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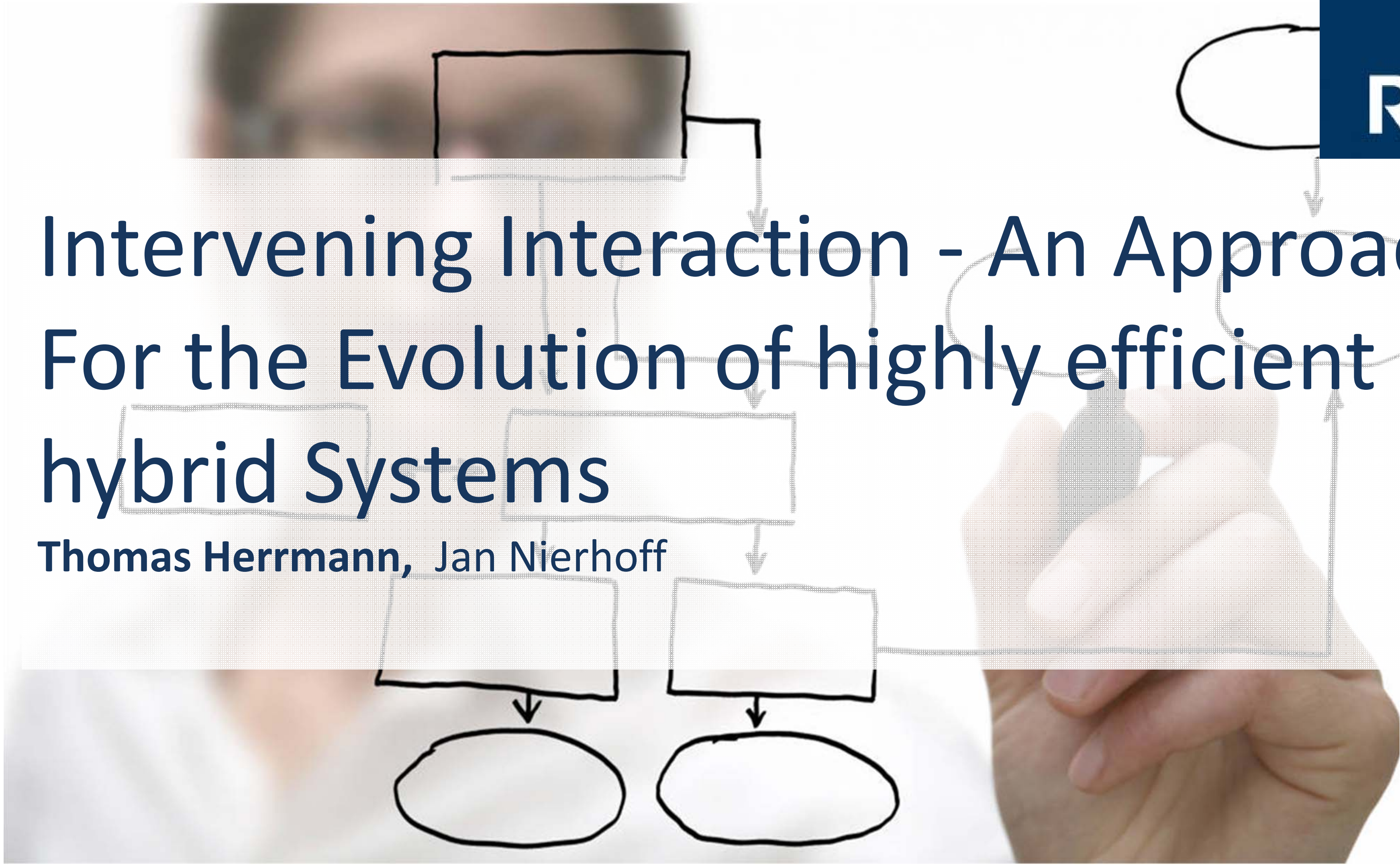

Intervening Interaction - An Approach For the Evolution of highly efficient hybrid Systems

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Overview

- leading questions
- The case of predictive maintenance
- Basic concepts: task, efficiency, challenging tasks
- Summary: Theoretical contributions

Leading questions – potentials of the interplay between human and AI-systems

- What kind of tasks can be in the core of human activities when using AI-based or autonomous systems.
- How far can these tasks allow for continuous increase of the efficiency of the socio-technical system?
- How far can these task contribute to a sustaining compliance between the socio-technical system and the interests and values of the workforce?
  With respect to experience, feeling of being in control etc.
- How far can the tasks be intertwined with a continuous evolution that keeps humans in the loop.

