RUB

Heuristic-based socio-technical Evaluation of Smart Factory Concepts

Thomas Herrmann, Jan Nierhoff, Alexander Nolte

Heuristiken für die Industrie 4.0

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GOAL

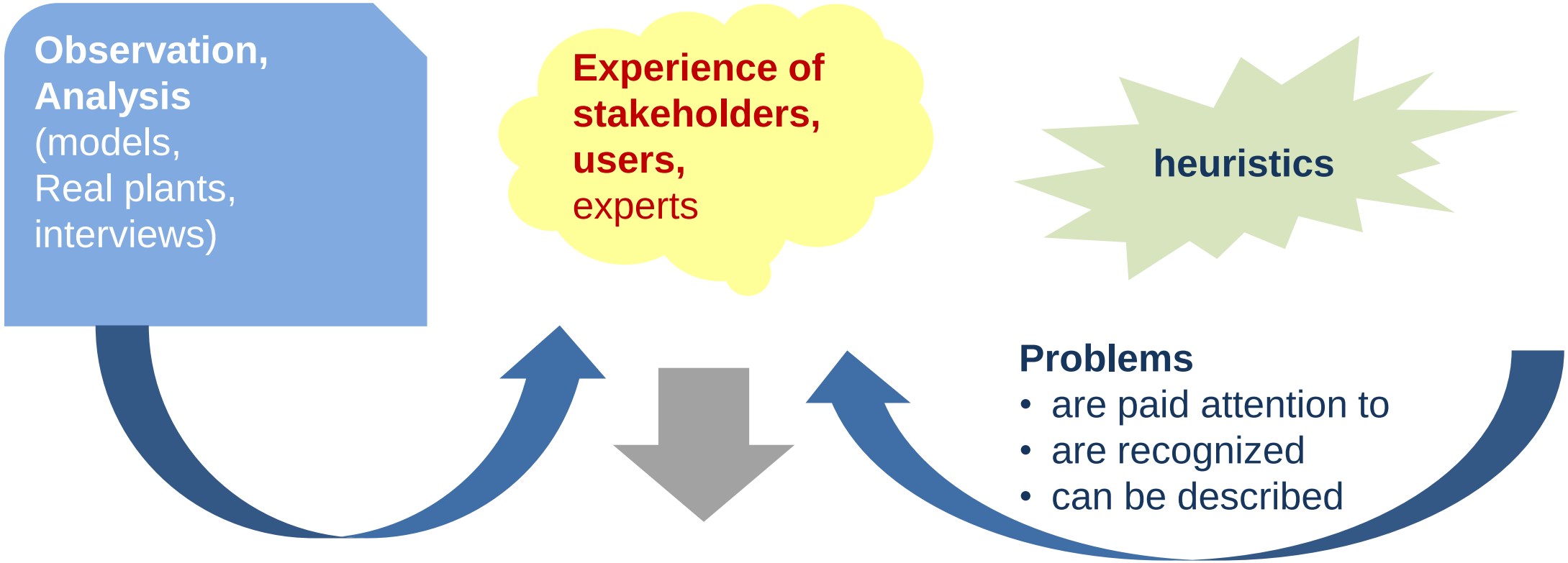
- An agile, formative evaluation of Smart Factory concepts as they are planned or implemented.
- Applying a holistic, socio-technical perspective to take human factors of work into consideration
- Initiating measures of improvement as early as possible

HCI-Heuristics are not sufficient …

For Example the Principles of Molich & Nielsen (1994)

1. *Visibility of system status:*
   The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.
2. *Match between system and the real world:*
3. *User control and freedom:*
4. *Consistency and standards*
5. *Error prevention*
6. *Recognition rather than recall*
7. *Flexibility and efficiency of use*
8. *Aesthetic and minimalist design*
9. *Help users recognize, diagnose, and recover from errors*
10. *Help and documentation*

… but the way they work is relevant …



Recognition of essential problems
And requirements for improvement
Impulses for deliberate discourses

Areas to be taken into account and getting focussed

- Socio-technical Design (STD)
- Human-Computer Interaction (HCI)
- Computer-Supported Cooperative Work (CSCW)
- Job Re-Design (JRD)
- Privacy (PRIV)
- Process Re-Design (PRD)

→174 Heuristic-Items were derived

→Grouping into 13 Heuristics

Testing by assigning a list of 223 problems to the heuristics

→Further Summarization → 8 Heuristics

Considered cases …

Smart Factories / Industry 4.0 (153 considered Problems):

1. Predictive maintenance in car manufacturing (77)
2. Digital Diary for handovers between shifts (33).
3. Self-Learning manufacturing workplace related to the coordination of maintenance, to visualization of trends for identifying expectable defects, and to possible solution (10)
4. Future WorkLab: Assistance for controlling and maintaining manufacturing machines (14)
5. Manufacturing of components for dental implants with variable production series (19)

8 heuristics

1. **Visibility and feedback about task progress**
2. ***Flexibility* for variable task handling leading to a participatory evolution of the system**
3. ***Communication support* for task handling and social interaction**
4. **Purpose orientated *information exchange* to facilitate mental work**
5. ***Balance* between perceived effort and benefit by task design**
6. ***Efficient organization* of task handling for holistic goals**
7. ***Compatibility* between requirements, development of competences and the system's features**
8. ***Supportive technology* and resources for productive and flawless work**

