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TRANS-EPISTEMIC DESIGN-(RESEARCH): THEORIZING DESIGN WITHIN INDUSTRY 4.0 AND COGNITIVE ASSISTIVE SYSTEMS

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Abstract
The paper suggests an innovative design research and intervention approach using a poststructuralist organizational education perspective. The potential of a high impact trans-epistemic design process is shown for the field of industry 4.0 and the specific context of cognitive assistive systems (CASs). The multi-layered approach addresses the design of technical, social and educational complexity to implement CASs sustainably on the shopfloor and exploit their potential in industry 4.0. Finally, we will shed light on how the approach can enhance deep organizational transformation in industry.

Keywords: cyber-physical systems, complexity, organisational education theory, multi-/cross-/trans-disciplinary approaches

1. Introduction

We live in a world of increasing ambiguity, complexity and uncertainty, and digitalization is one of the main drivers. The networked structure of transformation not only blurs organizational boundaries but transforms our societies towards a network society (Drucker, 2002). Digitalization can be regarded as a disruptive transformation, leading into hybridization and to a complete fusion of the digital and analogue worlds. In the field of production, digitalization is being promoted under the umbrella of the political program of ‘industry 4.0’ and is represented by cyber-physical systems (CPS), in which the virtual and the physical factory both evolve as a unit. However, most of the technological foundations (i.e. virtual engineering, artificial intelligence) were already innovated in the 1990s. Today, the biggest potentials for innovation can be seen in interconnected life cycle perspectives, in production processes along value chains within and across plants and products. In all those innovation processes, the sources, gathering, diffusion, and use of information within production systems are becoming of crucial importance (Wichmann et al., 2019). Information can become a resource for organizational improvements, for inter-organizational exchange of information and for new business cases (ibid). Yet, recent literature observes and our experience suggests that many organizations and companies are hindered to promote digitalization by ambiguity and lack of consensus (Wichmann et al., 2019; Eckert et al., 2019).
We assume that this dilemma can be traced back, among other things, to the fact that digitalization goes hand in hand with **new forms of knowledge production**, which have to be addressed by designers to achieve the potential of industry 4.0 but **require deep organizational transformation**.

- At the *inter*-organizational level, new forms of knowledge production emerge as a result of the increasing significance of multidisciplinary collaboration and innovation between industry, academia and society. For example, Etzkowitz and Leydesdorf already in 2000 suggested the "triple helix" model between industry, state and university. In those multi-stakeholder arrangements technological actors connect to socio-technical and human-centred perspectives, social demands and political strategies (Hirsch-Kreinsen, 2019; Graessler and Poehler, 2019; Hassannezhad et al., 2019). Over the last years, Carayannis and Campbell (2013) have enlarged this concept towards transdisciplinary arrangements including sustainability and civil society. Design activities within industry 4.0 undergo a diverse, multidisciplinary and agile paradigm and require system thinkers (Eckert et al., 2019), who are sensitive for and can deal with new forms of knowledge production.

- At the *intra*-organizational level, within CPS, new technical forms of processing knowledge appear. Employees in production use digitized plants, robots and systems based on artificial intelligence for collaboration and knowledge transmission. Besides, CPS require egalitarian collaboration across different business units and across the life cycle of products and plants. To achieve value creation through information requires a multidisciplinary, networked communication practice. Designers of CPS have to take social complexity and hybrid practices of knowledge processing into account.

The central **aim of this paper** is to introduce an innovative design approach that addresses **new forms of knowledge production**. This approach intends to achieve the full impact of industry 4.0-technologies through promoting a networked information practice and value creation across the life-cycle of products and plants. To shed light on the relevance of new modes of knowledge production within industry 4.0 in detail, we use the example of Cognitive Assistive Systems (CASs). CASs are part of a digital human-machine interface within CPS. They focus on supporting knowledge intensive tasks and employees' creativity, systems-thinking and self-organized acting. Through a normative lens, they oppose an automation-scenario and contribute to a specialization scenario, in which production employees direct the CPS instead of being directed by it. However, as we can see research on industry 4.0 technology design in general and CAS design in particular focuses on technology and methods. In fact, it neglects the **epistemic character of knowledge**, knowledge production as well as knowledge production strategies. We therefore argue that it is needed to emphasize the role of **epistemic reflexivity** in CAS design to implement CASs on the shopfloor, to realize their potential in practice and to achieve deep transformation.

