Measuring loss, PPU413

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PMS, Performance Measurement System

Agenda

- Setting up measurements
- Sources of loss
  - Machine hours, OEE
  - Man hours
  - Energy consuption
  - Material consuption
  - Tool consuption
- Loss in Change-over
- System constraints and bottlenecks
- Steps for development of an effective Performance Measuring System

Setting up measurements

Why shall we measure?

What is not measured can not be controlled.

Setting up measurements

Measuring (Coordination, Monitoring, Diagnostics):

- Provides feedback and build understanding.
- Provides forward looking predictions.
- Provides systematic thinking and structural changes.
- Provides a framework for understanding.

Setting up measurements

Basic questions:

- **Why** is measurement required? (Purpose.)
- **What** should be measured? (Finding factors that are important.)
- **How** should it be measured? (Methods.)
- **When** should it be measured? (Timeframe.)
- **Who** should measure it? (Owner of the process versus independent party.)

Sources of loss

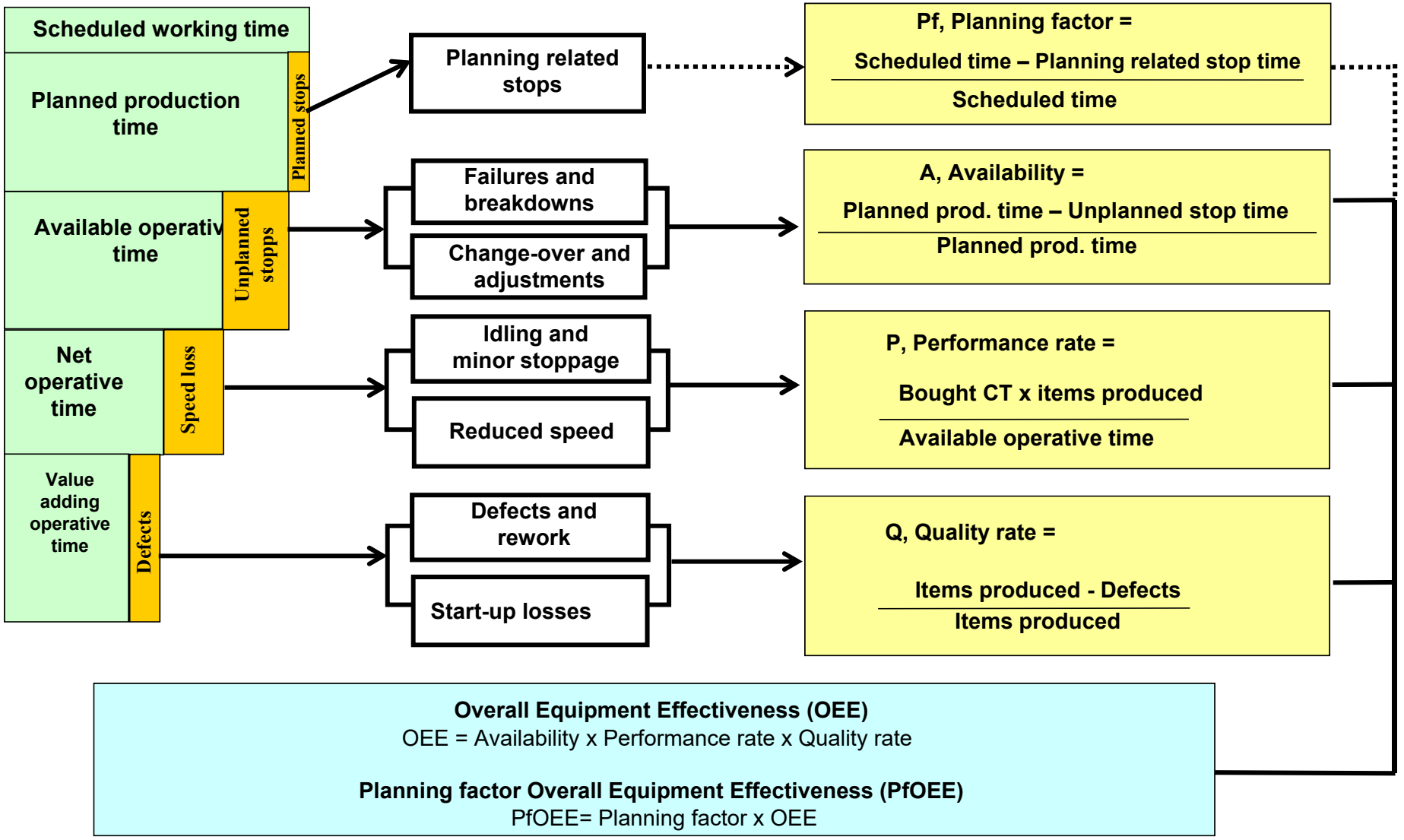
- Loss in machine hours, OEE.
- Loss in man hours.
- Loss in energy consuption.
- Loss in material consuption.
- Loss in tool consuption.

