

PTW | TU DARMSTADT

LEAN PRODUCTION WS 2024/2025

Chapter 3: Waste reduction

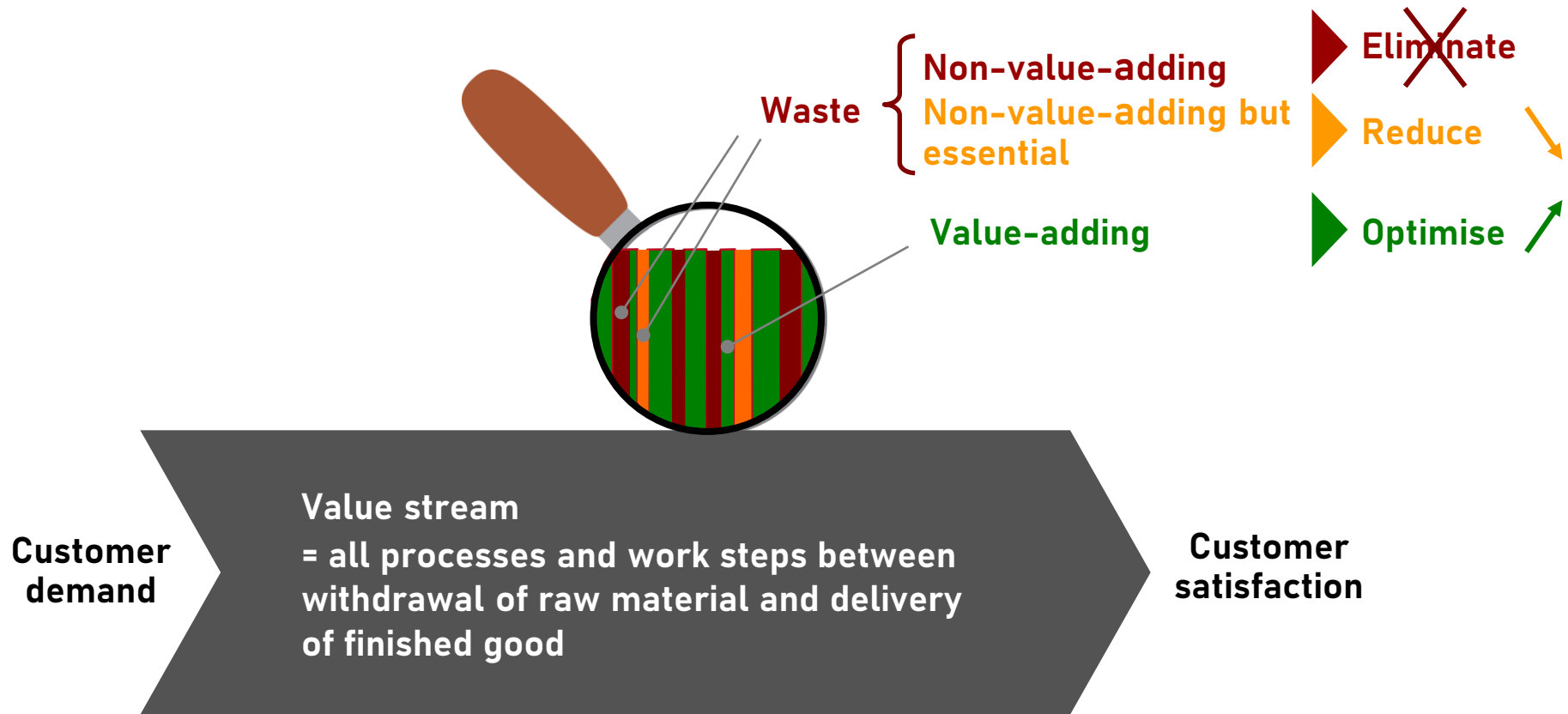
PROF. DR.-ING. JOACHIM METTERNICH

3.1 The basic concept of waste

3.2 Learn to see waste

3.3 Methods for waste identification

CONCEPT OF WASTE



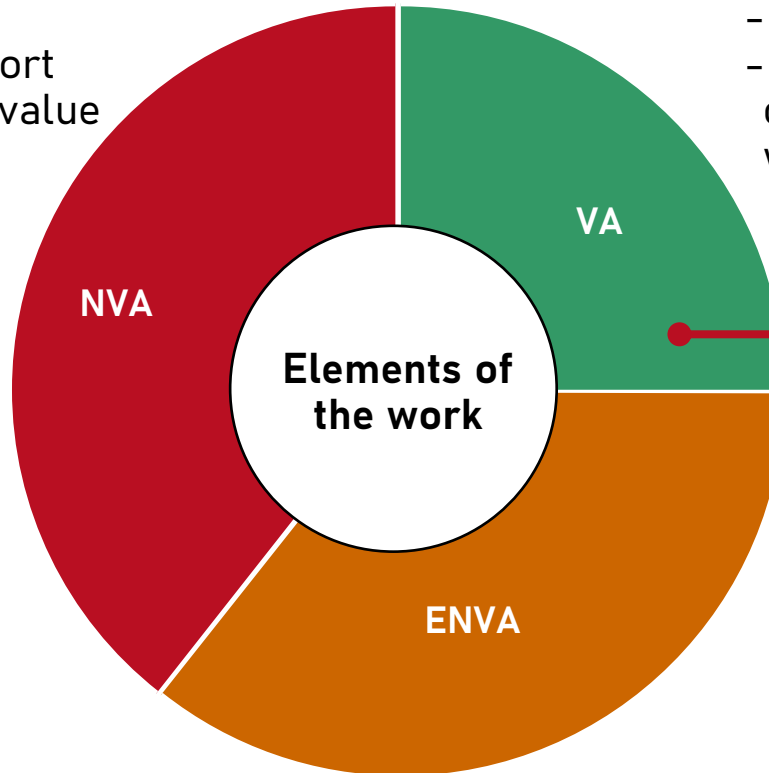
WASTE RAISES COSTS BUT NOT THE VALUE

Non-value-adding
activity:

- Any work or effort that creates no value

Value-adding activity:

- Directly creates value
- Changing the fit, form or function of the product - Is the customer willing to pay for this activity?



Goal:
Maximisation of the value-adding time share

Essential non-value-adding activity:

- Work that does not directly create value, but is required to perform value-adding activities

DIFFERENT TYPES OF VALUE ACTIVITIES

VA

Changing the fit, form or function of the product – Is the **customer willing to pay** for this activity?

NVA

These are activities that **are not in any way changing the fit, form or function of the product** and are **not necessary to enable the value-added operations to take place**. An example here would be the time a person walked to fetch a tool (transportation) if it was stored 50 meters away from his workplace when it could reasonably have been stored just 2 meters away.

