TRIZ Case Study: Allocation System for a Processing Machine

Horst Th. Nähler, c4pi

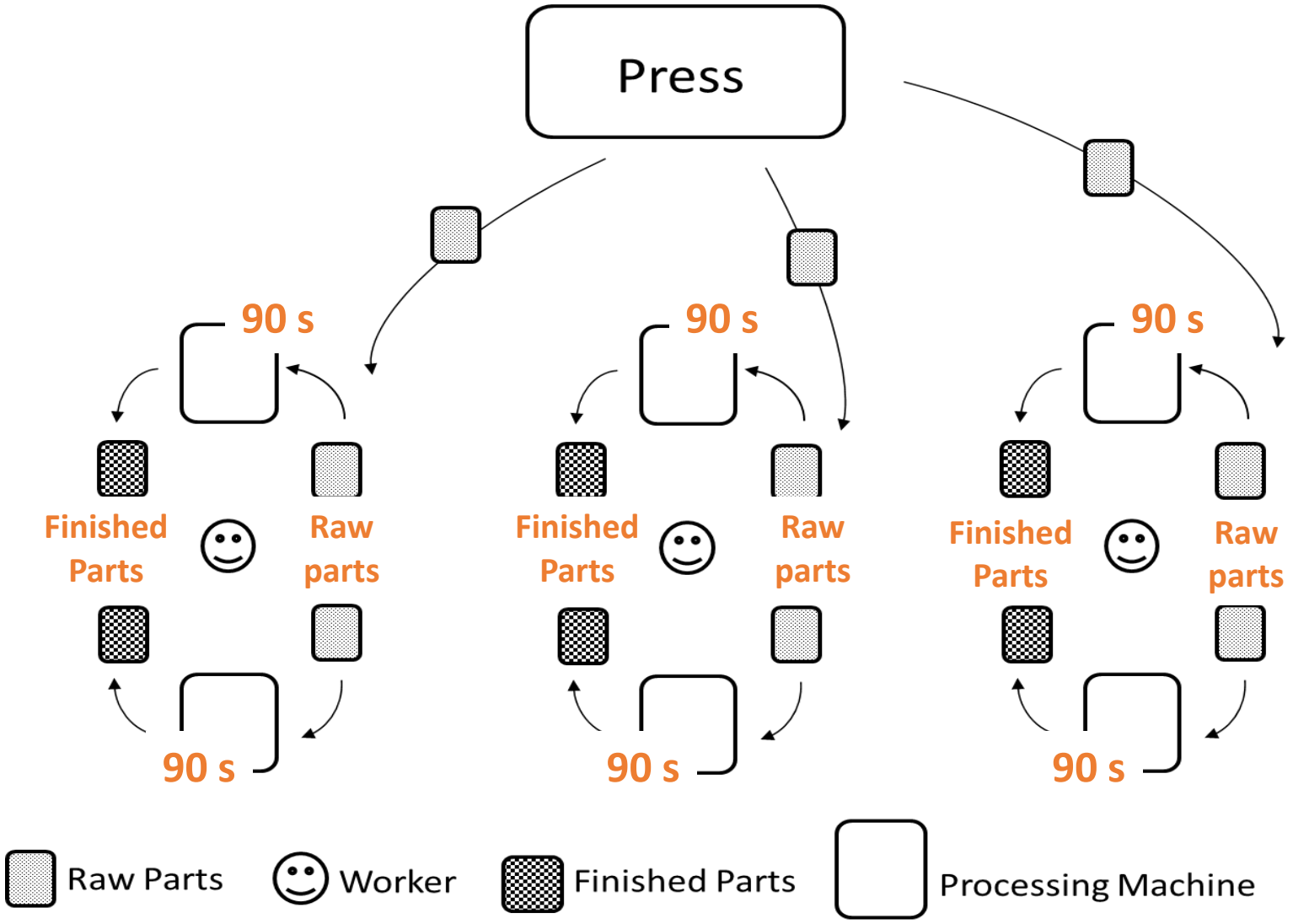
Barbara Gronauer, StrategieInnovation

StrategieInnovation

Ideen entwickeln
Ziele erreichen

