## Interdisciplinarity in philosophy of science

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# Interdisciplinarity in Philosophy of Science

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Abstract

This paper examines various ways in which philosophy of science can be interdisciplinary. It aims to provide a map of relations between philosophy and sciences, some of which are interdisciplinary. Such a map should also inform discussions concerning the question "How much philosophy is there in the philosophy of science?" In Part 1, we distinguish between synoptic and collaborative interdisciplinarity. With respect to the latter, we furthermore distinguish between two kinds of reflective forms of collaborative interdisciplinarity. We also briefly explicate how complexity triggers interdisciplinarity. In Part 2, we apply the distinctions of Part 1 to philosophy of science and analyze in which sense different styles of philosophy of science are interdisciplinary. The styles that we discuss are a synoptic-general, a reflective-general, a reflective-particular, a particular-embedded and a descriptive or normative style.

## 1. Introduction: How to think about interdisciplinarity

### 1.1. Boden's two types of interdisciplinarity

In order to address interdisciplinarity with respect to philosophy of science, it is helpful to first introduce what interdisciplinarity is in general and what kinds there are. Interdisciplinarity, most generally speaking, involves "contributing to, or benefiting from, two or more disciplines" (OED). In the following, we will employ a classification provided by Margaret Boden in order to specify different forms of interdisciplinarity. A situation where research contributes to two or more disciplines can be described as *synoptic interdisciplinarity,* as "an enterprise in which a single theoretical perspective is applied to a wide range of previously distinct disciplines" (Boden 1999, 19).[2] Cybernetics or evolutionary theory would be examples of such synoptic interdisciplinarity. They incorporate a synoptic, theoretical approach that is applied to many *different* problems and thus contributes to the disciplines that deal with those problems.

More often, however, the term "interdisciplinarity" refers to situations where knowledge (or methods of knowledge generation) from various disciplines is applied in a collaborative manner to one *common* problem, goal or object of inquiry. Common goals are derived from, for instance, major societal issues, such as energy policy, or from attempts to establish large technological infrastructures, such as space flight. Depending on the degree of collaboration exhibited with respect to the common problem, three subtypes of *collaborative interdisciplinarity* can be distinguished: shared, cooperative and integrated interdisciplinarity (Boden 1999). Shared interdisciplinarity does not involve day-to-day cooperation, though results of different disciplines do still complement each other. Actual teamwork occurs rather in an environment of cooperative interdisciplinarity. The upper end of what should best be thought of as a continuum of collaborative engagement can be called integrated interdisciplinarity. In these cases there is an actual influence of the disciplines on each other. Boden gives a number of examples for this most intense form of collaborative interdisciplinarity, ranging from literary criticism to cognitive science. It is from this kind of interaction that new hybrid disciplines can arise (see Klein 2010, 21).

1 Authors appear in alphabetic order.
2 Boden uses "*generalizing interdisciplinarity*," but because of distinctions regarding "general philosophy" made in Section 3, we opt for an alternative terminology here.

### 1.2. Reflective interdisciplinarity

There exist two further possible relations between disciplines that can be interdisciplinary and that we would therefore like to add to this classification. Both of them are *special kinds* of collaborative interdisciplinarity, and both pertain to disciplines that bear a reflective relation, which is why we call them *reflective interdisciplinarity*.[3] A relation between disciplines is reflective if one of the disciplines is the subject matter of the other discipline. This relation is particularly pertinent to philosophy of science, since the sciences are the subject matter of philosophy of science, although it by no means exhausts the relations between philosophy of science and the sciences (we elaborate on this in Part 2). Although the reflective relation constitutes a relation *between* philosophy and sciences, it is an *asymmetric* relation, since there is usually no reflection of the studied sciences on philosophy in return. We think that despite this asymmetry, reflective investigations can nonetheless be interdisciplinary in two ways.

First, philosophy of science can maintain interdisciplinary relations to *other reflective disciplines* having the same subject matter (e.g., sociology or history of science). We refer to this kind of interdisciplinarity as *reflective-level interdisciplinarity*. Philosophy of science can, second, interact *with respect to reflective problems* and in collaborative ways with the disciplines that are their subject matter. Thus, when the reflective questions (for examples see Section 2.2) become an issue in the sciences themselves, then it is a case of *interdisciplinarity with respect to reflective problems*.

Both types of interdisciplinarity are special kinds of collaborative interdisciplinarity, since there is a common problem, goal or object of inquiry that researchers from both disciplines investigate (i.e., either philosophy and another reflective science, or philosophy and the science it reflects).