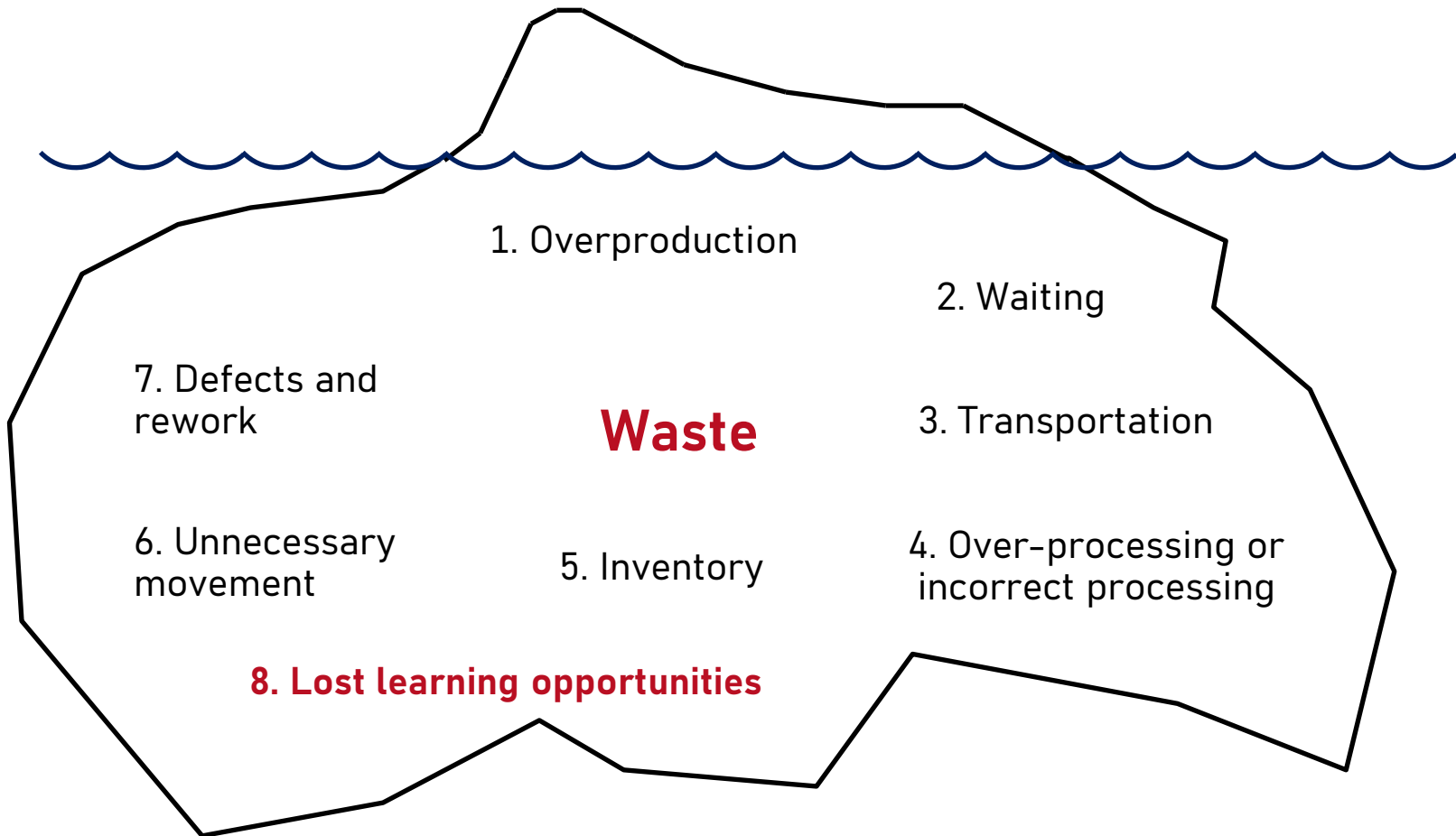
ENVA

These are activities that are **not in any way changing the fit, form or function of the product but are necessary to enable the value-added operations to take place**. An example here would be the time a person took to load/unload a machine, or another would be the time taken to pick up a hand tool.

CASE EXAMPLE: IMPROVING OPERATIONAL AVAILABILITY AT THE “CEDAR WORKS” CORP.

Activity	VA	ENVA	NVA
Handling wood		●	
Breakdown			●
Quality checks		●	
Blade cuts wood	●		
Waiting for wood			●
Banding bundles		●	
Moving bundles of wood		●	
Changing blades		●	
Clean up		●	
Adjusting saw		●	

THE 7 + 1 TYPES OF WASTE



CHAPTER 3 – WASTE REDUCTION

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THERE ARE 7 TYPES OF WASTE - TIMWOOD



An 8th kind of waste is “lost learning opportunities”

TRANSPORT – UNNECESSARY MOVEMENT OF PEOPLE OR PARTS BETWEEN THE PROCESSES



Moving material, parts and products from place to place in a process, even if it is only a short distance.

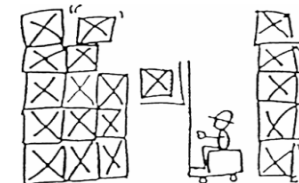


Source: The Toyota Way Field Book [2006], p. 35,36

INVENTORY – RAW MATERIAL, WORK IN PROGRESS OR FINAL PRODUCTS WITHOUT ADDED VALUE



Excess raw material, WIP or finished goods causing longer lead times, obsolescence, damaged goods, transportation and storage costs as well as delay. Also, extra inventory hides problems such as production imbalances, late deliveries from suppliers, defects, equipment downtime and long setup times.



Source: The Toyota Way Field Book [2006], p. 35,36

MOVEMENT – UNNECESSARY MOTION SEQUENCES OF PEOPLE OR MACHINES WITHIN A PROCESS



Any motion employees have to perform during the course of their work other than adding value to the part, such as reaching for, looking for, or stacking parts, tools, etc. Walking is waste, too.



Source: The Toyota Way Field Book [2006], p. 35,36

WAITING – PEOPLE OR MACHINES ARE WAITING FOR THE END OF ANOTHER CYCLE



Workers merely serving as watch persons for an automated machine, or having to stand around waiting for the next processing step, tool, supply, part, etc. or just plain having no work because of no stock, lot processing delays, equipment downtime, and capacity bottlenecks.



Source: The Toyota Way Field Book [2006], p. 35,36

OVERPROCESSING, INCORRECT PROCESSING



Taking unneeded steps to process the parts. Inefficiently processing due to poor tool and product design causing unnecessary motion and producing defects. Waste is generated when providing higher quality products than is necessary.



Source: The Toyota Way Field Book [2006], p. 35,36

OVERPRODUCTION – SOONER, FASTER OR IN LARGER QUANTITIES THAN REQUIRED BY THE CUSTOMER



Producing items **earlier** or in **greater quantities** than needed by the customer. Producing earlier or more than is needed generates other wastes such as overstaffing, storage, and transportation costs because of excess inventory.