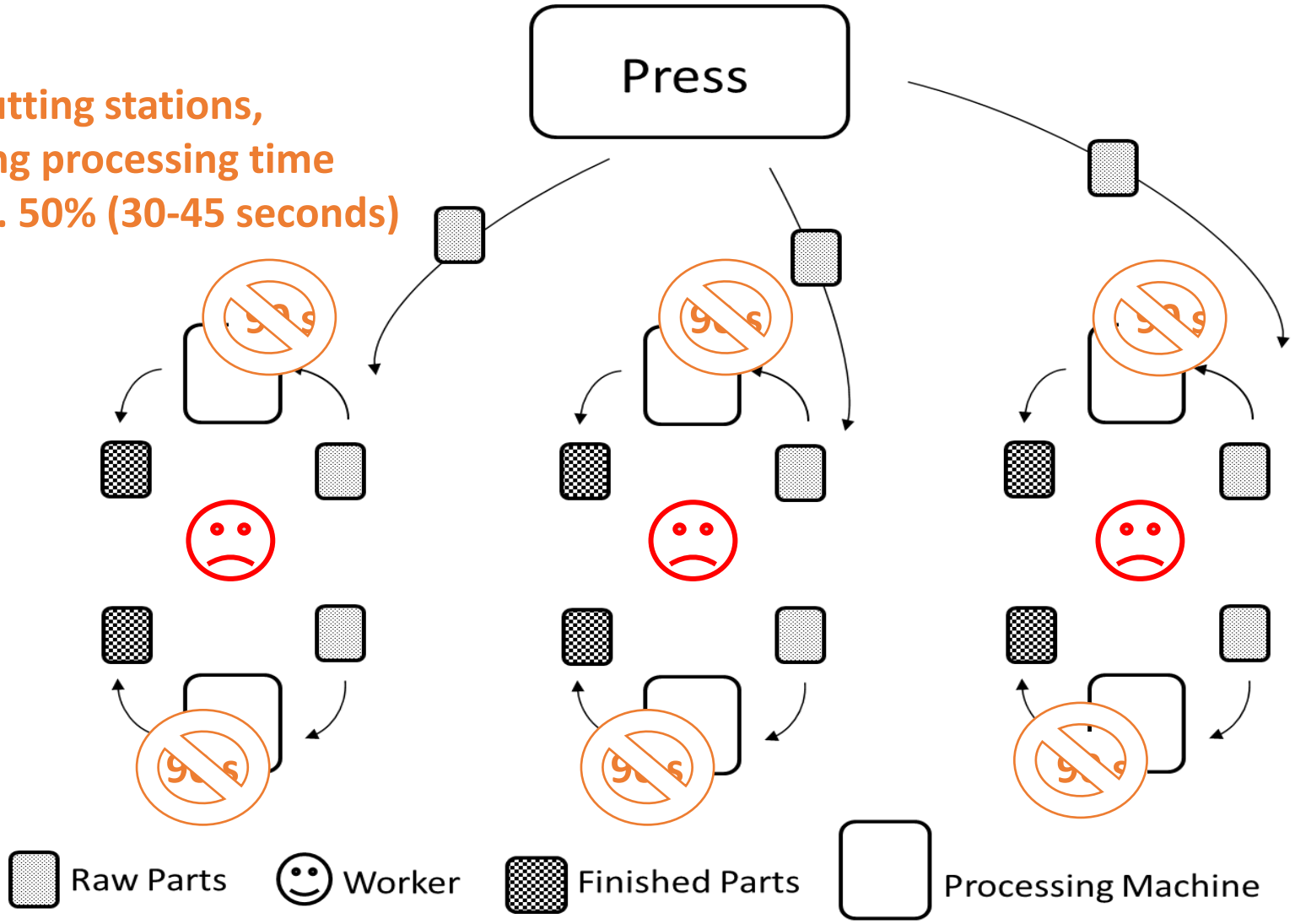
c4pi
Center for Product-Innovation

Manufacturing Process Scheme



Increasing Production Output

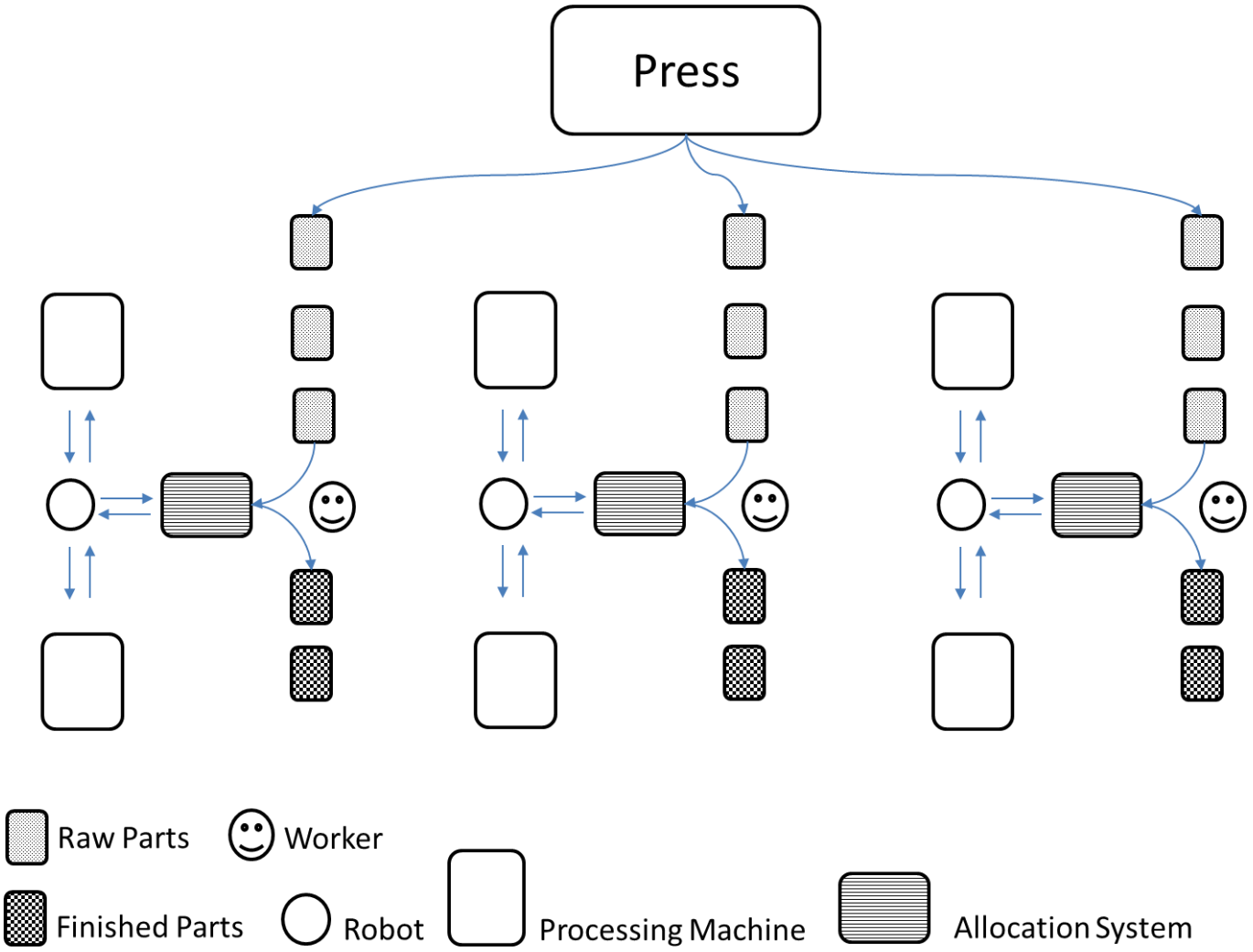
New cutting stations, reducing processing time by min. 50% (30-45 seconds)