Machine hours

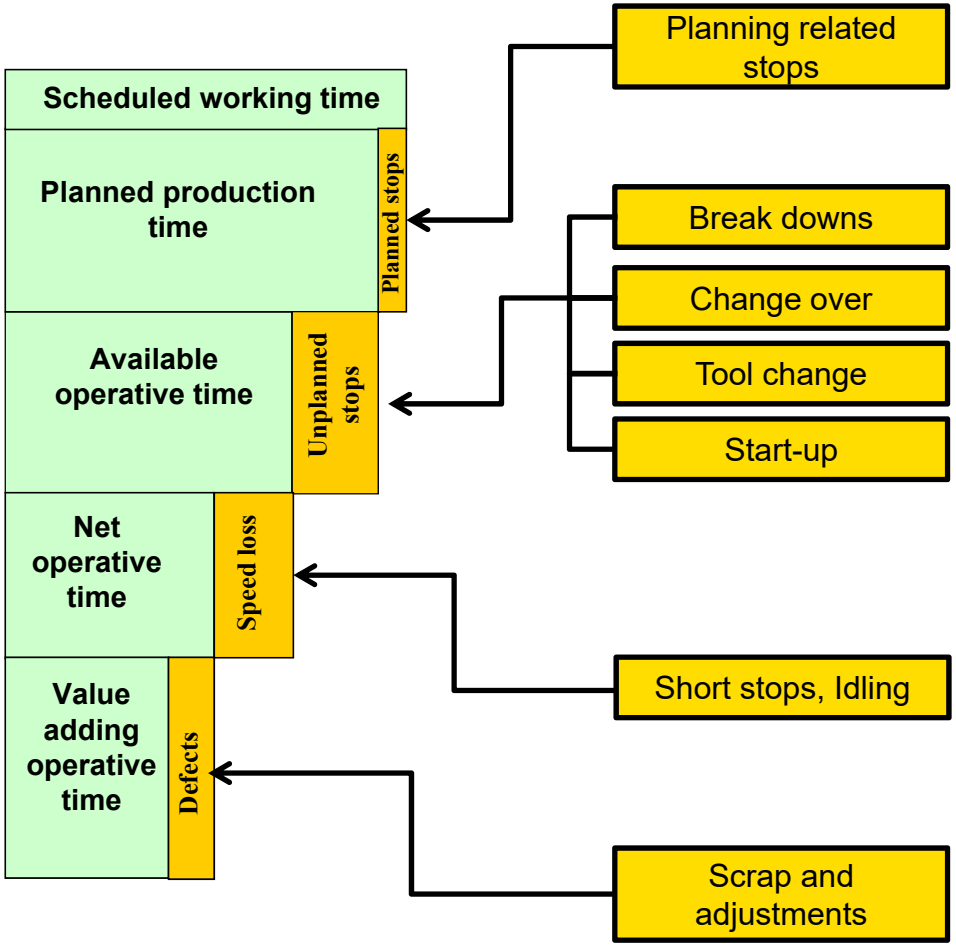
Machine hours, OEE

OEE = **O**verall
Equipment
Effectiveness

Machine hours, OEE



Machine hours, OEE, sources of loss



System loss in production system

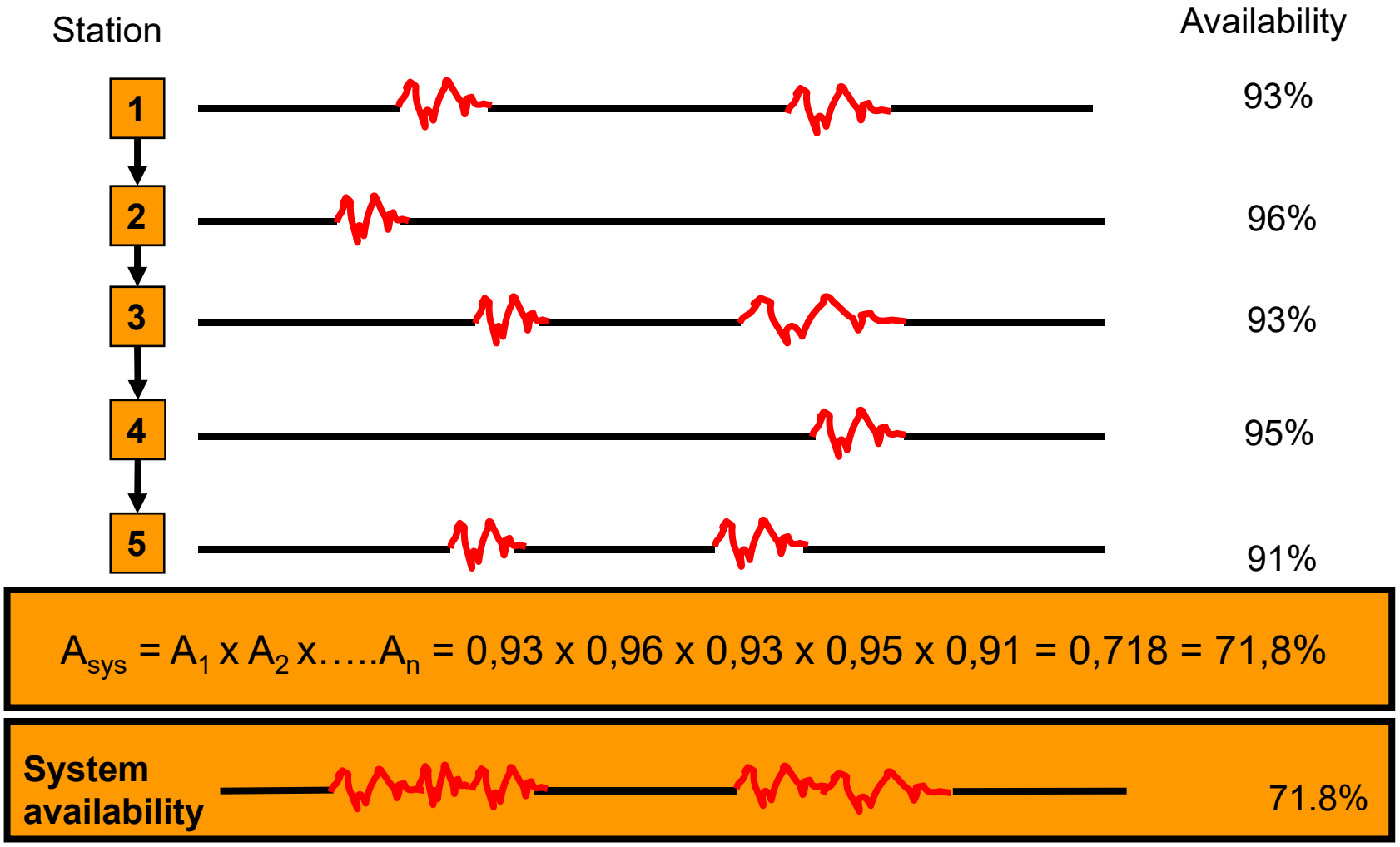
Machine hours, OEE, system loss in production system

- Conveyor systems between equipment.
- Failures in computer systems.
- Failures in buffer systems.
- Problem with power.
- Failures in central systems, for example central lubrication and compressed air.

