Management of critical situations

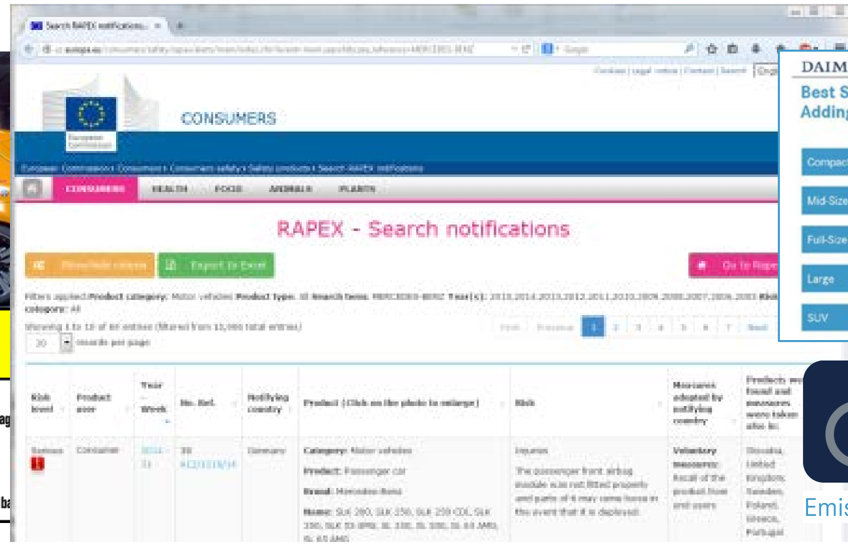
Impulse from automotive perspective

Thomas Naumann

Different phenomena of critical situations

Fail / Misuse

Product recalls



Increasing product complexity

Emission-free Accident-free Always on

- Phenomena occurs in the whole product life cycle.
- Phenomena have complex, contextual relations to characteristics of product, organization and process.
- Phenomena are related to each other but not causal → principles of contingency.
- Critical or unexpected events and their implications are usually unwanted.
- The objective is to influence critical situations early and in advance.
- Product development plays the most important role in product life cycle.

Badke-Schaub (2012) “Critical situations and crucial actions have influence in the goal, direction, concept, detail, teamwork, planning and ideation towards the design result.”

Process management in theory

Definition of critical situations

Research on critical situations has its origins in psychology: *Flanagan 1954, Jones 1970, Goldschmidt 1996*, especially Frankenberger 1997, Frankenberger and Badke-Schaub 1998.

Frankenberger (1997) “Critical situations are crucial and influence the further processes. They occur in common problem solving processes or come into existence of additional events (disturbances).”

Badke-Schaub (2012) Investigation of sources of critical situations and crucial actions and examples of negative and positive behavior.

“Different analyzed patterns of sequence:

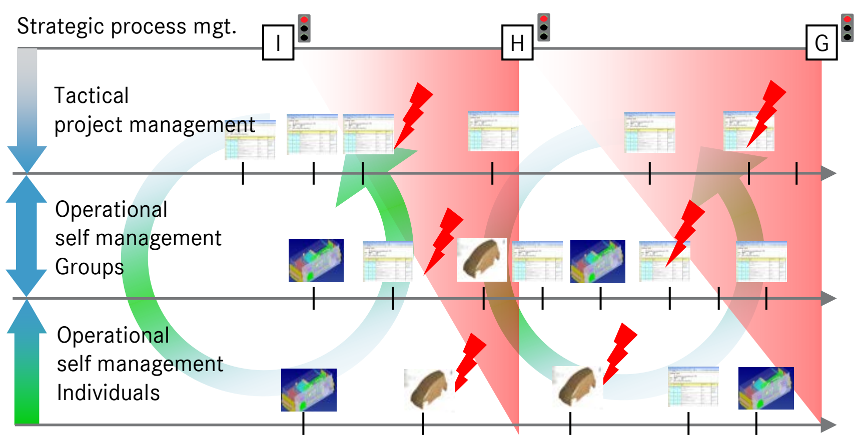
- Critical situations that are immediately perceived and the crucial action is known to have direct solution.
- Critical situations that do not have a successful resolution might lead to other critical situations.
- Crucial actions that are not taken might lead to unsolvable critical situations.
- Crucial actions that are not taken, might be excessive or insufficient, can lead to critical situations.”

Problems Existing (research) approaches analyze critical situations post-hoc, based on questionnaires and interviews :

- Effort and time need are high.
- Direct measurement of indicators is difficult.
- Analysts are perceived as disturbance variable.

Critical situations and Crucial actions in design

Sources	Challenges	Examples of observed successful behaviour	Examples of observed less successful behaviour
Dosage	Adequacy	Look for essential criteria	Missing criteria
	Balance	Make things matching	Over dosage
Planning	Probability	Preparedness	No probability evaluation
	Anticipation	Foreseeing opportunities	Overestimation of predictability
Framing	Orientation	Reflected choice	Difficulty to choose
	Focus of attention	Convergence	Stuckness
Ambiguity	Surprise	Opportunistic procedure	Missing opportunities
	Knowledge	Reflected analysis	Clients that do not know what they want
	Intransparency	Searching for indicators	Difficulty to grasp the features of a problem
Information Transfer	Communication	Transparent communication	Confirmation bias
	Exchange	Awareness of the need for sharing information	“Tunnel view”
	Documentation	Keeping record of sub-results	Not keeping record of sub-results
Interdependency	Interfaces	Awareness of the different interfaces involved	Acting without reference to others involved
	Suspension	Take time for decisions and keep in mind long and short term consequences	Missing feeling of competence
Envision	Open up solutions	Generating alternatives	Difficulty to think in the future



Conclusion High effort for time delayed benefit → Low efficiency → Limited usage for operational management!

