

Maintenance development

2018-04-26

San Aziz





Agenda

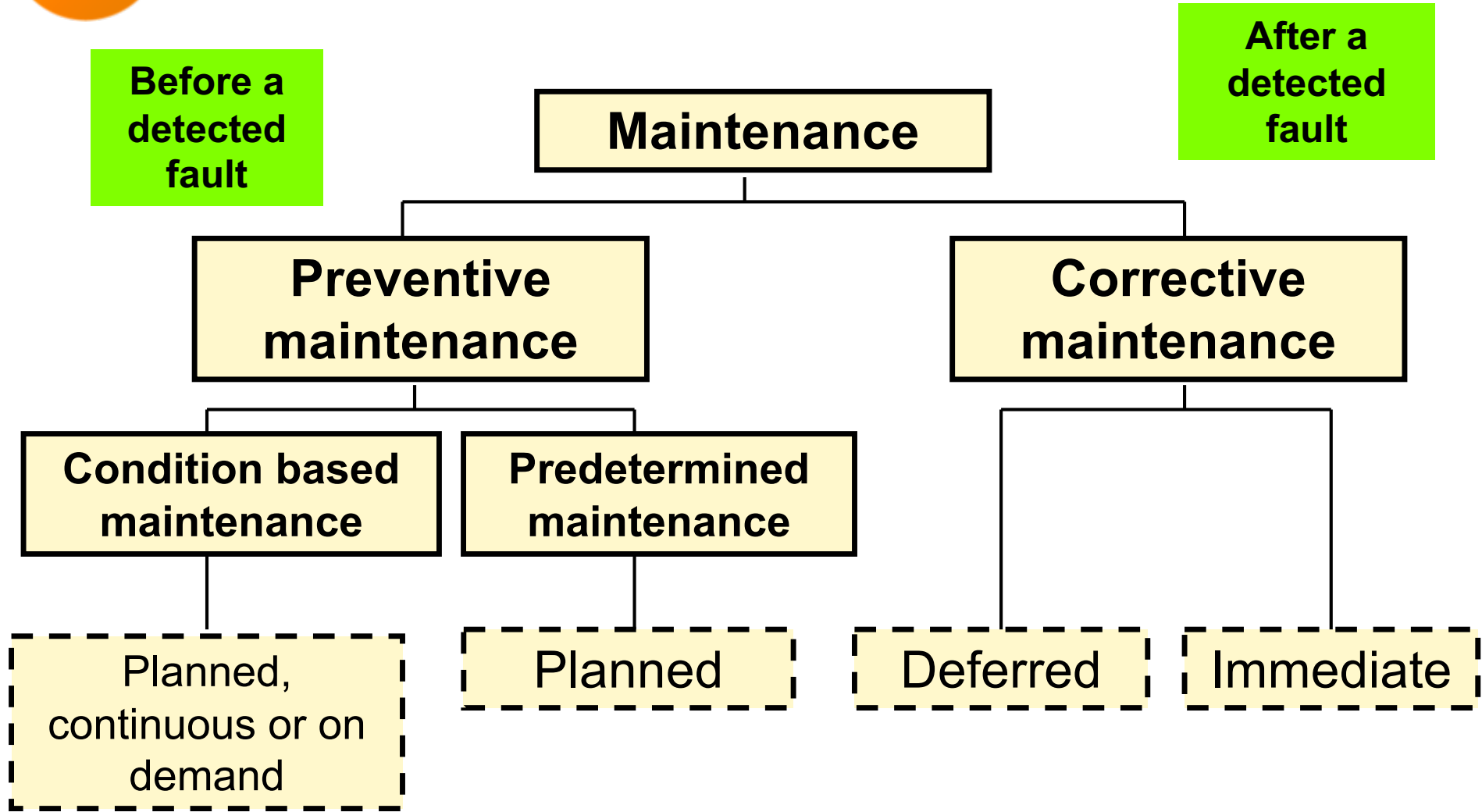
- Preventive Maintenance (PM)
- Corrective Maintenance (CM)
- Maintenance activities
- Dependability
- How to become a successful maintenance?
- The economical “iceberg”



What is maintenance?



Maintenance





Maintenance

**Definition according to
SS-EN 13306**



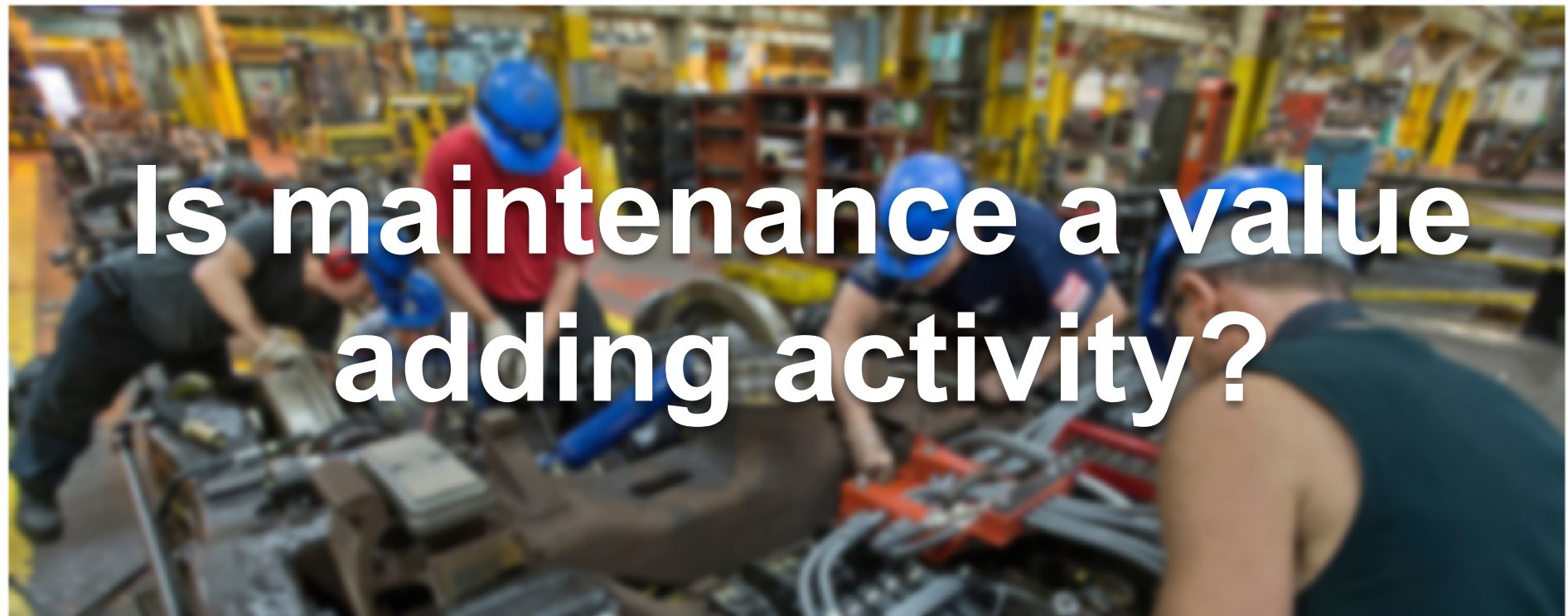
Maintenance

Combination of all technical, administrative, and managerial actions during the life cycle of an item intended to **retain it in**, or **restore it to**, a state in which it can perform the required function.



Maintenance activities

- Cleaning
- Lubrication
- Condition monitoring (indirect maintenance)
- Adjustments
- Reconditioning
- Parts exchange (preventive or corrective)
- Modifications and improvements



Is maintenance a value adding activity?