Each heuristic should

1. Mirror technical as well as organizational aspects of human collaboration
2. The continuous change and evolutionary growth of smart factory solutions
3. The relatedness of single aspects
4. Be as short as possible

1.Visibility and feedback about task progress

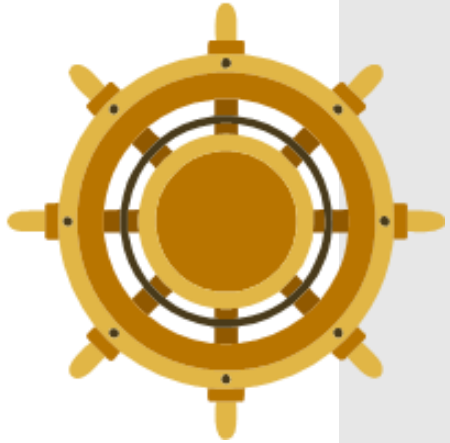
- Focused information is continuously offered about the progress of technical processes and – as far as permitted – about collaborative task handling. This helps to understand which further steps are possible or not and why, and how far the expectations of other people are met.

Example

- You can not only comprehend how many parts have passed a forming press, but you also see, whether and when a specialist is available to do maintenance work.

2. Flexibility for variable task handling leading to a participatory evolution of the system

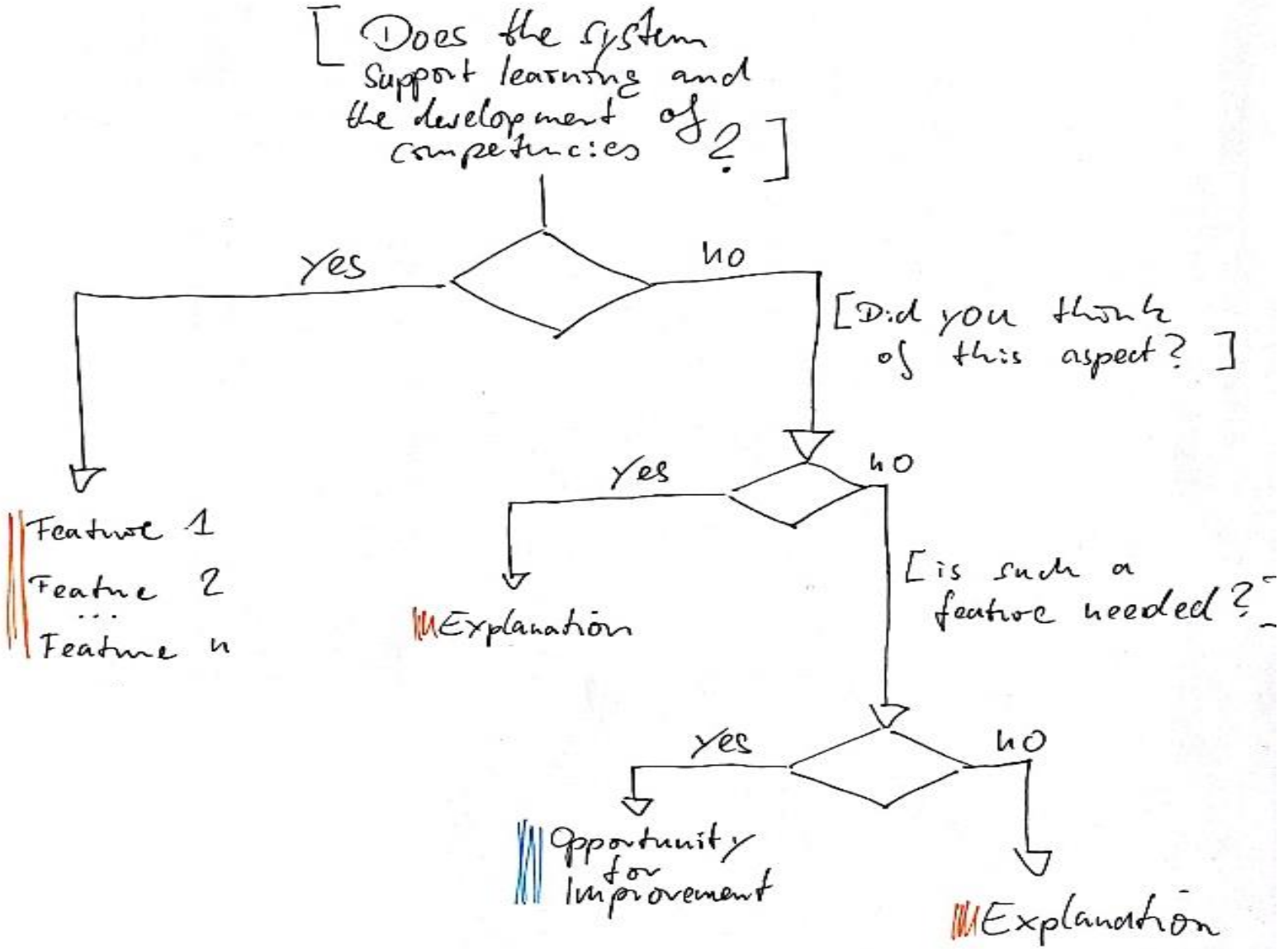
One can vary manifold options of task handling and can flexibly decide about technology usage, time management, sharing of tasks etc. Consequently, one can develop a wide range of competences that promote participation in the ongoing evolution of the whole system.