Process management in practice

Qualitative overview about today’s approaches and methods

<table>
<tr><th>Type</th><th>Who?</th><th>Objective</th><th>Method</th><th>Objects</th><th>Rota</th></tr>
<tr><td>Strategy</td><td>“Standard processes”</td><td>Standard PDP of Series and Power train</td><td rowspan="2">BPM</td><td>Gateways, milestones, metrics</td><td>annually</td></tr>
<tr><td>Tactic</td><td>Management teams und project management support</td><td>Project management of single series</td><td>Gateways, milestones, metrics, topics</td><td>monthly</td></tr>
<tr><td rowspan="3">Operational</td><td>Boards and work groups with standard communication</td><td>Coordination of distributed development tasks, decision making or preparation</td><td>“TRCI”, Task lists</td><td rowspan="3">Topics, Tasks</td><td rowspan="2">weekly</td></tr>
<tr><td>Teams with standard communication</td><td>Management of functional and geometrical maturities, decision making or preparation</td><td rowspan="2">Task lists</td></tr>
<tr><td>Individuals
(Engineers, Designers)</td><td>Management of responsible functional and geometrical maturities</td><td>daily</td></tr>
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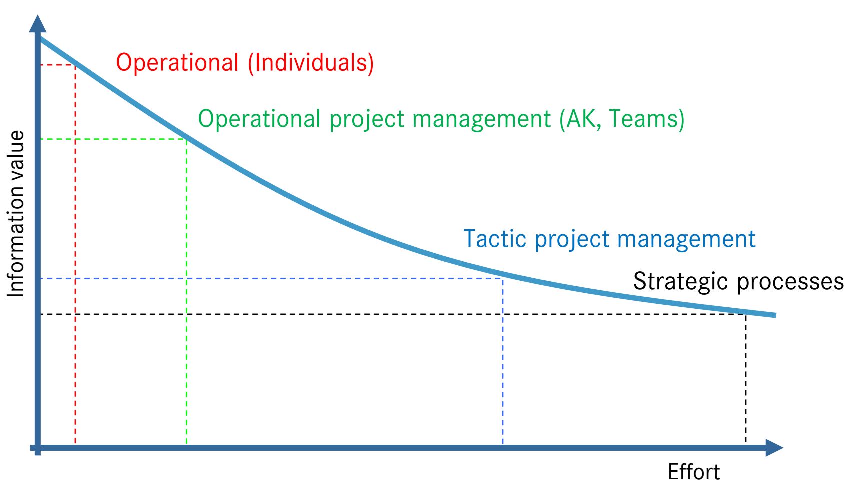


- The effort for standardized processes is high.
- The information value for operational management is limited because of the highly development dynamic.
- The meaning lies on orientation and **communication**.
- Processes for new topics and innovations usually don’t exist because process management is already post-hoc.
- **Topics** and **tasks** are the determining objects on the operational levels.
- The project state will primarily be measured in practice according the **maturity** level of the product.