Source: The Toyota Way Field Book [2006], p. 35,36

DEFECTS AND REWORK – REPEATING OR CORRECTING OF PROCESS STEPS



Repairing of rework, scrap, replacement production and inspection means wasteful handling, time and effort.



Source: The Toyota Way Field Book [2006], p. 35,36

LOST LEARNING OPPORTUNITIES – NOT LEARNING FROM FAILURES



Abnormalities that do not cause
corrective activities such as
root cause problem solving

Inappropriate problem solving
(solving the wrong problem or
ineffective problem solving)



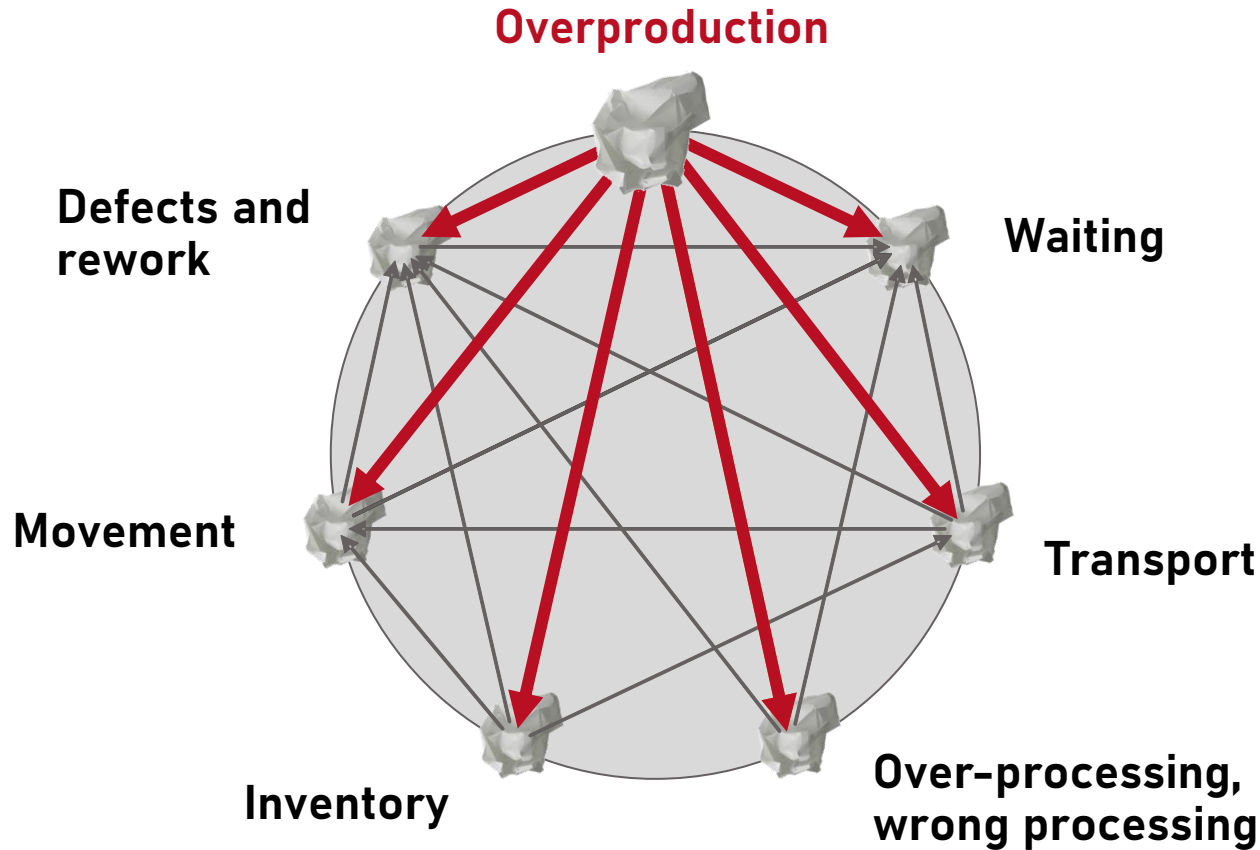
LOST LEARNING OPPORTUNITIES – NOT LEARNING FROM FAILURES



Missing commitment of management
and employees

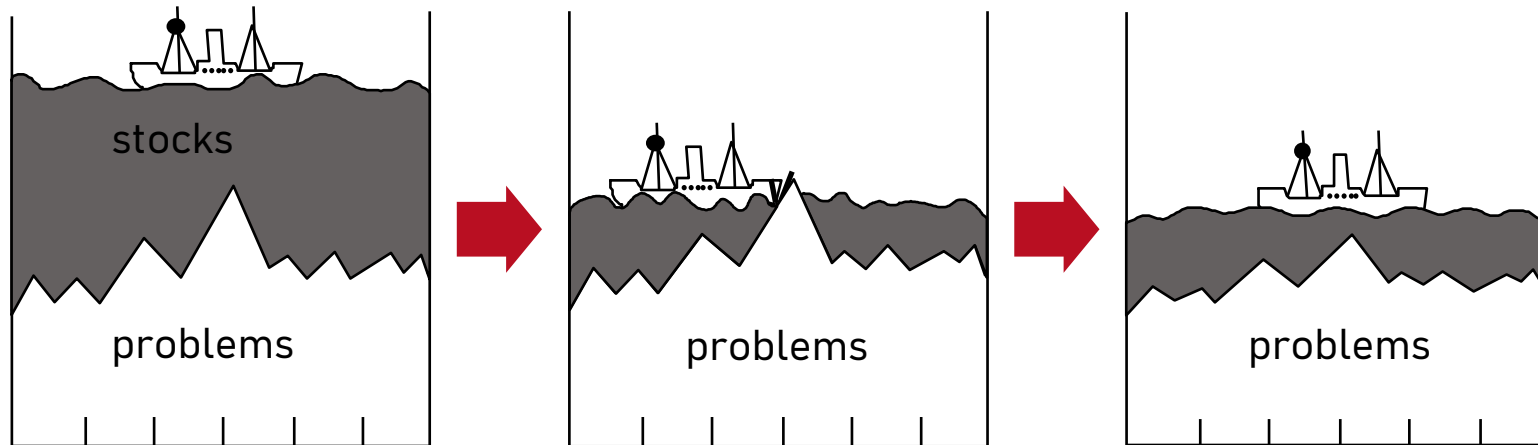


THE TYPES OF WASTE CAN INFLUENCE AND REINFORCE EACH OTHER



Overproduction is the worst waste because it causes more of the other types of waste as well.