We refer to a broad understanding of epistemic reflexivity as reflected modes of knowledge production in both research and practice that lead to transformative practices (Pintrich, 2002, Weber, 2014). We will therefore **examine** from a discourse analytical perspective what is in the respective research contexts currently emphasised and how it is argued. We also **investigate** how new forms of knowledge production can be systematically maintained in the design of products, social and educational processes. As a result, we develop a trans-epistemic design (-research) approach. In this respect, readers may expect a **programmatic and argumentative** rather than an empirical paper in the classical sense.

The paper is structured as follows. **Section 2** presents the potentials and challenges of CAS design. **Section 3** evaluates the state of the art in technical design research and argues for a complexity approach in design and design research. **Section 4** suggests the high impact and multi-layered trans-epistemic design (-research) approach. **Section 5** summarizes the potential for introducing the approach in industry.

2. Cognitive assistive systems – Potential and challenge of and in design

CASs are a conceptual technology, which interconnects to CPS. They provide object-relevant information to the employee, e.g. inspection documents, annotations from colleagues, requirements for action or current and historical sensory data. Relevant information usually shows on a mobile device. Ideally, the information is derived from the digital twin of a plant. Since the employee interacts with the CPS via a CAS, it forms a digital man-machine interface (Jachmann and Adler, 2017; Haase, 2017, Schenk and Berndt, 2016). CASs can be distinguished from physical and sensory assistive

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systems and from systems with a more instructional character. The latter are mostly used in tasks with low complexity (i.e. pick-by-light systems in commissioning). CASs in contrast correspond to the characteristics of knowledge systems (Keller, 2018), support problem solving activities, creativity and responsible action. Knowledge systems are applied for example in the field of maintenance within highly complex production systems, as they are given i.e. in chemical industry.

Designers and implementers of CASs face challenges, because they are non-trivial systems embedded in technical and social complexity. In fact, those technologies intervene into the organizational culture and ways of sharing knowledge. We will illustrate these challenges in the following.

- Fist, what information should and can be stored within a CAS? Even if a CAS can be an appropriate framework for the transfer of informal and experiential knowledge (Haase, 2017), until now it is unclear, whether at all it can be put into a format from where it can be used for artificial intelligence. In addition to this, it is controversial if it is possible to 'store' knowledge or if this is only true for information. A socio-constructivist and process-oriented perspective on knowledge assumes that knowledge generation only occurs within human beings' interaction. However, information processing is not primarily a technical issue, but deeply refers to knowledge creation in and between relevant actors of the life cycle of production systems as an organizational process of the plant. This requires a perspective on knowledge creation concerning the context of organizations to transform value creation in industry 4.0.
- Second, who should store the information and how? Should it be a maintenance expert, who will have high manual skills but less professionalism on knowledge transfer? Does she or he have the competences and time to enter relevant data and didactically structure content into a CAS? What is the role of the engineer of the plant and product owner or the production manager? Who is responsible for updating and maintaining data? Who conducts a pedagogical perspective on content to support individual and possibly collective learning processes on the workplace?
- Third, how should information be stored? A strategy for structuring object relevant data within different IT-Systems is essentially needed. This strategy should correspond to the emergence of the digital twin of a plant, a virtual and dynamical model connected to a large intelligent data space across a plant's life cycle, allowing real-time status analyses, predictions and simulations.
- Fourth, who would use CASs and how? Which disciplinary and professional backgrounds would play a role for use, information feed ins and information take outs to achieve collaboration and collective use of information? Employees from different disciplines interact with the CAS (i.e. department of documentary, engineers, production managers, plant managers and maintenance staff with different levels of expertise). Using a CAS for a different purpose, they will have different "mental models" of the plant. They will work and accordingly use information differently. For instance, a plant's 3D-Model provides a good way for navigating through the huge amount of data. Therfore, new professional backgrounds are required: Professionals on artificial intelligence will be the ones to sustain the digital twin; those who maintain the generation of knowledge from the vast information space will be educational professionals.
- Fifth, how are employees qualified for a successful usage of CASs? Studies in a variety of industrial branches found out, that the usage of CASs and industry 4.0-technologies requires systems thinking and process understanding (Keller, 2018). Users need to understand the IT-based information architecture to process information successfully. They also have to learn how to use CAS for an effective communication practice. In addition to this, reflection, abstraction and to a certain level didactical competences are needed. Furthermore, leaders in the field of industry have to rethink their concepts and practice of leadership.

