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What is a Problem?

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1. Introduction

1.1. *Problems are popular:* In the wake of the discourse on interdisciplinarity (ID) the notion of "problem" plays a key role (cf. Frodeman *et al.* 2010).

- Julie Thompson Klein *et al.* (2001) characterize ID as "joint problem solving among science, technology, and society".
- Jürgen Mittelstraß stresses, „by 'transdisciplinarity' we describe types of research and sciences that transcend disciplinary orientation in a problem-oriented manner." (Mittelstraß 1998, 1)
- Gotthard Bechmann situates „*problem*-oriented research in between public policy and science"; he draws the attention in particular to Technology Assessment (Bechmann/Frederichs 1996).

1.2. Problems with the "problem": However, referring to the buzz word "problems" is not very specific. Problems can also be found in disciplinary sciences as well as in the life world. Karl Popper stresses that "we study not disciplinary objects, but problems. Often, problems transcend the boundaries of a particular academic discipline." (Popper 2000, 97) Thus, there does not seem to be *differentia specifica* between ID and disciplinarity, or between interdisciplinary (id) and life-world action.

1.3. The objective of this paper is foster and facilitate the theory-discourse on ID, in particular a conceptual foundation of problem-oriented ID. My aim is to contribute to a clarification of both "problem" and "ID".

2. What Problem-Oriented ID is *not* …

2.1. Let us start *ex negativo,* with some demarcations. In order to clarify what problems and problem-oriented ID is, I will draw a line between problem-oriented ID and other types. What types of ID can hardly be considered as "problem-oriented"?

2.2. Object-Oriented ID: When we speak about „problem-oriented ID" we do not mean object-oriented ID. Indeed, "ID" may refer to objects or entities ("ontological" type). The historically established functional differentiation into disciplines does not seem to be totally contingent. Rather, it mirrors aspects of the structure of reality itself. Edmund Husserl, Nicolai Hartmann, Alfred North Whitehead, and others argued for a structurally layered concept of reality. Boundaries between micro-, meso-, and macrocosm seem to be evident. Interdisciplinary objects are thought to be located or constructed within the structure of reality. They lie *on* the boundaries between different micro-, meso-, macro-, and other cosm or *within* border zones between disciplines; for example: brain-mind objects, nano objects, or the hole in the ozone layer.

2.3. Theory-Oriented ID: In addition, when we consider "problem-oriented ID" we do not mainly focus on knowledge, theories, and concepts (epistemological type of ID). Here, it is asked whether id theories exist and how they may be specified and identified. Can we demarcate id knowledge from disciplinary knowledge and from non-scientific knowledge? Is there a unique context of justification of id theories? Do id models, laws, explications, descriptions, and explanations exist? Possible candidates for theories are meta-theories which can be applied to describe very different disciplinary objects. An epistemological non-reductionism with regard to disciplinary theories is the most compelling position. "Structural sciences" such as complex systems theory are prominent examples. Similar to complex systems theory are theories such as self-organization theory, dissipative structures, synergetics, chaos theory, nonlinear dynamics, and fractal geometry.

2.4. Method-Oriented ID: Further, we do not intend to consider ID methods if when talking about problem-oriented ID. Indeed, a *methodological type* of ID might exist. Methodology refers to knowledge production, to the research process, to the rule-based action of scientists, and to the languages in use. The central issue of methodology is *how,* and by the application of *which rules,* can and should we obtain knowledge? Id methodologies are thought to be not reducible to a disciplinary methodology. Biomimicry (biomimetics, bionics) is an excellent example for an id method.

3. What Problem-Oriented ID is …

3.1. Incommensurability thesis: It is striking to see that the above elaborated three types do not cover the breadth of "ID" that is present throughout the recent discourse. We

have to add another type that does justice to the discourse. It is frequently stressed that the world has problems, the science system has departments. Indeed, the world's problems on the one hand and the science system, in particular the university system, on the other hand seem to be incommensurable. The *incommensurability thesis* is the point of departure of those who advocate problem-oriented ID. Referring to the incommensurability, it is widely spread position that "problem-oriented research has to be interdisciplinary or transdisciplinary" (Bechmann/Frederichs 1996, 17). Similar conclusions are drawn by those who refer to "wicked problems" (Norton 2005).