ELIMINATING (SAFETY) STOCKS SURFACES PROBLEMS SO THEY CAN BE ADDRESSED



Problems are hidden

Problems become transparent

Elimination of causes

Examples:

- Machine failure
- Missing material
- Bottlenecks in production processes
- Quality defects

- Easy identification
- Urgency for quick problem solving

- Solving the problem enables production with lower stocks

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Getting started to see waste

- „Stand in the circle“ exercise
- „Spaghetti diagram“



Detailed waste analysis

- Process activity mapping (at a workstation)
- Record of process losses (e. g. Pareto analysis for runtime, downtime, quality issues)



Daily waste recognition

- Shopfloor management (+ PDCA)
- OEE recording and statistics



Waste in connected processes (project-driven)

- Value stream mapping

STAND IN THE CIRCLE EXERCISE AND “SPAGHETTI DIAGRAM”

Procedure

- Team of observers
- Form sheet
- On the shopfloor, by the line
- From two to eight hours
- Evaluation, quantification

Purpose of the exercise

- Genchi Genbutsu – go and see approach
- Get an impression of the real amount of waste before charging off into some Kaizen improvements
- Train TPS-newcomers how to see waste
- Good for those who are already blinded by routine
- Build experience and sharpen perception for waste
- Find the first layer of large waste – “clear the clouds”

STAND IN THE CIRCLE EXERCISE – TEAM EVALUATION

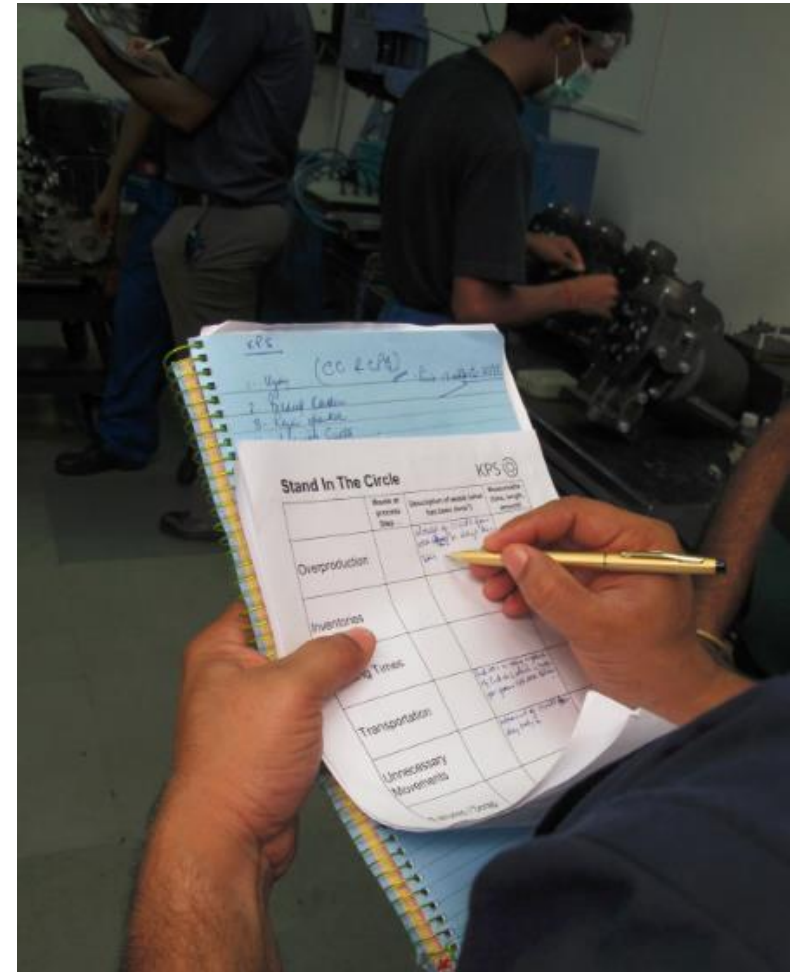
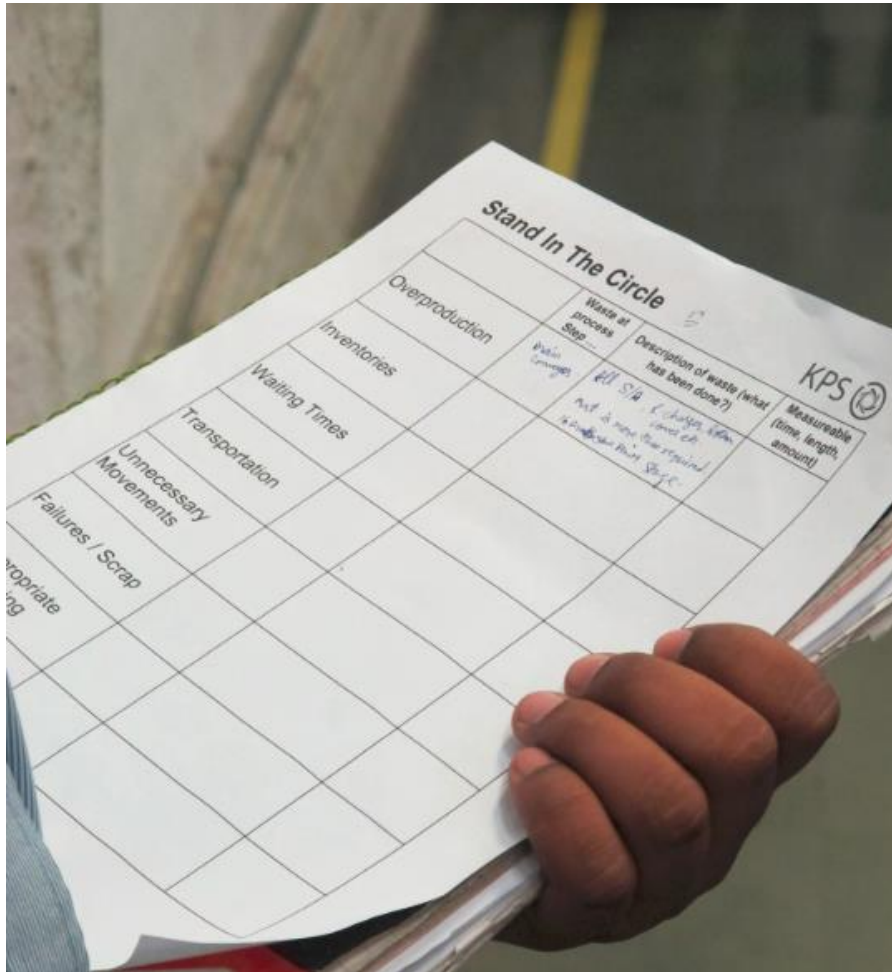
Describe and quantify the forms of waste you have experienced:

	Description:	Measurable:
1. Overproduction:		
2. Waiting:		
3. Transportation:		
4. Over-processing:		
5. Inventory:		
6. Unnecessary movements		
7. Failures/scrap:		
8. Lost learning opportunities:		