These aspects illustrate that CASs require company-specific adaptions of work processes and organizational development paths. A constructivist and complexity oriented perspective on the seemingly simple CAS-technology is necessary, since development, use and implementation are critical to new forms of knowledge production.

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3. Evaluating state of the art in technical design research - Challenging design for complexity

While the previous section highlighted the challenges on design at the example of CASs, in the following, we reflect on the criteria of design research. How to meet the necessities of industry 4.0 and CASs complexity? Formulating requirements in CAS design based on Weber's (2014a, b) dimensions of knowledge cultures we analyze, how recent research approaches and results address the criteria of 'complexity fit'. From a discourse perspective, we then evaluate whether and how these requirements appear and show in the respective research contexts.

3.1. Requirements for and towards design-(research)

First, focusing on the CAS as a technical artefact, design research has to consider **technical complexity regarding products and processes**. To develop a CAS interconnected with a wide variety of smart and CPS-technologies, design research requires a multi-stakeholder-orientation within technical design. Taking into account the multi-actor setting and different stakeholders involved, we have to acknowledge the systematic and structural difference of the given communities of practice and their specific knowledge sets. Institutional actors from academia, politics and industry all will refer to different rationalities, institutional sense making structures. Disciplinary worlds and mental models will shape approaches to design artefacts like a CAS and to conceptualizing process designs. Besides, design research has to consider language within design, as it plays a crucial role in communication between designers and users in developing a digital infrastructure for good and efficient collaboration in large information spaces (Keller and Fischer, 2019).

Second, when implementing a CAS in an enterprise, design research has to consider **social innovation and its complexity**. In general, discussions on social innovations within industry 4.0 focus on well-being at work and a human-centred realization of industry 4.0 (Kopp, 2016). In case of CASs, an effective information usage practice has to emerge. Designers should use usability and participatory methods, which address the workers' values and consider needs of different intraorganizational user groups (e.g. section 2). Therefore, again, design research has to acknowledge the systematic and structural difference of the given user groups of the CAS and their specific knowledge sets. Furthermore, CAS design can only achieve its' potential, when redesigning work organization and ergonomics (e.g. section 2). It should be noted here that a theoretical understanding of social innovation already includes epistemological, strategic and ethical approaches and is value-oriented (Moulaert et al., 2013). However, technology-driven and economic perspectives dominate discourses on industry 4.0 and CASs. The importance of social innovation within industry 4.0 can be seen both sceptically and as a path to a holistic strategy for tackling the challenges of digital change and good work (Kopp, 2016).