Focus on “challenging tasks” … instead of repetitive routine tasks

Free style chess tournaments

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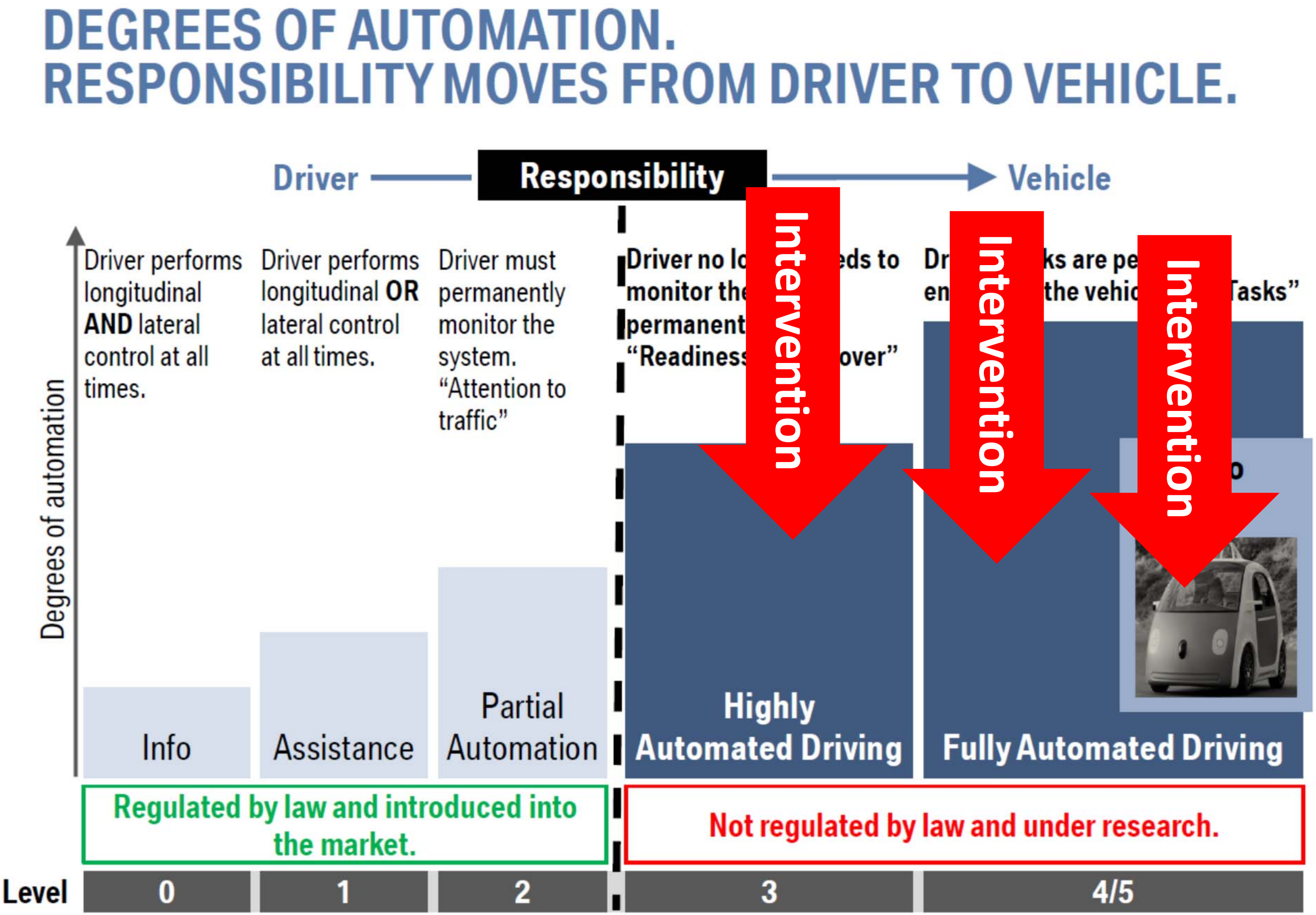
People with chess computers
←→ against others with chess computers.

Typical tasks for humans:

- **Increasing the performance of the computer systems**
- **Improving the in-depth- search**

Tasks and degree of automation



Final stage of efficiency vs. Continuous space for improvement

Different viewpoints:

A final stage of efficiency is achievable:

E. g. driving a car from A to B without an accident and as fast as possible within the prescribed speed limit

Vs.

Continuous improvement is possible

Energy saving, minimizing of variances of the time needed, allowing for scenic routes when driving from A to B