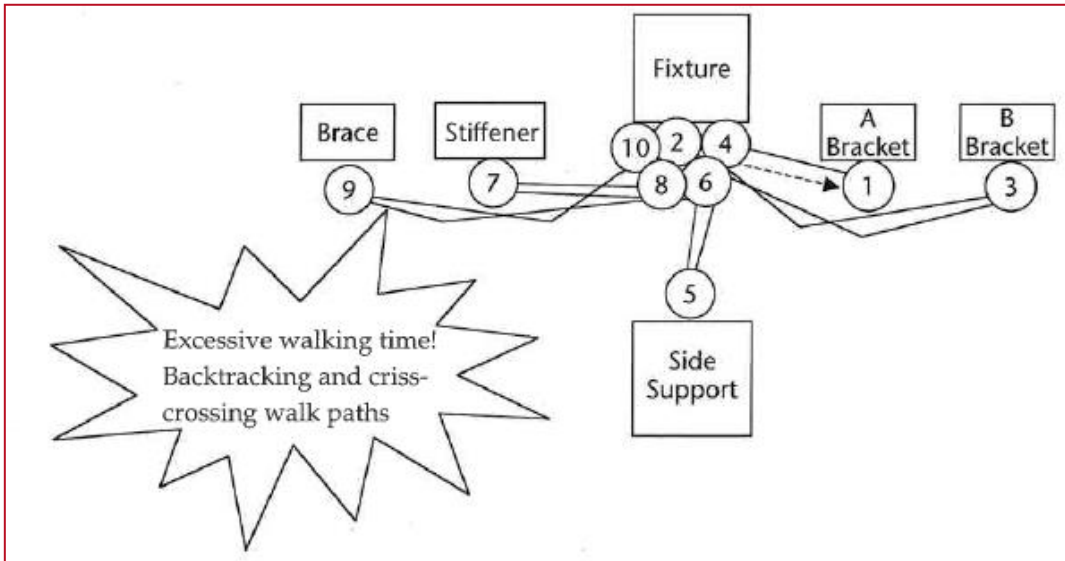
Which forms of waste are the most important ones? Which further activities would you recommend?

Results to be presented by the team

STAND IN THE CIRCLE EXERCISE



Spaghetti diagram



... and waste map

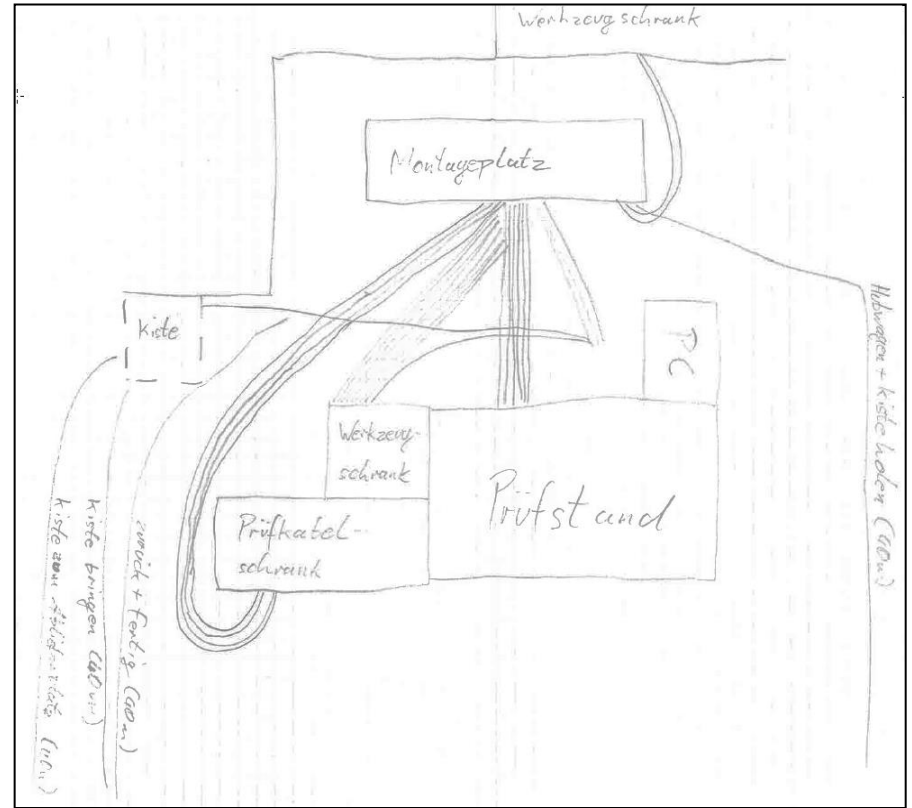
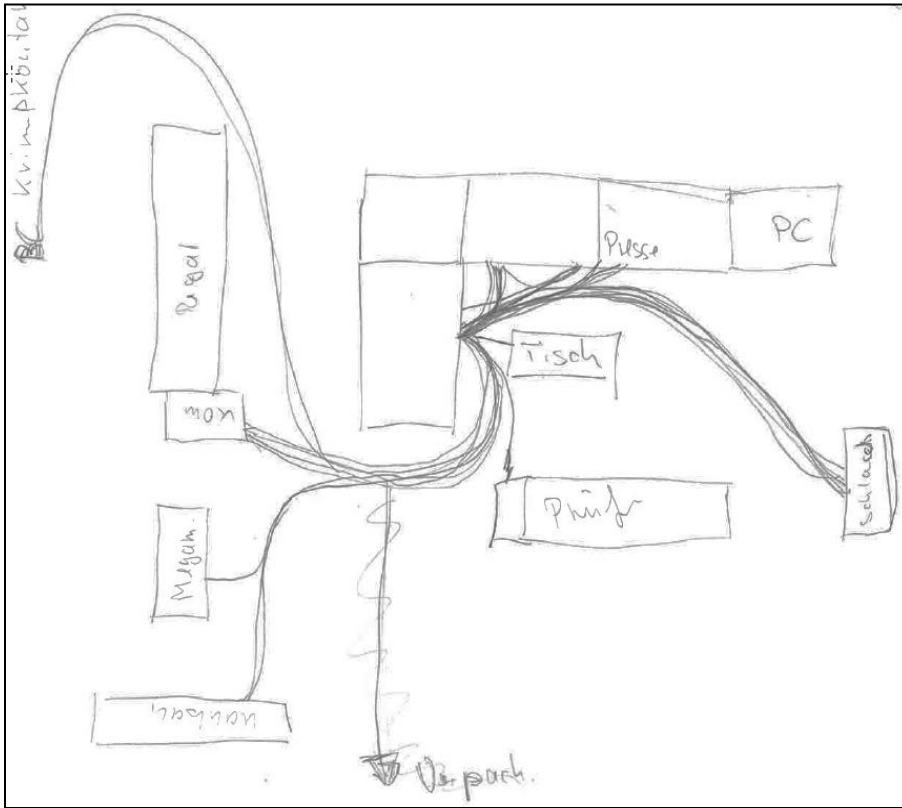
Work Step
1. Pick up A Bracket
2. Load Fixture (walk to fixture)
3. Pick up B Bracket
4. Load Fixture
5. Pick up Side Support
6. Load Fixture
7. Pick up Stiffener
8. Load Fixture
9. Pick up Brace
10. Load Fixture (start over)
Total Seconds