3.2 Problems as starting points: Problem-oriented ID is focuses on starting points. It reflects and revises goals and purposes—in other words, the problem constitution, identification and framing. Problem seeing and agenda setting, the volition or intention to obtain a certain knowledge, precedes both the context of discovery and the context of justification, i.e., the methods and theories. The first step in scientific inquiry is often judged to be an external contingent factor. It has been widely ignored or devaluated by philosophers of science. The lack of consideration of problems turns out to be a deficit in specifying this fourth type of ID. The reflection on and revision of starting points can be regarded as one central criterion for demarcating ID from disciplinarity (Jantsch 1970).

3.3 Pressing societal issues: ID problems are somewhat external to disciplines or to sciences: Such problems are primarily societal ones which are mainly due to *and* defined by society, lay people, politicians, and stakeholders. These problems demand a solution for the societal prospect. ID has a functional side in the future development of scientific-technological civilization. Problem-oriented ID starts with life-world problems or with the anticipation of possible problems in the future. In order to counteract the emergence of problems, advocates of problem-oriented ID aim to develop a "problem radar": problem-oriented ID aims to anticipate problems before they appear.

3.4. Note on the history: Problem-oriented ID is not as novel as it seems; it has its own history. In an epochal breaking approach Alvin Weinberg (1972) was the first to suggest the term "problem" in the context of research for society. Weinberg speaks about „Big Problems", e.g., pressing issues of national security, of the future of the social welfare system, and of the environment. His diagnosis was: the science system does not provide any contribution to cope with societal pressing issues. In order to overcome the deficits Weinberg developed the concept of "trans-science". In line with this approach but a bit earlier, Erich Jantsch (1972) argues in favor of a "purposive understanding of ID" and a "purpose-oriented ID": An explicit reflection and revision of purposes should be regarded as the highest level of ID. This comes close to today's science-based enterprises such as Technology Assessment, sustainability- and global chance sciences. Jürgen Habermas (1970) draws attention to the interests of the sciences and to the purposes interlaced with research processes; in line with this is the concept of discourse ethics. Problems turn out not to be as *ir*rational or *a*rational as it seems.

3.5. Neglect by Philosophers: Unfortunately, these efforts did not have a broader influence on the understanding of sciences. The neglect of problems seems to be rooted in the self-mythologization of scientists and philosophers of science. According to Ludwig Wittgenstein, "the success of the experimental method contributes to the odd belief that we have the means to cope with all of the problems that worry us." This is a misperception insofar as "problems and methods do not match." (Wittgenstein 1999, xiv) The neglect of the notion of problems can be regarded as a consequence of the implicit predominance of the analytical philosophy of science. Analytical philosophers of science have always been reluctant to consider normative aspects; they still parade the value-free view of natural sciences. However accompanied by the notion of problem, normativity is around. Framing knowledge production from the angle of "problem" may contribute to the critique of the self-stylization of science as a value-free enterprise. Therefore, the notion of problem is a reflexive term.

3.6. Implicit presence in the works of Philosophers: Although philosophers have been hardly addressed the notion of problem, the word is present in the works of many prominent philosophers. Karl Popper stresses that "good hypothesis have to include risky problems", Thomas S. Kuhn believes that a „paradigm determines the choice of problems", Imre Lakatos coins that notion of „progressive vs. degenerating problem shift", and Larry Laudan regards "sciences as a problem-solving action". Kuhn, e.g., presents a thought-provoking idea that come close to the recent discourse on problem-oriented ID. He sees a professional blindness and ignorance of scientists: "A paradigm can isolate the scientific community from societal relevant problems that resist being reducible to the form of puzzles insofar as these problems cannot be expressed in the terminolog-

ical and instrumental equipment of the paradigm." (Kuhn 1996, 51)

3.7. Problems versus puzzles and solutions: Thomas Kuhn reminds us: „The societal pressing problems are certainly no puzzles, e.g., therapy against cancer or concepts for permanent peace." (ibid.) Problems are not to be considered puzzles, also, because they do not have clear solutions in a way as scientific puzzles are assumed to have. Problem-oriented ID does not offer solutions in a way engineering sciences accomplish to come up with a new artifact that solves a technical problem. Rather, within problem-oriented ID much is achieved, when the problem is constituted, framed and clarified—in other words: when rational arguments presented that underline that a certain situation is a problem: decision-support, not the decision itself. For any kind of solution, the science system itself is not legitimized. Otherwise democratic societies would turn to expertocracies.