Depends on the larger context – the socio-technical system

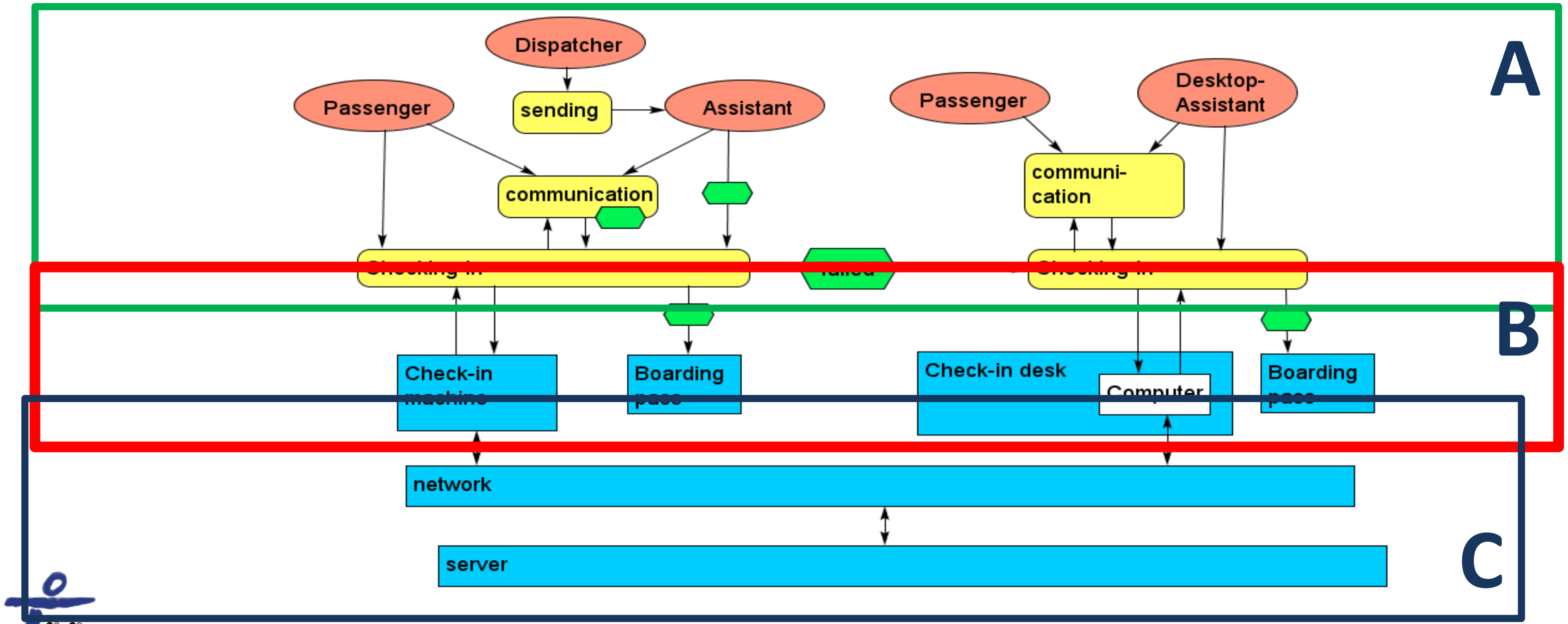
Sozio-technisches Design

The planned integration of

a. social collaboration and communication

b. **Interaction between human and computer**

c. And technical infrastructure



Case of predictive maintenance

Case: predictive maintenance

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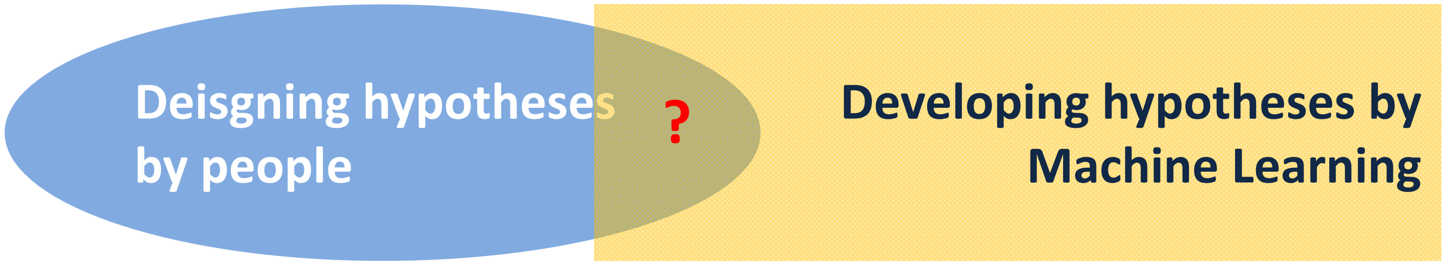
- car manufacturer’s body assembly**: break-downs are dealt with ad-hoc,**
- a schedule-driven maintenance has not taken place
- Malfunctions lead to a standstill of the plant and parts have to be replaced as fast as possible by the plant operator → causing stress

Predictive maintenance:

- **Hypotheses were built to foresee where and when break-downs might occur - warnings based on the exploitation of sensor data**
- **Anticipative warnings are displayed → The plant operator initiates and monitors maintenance activities (to be carried out at once, during breaks or at the weekends)**
- **… or he delegates the decision about maintenance work to a coordination meeting**
- **Potentially, specialized maintenance experts have to be included**
- **Every warning has to be evaluated whether it is relevant and reliable**
- **The thresholds and logical assumptions that trigger a warning, possibly have to be adapted**

Problem: Appropriate thresholds that cause a warning

Hypothesis - Example: If the pressure in the tube for feeding the coolant increases more than 50% the tube might be kinked