Machine hours, OEE

System availability

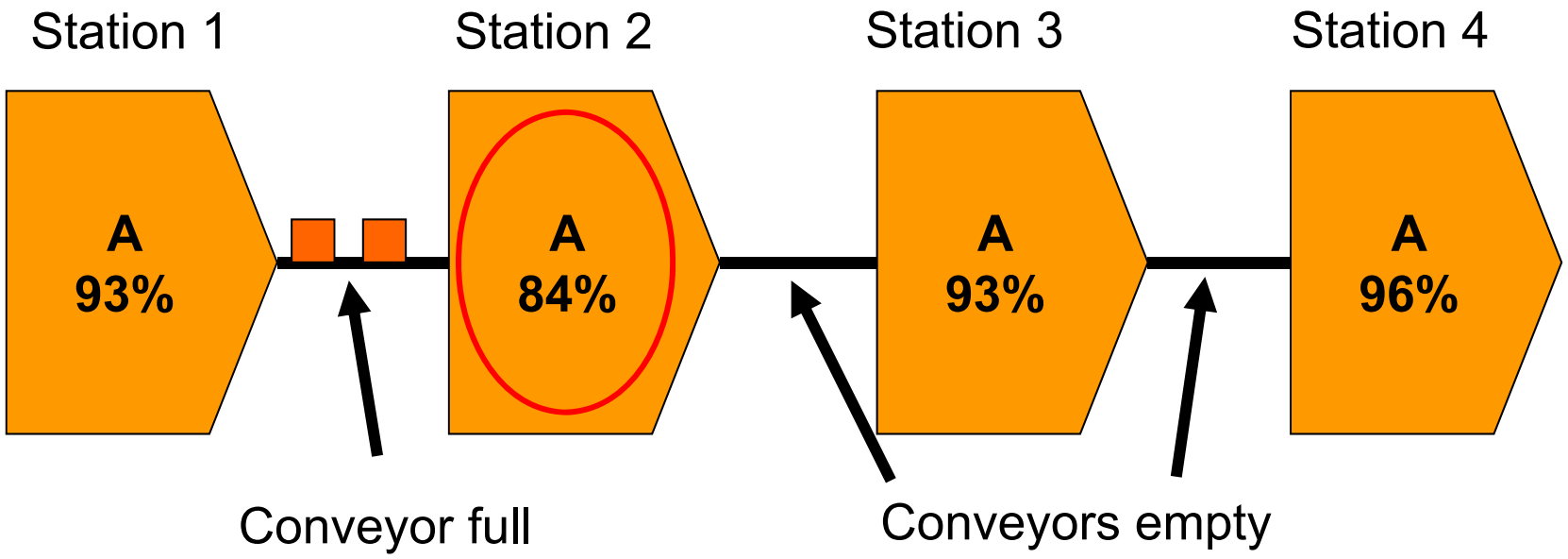
Machine hours, OEE, system availability



Machine hours, OEE

System availability loss

Machine hours, OEE, system availability loss



Machine hours, OEE

Cycle-time

Machine hours, OEE, cycle-time

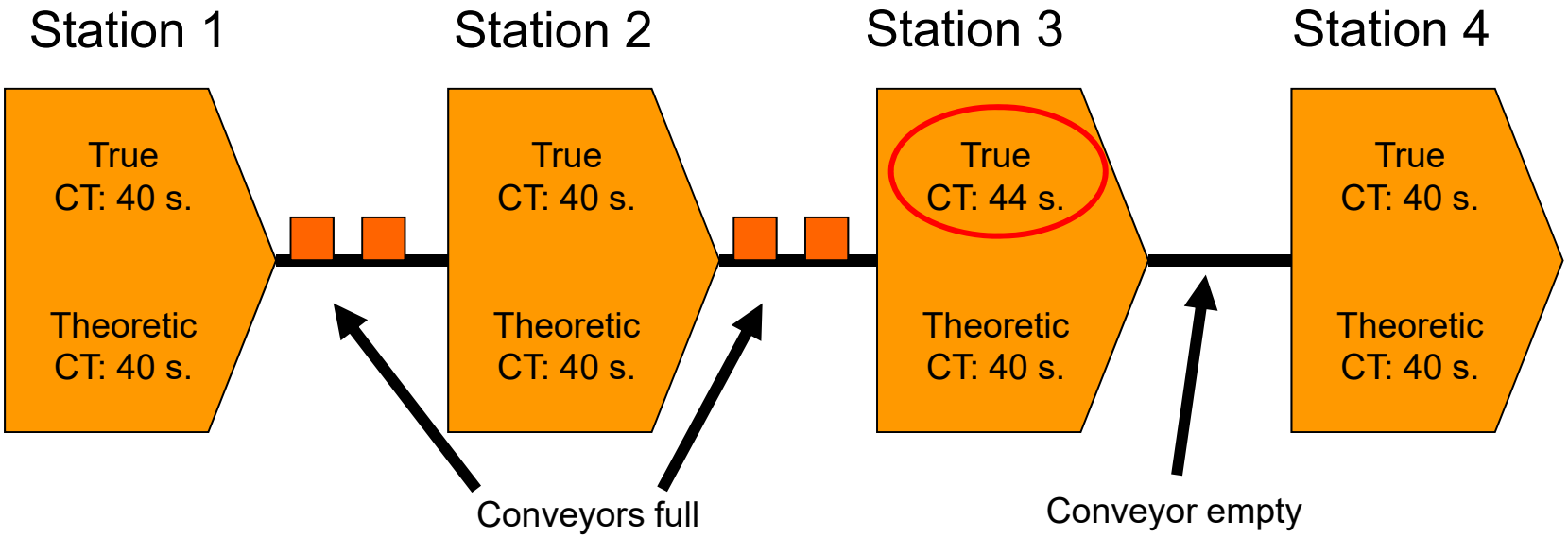
Cycle-time

Every station/equipment in a production system has cycle-time

Cycle-time loss in production system

Machine hours, OEE, cycle-time loss in production system

So, how about the true cycle time of this system?