Source: The Toyota Way Field Book [2006], p. 63

Steps of the spaghetti diagram method:

1. Draw a simple sketch of the cell/workplace layout
2. Follow worker and/or material as he/it moves within a cell or between cells
3. Draw a line for each walked way by hand, take distances
4. Comment the work step to connect it with the waste map

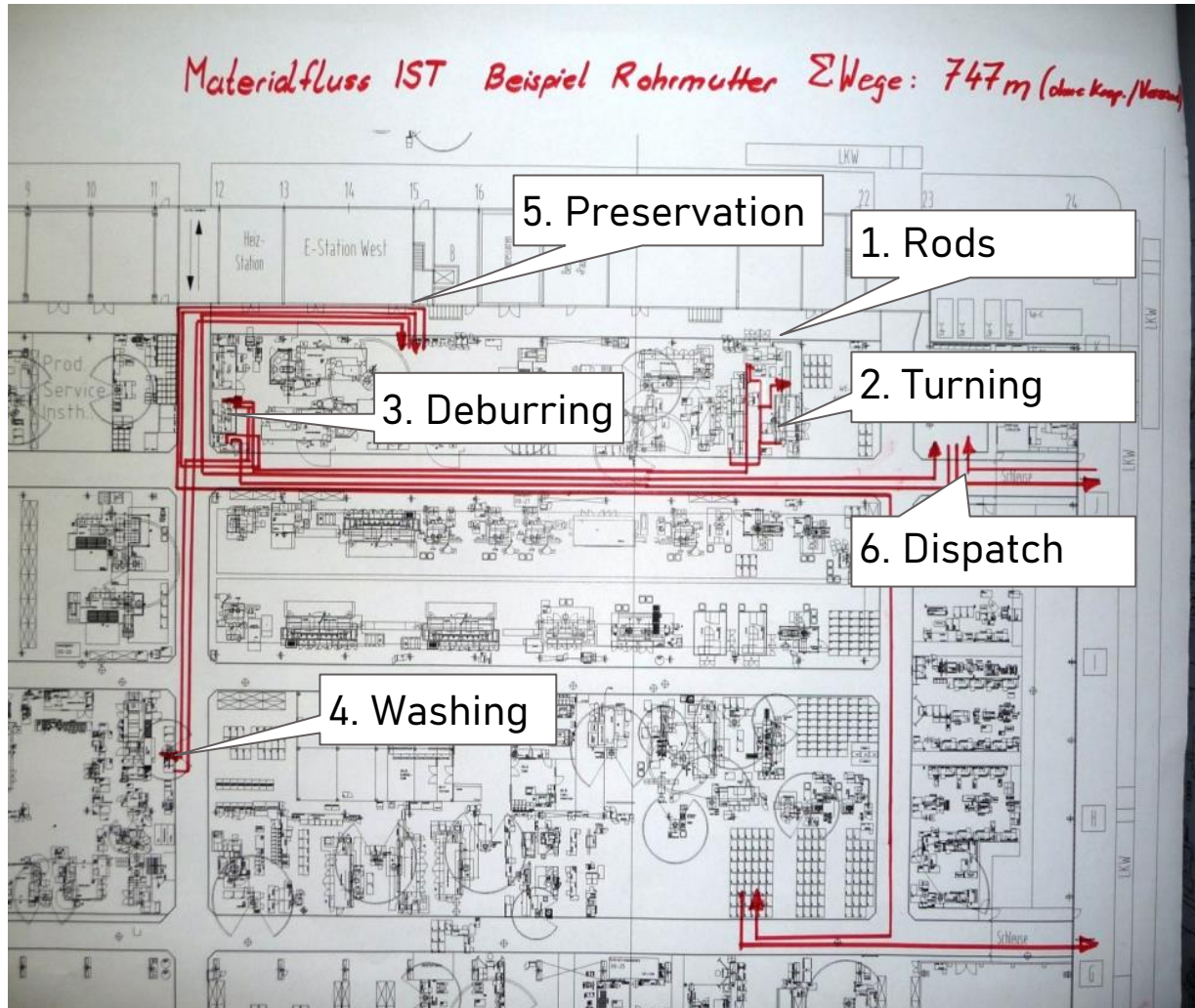
SPAGHETTI DIAGRAM – EXAMPLES



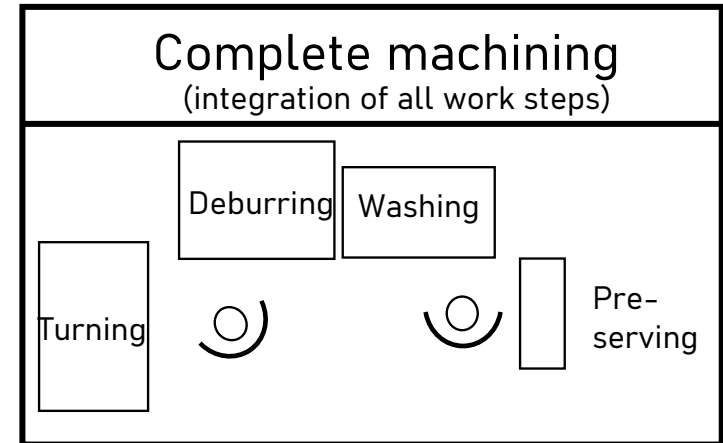
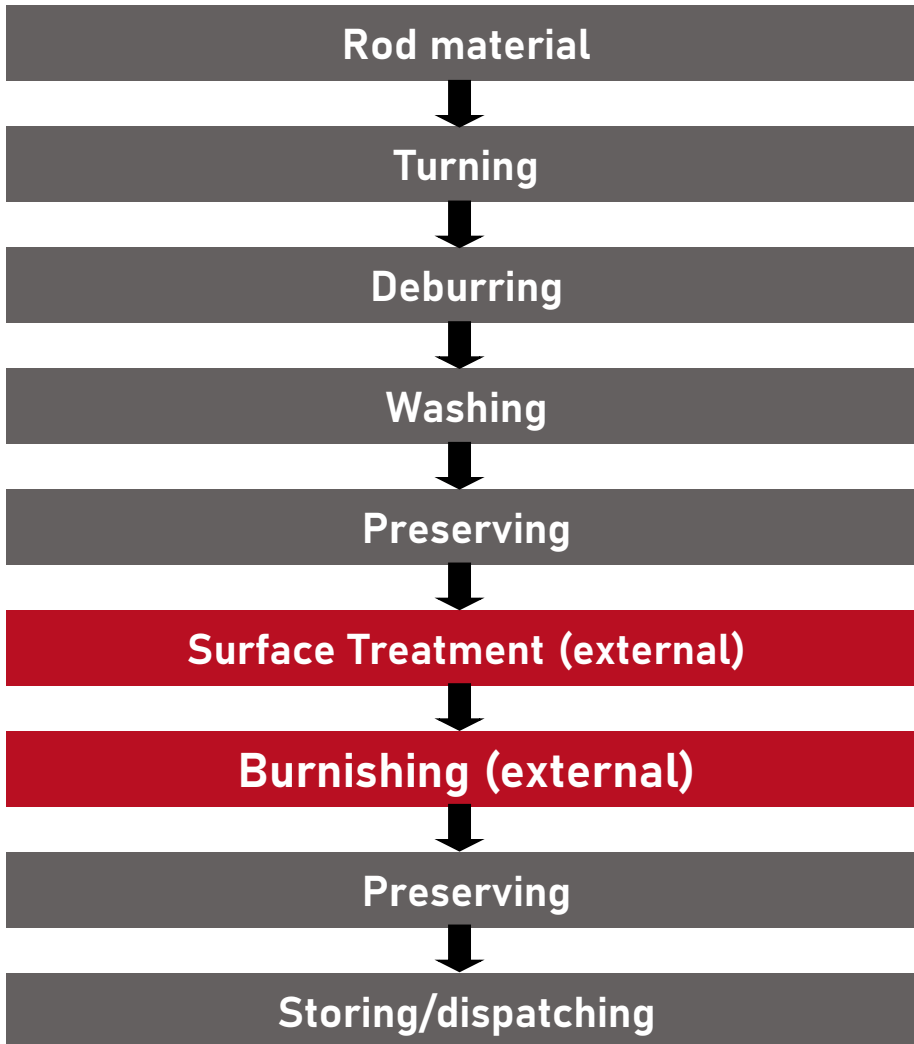
- Calculate the covered distance for each work step!
- Which work steps require longest walking (Pareto)?
- Calculate the whole walking distance per produced unit!
- Calculate the whole distance per year (no. of units x walking per unit)!
- If you remove the longest walking distances (e. g. by creating a flow), what is the possible saving per unit/per year?
- Which ways/distances would you address first? How?