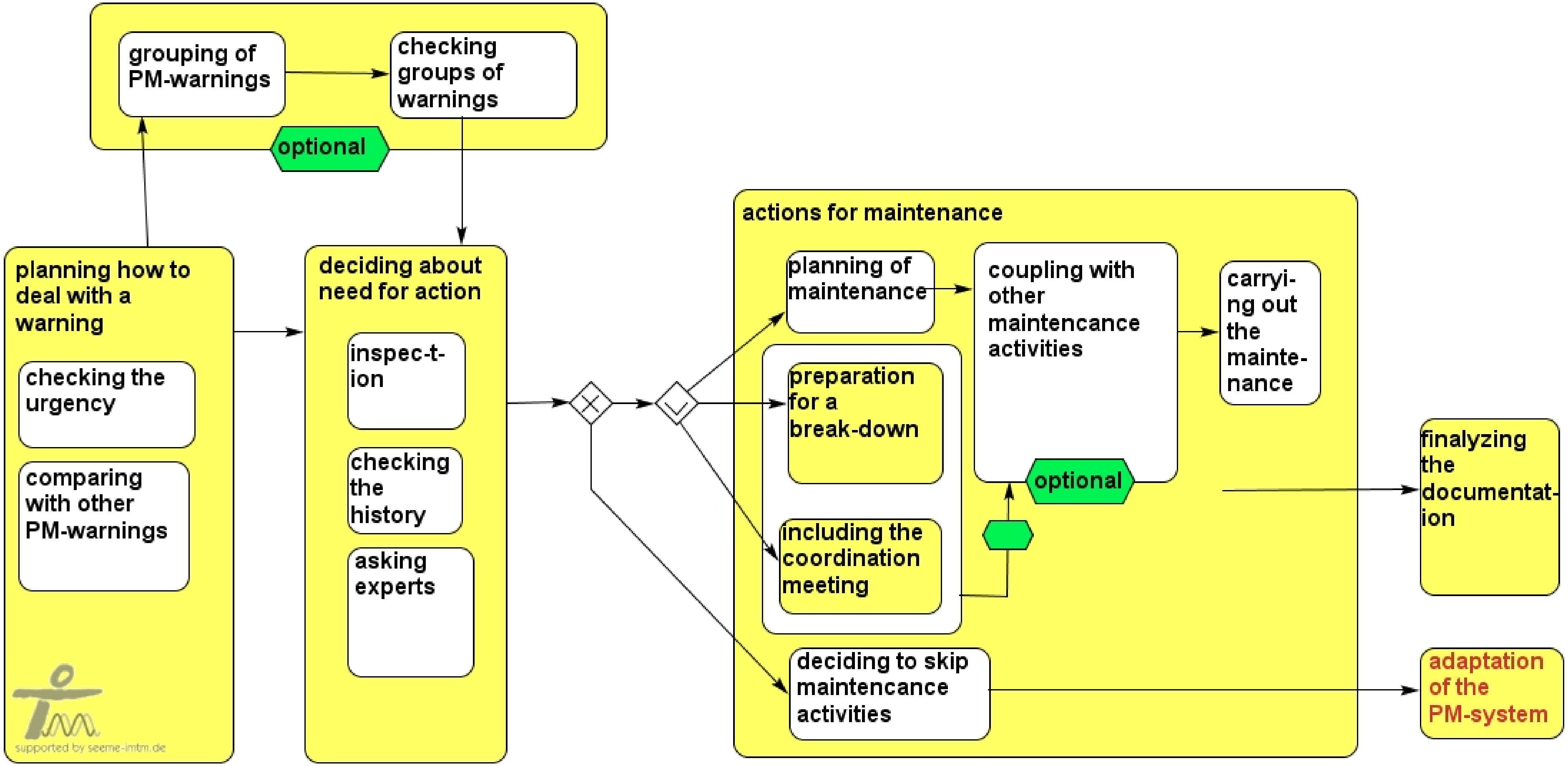
Challenge: "Every robot is its own robot [with its specific features]"

The contributions of humans depends on the question how far the development and adaptation of PM-hypotheses can be automated.

Revised workflow of dealing with break-downs and with warnings (consideration based on the PM-concept) -I