**Maintenance
restores
availability, ...**



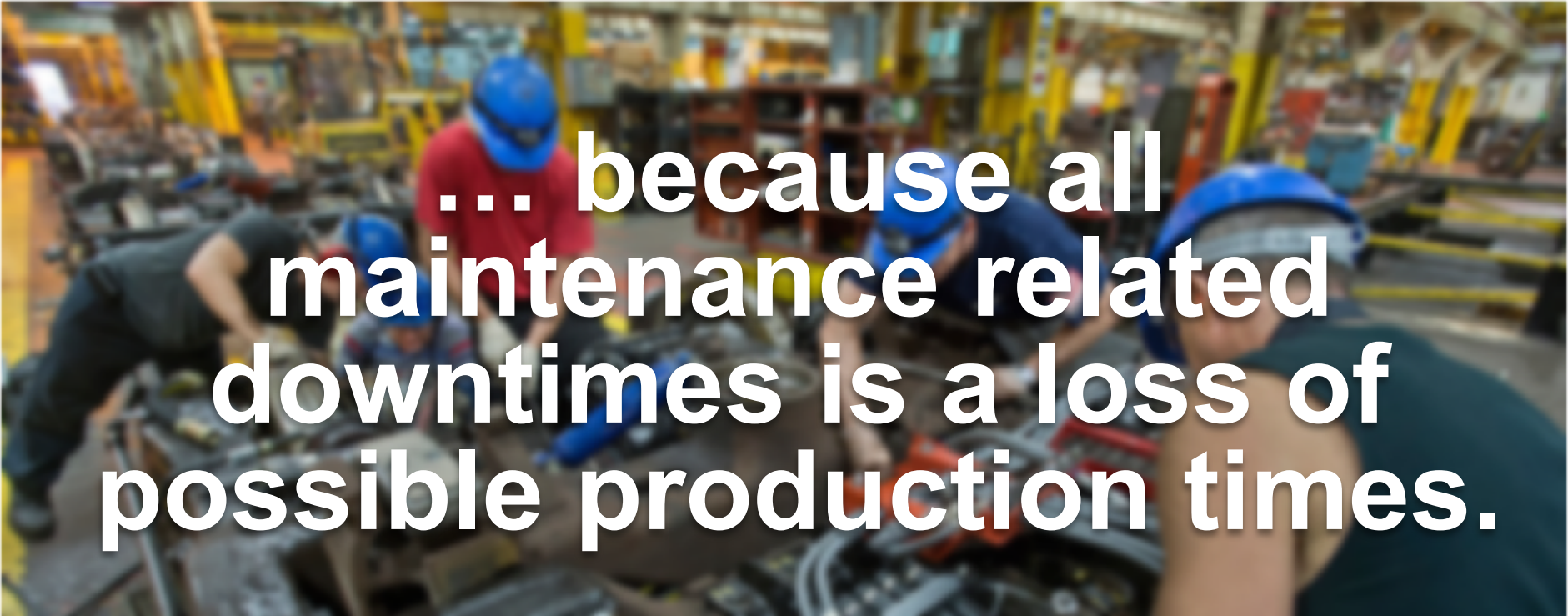
... but maintenance not adding new value ...,



**... just restores the
availability, so we can
continue produce.**



Maintenance is benefit for the customer, for example production and assembly ...,

A photograph of a factory floor where several workers wearing blue hard hats and safety glasses are focused on a piece of machinery. The background is filled with industrial equipment, including conveyor belts and structural frames, creating a busy manufacturing environment.

... because all maintenance related downtimes is a loss of possible production times.



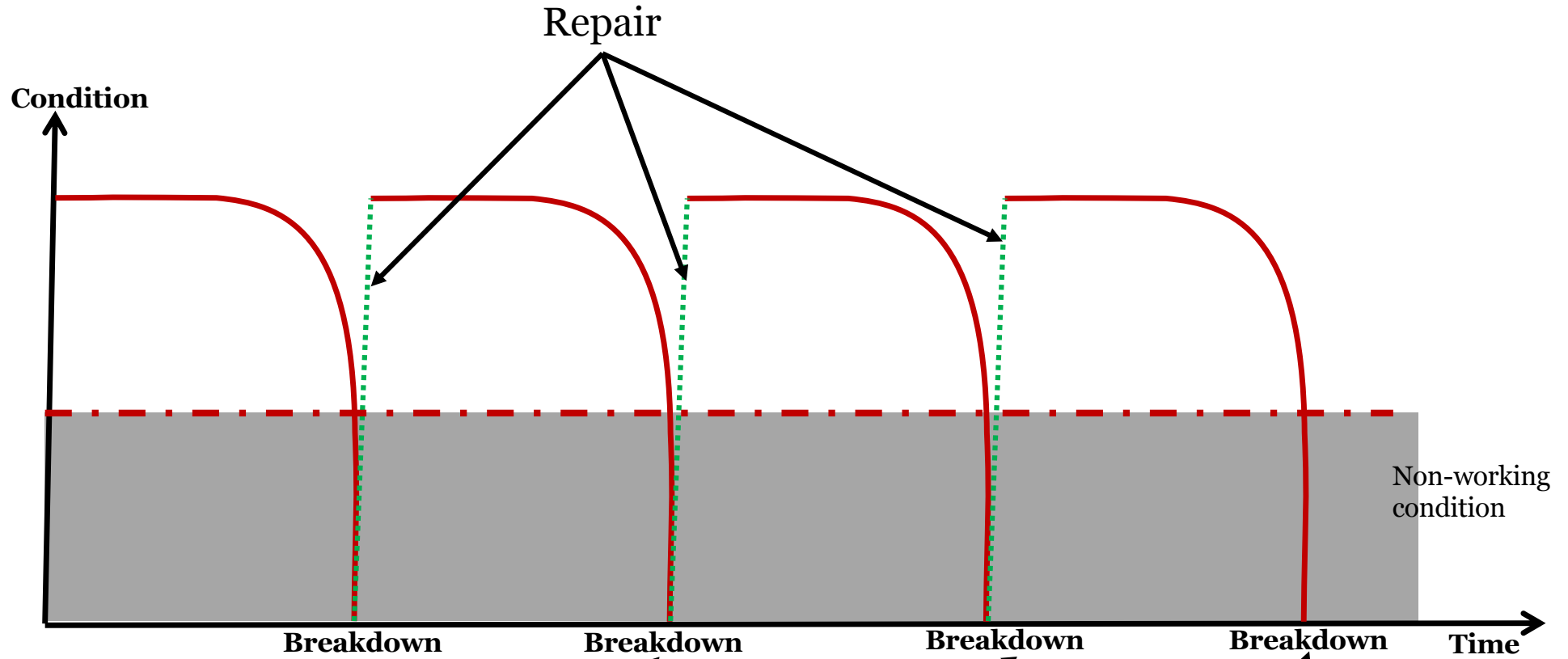
Corrective maintenance

=

Unplanned stops



Corrective Maintenance (CM)

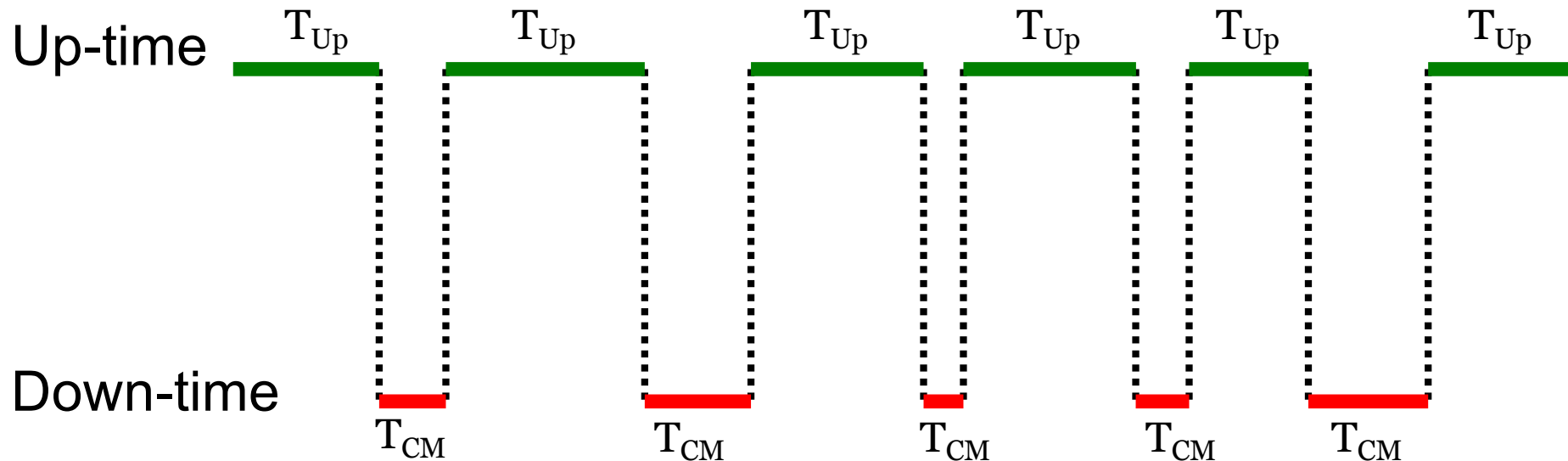


Run To Failure (RTF)