Task for the SME

- Designing an Allocation System to uncouple the cutting process from the worker.
- Therefore, the Allocation System needs to provide a cache for raw parts to be delivered to the cutting station and processed parts to be transferred further.

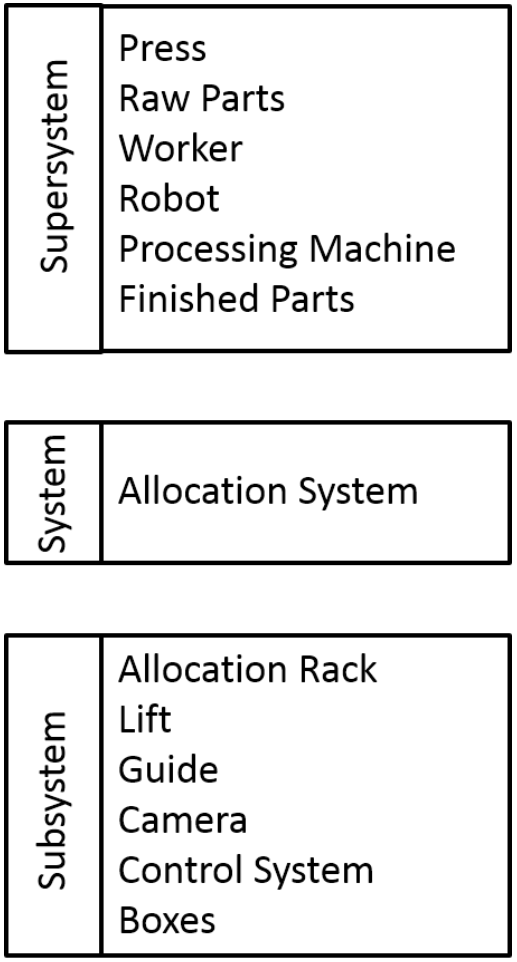
Desired Workflow with an “Allocation System”