True cycle time of system: 44 s

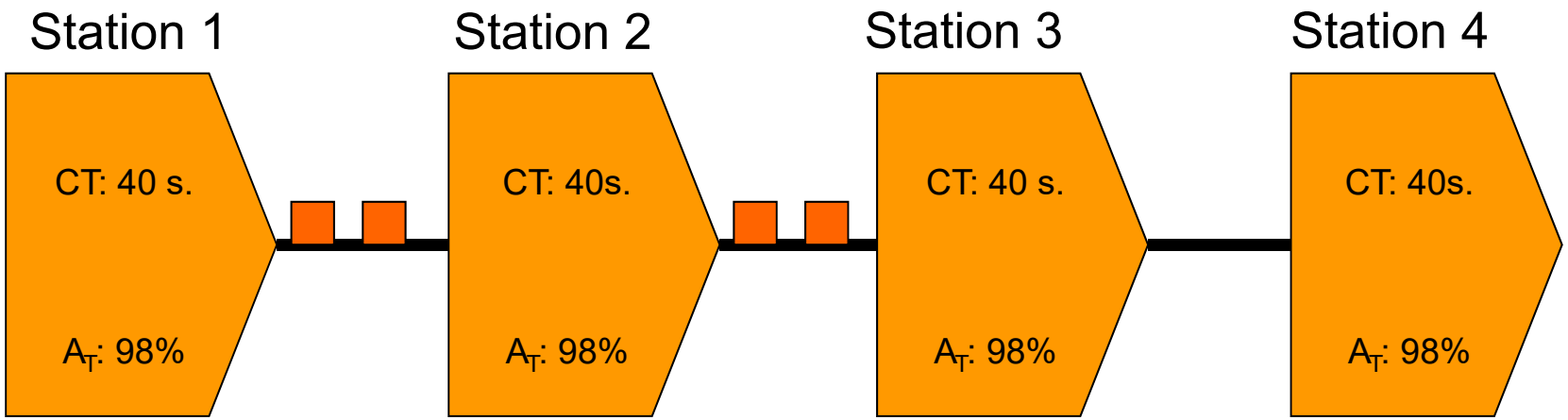
Machine hours

System capacity

Bought capacity

True capacity

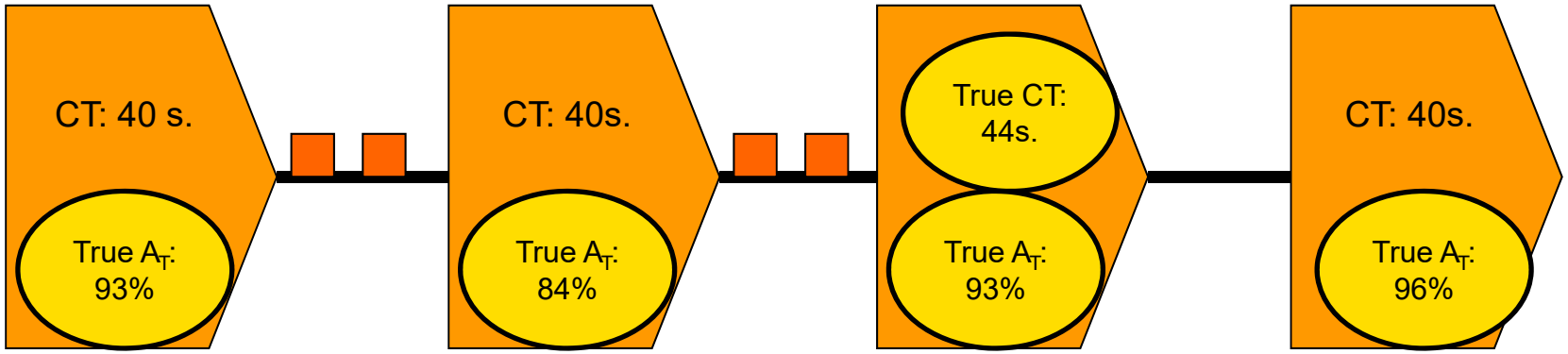
Machine hours, OEE, system capacity, bought capacity



Bought capacity (with an assumed A_T of 98% and CT = 40s):

C_{sys} = (3600/40) x 0.98 x 0.98 x 0.98 x 0.98 = 83 u/h

Machine hours, OEE, system capacity, true capacity



True capacity, based on the actual data, presented above:

C_{sys} = (3600/44) x 0.93 x 0.84 x 0.93 x 0.96 = 57 u/h

Machine hours, OEE

How to measure?

When your are at the company for your industrial project, start by asking if OEE are available!

Machine hours, OEE

If the company has OEE, check:

- Definitions
- Measurement method
- Reliability

Machine hours, OEE

What about if the company not has OEE?

$$\frac{\text{Achieved output}}{\text{Planned output}} = \text{OEE}$$

Machine hours, OEE

Some types of data sources

Machine hours, OEE, data sources

- Operators log books.
- Manual measuring.
- Documentation of previous studies.
- System data.
- Interviews.