Example

There is not only a simple and fast way to install new software features but I can also ask somebody to do this for me … and this person should able to show me how I can do this by myself if necessary.

How to apply the heuristics



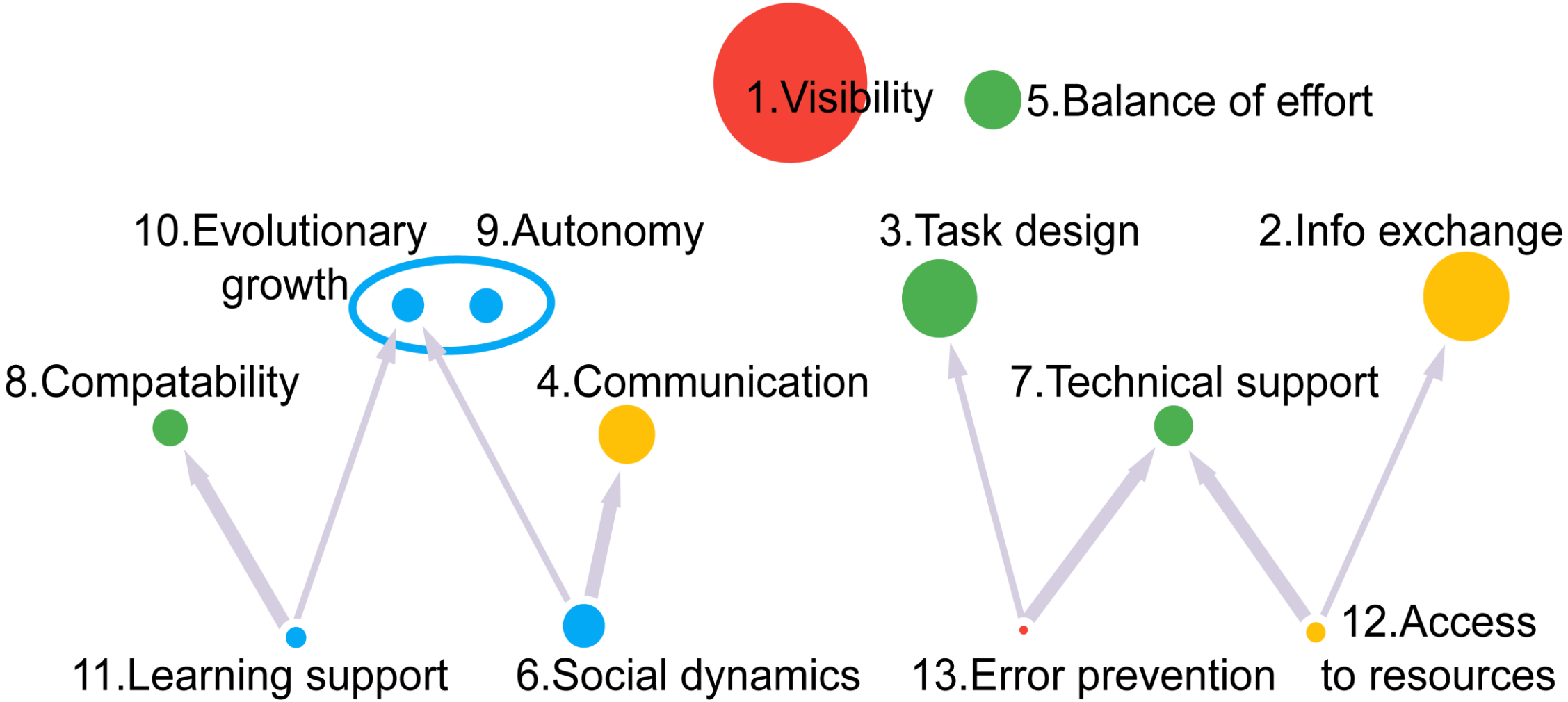
Deepen understanding of system

Identification of system flaw

Concluding remarks

1. **Compatibility, flexibility and visibility were most frequently assigned to the smart factory problems**
2. **Autonomy of people vs. autonomy of technical systems proves as one of the most relevant challenges**
3. **Design for intervention might prove as a promising way to deal with this challenge**
   (Intervention User Interfaces: A New Interaction Paradigm for Automated Systems Schmidt, A., & Herrmann, T. (2017). *interactions*, *24*(5), 40-45.

Back-up


1.Visibility
5.Balance of effort
10.Evolutionary growth
9.Autonomy
3.Task design
2.Info exchange
8.Compatability
4.Communication
7.Technical support
12.Access to resources
11.Learning support
6.Social dynamics
13.Error prevention