Third, as the example of CASs shows, design research has to consider **epistemic reflexivity** (Heidelmann et al., 2020**,** Keller and Fischer, 2019). CAS design in a holistic way refers to transforming organizational information and knowledge processing in respect to the rising value of information their importance for new ways of value creation. To achieve impact for the company, the use of information within CPS generally becomes more reflective, networked, non-hierarchical etc.. To reach out for the potential of a networked information practice within a CAS, organizational and mental concepts of 'the employee' have to transform, too. Here, companies need to change linear into networked imaginaries of the organization and their work (Keller and Fischer, 2019). Thus, individual and organisational orders of attention and awareness become relevant for design (-research) (e.g. Weick, 1995). Designers should systematically reflect how they intervene into these orders of awareness with the purpose to highlight the importance of communication processes in circular and networked value creation systems. Participating stakeholders have to imagine a digital 'vision' of the organization, which will match to organizing according to the life cycle of products and plants. Furthermore, we assume that a CAS also place the relationship between man and machine, between language and action and between understanding of self and the world at disposal (Mareis, 2016), which has to be explored by research from an transformative educational perspective.

As we observed, all three dimensions of knowledge cultures in design require to a certain degree a **reflexive and process-oriented design**. This can help multidisciplinary design-teams to navigate in

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uncertainty and ambiguity throughout the complex design process(es). As non-trivial machines, CASs appear complex to the observer because she or he cannot explain or predict their output for the enterprise. Thus, standardization, functional approaches and mechanical thinking do not fully meet the requirements of CAS design. Design research, in contrast, has to consider unintended effects, which appear in the social practice within the use of CASs. Besides, design (-research) essentially requires the **addressing of meaning and sensemaking** (Weick, 1995).

3.2. Evaluating state of the art in technical design processes

To evaluate the state of the art in technical design processes, we reflect them based on the above listed criteria. We analyze specific approaches that have shaped the technical design discourse and can serve as an ideal type of approach, which is predominantly taken into account. A complete analysis of all design approaches would not only go beyond the limits of this work, but does not seem necessary, as an epistemological differentiation already refers to the core rationalities and the core notions of complexity addressed here. Approaches will be differentiated into the three streams of technical complexity, social complexity and educational complexity (Weber 2014a, b).

At the level of **technical complexity**, the internationally recognized standard work by Pahl and Beitz (1996) on engineering design gives an overview to cognitive methods applied in this field, e.g. methods that emphasize intuition, such as synetics or brainstorming and also discursive methods. From the perspective of 'complexity fit', this work reflects a strong orientation towards methods in the field of engineering design. The selection of methods which are presented, usually seem to be under complex as far as cognitive processes are concerned. This analysis also seems to apply to Knowledge Based Engineering (KBS), where the design process of knowledge-based systems is itself described as knowledge-intensive. However, the concepts of knowledge revealed in a literature review of the KBS approach (Verhagen et al., 2012) do not reflect a constructivist and process-oriented view. The research on KBS lacks a constructivist view on sensemaking and reflexivity on the processing of knowledge between stakeholders in engineering design. Nevertheless, if we look on technical design in the context of industry 4.0, we can identify approaches with a strong multi-stakeholder orientation such as open innovation spaces. Yet, these lack considering organizational dimensions, which are important contextual and epistemological spaces for sensemaking, reflexivity and interpretation.

In general, within the context of industry 4.0, approaches to a certain extent do take **social complexity** and human-centred design into account, like i.e. user centred design and designing interactive systems (i.e. DIN e.V., 2006). Those approaches refer to claims of participation and participatory processes within design. Some approaches primarily refer to socio-technical interdependencies of industry 4.0-technologies concerning ergonomics and work design, organizational context, strategy and change (i.e. Iureva et al., 2019; Watanabe and Fukuda, 2019). Researchers also combine methods to develop a framework for specific design goals, i.e. design thinking, lean-management and so on (i.e. Kadir et al., 2019). The German industrial sociologist Hirsch-Kreinsen (2019) already took into account the design of interdependencies between technology, humans and organizational development.

Approaches that refer to transforming organizational practice as transforming sense-making and developing a future imaginary (i.e. Eriksson and Fundin, 2018) are rare. **The state of the art so far does not connect to epistemic reflexivity.** A design (-research) approach promoting transformational and epistemic practice for industry 4.0 is not yet systematically modelled or has been theoretically shaped.