Machine hours, OEE

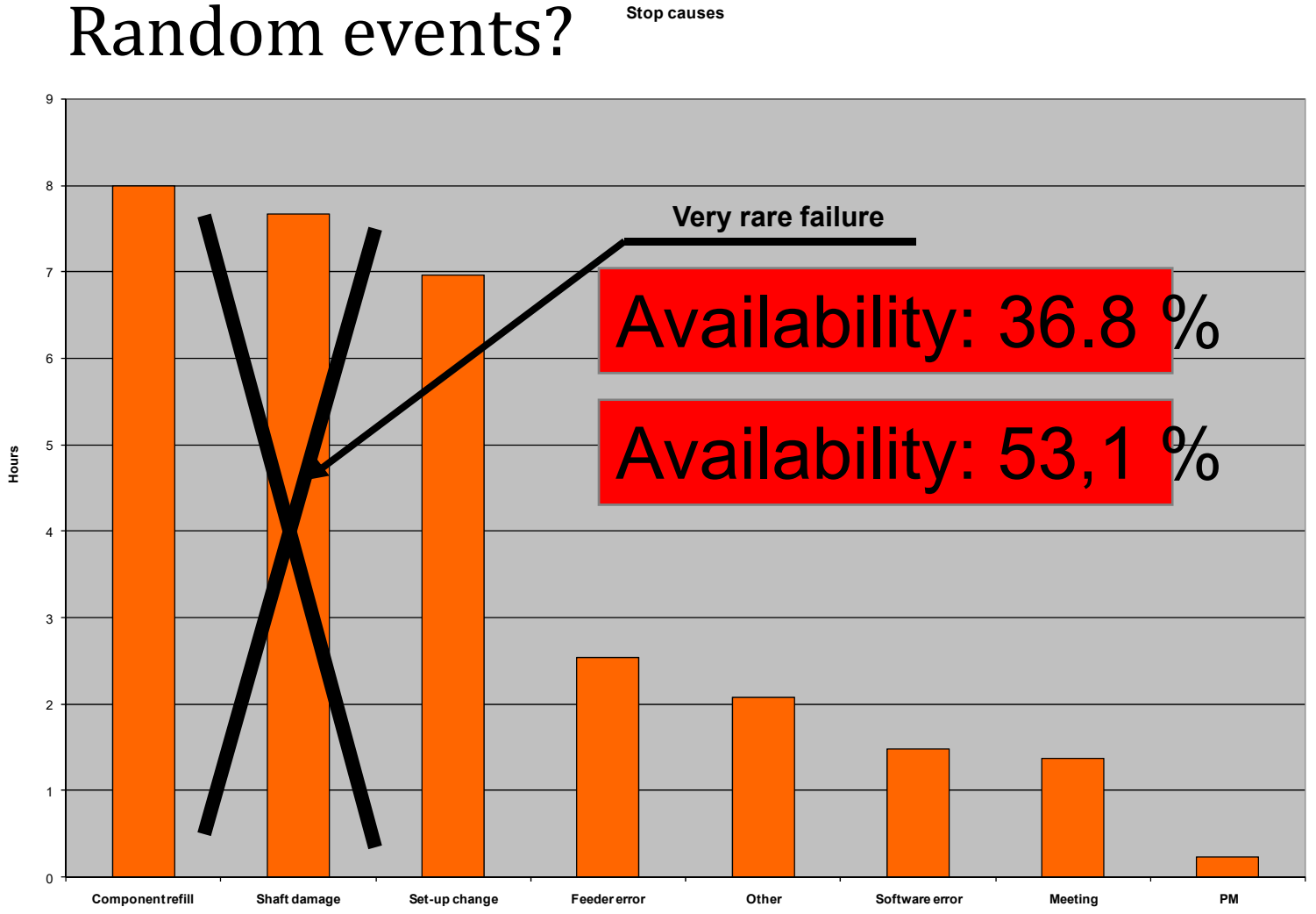
Some types of error sources

Machine hours, OEE

Example 1 from an industrial company in Sweden

Machine hours, OEE

Random events?



Machine hours, OEE

So, how to check validity and reliability?

Machine hours, OEE

When your are at the company for your industrial project, so let the staff verify your findings, for example operator and production leader.