Unplanned stops



Corrective Maintenance (CM)



$$MTBM_{CM} = MTBF = \frac{\Sigma T_{Up}}{n_{CM}}$$

$$\overline{M}_{CM} = MTTR = \frac{\Sigma T_{CM}}{n_{CM}}$$

$MTBM_{CM}$ = Mean Time Between Corrective Maintenance

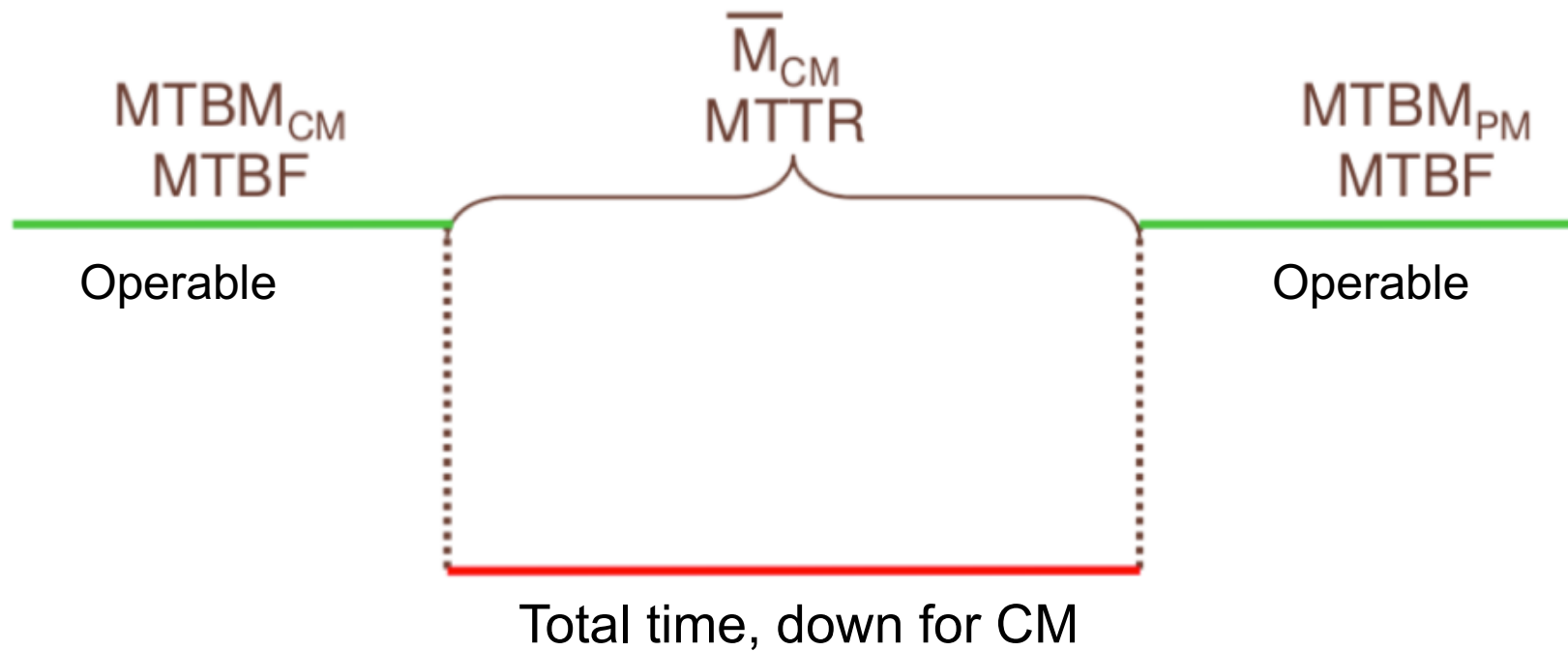
MTBF = Mean Time Between Failure

MTTR = Mean Time To Repair

\overline{M}_{CM} = Mean active corrective maintenance time

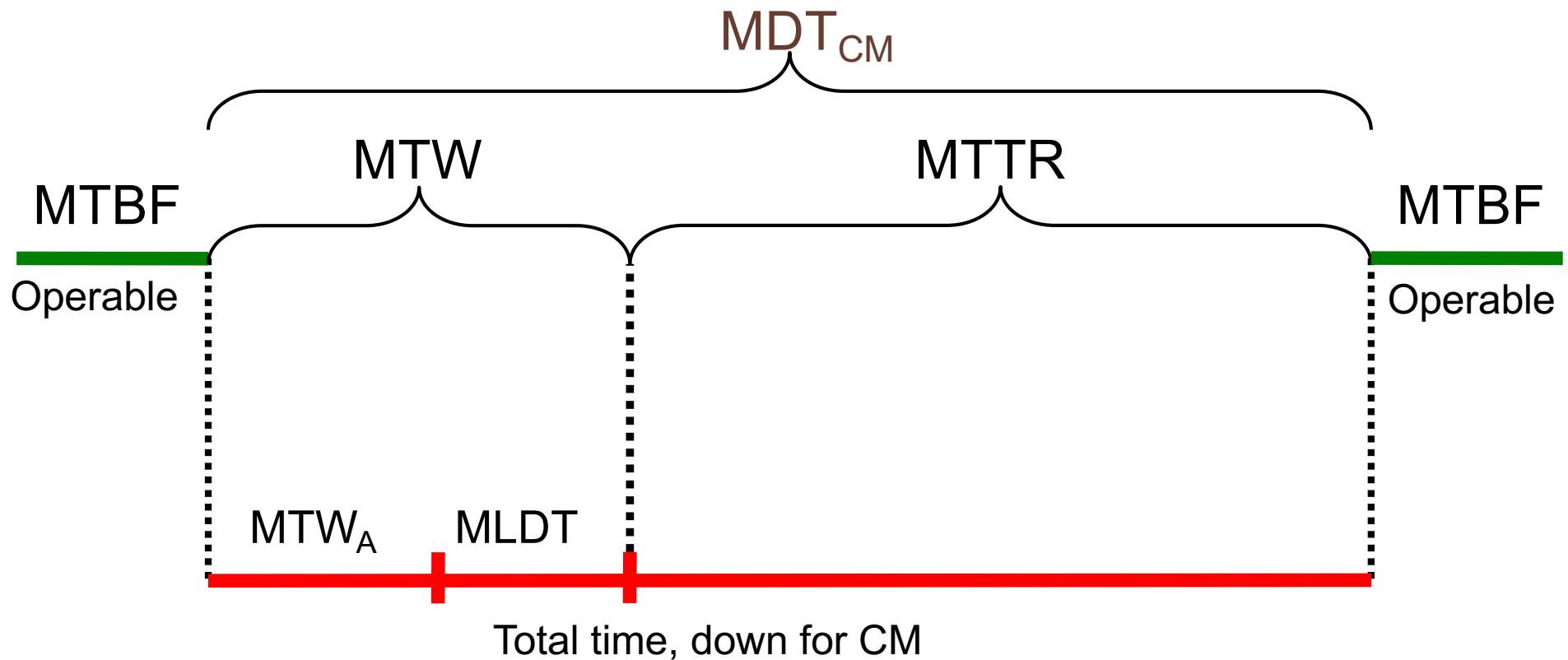


Corrective Maintenance (CM)





Corrective Maintenance (CM)