4. Formal Clarification: Problems

4.1. Incompatibility thesis: How do we know that X is a problem? Gereon Wolters defines a problem as the "incompatibility of some propositions (the 'problems') with the set of those propositions that are considered as true or evident." (Wolters 2004, 347) To put it in other words: A problem is what does not fit to the general body of accepted knowledge; thus, the notion of problem is a relational.

4.2. Philosophy of Action & Action Theory: Problems call for action. The notion cannot be limited to propositions and cognitive aspects that are traditionally addressed by philosophers of science. Therefore, philosophy of action (action theory) has to complement the philosophy of science. An integrative approach has been developed by Dietrich Dörner and by Roland W. Scholz.

According to Dörner, who does not refer explicitly to "ID", a "problem" is a relation that includes:

1. undesired (initial) state of the current situation,
2. desired (target) state of how the future should look like, and
3. a barrier, obstacle or border that hinders or blocks the transformation of the present-day's undesired to the desired state (Dörner 1979).

Similarly, Roland Scholz argues that when speaking about a "problem" we mean

- a difference or divergence between (a) a *target-knowledge* that refers the desired state of the future ("target state") and (b) a *system-knowledge* that reflects the current state ("actual situation"), and
- a non-existence of an appropriate *transformation-knowledge* that enables to action to transfer the actual situation to the target state (Scholz 2011).

Thus, the notion of problem encompasses normative and descriptive elements.

4.3. Widening the horizon to the future: In addition, a temporal dimension should be considered. Now, generally speaking problem-oriented ID contributes to the perception and framing of a situation as a "problem". The buzz word "situation" can refer to

- an *actual* state or,

as an extension of Dörner's and Scholz's approach, to

- an anticipated *future* state.

A certain future state can be largely undesired—a dystopia—, whereas the actual state can be the one we would like to keep, e.g., regarding global change effects. In this case the problem has not yet emerged to it's full extend but might or will emerge prospectively in the future. Well known is the (anticipatory) precautionary principles: problems should be hindered to emerge, e.g. by a "problem radar". Thus, problem-oriented ID is inherently future oriented.

5. Methodological Clarification: Boundary Transfer

5.1. Boundary assumption and the intern-extern-dichotomy thesis: A demarcation is considered to exist between sciences and society (*intern-extern*-dichotomy thesis). Insofar as problem-oriented ID aims to transgress the border it has to assume the border's existence first: the border is a necessary condition to talk about problem-oriented ID. Problem-oriented ID transgresses this border in two directions. It picks up (science-) *external* societal problems, works on them (science-) *internal* and transfers the results to societal domain in order to contribute to (science-) *external* societal problem-solving. This thesis is not novel. In the 1970s, it was broadly present in the so called *finalization thesis* advocated by Wolfgang van den Daele, Wolf Krohn and Gernot Böhme (1978). Similar dichotomies can be found in concepts such as post-normal, post-academic, mode-II- or techno-sciences.

5.2. Transgressing and translation across the border: Therefore, certain kinds of problems are not meant when talking about problem-oriented ID: (i) science internal disciplinary problems, (ii) problems referring to objects that spread across many academic disciplines or, (iii) engineering or technical problems. For these kinds of problems the

science-society border is irrelevant. Conversely, the border assumption is indispensable for the notion of problem-oriented ID. It can be regarded as a transfer, translation or circulation science—from the external to the internal and, then, from the internal to the external.