Machine hours, OEE

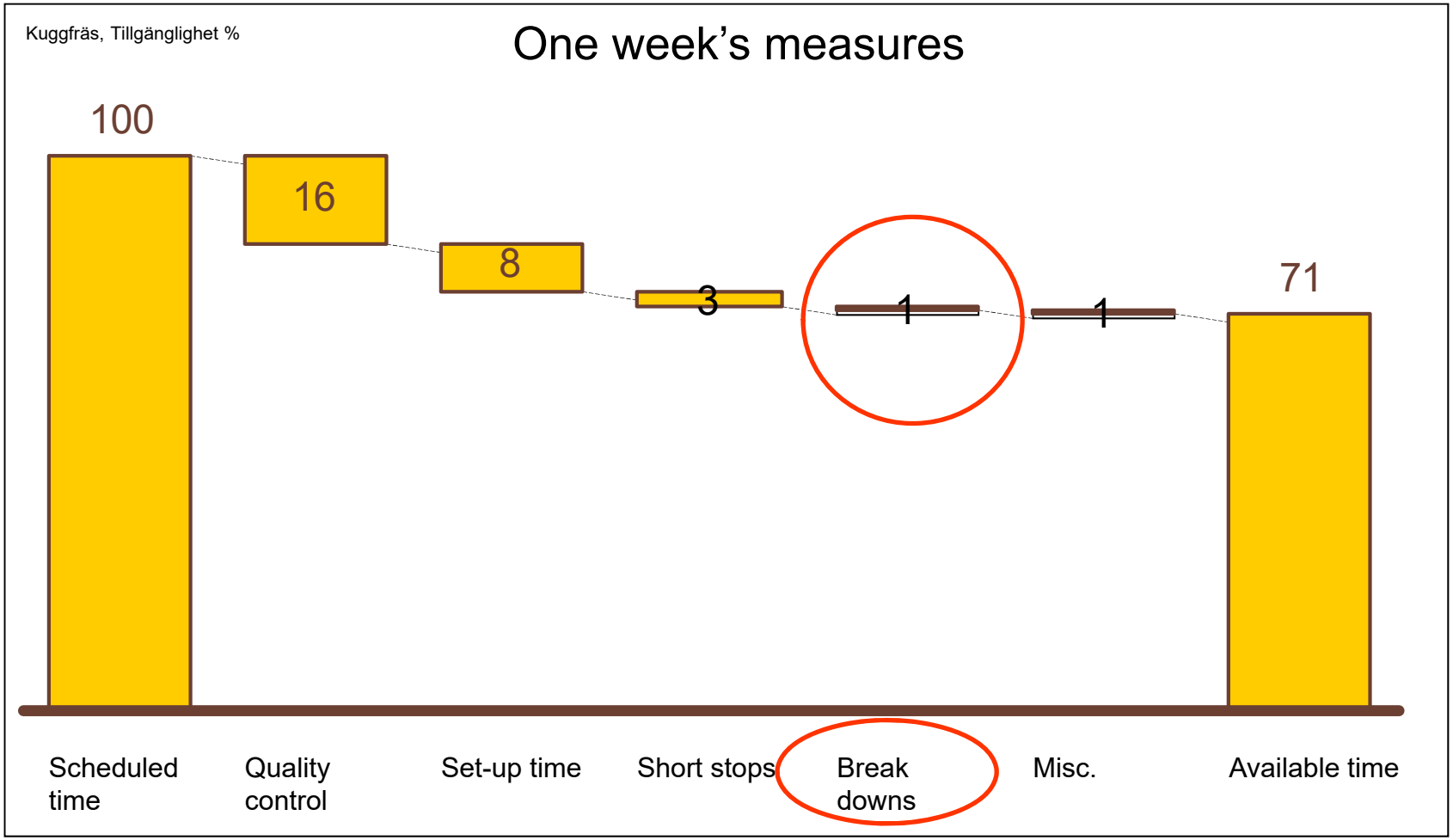
You can also compare your findings with alternative data sources.

Machine hours, OEE

Example 2 from an industrial company in Sweden

Machine hours, OEE

Too short time span?



Machine hours, OEE

Alternative data sources?

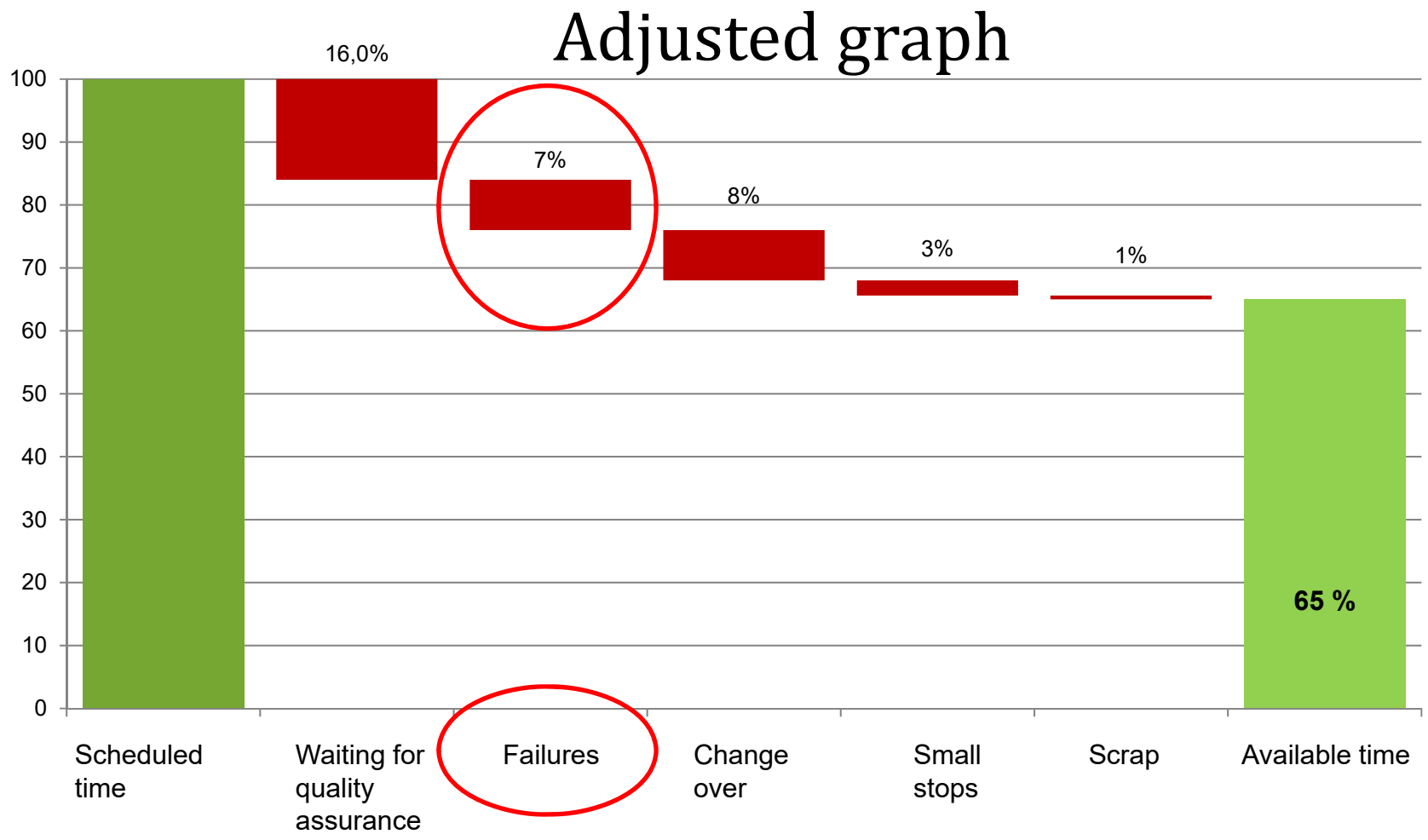
Milling	Grading
MTBF = 113h	MTBF = 117h
MTTR = 6h	MTTR = 3h