Research on **CAS design** has primarily been conducted at the socio-technical level. For instance, Hirsch-Kreinsen (2019) develops design guidelines based on the example of digital assistive systems. Other researchers also investigate the design of digital assistive systems, i.e. from a didactical and an ergonomical point of view, from ergonomics perspectives (Schlick et al., 2018) or from the perspective of learning-friendly design (Haase, 2017), among others.

Obviously, the state of the art in technical design and CAS design to some extent takes into account the epistemic dimension (sense-making, reflexivity and interpretation), but omits the theorization of this dimension. For example, introduce didactical design and ergonomics to the design of CASs, lacking a theoretical foundation of the given epistemic relevance, meaning making, process generation

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of and within design practices as such. For this reason, they are rather static, since being standardized both in 'step-by-step' approaches and in simplified transfer approaches.
Overall, regarding technical design in general and especially within industry 4.0 and of CASs, we observe the need to theorize design-activities as epistemic interventions into sense-making and attentional orders (Weber, 2014a). Therefore we argue to take into account an organizational education perspective, which supports ‘complexity-fit’ and points out an epistemic perspective on design transforms value creation in industry 4.0 (Göhlich et al., 2018).

4. Suggesting a high impact trans-epistemic design-(research) approach

We introduce our trans-epistemic design approach by theorizing CASs from an organizational education perspective (OEP). For this purpose we start with a small overview of the organizational education theory and how it sheds light on a deeper understanding of CASs, challenges of knowledge processing within industry 4.0 and the consequences for design(-research). A second part of the section illustrates the approach itself.

4.1. Organizational education theory and its relevance for CASs, industry 4.0 and design-(research)

Organizational education theory deals with the question of organizational learning in, of and between organizations (Göhlich et al., 2018). It focuses on knowledge orders within organizations, which are important for organizational strategies and practices. It also deals with the question of changing organizational routines and the learning of change actors. Regarding a poststructuralist perspective, the relationship between linguistic practice and social reality in an organization becomes the focus of research (Weber and Wieners, 2018). The key view here is that language and visual artefacts not only depict reality in organizations but also produces it through its distinctions. This means that the conditions under which sensemaking happens do become an issue for research (ibid.).

4.1.1. CASs are part of reinventing the organization for industry 4.0 value creation

A CAS, social practice with a CAS and its organizational context appear in OEP as a whole setting or as a 'zone of organizing of the digital' (Weber, 2019). This zone “*organizes knowledge flows, humans and socio-technical arrangements in a specific way*” (ibid.). Thus, rather than seeing a CAS simply as a digital tool or a man-machine-interface, we refer to an understanding of a CAS as organizing rationalities (Weber, 2015) and as a context for a digital organizational learning culture which underlies different goals and (normative) programmatics. In addition, the mental models of the employees of the organization (machine/ functional, brain/ holistic, etc.) are important for a successful organizational embedding of CASs. Mental models guide actions and therefore shape the handling of information in the digital world of CPS. For example, employees in the future vision of industry 4.0 should give high priority to the exchange of digital information themselves (this includes, among other things, seeking to understand different contexts of origin of information). Overall, it is clear, that CASs can contribute to ‘reinventing’ organizations in a holistic sense.

4.1.2. The design process as a temporal organization in a holistic view

The design process itself in an OEP perspective can be seen as a temporary or fluid organization (Weber, 2005) since it organizes a multi-stakeholder setting developing a common (design-) goal. This temporary organization carries a multiplicity of different knowledge sets and (sub-)institutional rationalities. It sheds light on learning processes, knowledge processes and the transformative character of the (cross-organizational) design setting itself (Weber, 2014a). Integrating multi-stakeholder groups into design strategies refers to many fields of organizational research (Weber, 2018a).
Based on an epistemic conceptualization of organizing temporal transitional spaces (Weber, 2005), innovation processes can’t be understood any more as linear, segmented and expert-based activities. They are imagined and designed as networked, systemic, simultaneous multistakeholder activity (ibid.). Design for innovation becomes a “*discursive, conflictual social practice by and in organisations and networks*” (Weber, 2018b). Here, methodologies and methods for the analysis of sensemaking as well as

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of transforming symbolical orders are an integral part of a theory-based and epistemologically oriented (design-)research (cf. ibid.).