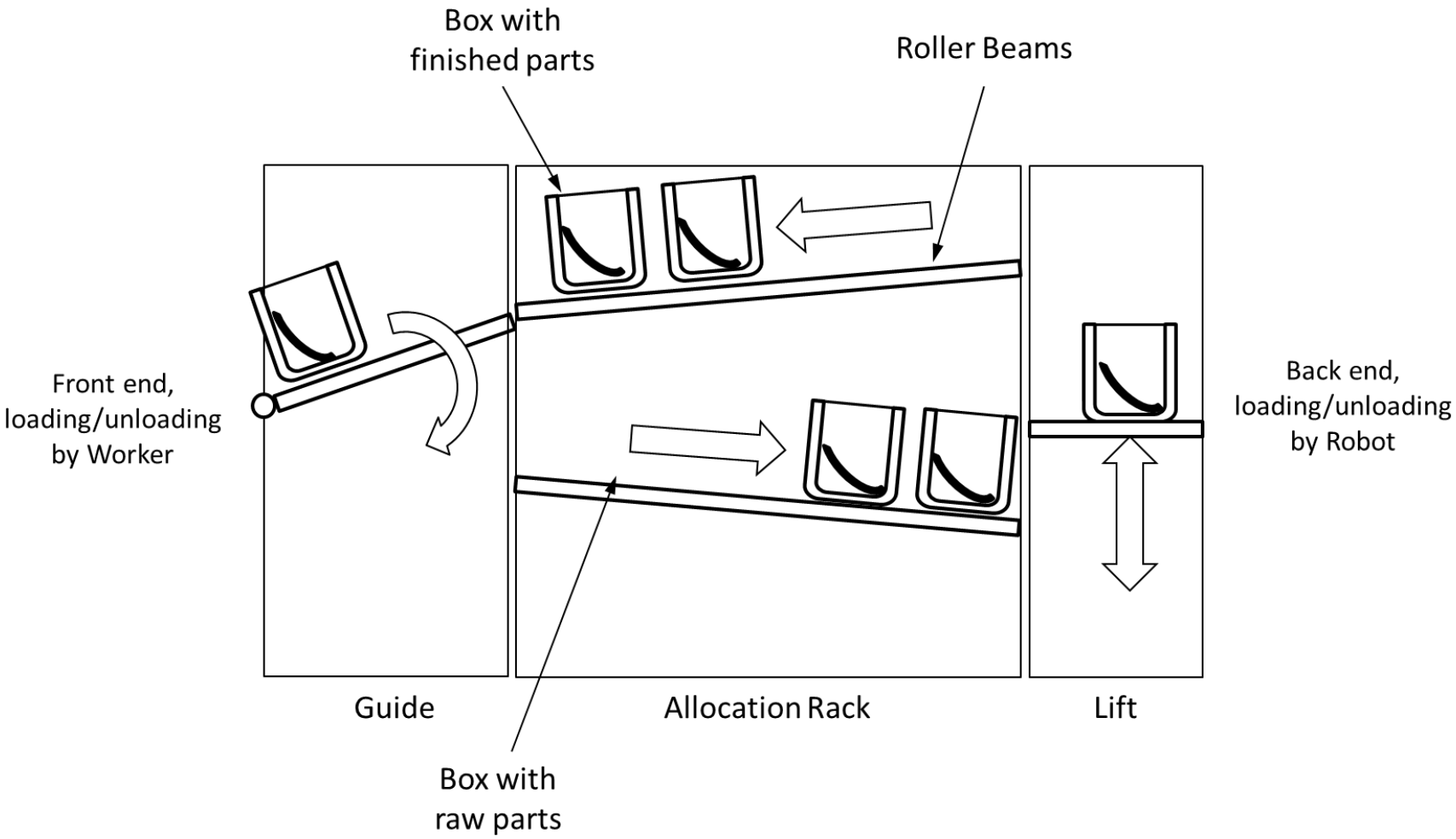
Requirements

- Cycle times need to be reduced by at least 50%.
- No risk of injury for worker (top priority).
- Robust within shopfloor conditions (dust, abrasive particles etc.).
- Minimum maintenance effort.
- Must stay withing targeted investment costs.
- No special supply materials (limited use of compressed air, lubrication etc.).

Initial System-Structure of the Allocation System



Allocation System, simplified scheme of initial concept



Completed Multiscreen Model

	Past	Present	Future
Supersystem	Press Raw Parts Worker Processing Machine Finished Parts	Press Raw Parts Worker Robot Processing Machine Finished Parts	Press Raw Parts Robot 1 Robot 2 Processing Machine Finished Parts
System	Allocation operator	Allocation System	Allocation System
Subsystem		Allocation Rack Lift Guide Camera Control System Boxes	Allocation Rack Lift Guide Camera Control System Boxes