Development of a new approach

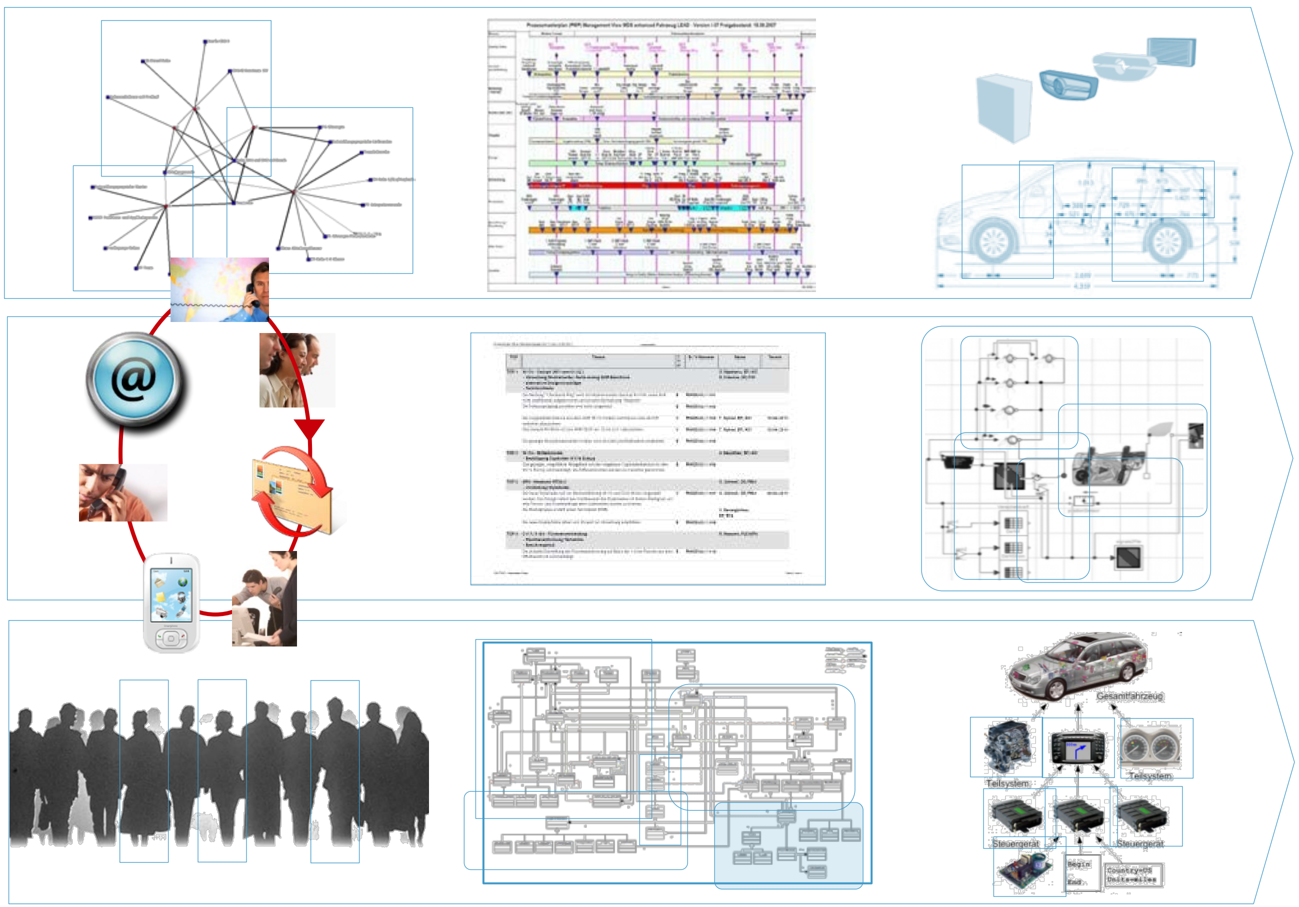
Derivation of existing models and approaches

Organization
Organigrams, interaction and communication, networks, ...

Process- and project management
PDP, task lists, data models, ..

Product
Product conf. (BOM), function structures, specifications, ...

New Systems based approach for efficient management of complexity



Understanding of procedural complexity, self management and self organization
as well as
critical situations

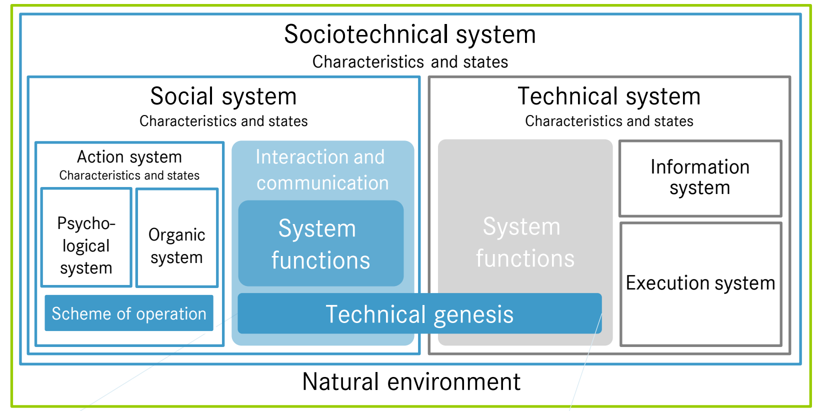
Understanding of characteristics: structures, functions, forms, ...

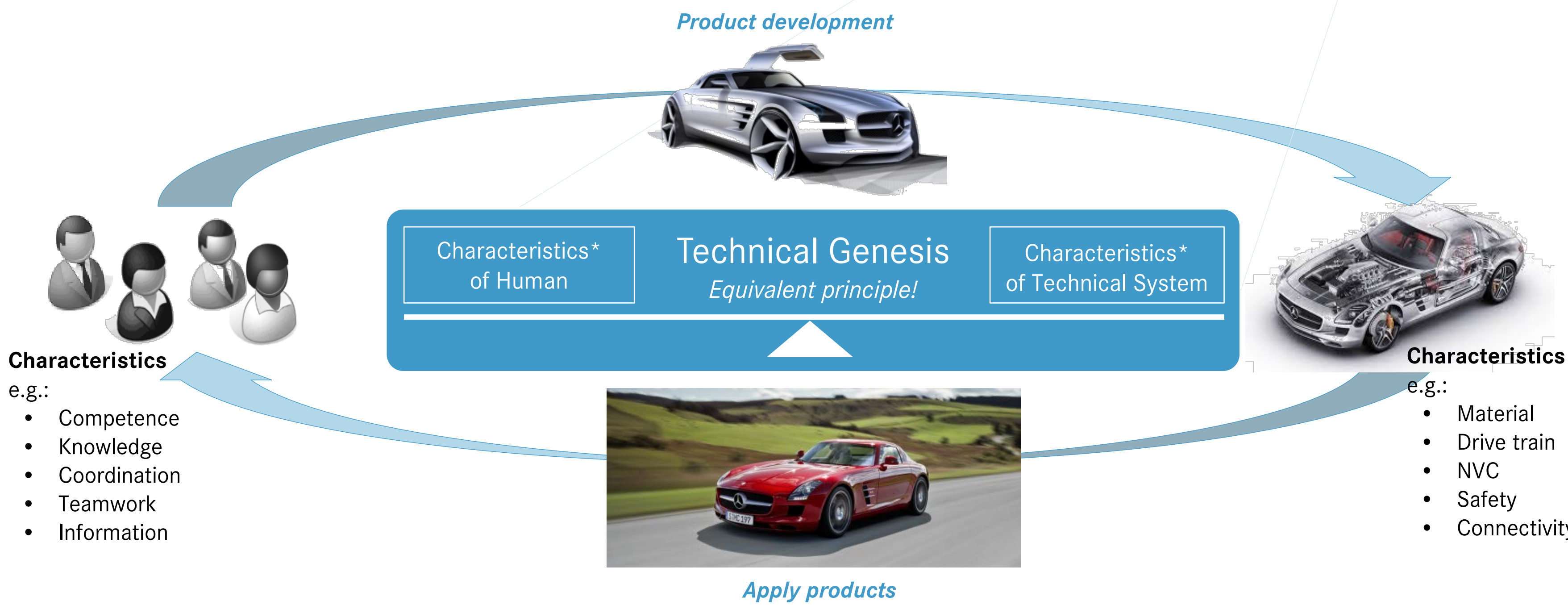
Understanding of objects and their relations