MTW_A = Mean Time Waiting Administrative

$MLDT$ = Mean Logistics Down Time

$MTTR$ = Mean Time To Repair



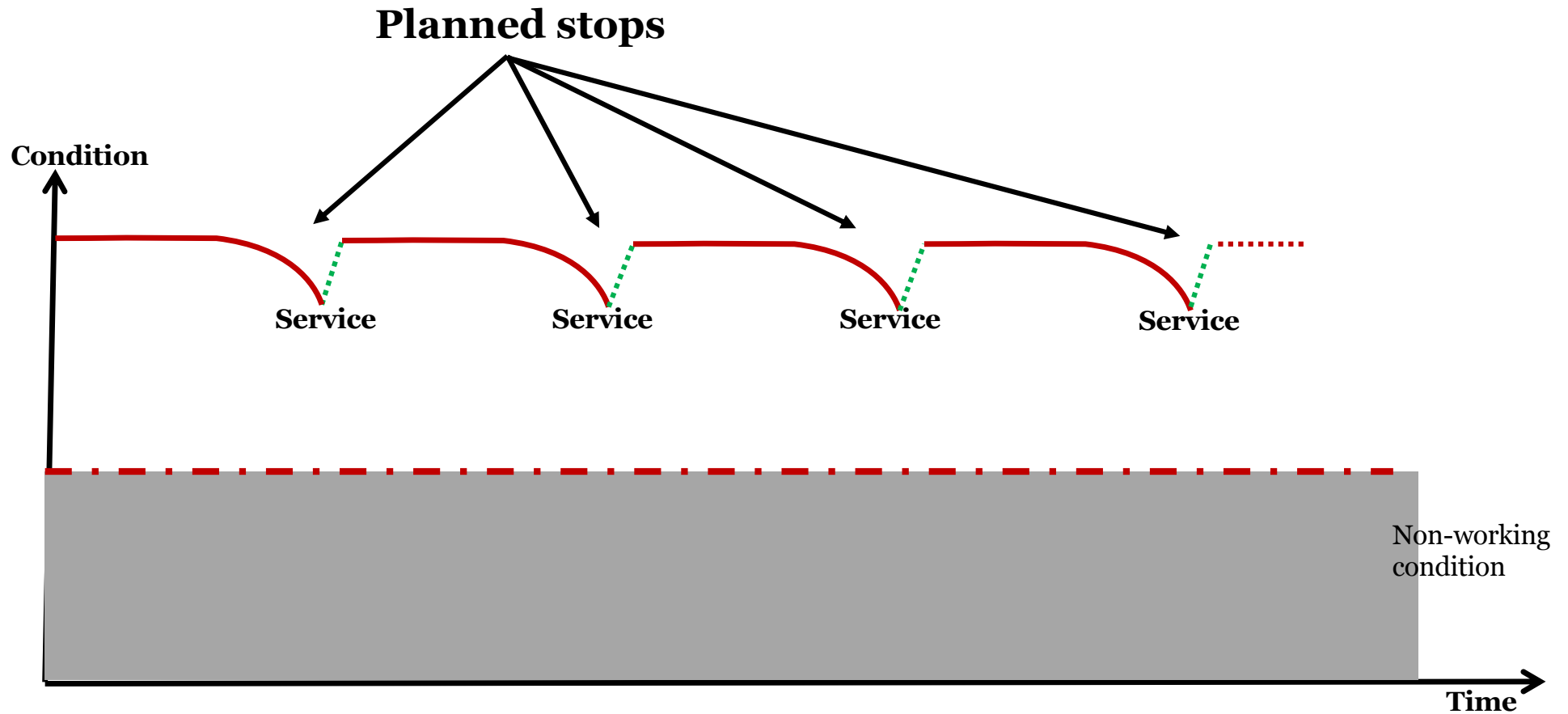
Preventive maintenance

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Planned stops

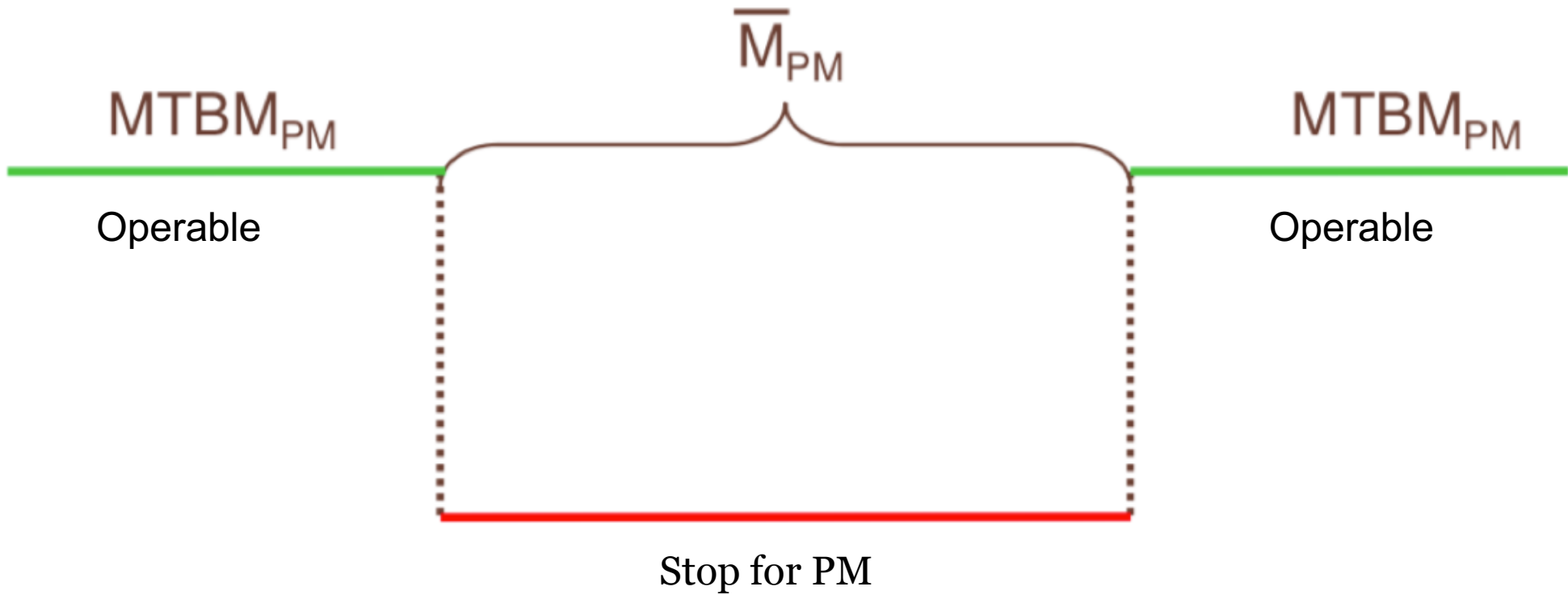


Preventive Maintenance (PM)



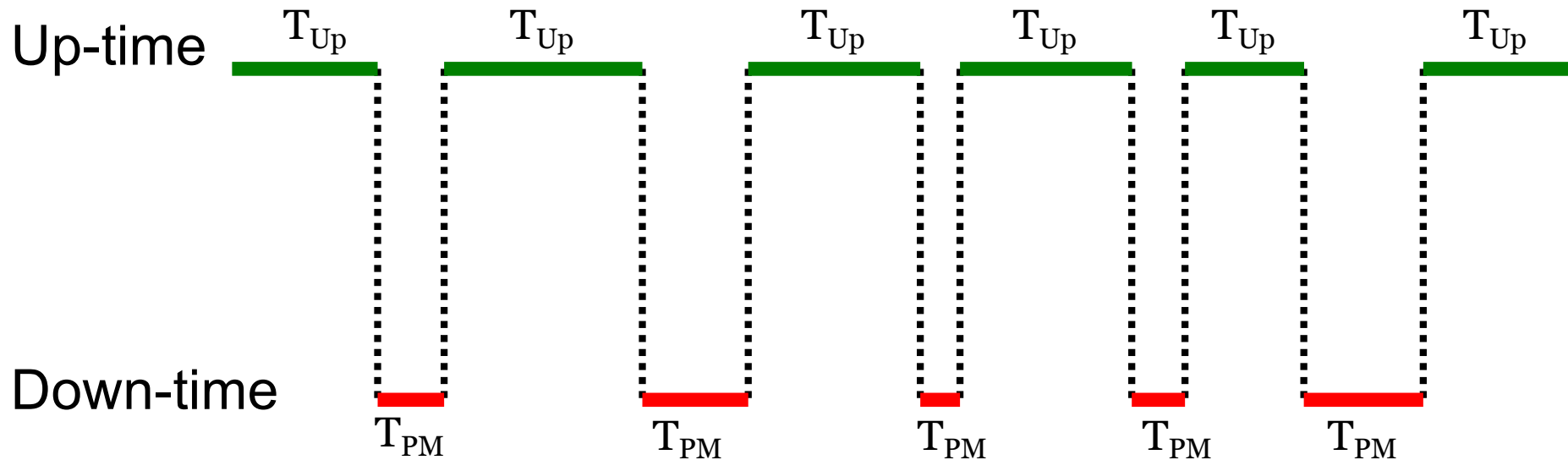


Preventive Maintenance (PM)