5.3. Translation methodology: The transfer and translation of problems across the society-science border turns out to be the central point in the methodology of ID. Until now, criteria for a successful transfer and translation from one domain to another have not been developed: What happens on the way from (a) societal problem-perception, (b) science-external problem constitution, (c) scientific problem definition, (d) discipline-oriented problem division, and (e) to the synthetic procedures of re-translation to the science-external, societal realm? This way is not, indeed, a mono-causal process rather than an iterative one. Egon Becker und Thomas Jahn speak about „problem dynamics" in order to describe the transfer between science and society. According to Christian Pohl and Gertrude Hirsch Hadorn "the core element of transdisciplinary research is how problems are being identified, framed and structured within a broad area under consideration." (Pohl/ Hirsch Hadorn 2006, 40)

6. Epistemological Clarification: Beyond constructivism and realism

6.1. Two contrary positions: In addition to formal and methodological aspects of "problems", their epistemological status is not clear at all. Two contrary positions are common. According to a *realist* position, problems are presupposed to exist in the ontological depth of the entire world, regardless of human perception and knowledge; in difference to this position, *constructivists* assume that problems are constituted or constructed by humans. Throughout the 1980s, this *realist-constructivist-gap* in epistemology was very present in the discourse on risks: Ulrich Beck's risk-*realism* versus Niklas Luhmann's risk-*constructivism*.

6.2. Beyond dichotomies: These traditional dichotomies are not fruitful at all. Rather we should consider that (a) something does really exist and that this real object is the source of the "problem". The hole in the ozone layer is not a social or cognitive construction; the undesirable state really does exist or will exist in near future. A *minimal realism* seems to be the best fundament to acknowledge the matter of facts. (b) However, the reference or relation to something that really exists is a necessary, but not sufficient condition to characterize something as a "problem". Nuclear power plants including the nuclear waste or the hole in the ozone layers alone do not seem to be a "problem".

6.3. Three kinds of constructions: Different kinds of (realist's) constructions, including normative based decisions, are indispensable to frame an object, a state or a situation as a problem—and to obtain knowledge: (i) The *system construction* encompasses the demarcation decision about what the system is and what is its environment ("systems knowledge"). E.g., should we consider the proliferation of nuclear fuel and waste as a part of the system "nuclear power plant", or not? (ii) The *target construction* refers to the desired future state interlaced with the goal setting procedures ("target knowledge"). (iii) The transformation *barrier* (re-) *construction* means to frame and analyze to barriers and obstacles that hinder us to reach the desired future state. – Normativity is present within all types of constructions and reconstruction. This is part of the position of methodological constructivism and of pragmatism.

6.4. Against naïve realism and the priority of action: Therefore, in a certain sense, constructivism and realism converge in problem-oriented ID—this is an epistemological position I call tentatively *real-constructivism;* it is linked to pragmatism. Based on real situations and matter of facts, problems are constituted along normative criteria. John Dewey underlines: "Only by means of a certain [knowledge-] action a situation under consideration turns into a problem." (Dewey 2001, 223) A naïve problem-realism simply would presuppose problems as merely given without reflecting the source and background that make these problems to emerge. For instance, a naïve problem-realism is present throughout some US-engineering ethics textbooks for higher education (e.g., c.f. Harris et al. 2005). Problems are often presented accompanied by a pressure to solve them; the problem itself is not reflected as well as the question whether this problem is the appropriate one that needs to be solved. In an extreme case the problem to be solved is whether to prefer the electro-execution or the injection-execution. Fundamental questions about death penalty and execution conducted by a democratic state are not posed. Problem-oriented ID rejects this kind of naïve problem-realism. A central issue is in every ID project is: *What is the problem?* The problem constitution and construction requires a rational justification based on reflection and revision of normative relevance criteria that guide this discourse. Intersubjective agreement on what is the problem is the central part as well as

the entry point for any project that is called “problem-oriented ID”.

7. Prospects

The objective of this paper was to elaborate on the vague notion of problem in order to give some substance to a specific type of ID—namely to problem-oriented ID. Indeed, we have problems with the problems. By the approach presented here some elements *for* a foundation of the notion of problems may have been proposed. An interdisciplinary open philosophy is called for that addresses “problem” and the problems with the problems in more depth.