Basic understanding

Model approach

- Meta-model of sociotechnical systems (Naumann et. al. 2011, 2014)
- Equivalent principle and understanding of characteristics
- Comprehension of interaction and communication
  - → Communication as control parameter
- Comprehension of processes
  - → **Meaning of complexity as control parameter**
- Systems engineering methods and tools
  - → Traceability as control parameter

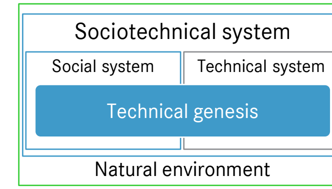




* *Characteristics are structure, function, form, material, and more.*

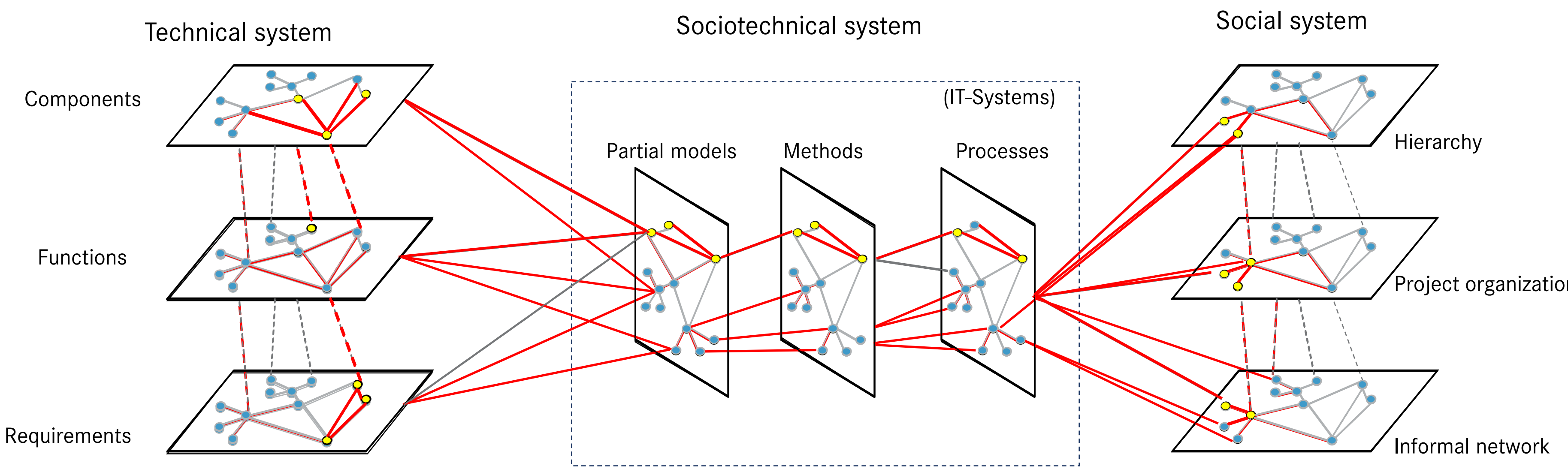
Basic understanding

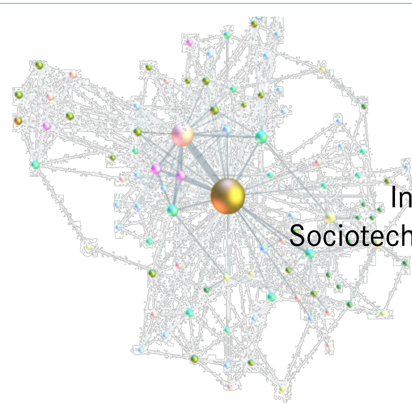
Complexity as control parameter



Every social system can only limitedly handle technical complexity in an organizational and procedural manner.

→ Identification of critical situations with complexity values.