It must be emphasized, however, that reflective philosophy of science need not be interdisciplinary in any of these two ways. Even if there is no common problem (either in the synoptic or the collaborative sense), reflective philosophy of science can interact with the sciences it studies in intense and fruitful ways (e.g., by sharing information or by cooperating), without there being an interdisciplinary relation between them. We elaborate on this in Section 2.2.

Figure 1 illustrates the different kinds of interdisciplinarity (and non-interdisciplinarity) that we distinguish.

Fig. 1: Different kinds of interdisciplinarity

On the basis of these distinctions between different types of interdisciplinarity, we will discuss in Part 2 the ways in which different styles of philosophy of science can be interdisciplinary. But before that we will turn to complexity as one of the main drivers of interdisciplinary research.

### 1.3. Complexity as driving interdisciplinary research

Interdisciplinarity is often linked to complexity. Klein and Newell (1997, 393), for instance, write: "*Interdisciplinary studies* may be defined as a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession." In particular, research-related institutions often define their engagement in interdisciplinary science in these terms. For instance, Bielefeld University writes in its mission statement: "Since its foundation the University has been guided by the paradigm of interdisciplinarity, as today's complex problems can no longer be adequately tackled through mono-disciplinary approaches alone."[4] A report by the US National Academy of Sciences "Committee on Facilitating

[3] Note that the way we understand this notion differs from the various ways that other authors have used the term "reflexive interdisciplinarity." Weingart (1996) seems to use the term to refer to processes of monitoring interdisciplinary work from within, while Blanchard (2012) takes it to refer to the way in which scientists working in interdisciplinary fields such as research on climate change and biodiversity reflect on their role in society at large.

[4] See: http://www.uni-bielefeld.de/Universitaet/Ueberblick/Ueber_uns/, last access May 15, 2014.

Interdisciplinary Research" concludes: "Perhaps the most common driver of interdisciplinarity toward the emergence of new disciplines is the sheer complexity of nature, which draws researchers toward the next important question, moving toward interfaces with other disciplines and partnerships with colleagues in them" (2004, 253). There are competing definitions and probably different kinds of complexity with respect to "the complexity of nature", or what might be called ontic complexity. Sandra Mitchell (2009, 21), for instance, distinguishes multilevel organization, multicomponent causal interactions, plasticity in relation to context variation, and evolved contingency. However, for our purposes, it is sufficient to rely on the pragmatic intuition that all these forms of complexity relate to multiplicities that cannot be analyzed from only one perspective.

While in the natural sciences, complex problems are often states of affairs, such as climate change, complexity in the humanities takes a different form. Due to various actors making use of key terms in society (e.g., "utopia"), and the diverse contexts and roles of such terms, the latter often exhibit considerable ambiguity and ambivalence (Voßkamp 1987, 93). This might be called semantic complexity and is indicated by the fact that many disciplines (such as literary studies, philology, art history and philosophy) address such key notions simultaneously. An interdisciplinary exchange between these disciplines can further the understanding of differences in meaning with regard to the respective cultural history and contemporary relevance of the terms. Since many key terms of science, such as "climate," not only refer to complex state of affairs but are also ambiguous, due to their history and their use in different arenas of society, there is a strong relation between ontic and semantic complexity. Here we find one possible motivation for an interdisciplinary exchange between science and the humanities. Finally, the structure of science itself (as a sociocultural activity) is complex. Consequently, for disciplines studying science at a reflective level science itself is a complex phenomenon.

## 2. Interdisciplinarity and the various styles of philosophy of science

On the basis of the analytic distinctions regarding kinds of interdisciplinarity and of complexity made in Part 1, we can now specify in detail the interdisciplinary character of different styles of philosophy of science. To do so, we examine how the three different interdisciplinary relations (synoptic, collaborative and reflective) relate to other distinctions commonly drawn between different styles of philosophy of science – for instance, between *general philosophy of science* and *philosophies of particular sciences* (e.g., philosophy of physics, philosophy of biology, philosophy of social sciences, etc.), and between *normative* and *descriptive philosophy of science*. General philosophy of science comes in two kinds: a synoptic variant and a reflective one (see Sections 2.1 and 2.2). Philosophy of the particular sciences can be reflective or *embedded*. If the philosophies of the particular sciences engage in problems that are generated by the agenda of the sciences in question (rather than by philosophy), then we call this style embedded (see Section 2.3). Since the reflective as well as the embedded style can be normative, we address the normative style in Section 2.4.