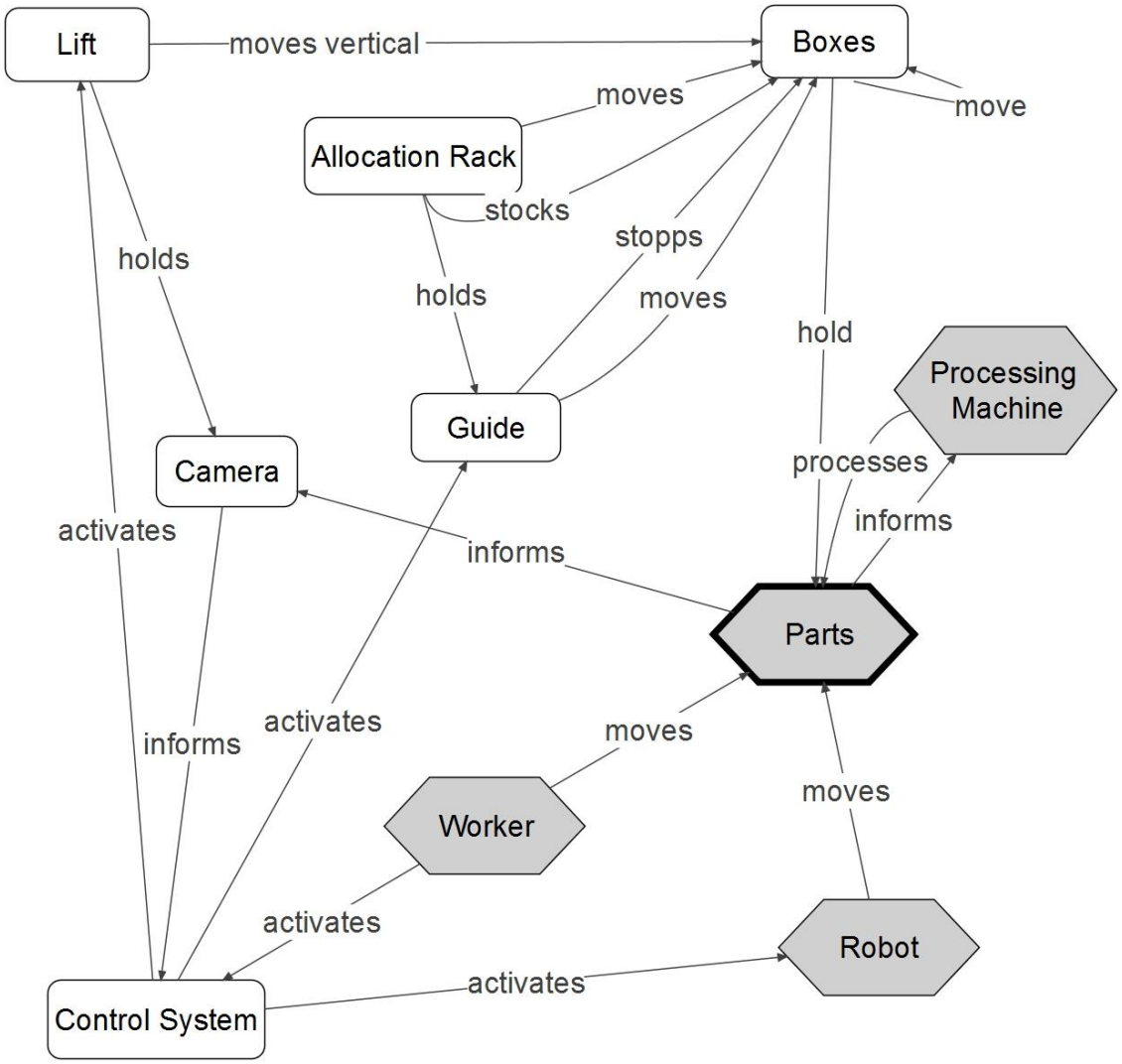
Problem Analysis

The second step consisted of analysis of the problems and obstacles that had to be tackled.

As a prerequisite for problem solving, a function model was build. The function analysis was conducted in two steps:

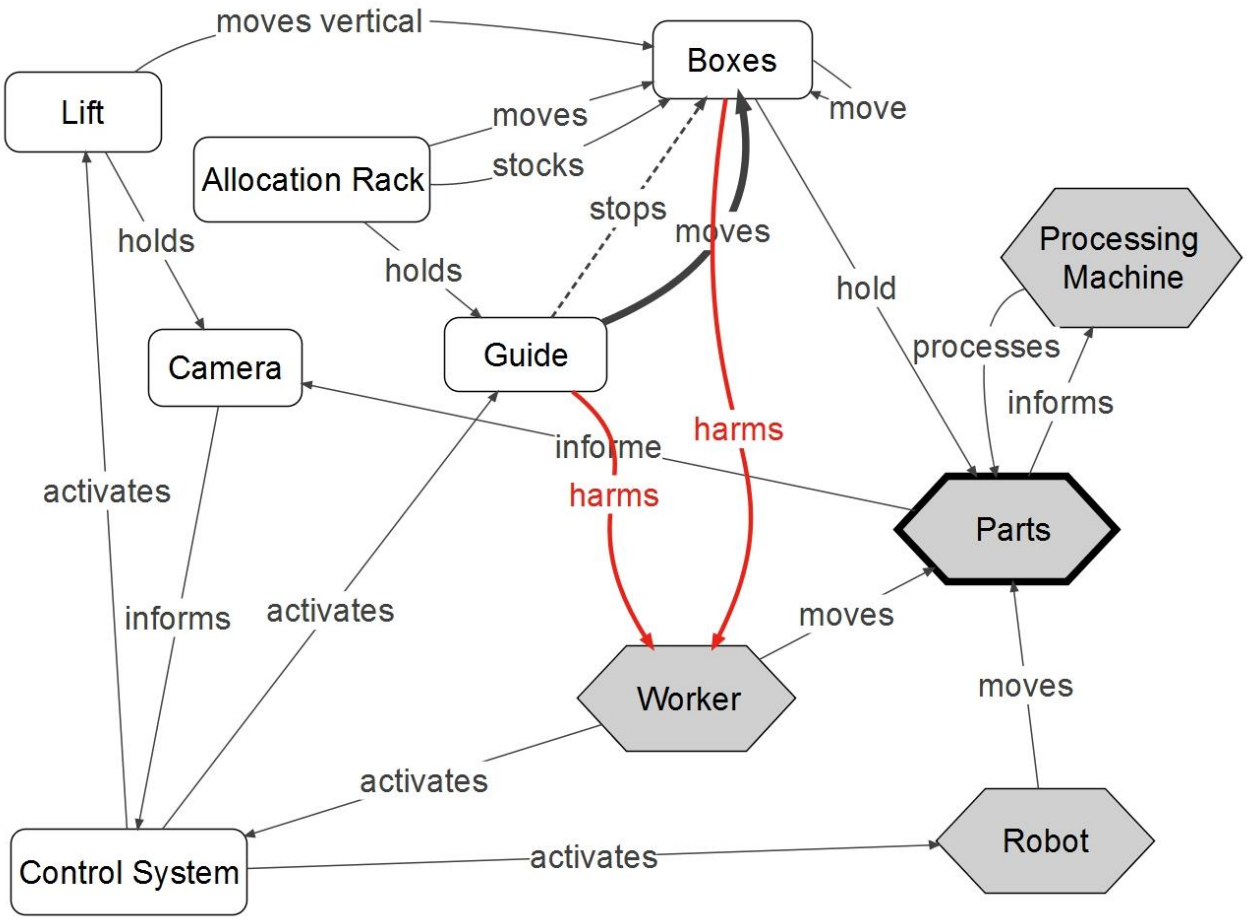
1. Build a Function Model for the current design as a working system free of disadvantages.
2. Identify disadvantages in terms of harmful, insufficient and excessive interactions.