Changes of the workflow

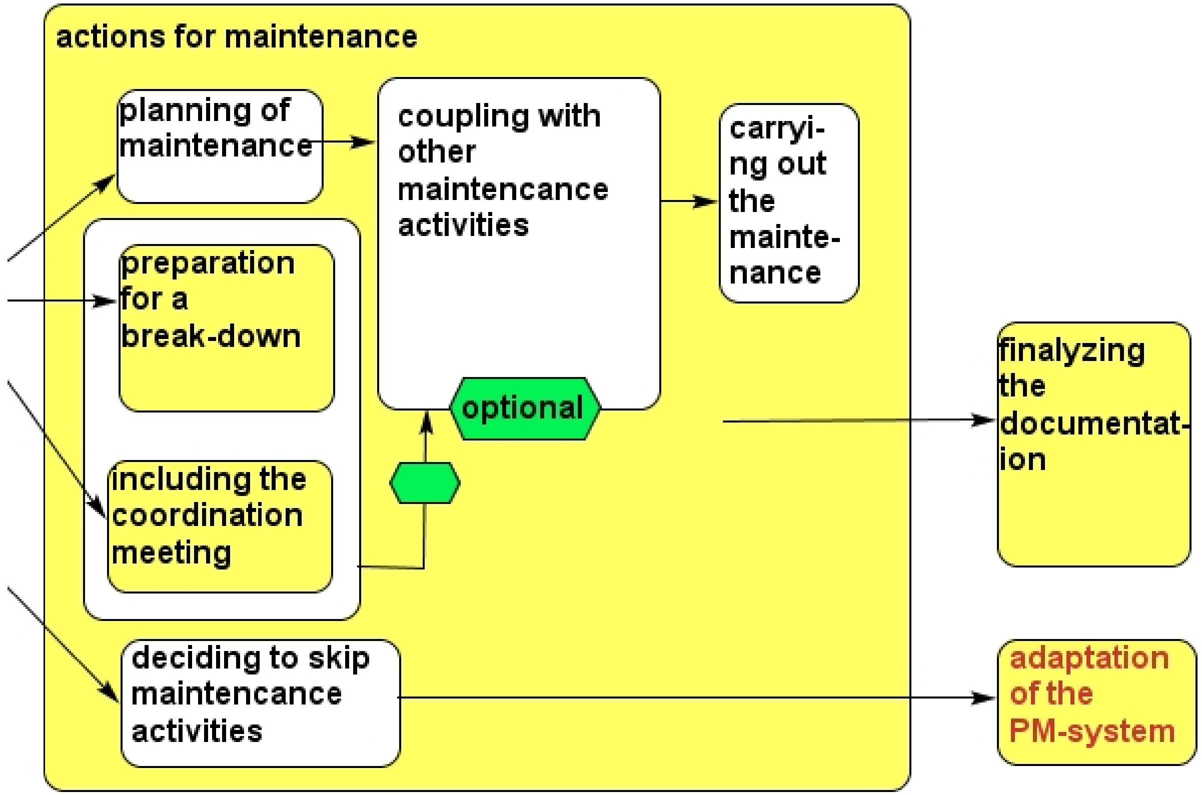
- Warnings can be grouped before dealing with them
- The number of cases where ad-hoc reactions are required – including stress of reacting as fast as possible – is reduced
- Time slots where maintencane takes place are shifted (to regular breaks or weekends)



Revised workflow of dealing with break-downs and with warnings (consideration based on the PM-concept) -II

Possible actions

- Decision about when a warning has to be dealt with
- Evaluation of the warning
- Planning of further steps
- Carrying out and supervising of maintenance
- Concluding documentation



Shift from maintaining the plant to maintaining of hypotheses - I

The evaluation of the warning includes several aspects

- Is there a real problem?
- Is the point of time - when it is displayed - appropriate
- Is the remaining time until a maintenance activity has to be carried out appropriately estimated
- Are the reasons for the warning that are assumed by the system appropriate

Shift from maintaining the plant to maintaining of hypotheses - II

Possible reaction on inappropriate warnings: adaptation of the thresholds
Challenge: Decision who will be authorized to do this
Solution: Intervention that allows for exploration but is not a final adaptation

Alternatively: **Adaptation of threshold by Machine Learning:**
An inappropriate warning or a break-down without warning is detected by a human and entered into the system as training input.
? Is the number of data or comparable cases sufficient?

OR: A hybrid man-machine system:
People experimentally adapt a threshold
→ Technology evaluates the consistency: will warning that were appropriate in the past still be triggered after the adaptation of the threshold?
→ What is an appropriate step width when a threshold is experimentally adapted.

Two potential future developments: Limited involvement of human actors vs. Adaptation of PM as a challenging continuous task

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The adaptation of the hypotheses for PM takes place within a short temporary phase of introduction

The number of necessary adaptations is limited and can be carried out by a few experts.

The adaptation can be carried out by machine learning.

vs.

The adaptation of the hypotheses and thresholds for PM is a continuous task

This continuing adaptation needs a large number of experienced actors

The adaptation of the PM continuously requires the participation and decision of human experts

Continuous enhanced of technology (sensors etc.) has to be taken into account

Potentially ***remaining challenging*** tasks to make the system more ***efficient***:

- evaluation of warnings
- intervention and exploration
- reconfiguration / adaptation
- considering new technical possibilities
- coordination of maintenance
- negotiation about adapting the PM

