really eliminate the root causes!

Task 4: Design of production service system

Current state:

* Independent maintenance department
* Predominantly reactive maintenance, time-based preventive maintenance based on vendor recommendations
* Close collaboration with production, but no collaboration with other departments (e.g. product development, purchasing, logistics)
* No close collaboration with external partners (e.g. machine vendors, service providers)

“Production Service Systems” are maintenance organizations with a much broader view! (reactive, preventive, improvements / delivering production-as-a-service)

A new organizational design for maintenance is needed (How should maintenance of the plant be managed?)

Use your knowledge gained throughout the course

Explain the difference of your proposal compared to current state

Explain how your proposal will impact the goals fo the company

Visualize and explain:

- Organizational structure
- Key roles and responsibilities
- Internal relationships
- External relationships

Thank you!