Results to be presented by the team

SPAGHETTI DIAGRAM – EVALUATION



SPAGHETTI DIAGRAM: CREATE A FLOW-ORIENTED LAYOUT IN THE ORDER OF PRODUCTION STEPS



DETAILED PROCESS ACTIVITY MAPPING – PROCEDURE AND PURPOSE

Procedure

- Two observers (one writer, one timekeeper)
- Form sheet + stopwatch
- On the shopfloor, by the line, observing the operator
- Evaluation, quantification

Purpose of the exercise

- Get a detailed understanding of waste activities at a workplace (of a line)
- Distinguish between VA, ENVA and NVA and quantify them
- Get clear and undoubted evidence of the waste status a workplace is in
- Prioritise measures to improve the share of value-added work
- Prepare line balancing activities to create flow lines

DETAILED PROCESS ACTIVITY MAPPING (WASTE MAPPING)

No.	Process Step Activity What is the process step	Description of Waste started at 2:10pm to 3:35pm	Element Times [sec]			
			total	va	nva	enva
1	Pick up underpart housing from blue bucket - and overpart housing from skid - approx 20m walking		80		75	5
2	change glasses		15		15	
3	Take loctite degreaser 7063 and spray on both housings three times each		5	5		
4	Blow off both housings using air house directed away from bench		35		15	20
5	place activator		10	10		
6	Clean table with rag (due to overspray from degrease can)		5		5	
7	Place air hoseback on hook at left side of bench (note operator is right handed - x-over)		10			10
8	Take main SS bushing from part rack -one for the under housing one for the middle housing,		15		10	5

- Conduct a detailed process activity map (waste map) of all operations and elements of work within operations required to produce one product
- Capture every work step and record the time
- Describe the waste you observe

DETAILED PROCESS ACTIVITY MAPPING (WASTE MAPPING)

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- Make judgment if each step is either VA, ENVA or NVA
- Identify areas for improvement / waste reduction
- Action plan items in detail to reduce waste and improve operations

DETAILED PROCESS ACTIVITY MAPPING



DETAILED PROCESS ACTIVITY MAPPING – RESULTS (EXAMPLE)

Part No. 1: 3T 102792R29-00

- Removal of red sticker from blocked part takes one minute
- **Failure: Sticker missing for ground cable**
- New red sticker added with failure description

Part No. 2: 3T 102792R29-00

- Visual and mechanical control (i. o. / n. i. o.)

Part No. 3: 3TD 03247R31-001

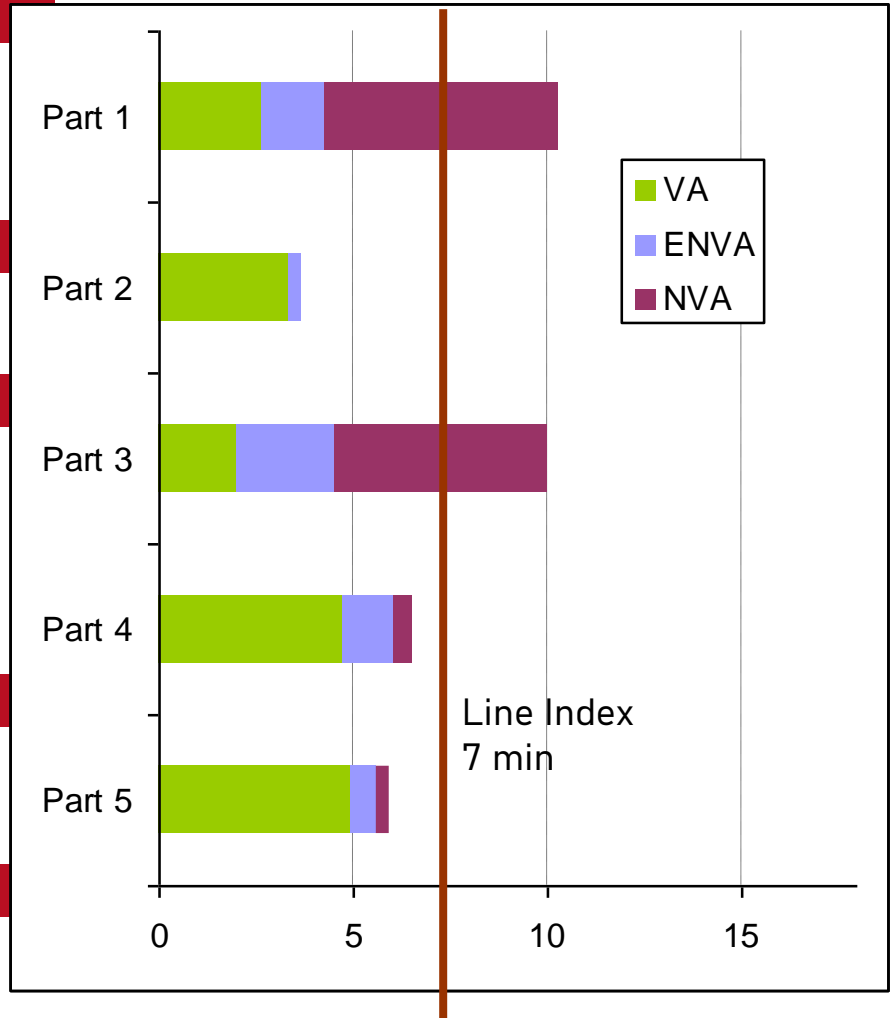
- No instruction for inspection available (-> CADIM, BOM)
- **Failure 1: Label missing**
- **Failure 2: Lock not ok**
- Cleaning of parts surface
- Search for right failure code -> waiting for Q-auditor