Preventive Maintenance (PM)



$$MTBM_{PM} = \frac{\Sigma T_{Up}}{n_{PM}}$$

$$\bar{M}_{PM} = \frac{\Sigma T_{PM}}{n_{PM}}$$

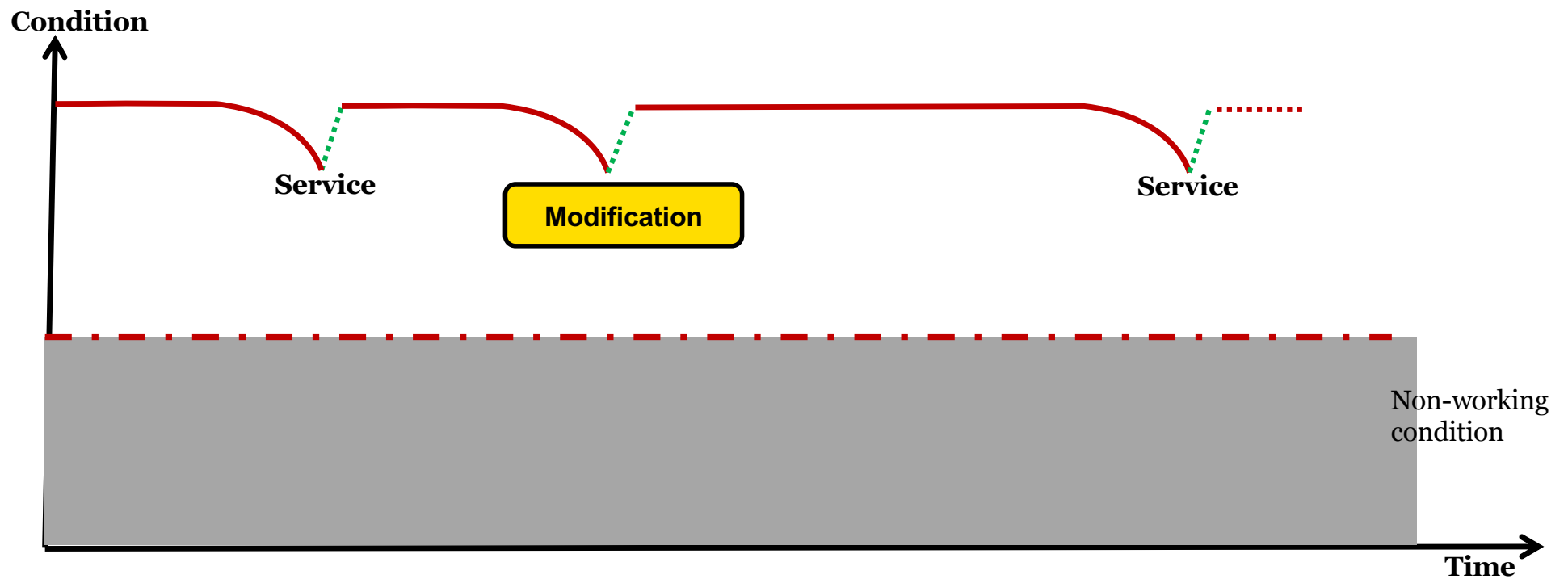
$MTBM_{PM}$ = Mean Time Between Preventive Maintenance
 \bar{M}_{PM} = Mean active preventive maintenance time



Improvement maintenance



Improvement maintenance

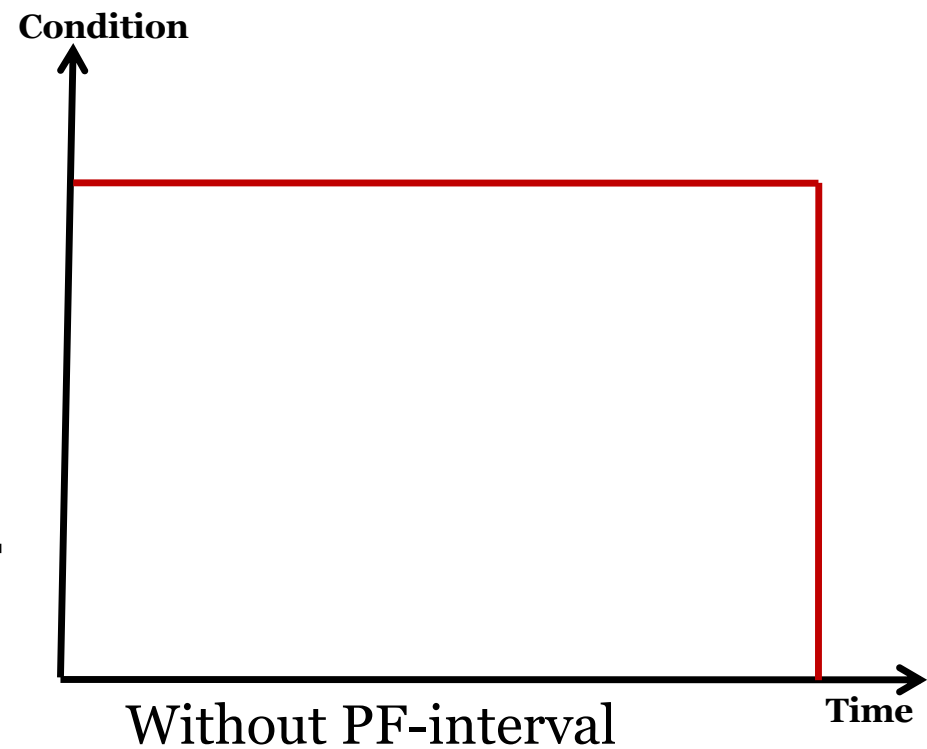
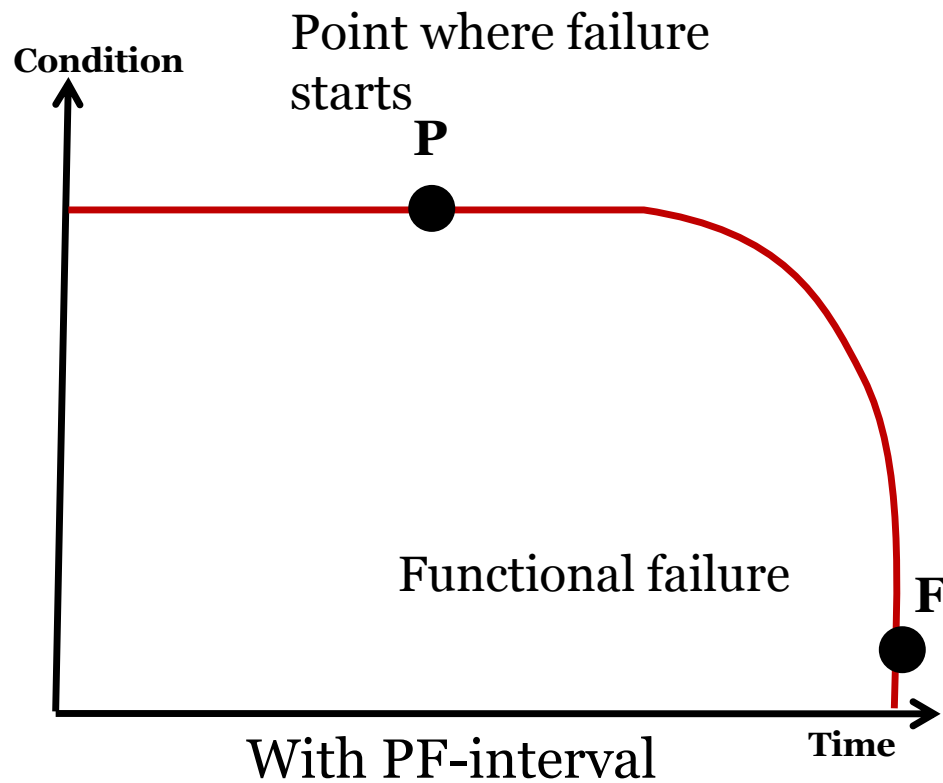