Availability, milling $\frac{MTBF}{MTTR+MTBF}=\frac{113}{113+6}=\frac{113}{119}=0{,}95$

Availability, grading $\frac{MTBF}{MTTR+MTBF}=\frac{117}{117+3}=\frac{117}{120}=0{,}98$

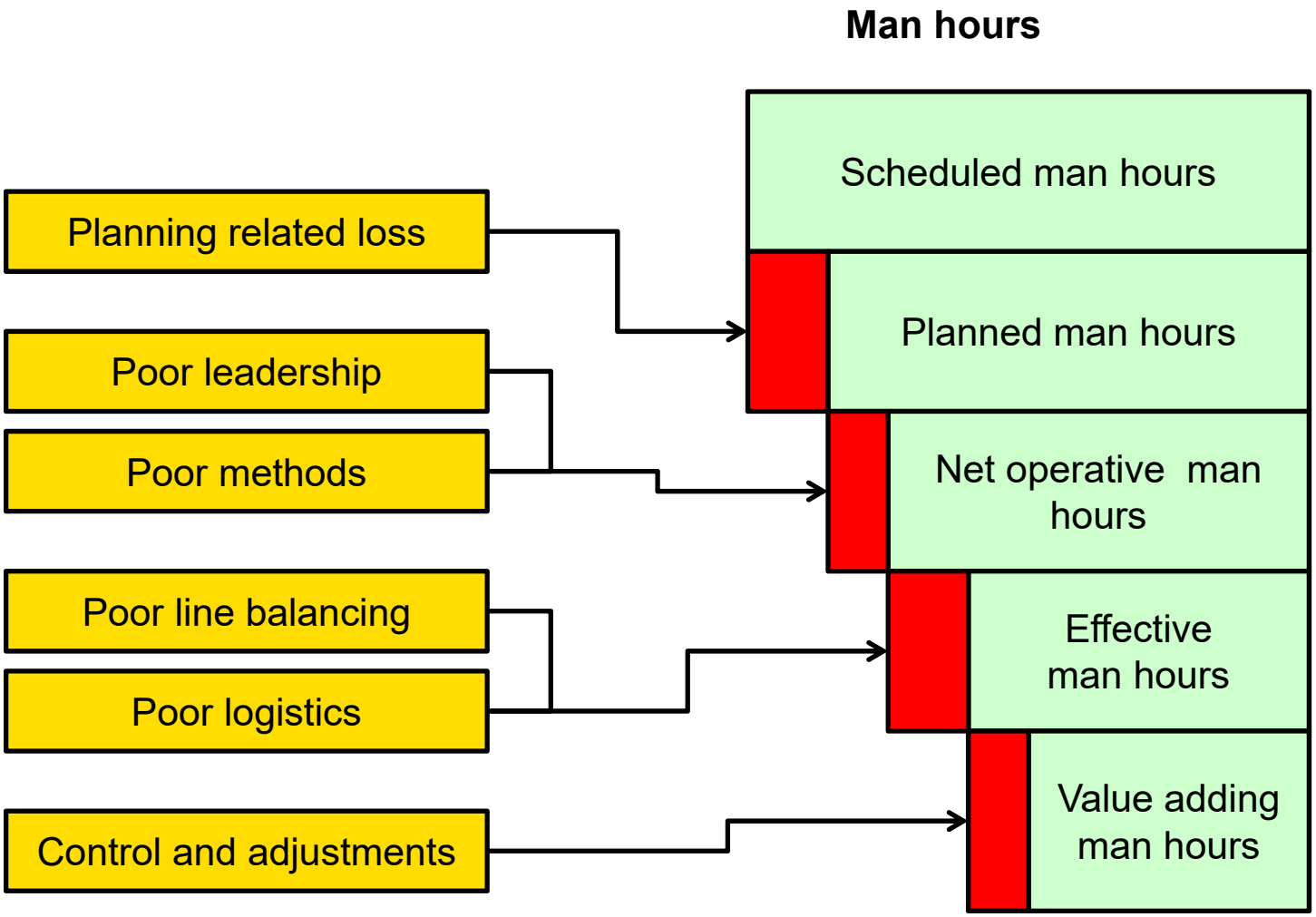
Availability, system: 0,95 x 0,98 = 0,93 = 93%
Failure: 100% - 93% = 7%, instead of 1%