Part No. 4: 3TD 03247R31-001

- **Failure: Paint bubbles**
- **Failure code unclear**

Part No. 5: 3TD 03247R31-001

- **Failure: Wheel adjustment incorrect**



Analysis

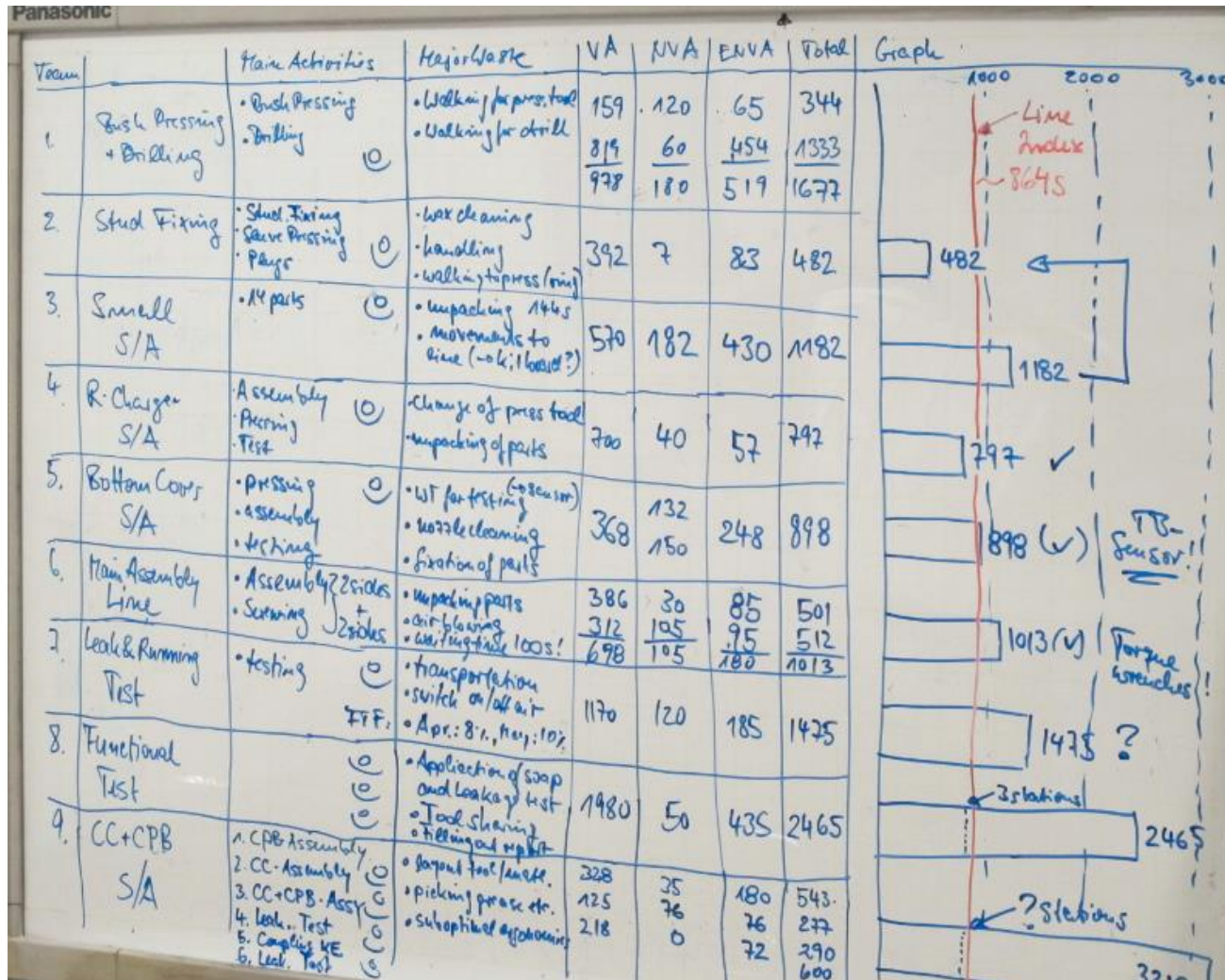
1. Distinguish between VA, NVA, ENVA time
2. Summarise the time for the three different kinds of work observed
3. Calculate a ratio:
$$\frac{(VA + ENVA)}{\text{total time}}$$
$$\frac{VA}{\text{total time}}$$

Evaluation

- If you remove the NVA from the total time: how much work time is left per unit?
- Identify the three most important categories of waste.
- Make suggestions to eliminate these forms of waste.

Results to be presented by the team

DETAILED PROCESS ACTIVITY MAPPING – AS A PREPARATION FOR LINE BALANCING



Procedure

- Identify the product family that is to be mapped
- Value stream manager plus stakeholder of involved departments
- Walk the complete value stream and draw a sketch
- Collect value stream indicators (such as cycle time, inventories etc.)
- Identify and quantify the forms of waste in the value stream

Purpose of the exercise

- Understand waste in connected processes
- Understand a complete value stream (instead of isolated processes)
- Picture the whole value stream and build a common understanding between functions
- Quantify and prioritise the recognised forms of wastes
- Understand the potential of improvement projects



Discussed in more detail in chapter 5

PMW
TU DARMSTADT

Institut für
Produktionsmanagement,
Technologie und
Werkzeugmaschinen



Waste

- What is waste?
- What kinds of waste are there?
- What is the worst kind?

Learn to see

- How to get started?
- How do you do detailed waste analysis?
- How do you recognise waste on a daily basis?

4P

- What is “Stand in the cycle”?
- What do you identify in a spaghetti diagram?
- What does a detailed process activity map look like?

The participant



- ... has a basic understanding of the concept of waste
- ... can name examples for activity types (NVA, ENVA, VA)
- ... knows the 7+1 types of waste
- ... can explain why Overproduction is the worst type of waste
- ... knows the methods to systematically identify waste and can explain them
- ... knows the procedure and purpose of the detailed process activity mapping