Function Model of the Allocation System

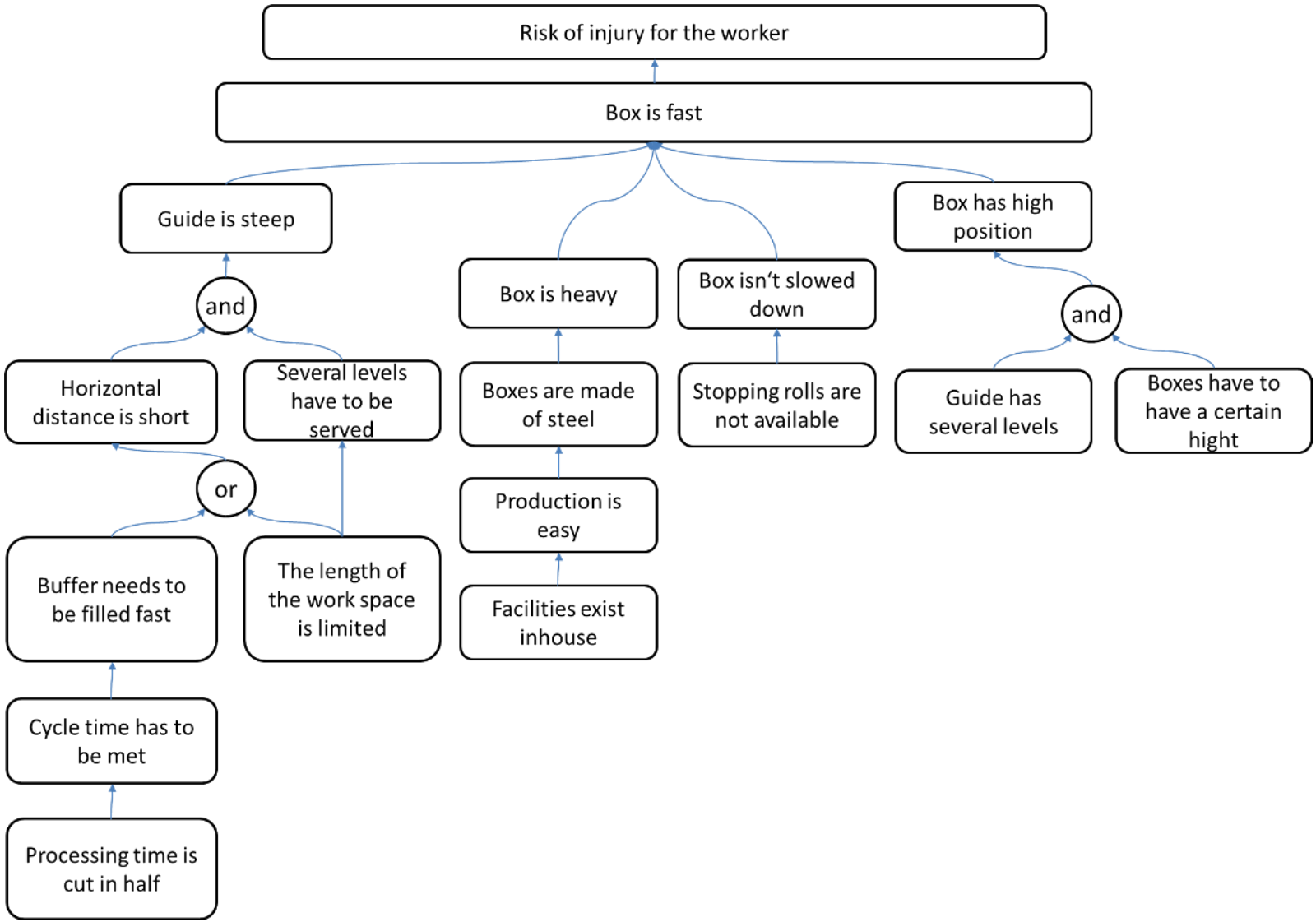


Function Model with Function Disadvantages

- Main focus on worker safety and health:



Cause Effect Chain Analysis for Risk of Injury

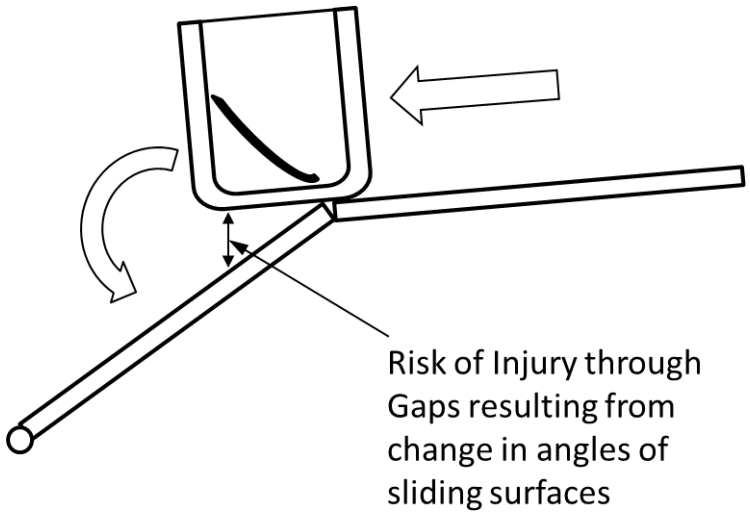


Identified Main Disadvantages

- Guide stops boxes excessively:
  - High velocity of sliding boxes generate a hard impact, resulting in threat of injury and noise generation.
- Guide harms worker:
  - Moving parts of guide represent potential threat for worker (e.g. clamping)
- Boxes harm worker:
  - Relative movement of boxes and parts of the guide can harm the worker.
- Guide moves boxes excessively:
  - Steep sliding surface of guide leads to high kinetic energy and potential risk for worker.

Example for “Operating Zone”

- With the function model the components of the system that cause a disadvantage could quickly be identified.
- Operating zones could then be assesed.
- Finally, a Cause Effect Chain Analysis (CECA) uncovered several key problems which could then be adressed.



Engineering Contradictions

- While working with the Multiscreen Approach, Function Analysis and CECA, several ideas were gathered in an idea pool.
- Several ideas provided advantages but also worsened other aspects. Of course we knew how to deal with such situations.

If	we use a brush belt conveyor
Than	the safety is higher
But	a power drive is neccesary
If	we use a brush belt conveyor
Than	the weight is low
But	a power drive is neccesary

Exemplary Engineering Contradictions resulting from using Boxes and using Lifts

If	we use boxes
Than	the system is simple
But	the weight is high
If	we use boxes
Than	the parts have a defined space
But	the weight is high
If	we use boxes
Than	the movement of the parts is easy
But	the risk of injury is higher

If	we use two lifts
Than	we have a high functionality
But	the mechanical effort is high
If	we use two lifts
Than	we have no edges
But	the mechanical effort is high
If	we use two lifts
Than	the worker is save
But	the mechanical effort is high

If we construct our system without a second lift (guide)

Than we have a simple system → Parameter: Complexity (Nr. 45)

But we have more edges, too.

↳ Parameter: Risk of Injury/Safety (Nr. 38)

Innovative Principles:

28 Mechanics Substitution

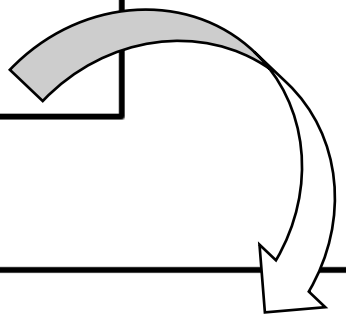
05 Merging

24 Intermediary

10 Preliminary Action

Heart of the Problem: Physical Contradiction

If	we stopp the boxes
Than	the safety of the worker increases
But	the cycle time will be to long