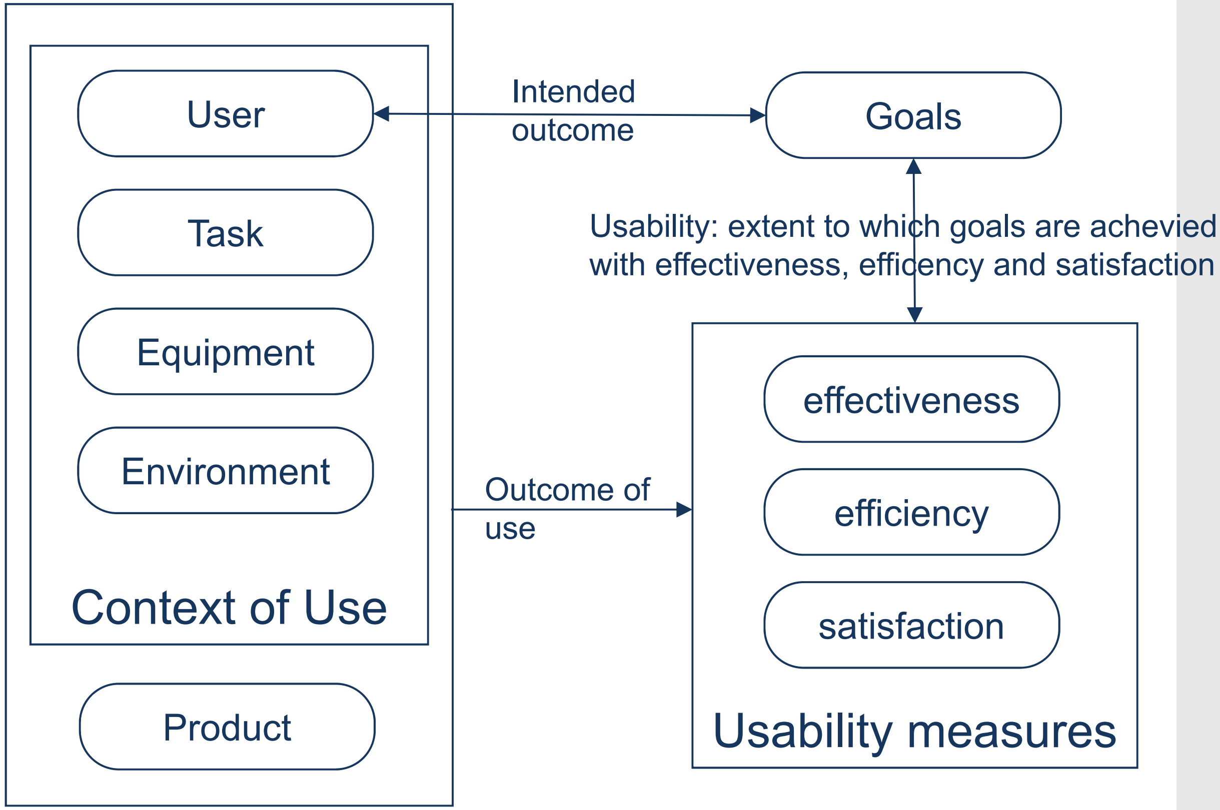
Understanding of Tasks → GOMS

Goals, Operators, Methods, Selections

- **Goals** - what the user intends to accomplish
- **Operators** - are actions that are performed to reach the goal.
- **Methods** - are sequences of operators that accomplish a goal.
- **Selections** - there can be more than one method available to accomplish a single goal; used to describe when a user would select a certain method over the others.

Efficiency (context ISO 9241)

Resources expended in relation to the accuracy and completeness with which users achieve goals.
Also includes:
- **time for preparation,**
- **number of errors,**
- **effort to recover from errors**



Challenging Tasks … Complexity, Creativity, social networking

Complexity – Means and goals

	clear	unclear
Means		
Goals		

Wicked problems

1. There is no definitive formulation of a wicked problem
2. Wicked problems have no stopping rule
3. Solutions to wicked problems are not true-or-false, but good-or-bad
4. There is no immediate and no ultimate test of a solution to a wicked problem
5. Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly
6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan
7. Every wicked problem is essentially unique ???
8. Every wicked problem can be considered to be a symptom of another problem
9. The existence of a discrepancy representing a wicked problem can be explained in numerous ways.
10. The choice of explanation determines the nature of the problem's resolution

Creativity

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… ability to come up with ideas or artifacts that are novel and valuable (e.g. Boden)

Creative procedures

- Producing variations
- Combining features from various domains
- Integrating perspectives
- Alternation between divergence and convergence: freely contributing and critical inspection of contributions
- …

Intellectually challenging

… mental ability (or abilities) that allow people to understand

… being curious … seeking for explanations

… striving for variation and exploration

… integrating new perspectives into a field

… social networking abilities

Task taxonomy according to Frey & Osborn

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TABLE I. O∗NET variables that serve as indicators of bottlenecks to computerisation.