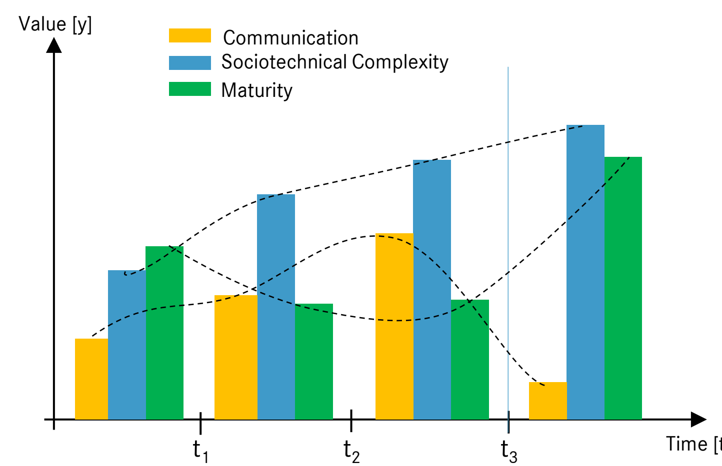


Network metrics

Interaction = e. g. Sum of communication events

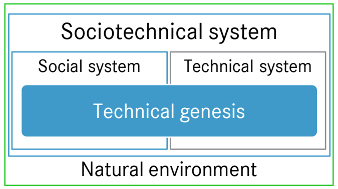
Sociotechnical Complexity = Sum of all nodes and edges

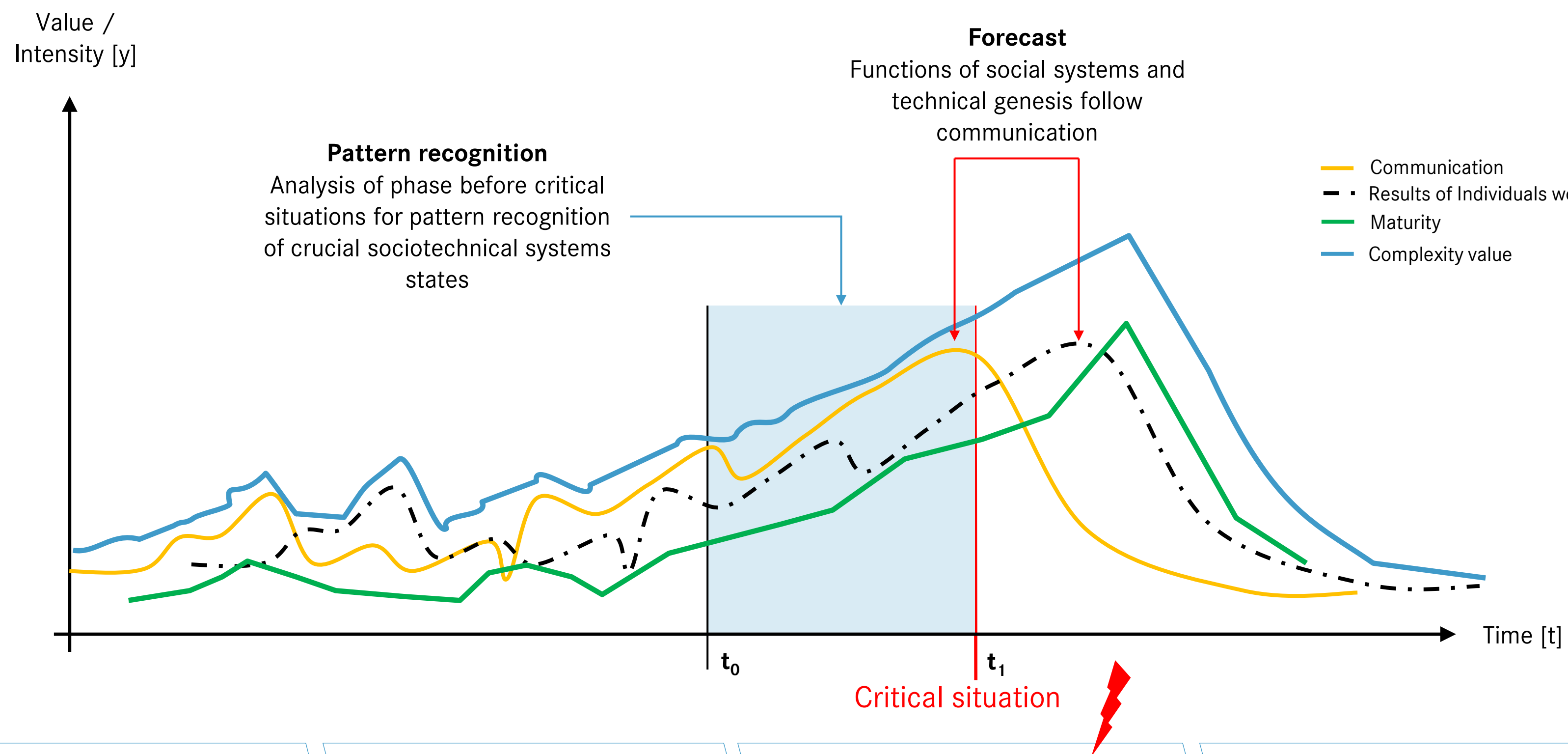
Maturity = e. g. Sum of fulfilled requirements



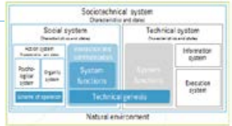
Methodology

Analysis of critical situations

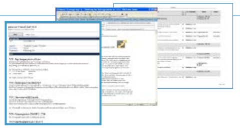




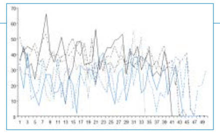
Model approach: Each event of a social function or a technical function realizes a new status



Data processing of existing interaction and communication data e. g. protocols, task lists, releases, … (Privacy policy!)