Machine hours, OEE



Man hours

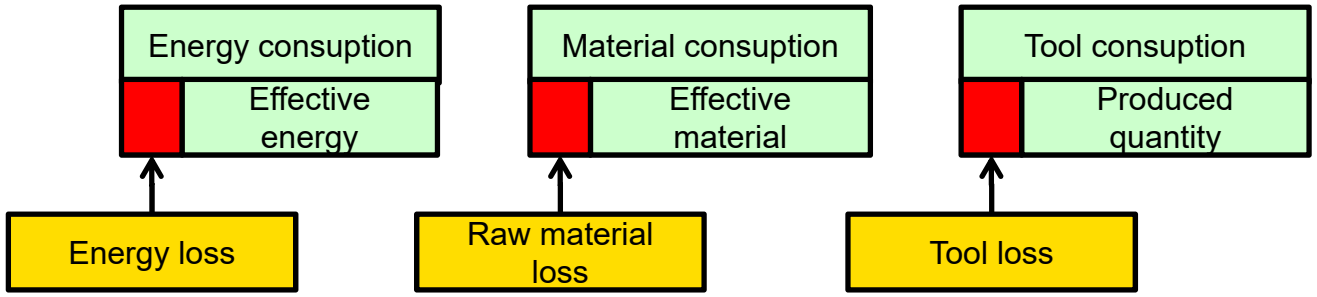
Man hour, sources of loss



Man hour, methods for identifying of loss in manual labor

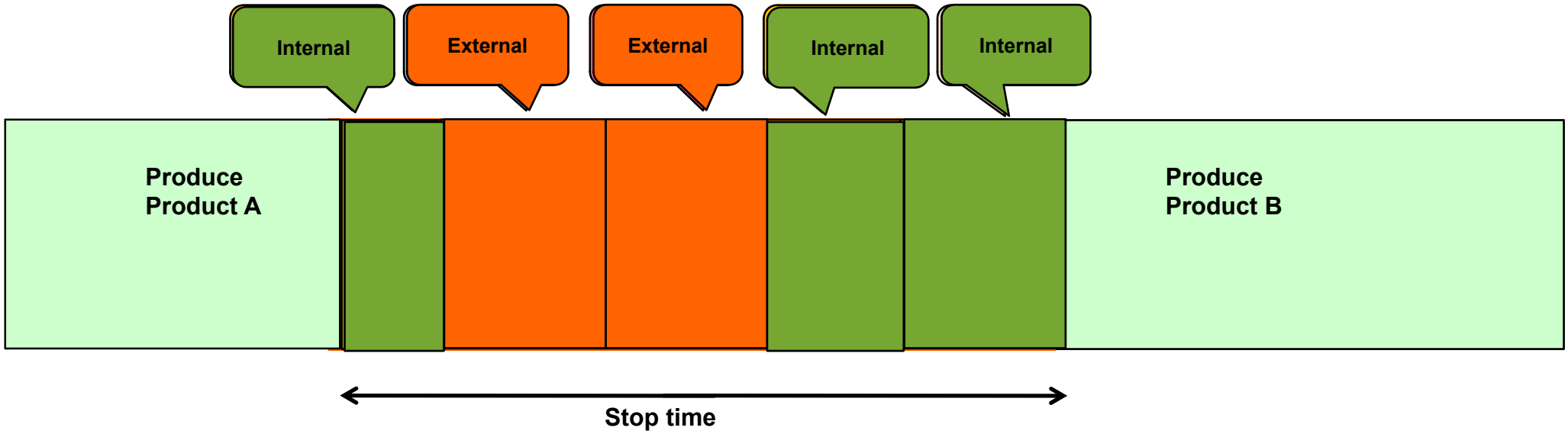
- Time studies
- Frequency studies
- Time formulas

Other sources of loss



Loss in Change-over

Internal and external work



Loss in Change-over

Further reading

- Muchiri, P., Pintelon, L., (2008), ”Performance measurement using overall equipment effectiveness (OEE): litterature review and practical application discussion”, International Journal of Production Research, Vol. 46, No. 13, pp. 3517-3535.
- Shams-Ur, R., (1998) ”Theory of Constraints: A review of the philosophy and its applications”, International Journal of Operations & Production Management, Vol. 18, Iss: 4, pp.336-355.
- Mali, Y.R., Inamdar, K.H., (2012), ”Changeover Time Reduction using SMED Technique of Lean Manufacturing”, International Journal of Engineering Research and Applications, Vol. 2, Issue 3, pp. 2441-2445.
- Wisner, J. D., Fawcett, S. E., (1991) ”Linking firm strategy to operating decisions through performance measurement”, Production and Inventory Management Journal, Vol. 32, No 3, pp. 5-11.

Theory Of Constraints

Theory Of Constraints

Constraints represents opportunities for improvement.

Theory Of Constraints

Every system must have at least one constraint, for example bottlenecks.

Theory Of Constraints

So, how to eliminate bottlenecks?

So, how to eliminate bottlenecks?

Process to follow:

1. Identify the bottlenecks
2. Exploit the bottlenecks
3. Subordinate all other decisions
4. Elevate the bottlenecks
5. Avoid inertia

Theory Of Constraints

1. Identify the bottlenecks

bottleneck is the operation that has the lowest capacity of the system.

It might be a high speed machine with low utilization.

It might be a low speed machine with high utilization.

Theory Of Constraints

2. Exploit the bottlenecks

Increase the capacity of the bottleneck as much as possible.
Maybe with increase of the utilization.

Theory Of Constraints

3. Subordinate all other decisions

The non-bottleneck resources should support the bottleneck and not produce more than it can handle.

Theory Of Constraints

4. Elevate the bottlenecks

If the previous activities have not eliminated the bottleneck, the company needs to change the system by investments or changing of working hours.

Theory Of Constraints

5. Avoid inertia

When the original bottleneck is eliminated, there is a high probability that some other part of the process has become a bottleneck.

Therefore it is important not to stand but start working with the new bottleneck.

Development of an effective PMS

Performance Measurement Systems

Why do we need a system for Performance Measurement?

”An effective performance measurement system should lead to the integration of operations, marketing, finance, engineering, and accounting so that they act as one coordinated value-adding system.”

(Wisner and Fawcett, 1991)

Development of an effective PMS

1. Clearly define the firm's mission statement
2. Identify the firm's strategic objectives using the mission statement as a guide.
3. Develop an understanding of each functional area's role in achieving the various strategic objectives.
4. For each functional area, develop global performance measures, capable of defining the firm's overall competitive position to top management
5. Communicate strategic objectives and performance goals to lower levels in the organization. Establish more specific performance criteria at each level.
6. Assure consistency with strategic objectives among the performance criteria used at each level
7. Assure the compatibility of performance measures used in all functional areas.
8. Use the performance measurement system to identify competitive position, locate problem areas, assist the firm in uppdating strategic objectives and making tactical decisions to achieve these objectives and supply feedback after the decisions are implemented.
9. Periodically reevaluate the appropriateness of the established performance measurement system in view of the current competitive environment.

(Wisner and Fawcett, 1991)

Next lecture

- Production system development and simulation of production systems.
- With Erik Flores and Jessica Bruch,