Fault development

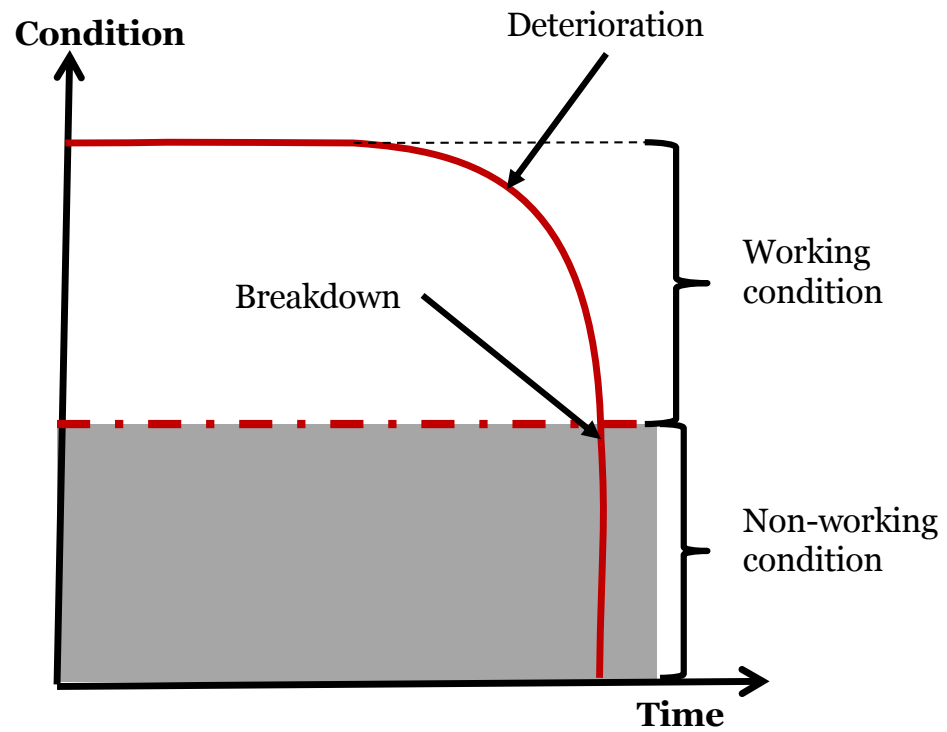


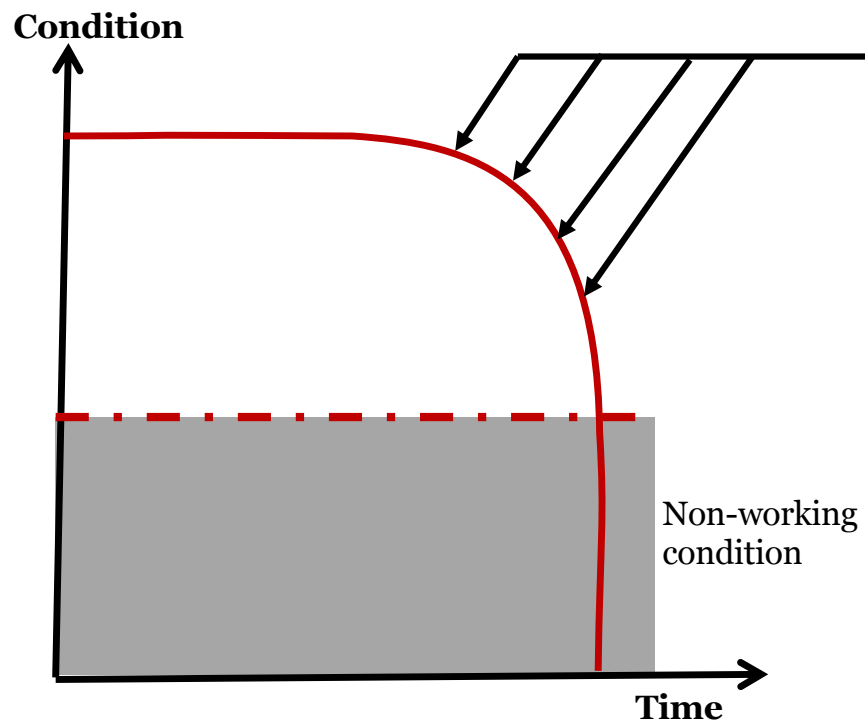
Fault development





Deterioration

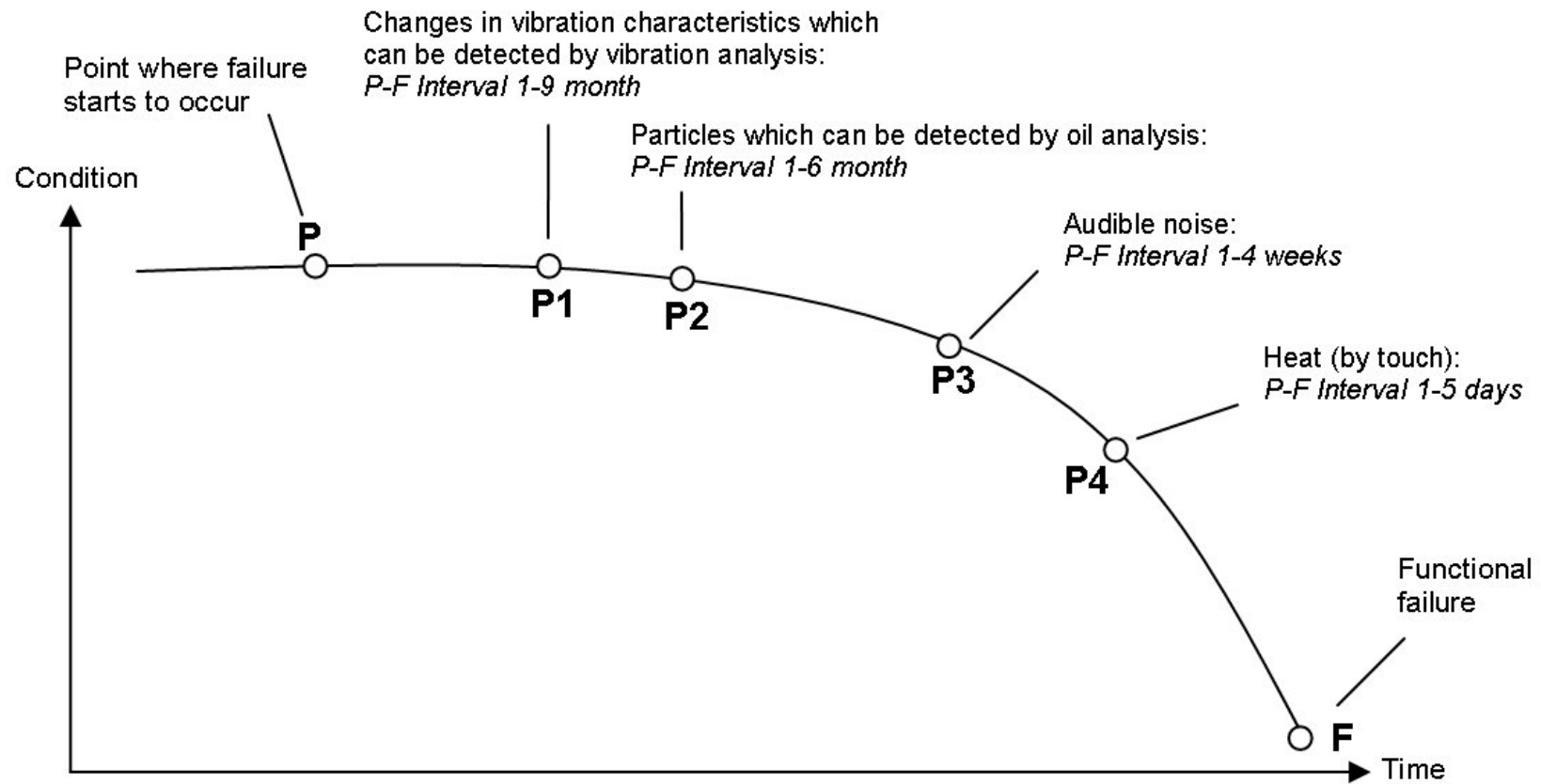




Can we detect this before
breakdown?