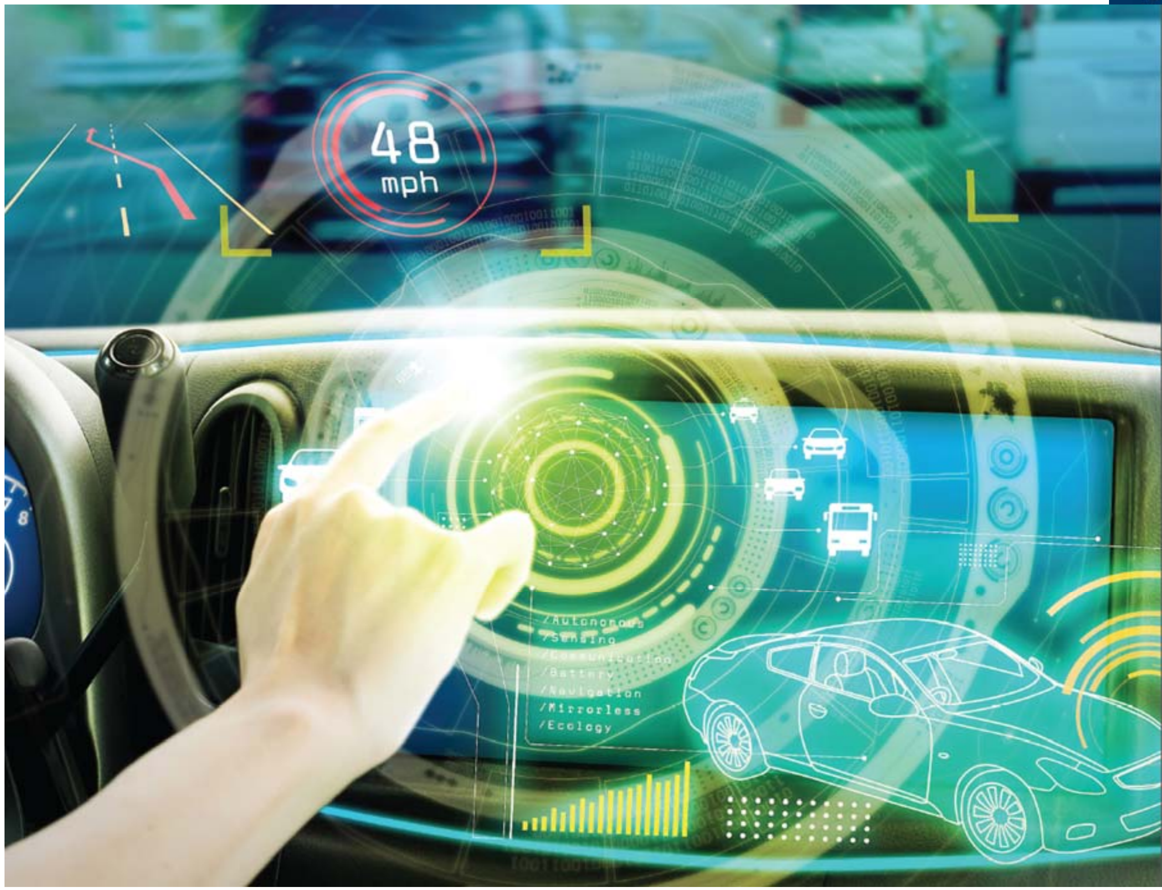
Computerisation bottleneck	O∗NET Variable	O∗NET Description
Perception and Manipulation	Finger Dexterity	The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
	Manual Dexterity	The ability to quickly move your hand, your hand together with your arm, or your two hands to grasp, manipulate, or assemble objects.
	Cramped Work Space, Awkward Positions	How often does this job require working in cramped work spaces that requires getting into awkward positions?
Creative Intelligence	Originality	The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem.
	Fine Arts	Knowledge of theory and techniques required to compose, produce, and perform works of music, dance, visual arts, drama, and sculpture.
Social Intelligence	Social Perceptiveness	Being aware of others' reactions and understanding why they react as they do.
	Negotiation	Bringing others together and trying to reconcile differences.
	Persuasion	Persuading others to change their minds or behavior.
	Assisting and Caring for Others	Providing personal assistance, medical attention, emotional support, or other personal care to others such as coworkers, customers, or patients.

Intervention – an example of a typical type of human tasks within hybrid systems

From continuous interaction to intervention

Intervention User Interfaces: A New Interaction Paradigm for Automated Systems

Schmidt, A., & Herrmann, T. (2017). *interactions*, *24*(5), 40-45.



Decrease of granularity of control:

self-controlled → highly assisted → completely automated + intervention

Interaction vs. Intervention

high granularity of steps	←→	initial step + occasional input
input leads to immediate response	←→	input starts • preprogrammed steps Followed by • implicit • or context-based actions
Input as a regular event	←→	Input as an exceptional, intervening action

Transferring intervention to socio-technical processes

continuous monitoring and interaction (from inside or outside) is not appropriate in many cases:

- We have to deal with too many socio-technical processes
- no extra benefit if we stayed in a permanent loop of monitoring and interaction.