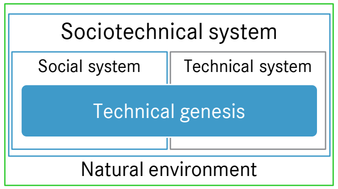
„Toolbox“ e.g. with network analyses for the interpretation of data

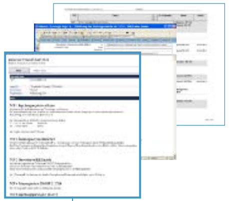


Feedback to the teams and evaluation of the reflections effects on the further processes

Methodology

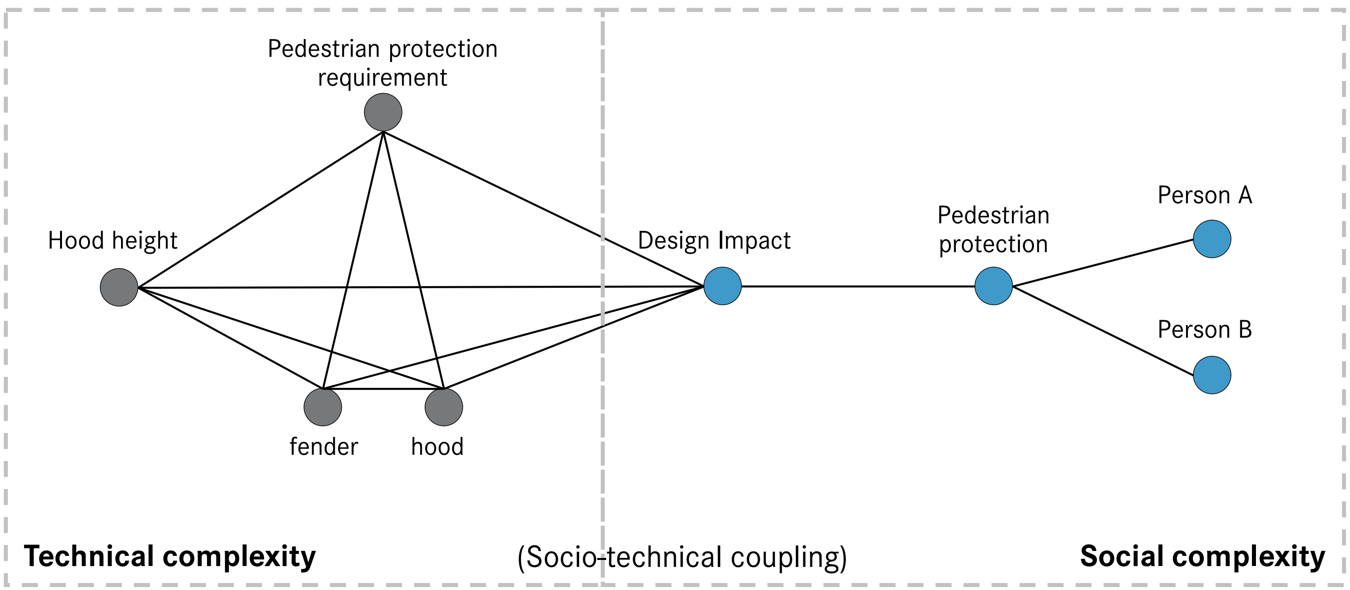
Derivation of dynamic sociotechnical networks in detail





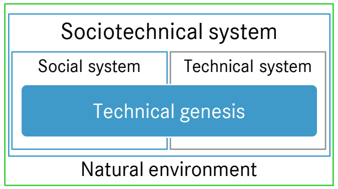
Protocols,
task lists,
releases, …

Date	Content	Subtopic	Topic	Resp. Person
10.02.2008	"Pedestrian protection requirement affects hood, hood height and fender."	Design impact	Pedestrian protection	Person A Person B



Validation

Research design and data



Technical systems:

"side-mirror"

"Pedestrian protection"

Comparative longitudinal case study

- The study was embedded in a process optimization program to harmonize organization, process and IT-systems between 2010-2013.
- **4 NPD projects** between **2006 and 2010**
- Focusing on **design phase** starting with **project kick off** until **design freeze**
- Analysis of **2 topics** with **different complexity** in a single project

Data collection

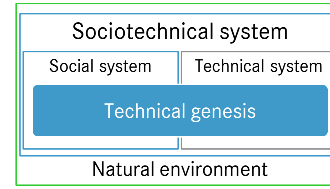
- **Weekly meeting protocols** (cross functional meeting to solve technical issues)
- Project **status reports** including vehicle design maturity level
- Log data from **PDM system** (exchange of CAD-documents)
- Expert **interviews**

Analysis (mixed method approach)

- Explorative evaluation of data, Top down codification
- Descriptive statistics
- Methodological triangulation