The often hidden, unrevealed and underestimated complexity of technical devices like a CAS can be developed to its full potential, when imagining the digital revolution taking place in any technical device, transforming not only the shop floor of firms and organizations but transforming the rationality of organizing as such. This is why it does make sense to refer to concepts of strategical innovation and of strategizing and 'strategy as practice'-research (Weber, 2018b). These conceptualizations do see strategies not only as intentional, long term and broad range decision making based on markets and shareholder values but as practical activity, as underlying rationality, as a practice of strategizing, which carries its' specific attentional orders and the 'blind spots' accordingly.

Design research within industry 4.0, therefore, has to be regarded as an intervention into organizational culture and strategical development, as well as in power distribution and control. As we can see, the epistemological perspective on innovation and design-strategies supports a complex and multi-layered notion of design. It involves the practice of strategizing and innovation and makes use of different disciplinary streams and epistemic knowledge sets of design. They connect to organizational learning from a discursive design perspective (Weber, 2014b, Weber and Wieners 2018).

4.1.3. Educational complexity, meaning, and aesthetics in CAS design

Artefacts like a CAS in this perspective are subject to constructed categories and formability (Mareis 2016). As we already have described, the way employees use a CAS and the way they apply and transmit information, the way and quality of valuable knowledge creation depend on mental models, attitudes and sensemaking. Consequently, CAS design itself forms complex organizational narratives and produces both meaning and cultural codes (ibid.). By the way, information is handled with, the design process itself produces narratives about value creation. As the design setting always will be shaped and organized in multidisciplinary teams, the design setting, in general, carries the potential to experience the functioning of a network organization. In this sense, it can be transformative as such.

The organization understood as an educational process strongly connects to an aesthetical understanding of organizations (Weber, 2014a). Thinking organizing from the senses and the organizational practice allows us to take a closer look into the micro-practices bringing about the organization by daily routines, by a flow of activities and sensemaking. This in-depth understanding of organizing can't be grasped by functionalist and rationalist approaches. Asking for sensual perception, human consciousness and mind (Strati, 1999; Weber, 2019) allows us to deeper understand structures, systems, and processes around a CAS as an aesthetic performance (Mareis, 2016). Emotions, symbols, and subjective resources of consciousness not only are relevant dimensions but even may become an object of design themselves.

4.2. Design approach

The trans-epistemic approach aims to develop deep innovation through the design process of CASs. Knowledge processing here is designed in a funnel - involving the horizontal and vertical interconnection of relevant stakeholders for strategic organizational transformation. In this design approach, both design practitioners and design researchers are involved (Figure 1).

The input in **vertical knowledge processing** is a conglomeration of problems, ideas, and hopes that arise both within and between organizations. By a trans-epistemically arranged design practice, organizations may incorporate a CASs into its existing IT-infrastructure as well as develop and 'anchor' new patterns of knowledge production with the CAS into the lived daily practice of activities and routines. Beyond that, the trans-epistemic approach in a systematically and permanent way supports the reflection of current change and organizational practice of working with the CAS. Based on a visioning process, a future imagination of the best performing digitalized CAS in its organizational context is projected and designed (Weber, 2014b). This process of combined imagination and reflection supports transforming organizational practice in a step by step approach. Based on economic, social and organizational education knowledge sets, the trans-epistemic innovation strategy suggested here transforms into lived organizational practice. This happens both within the organization (using CASs in CPS environments) and within an organizational multi-

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stakeholder network (a collaboration between industry, academia, and politics as well as via data-driven interconnected business models).