Condition Based Maintenance (CBM)





Condition monitoring

Some common condition indicators:

- Vibrations
- Particles (e.g. in gearbox oil)
- Sound
- Cracks
- Increased temperature
- Electrical effects

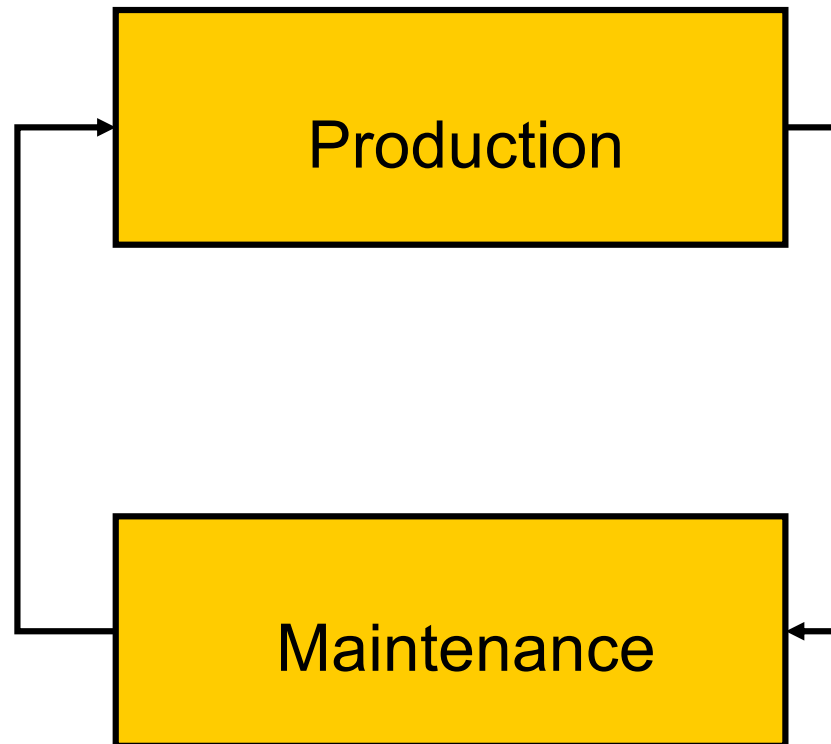


Depentability



Dependability

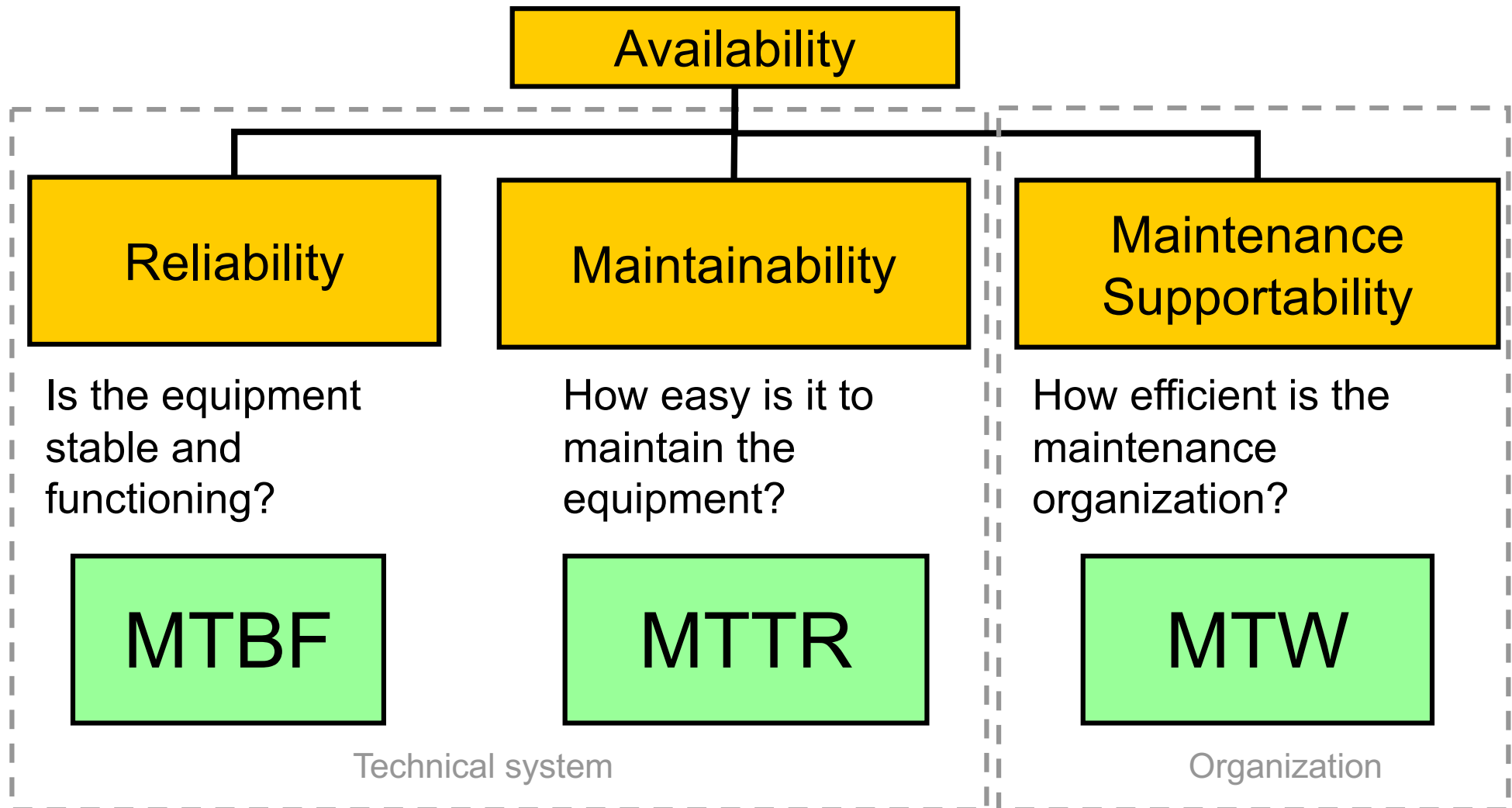
Dependability



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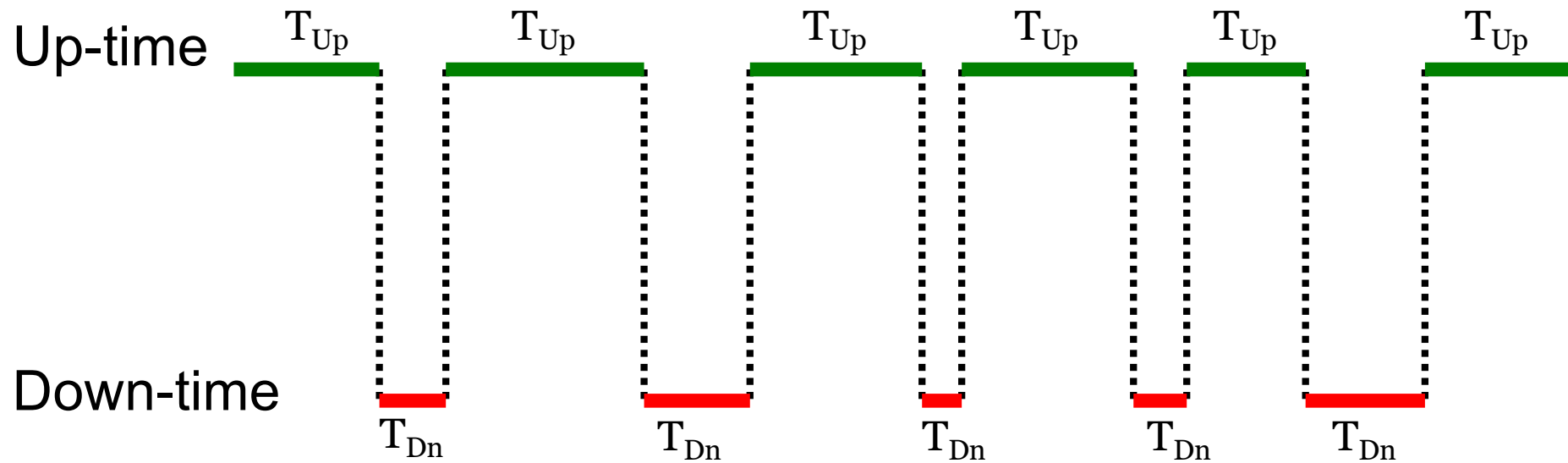