Results

Analysis of complexity

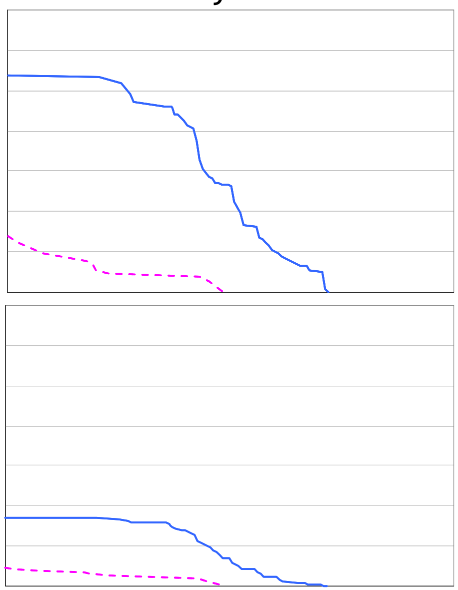


Input for managing of organizational complexity and processes

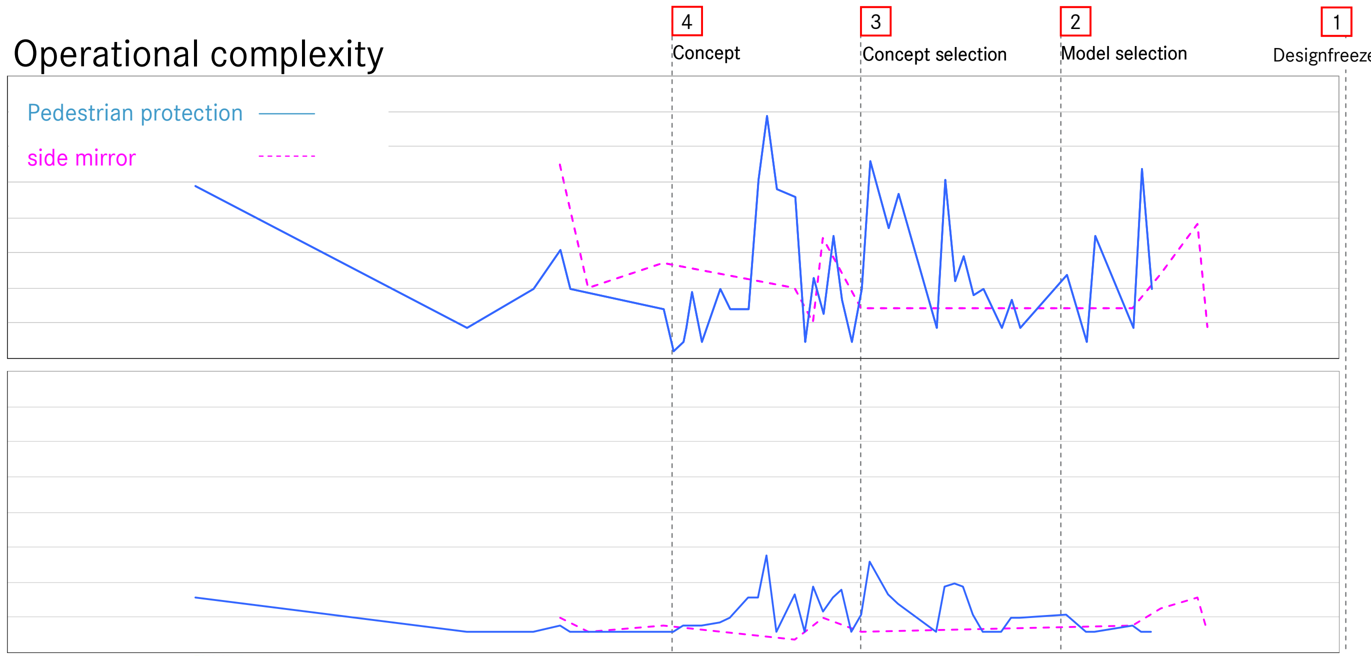
Technical net

Social net

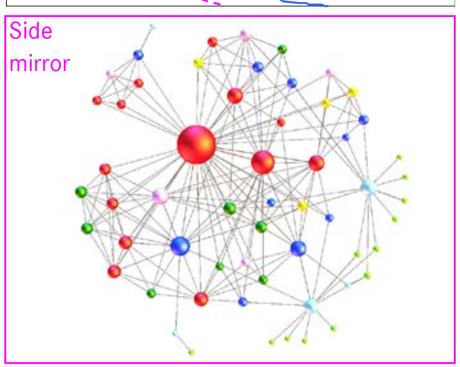
Survival analysis

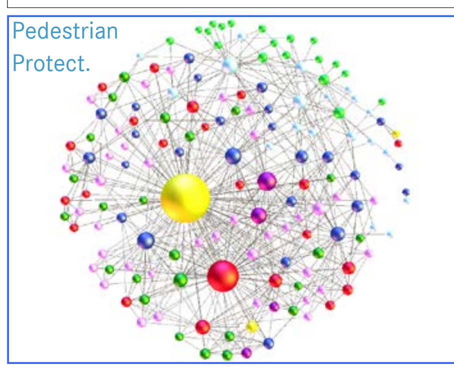


Operational complexity



Socio-technical net





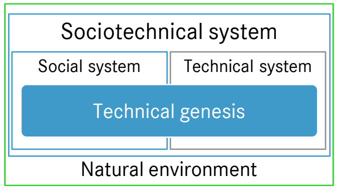
Nodes Category and distribution	Ped. Protect.	Side mirror
Topic	19 (12)	5 (9)
Subtopic	26 (17)	10 (17)
Person	19 (12)	12 (21)
Requirement	3 (2)	4 (7)
Function	4 (3)	0 (0)
Physical part	22 (14)	14 (24)