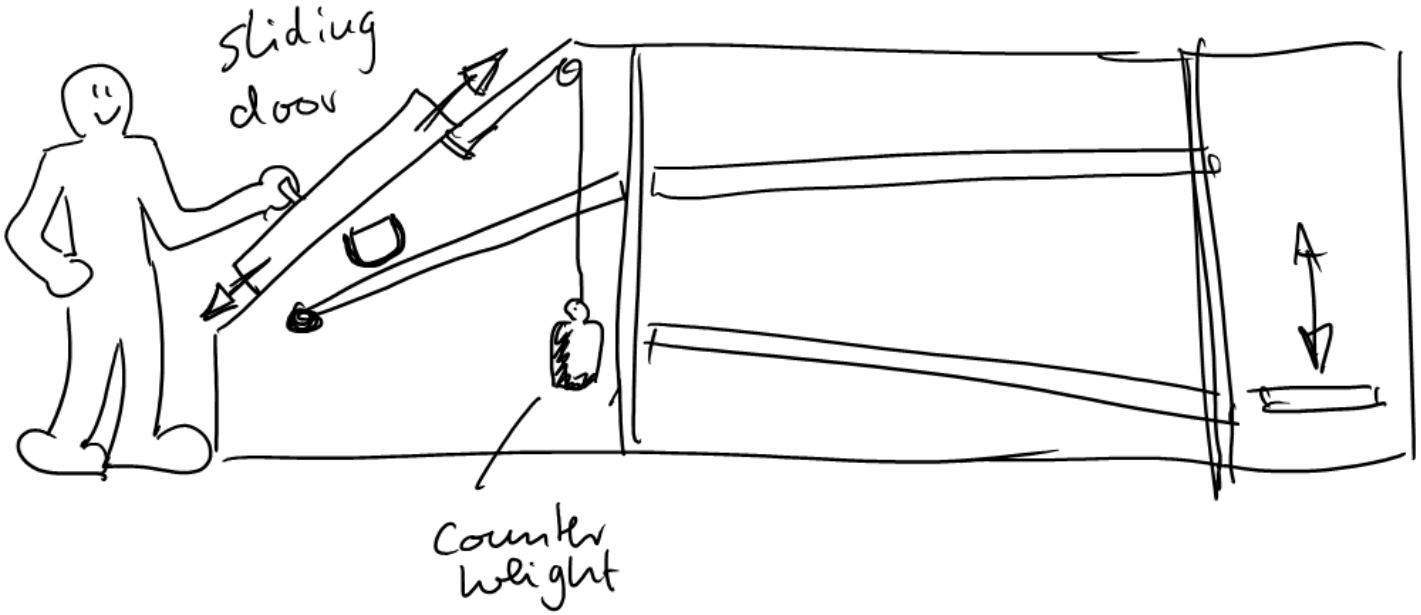
The boxes

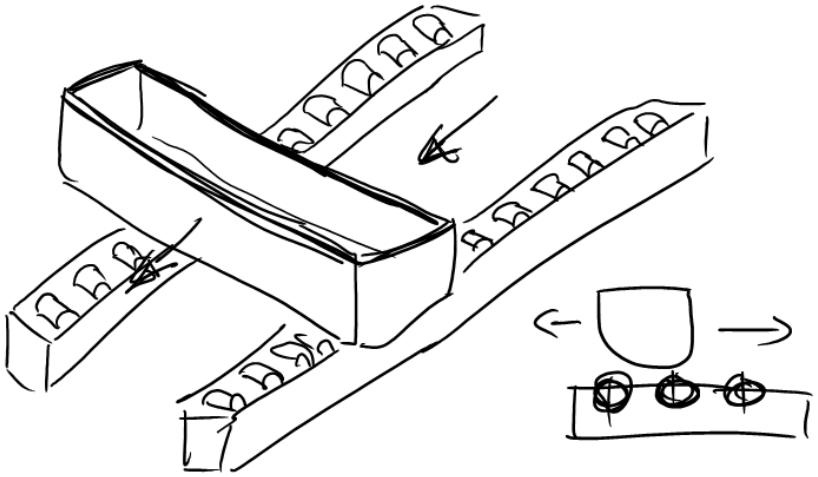
should be moving fast to reach a short cycle time and

should be standing still to ensure a save work situation

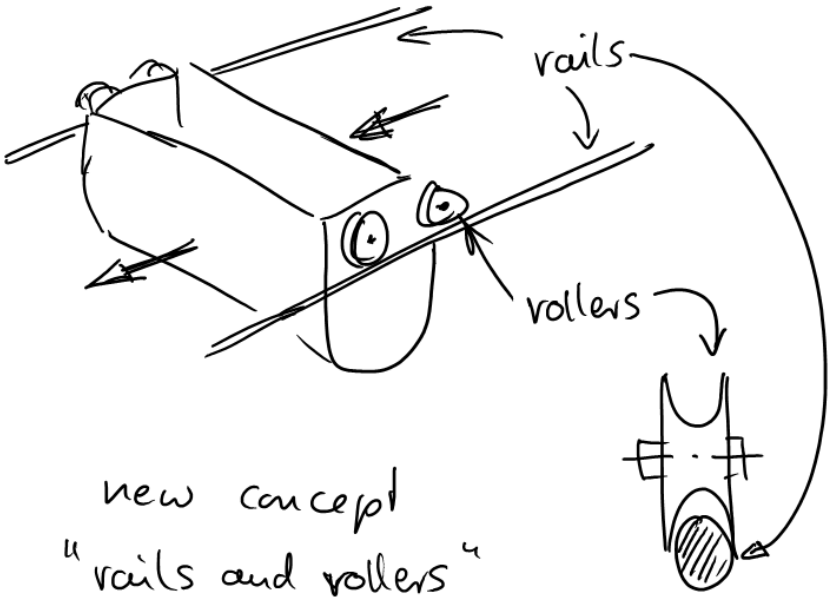
Solutions generated

- Enclosed loading area with „self-opening“ sliding door that opens when all moving parts have come to a halt.
- Changing the „roller beam“ concept to a rail system with profiled rollers fitted on the boxes, thus eliminating changing angles between boxes and sliding surfaces. Additionally this concept is robust against dust and poses self-cleaning abilities. Furthermore this system eliminates the need for a belt moving the boxes in the off-loading lift. The boxes move themselves in and out of the lift.





old concept
"roller beams"



new concept
"rails and rollers"

Conclusion

- Besides the ability of TRIZ to provoke inventive solutions for tough engineering problems, it is an effective means for structuring and systemizing the product development process.
- TRIZ provides tools and methods to spark and enhance as well as objectify communication in working teams,
- TRIZ leads to shorter development times not only by speeding up the solution finding but also the situation clarification and problem analysis process.

Thank you for your attention!

We appreciate your questions,
comments and feedback!