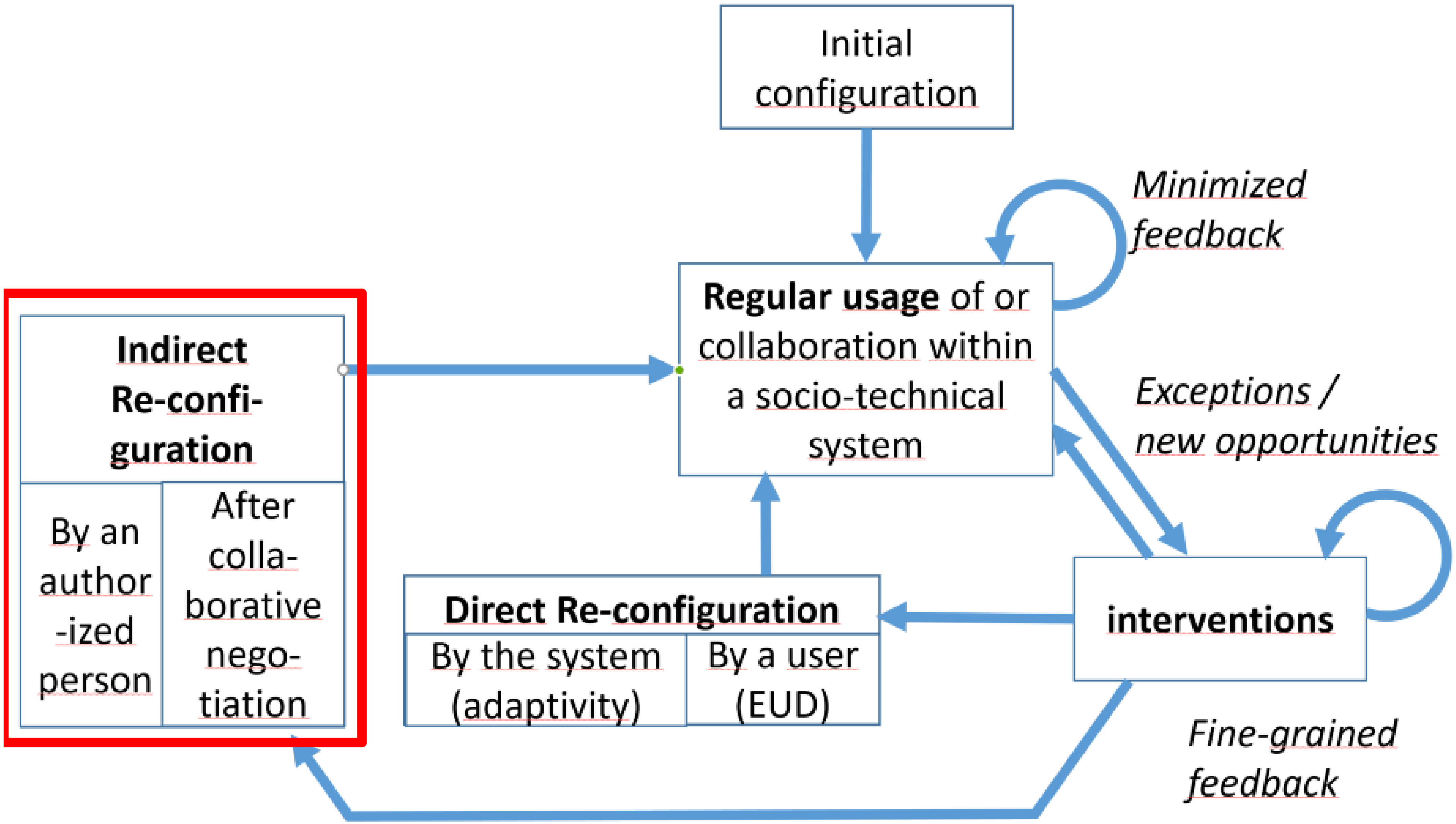
Applies to

- Highly routinized and self regulated processes (processing of e-commerce orders)
- Processes that include automated technical systems (public transportation)
- Software driven workflows (claims settlement by insurances)

Characteristics of intervening usage

- There is no pre-specified plan when and whether it occurs; intervention happens exceptionally
- Interventions are only effective for a limited period of time and for a limited scope of effects.
- immediate termination of interventions are possible at every point of time
- Interventions support the exploration of effects of variations
- **Interventions can address automated technical systems as well as people who contribute to completing a routinized workflow.**
- People must be able to start interventions fast enough by applying technical means **or via communication** so that the demanded effects take place in time.
- Situations that require intervention are emergent and contingent and contribute to the emergence of new patterns of behavior.
- In alternation with re-configuration, intervention cyclically helps to improve automated or routinized behavior.

Intervening usage and configuration



Principles for intervention design

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- **Strive for consistency:** intervention is possible in the case of experienced inconsistency; effect of intervention must meet expectations
- **Enable frequent users to use shortcuts:** immediate starting of an intervention with immediate effects; direct access not only to technology but also to people
- **Offer informative feedback:** need for intervention must be recognizable; effects of intervention are understandable / clearly communicated
- **Design dialogue to yield closure:** Intervention is an integrated means to be in control of complete and meaningful tasks
- **Offer simple error handling:** Intervention to avoid errors; robustness to avoid unsolicited effect of intervention – only few opportunities to train interventions -

Conclusions

Theoretical contributions - a

Which comparisons are relevant if the task distrubition between man and machine is evaluated?

- **Not only man vs. machine**
- **But man vs. man and machine vs. machine**
- **Between groups of people employing technical infrastructure**

Theoretical contributions - b

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Which factors indicate that including humans might be still reasonable

- Complexity
- Need for creativity
- Vagueness
- Integration of different perspectives and domains
- Low rate of repetition of the same conditions
- …

Theoretical contributions - C

What are typical types and patterns if action and interaction

- Intervention
- Experimental exploration
- Re-configuration
- Identification of relevant people
- negotiation

Intervention design is new

Interventions do not just happen but are systematically supported

It is not:

- A workaround (but accepted and promoted)
- EUD or Meta-Design (but before re-configuration)
- Exception handling within workflows (but initiated from outside).