Nodes Category and distribution	Ped. Protect.	Side mirror
Parameter	24 (16)	8 (14)
Partial model	37 (24)	5 (9)
Density	0,052	0,117
# Nodes	154	58
# Edges	617	194

Numbers in brackets are given in percent [%]

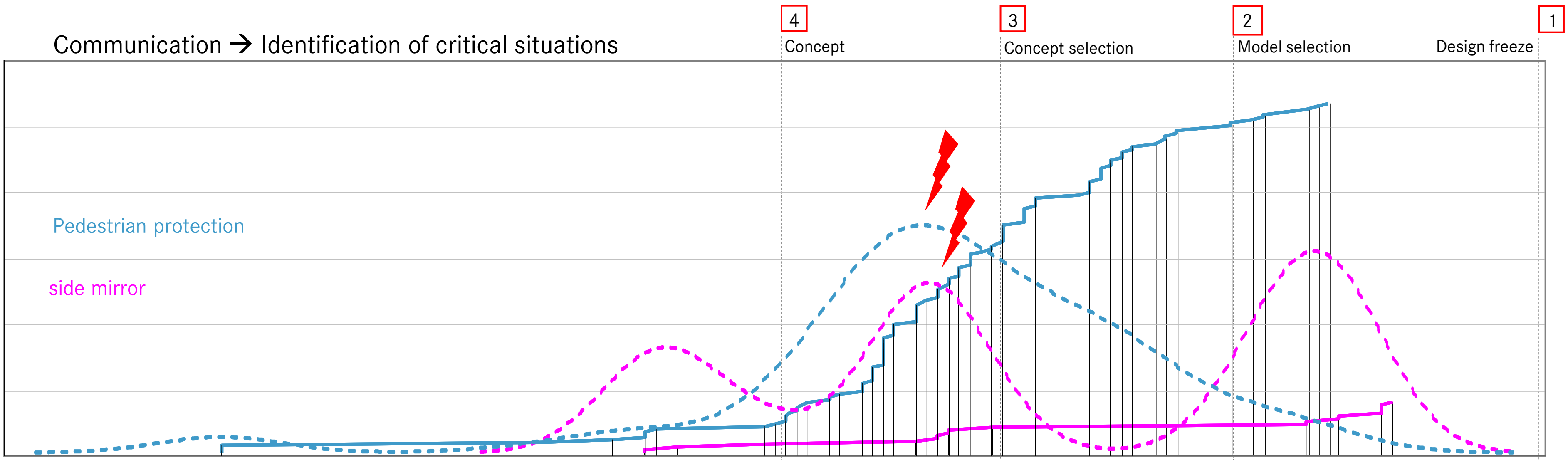
Results

Analysis of critical situations

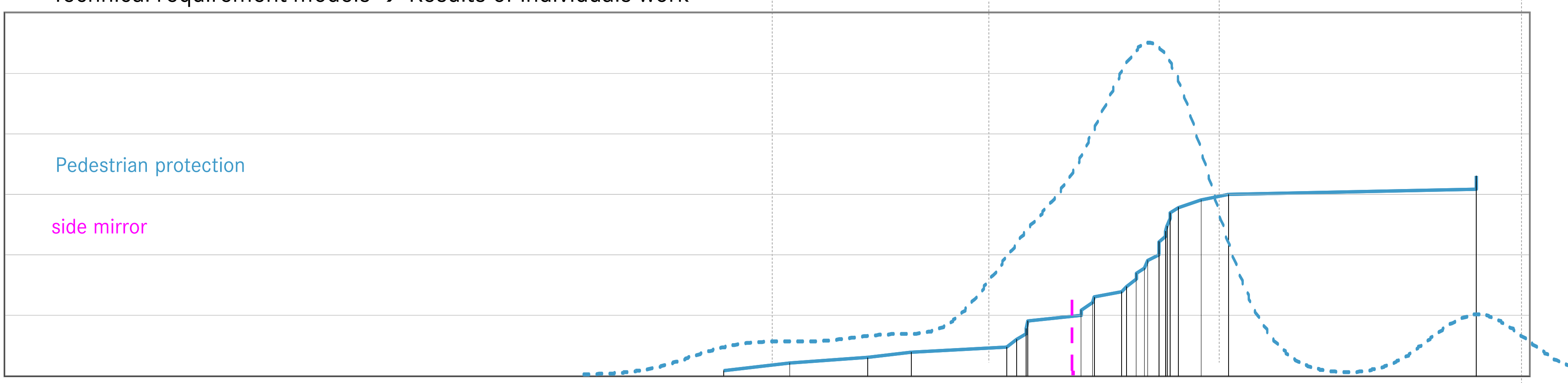


Input for process management and reflection

Communication → Identification of critical situations



Technical requirement models → Results of individuals work



Summary

Thank you for your attention

Theory of Social Systems Engineering