Dependability





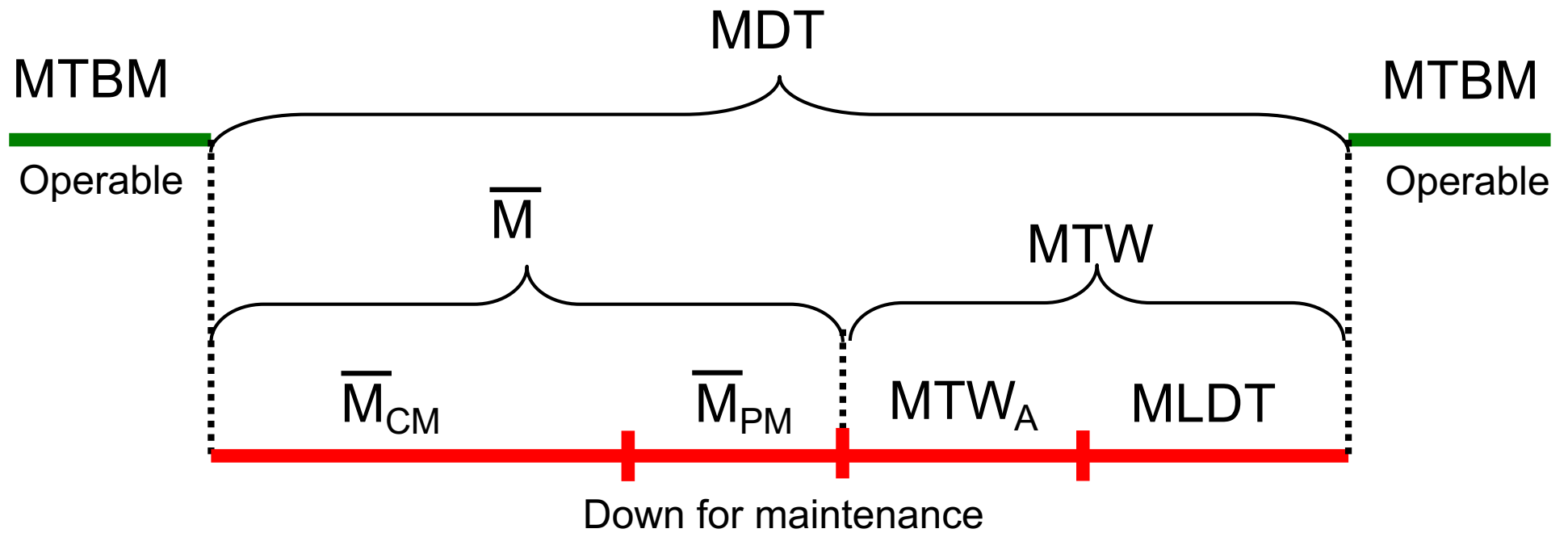
Availability



$$A = \frac{\Sigma T_{Up}}{\Sigma T}$$



Availability





So, how to improve reliability?



Improving Reliability (MTBF)

- Equipment design
- Preventive maintenance plan
- Condition monitoring



**So, how to improve
maintainability?**



Improving Maintainability (\bar{M})

- Component standard
- Modularization
- Poka-yoke
- Documentation
- Condition monitoring



So, how to improve supportability?



Improving Maintenance Supportability (MTW)

- Spare part management
- Staff competence
- Method optimization



**How to become a
successful
maintenance?**



Successful maintenance

- Minimize breakdowns
- Minimize downtime
- Minimize rework
- Minimize inventory
- Minimize spare parts
- Minimize overtime
- Minimize accidents

- Reduce cost of maintenance system
- Reduce the cost of reactive maintenance

- Improve reliability & availability
- Improve plant performance
- Support new market opportunities

- Improve product quality to secure, or even increase the customers

Loss of Production (maintenance indirect cost)

Maintenance Direct Cost

Volume

Price

Reduce Cost

Increase Revenue

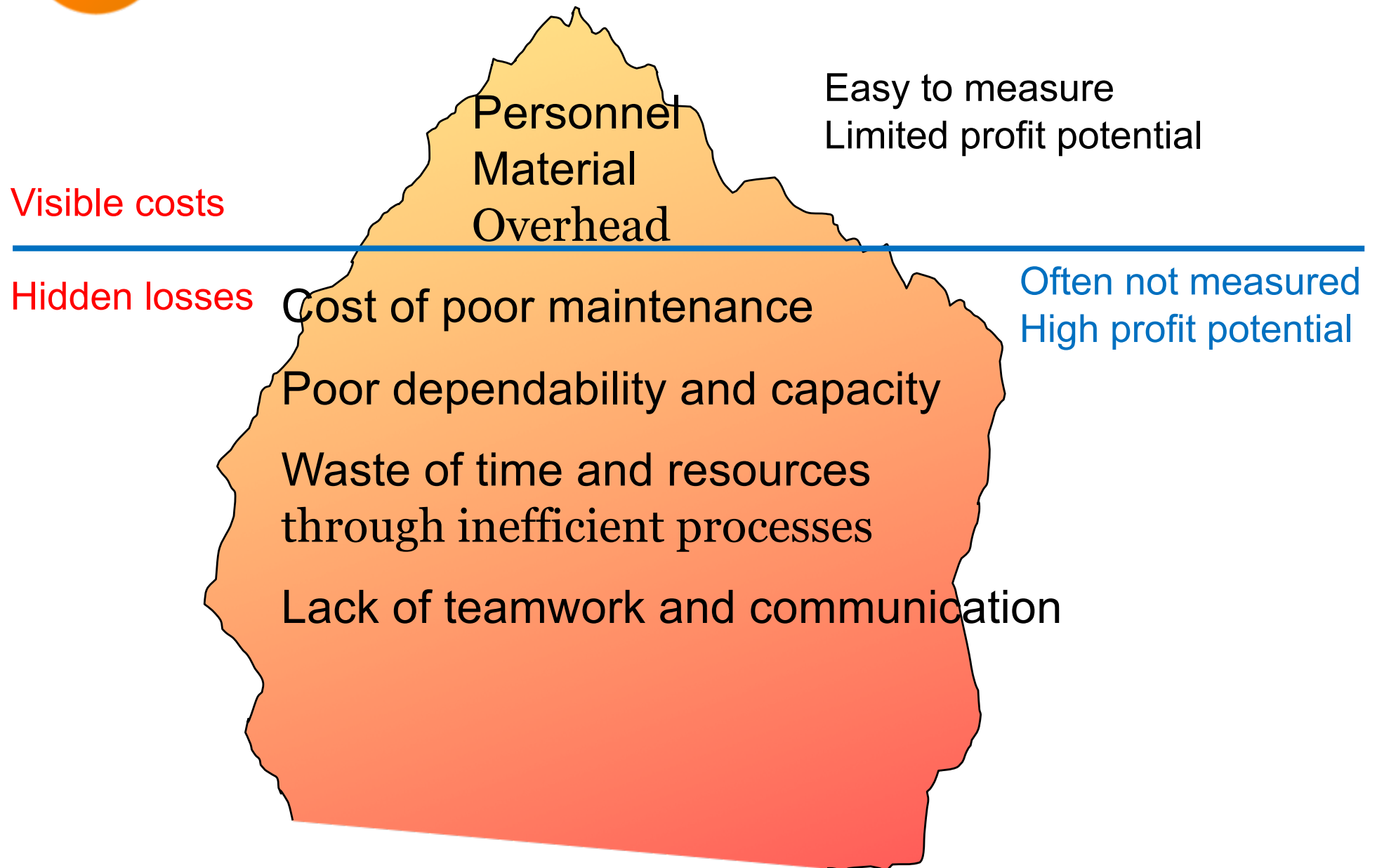
Profit



The economical “iceberg”



The economical “iceberg”





**So, what about
maintenance research
at MDH?**



Maintenance research at MDH

- Implementation of CBM.
- Strategic maintenance development in manufacturing industry.
- Reducing maintenance related waste.
- Data analytics in maintenance planning.



Guest lecture: Dr. Ali Rastegari, Volvo GTO
Condition Based Maintenance