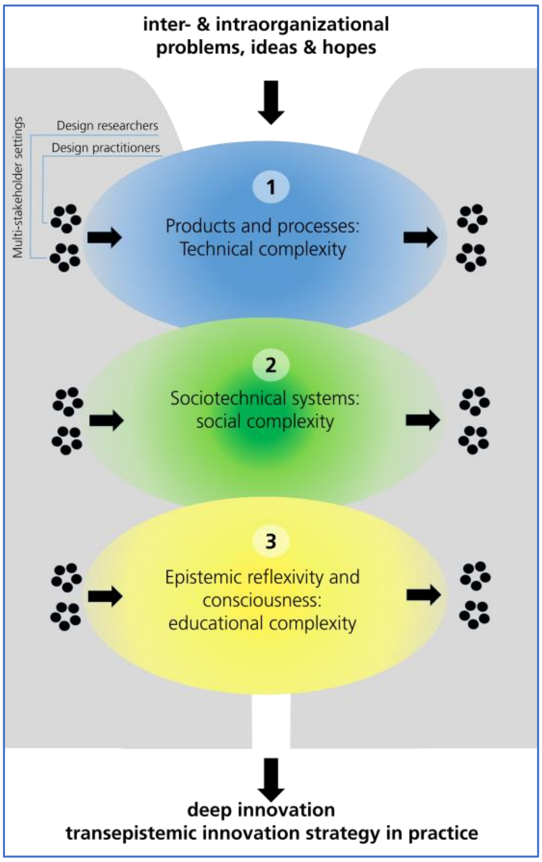

Figure 1. Vertical and horizontal knowledge flow in a trans-epistemic design approach[1]

In **horizontal knowledge processing**, the design process runs through all three levels of technical complexity, social complexity, and educational complexity. All levels are regarded and designed as epistemic terrains and provide specific modes of knowledge processing in design. They each address and use specific disciplinary knowledge sets, whereby increased imagination and reflection are sought for at any of the three levels. At all three levels of complexity, the multi-stakeholder community to be involved is part of this multidisciplinary design process. In our approach, research and practical development go hand in hand. Within this design research approach, the actors refer to the disciplinary knowledge of economic innovation and relate to products and processes. The second level addresses system development of the sociotechnical system to be created and the third level reaches out to consciousness and attitude of the (change-) actors involved.
As disciplinary rationalities differ from each other, they are organized as an interrelated process. Nevertheless, any of the dimensions of complexity will be relevant at any 'level' or step in the process. Social complexity must be taken into account when designing technical complexity. In an integral and multi-rationality approach, we suggest a three-step iterative design process, deepening the level of intervention in a funnel approach.

5. Conclusion: Epistemic reflexivity for industry 4.0

To summarize, the trans-epistemic design-approach is to be understood as a process of collective strategizing (Weber, 2018b) in a multidisciplinary approach. It systematically addresses the organizational dimension and deals with complexity in its material, social and epistemological aspects. Especially in CASs development and implementation, when striving at technical and social innovation,

[1] This way of graphical representation should reflect a holistic way of thinking.

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we need to take into account the 'deep' foundations to be discovered in organizational discourse which means in rationalities, organizations and their members live by. From an organizational education perspective, we need to design conditions for imaginary articulation, epistemic reflexivity, and process creation. As a process of design (research), the trans-epistemic design approach for and with CASs leads to deep organizational transformation. When connecting to technical, social and aesthetic dimensions, the multi-layered design approach takes into account different traditions, epistemologies and cultures of design (Mareis, 2016; Weber, 2014). As our analysis of current design approaches demonstrates, our trans-epistemic design-approach is innovative and new, as other approaches in the context of industry 4.0 and CAS do not systematically consider the role of epistemic reflexivity.

While design pedagogy, design cognition or design for learning are familiar disciplines, a design approach considering epistemic reflexivity promises important insights. An organizational education perspective seems to be suitable as a theoretical foundation, especially for dealing with information in a complex and digital world. Enhancing not only continuous and long-termed organizational reflection, but fostering organizational imagination contributes to a trans-epistemic innovation strategy. Future research will allow highlighting the application in detail, empirical potential, and outcome of the trans-epistemic design approach within CAS strategic implementation projects and for industry 4.0 in general.

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