Evidently, many activities in philosophy of science may not fall neatly into one of the categories, and some philosophical inquiries concerning sciences – whether they come under the label "philosophy of science" or not – may not be captured at all. However, our intention here is to provide a map of possible relations between philosophy and the sciences. This map will not only help to distinguish and locate certain philosophical research agendas but also contribute to metaphilosophical issues regarding the question "How much philosophy is there in the philosophy of science?" One question that guides our analysis is, for instance: "Is philosophy of science only interdisciplinary if there is more science (how much?) and less philosophy in it?" We will come back to this question in the conclusion. Finally, our map provides a basis for discussions about the institutional implementation of interdisciplinarity and the individual planning of careers in interdisciplinary fields. Since these considerations are more practical and political, they will be published elsewhere (see Kaiser, Kronfeldner, Meunier, forthc.).

## 2.1 Synoptic philosophy of science

When general philosophy of science takes on a *synoptic* style, it brings together the knowledge developed in different disciplines. An example is the Darwinian theory of the evolution of biological species that philosophers (together with scientists) have developed into a generalized, if not universal, theory of evolution, as applied to the immune system, cultural traditions, science etc. (see Kronfeldner 2010 on this example). Synoptic philosophy of science can even function as incubator for the scientific fields synthesized, as illustrated by Godfrey-Smith for the history of associationism.[5]

The relationship to the scientific disciplines in synoptic philosophy of science is different from that in reflective philosophy of science. Synoptic philosophy brings together knowledge from diverse disciplines and thereby also contributes to each of these disciplines; however, it *addresses the problems of the respective sciences*, rather than developing a specific reflective philosophical problem, e.g., concerning the nature of science in general. Instead of starting with its own philosophical problem, it takes (or shows that there is) a theoretical problem or approach common to the different disciplines (e.g., evolutionary principles), thereby synthesizing knowledge from the different disciplines and drawing the broadest possible generalizations concerning that problem or approach.

In the following section we look more closely at the reflective forms of general philosophy of science.

## 2.2 Reflective philosophy of science

Reflective philosophy of science (by contrast to synoptic philosophy of science) addresses genuine philosophical problems. These problems can pertain to science in general or to particular sciences. Accordingly, we can distinguish between reflective *general* philosophy of science and reflective philosophies of the *particular* sciences. Typical questions that are addressed in reflective *general* philosophy of science are: What makes an inquiry scientific and distinguishes it from non-science or pseudoscience? How do scientific theories and models relate to observations and in what sense do they represent the world? How can we specify general concepts like causation? What is the role of values in science? What governs scientific change and what form does it take? What is the nature of scientific explanation? Questions like these typically express genuine philosophical problems about science, which is why they lead to reflective philosophical investigations. By contrast, reflective philosophies of the particular sciences address questions particular to the respective sciences they focus on, or they address the general questions with a rather exclusive and specific focus on the situation in the particular sciences they reflect upon. In general, reflective philosophy of science is concerned with questions that, despite being generated by the particular sciences, are typically not on the agenda of these sciences, since that would require a reflective stance, which cannot be the standard operating stance in which scientists produce results in accord with established approaches. Sometimes, however, scientists will take a reflective stance. This is particularly likely to happen in cases where sciences are in phases of crisis and philosophical assumptions become destabilized.

At first glance, reflective philosophy of science (general or of particular sciences) seems not to be interdisciplinary in either the synoptic or collaborative sense. Philosophy reflects on science, but philosophers and scientists need not work together to solve a common problem (to pursue a common goal or to study the same object). Nonetheless, as mentioned above, reflective philosophy of science *can be* interdisciplinary, namely in two different ways: it can be collaborative-interdisciplinary *on the level* of reflective sciences or it can be collaborative-interdisciplinary *with respect* to reflective (e.g., philosophical) problems.

First, there is interdisciplinarity of the collaborative sort *between reflective disciplines* (e.g., philosophy, sociology or history of science). As mentioned above, not only the phenomena and problems that scientists study are complex, but also science itself: scientific activities have conceptual, material, social, ethical and historical dimensions. To study all aspects in their relation to each other thus requires the interaction of more than one reflective discipline: philosophy of science is

[5] Talk at the first conference of the German Society for Philosophy of Science (*Gesellschaft für Wissenschaftsphilosophie*) in Hanover, 2013, Germany.

more focused on the conceptual dimension, anthropology and sociology of science more on the material and social dimensions, ethics on the moral dimension, and history of science on the historical dimension. It is the complexity of scientific practice – a semantic as well as ontic complexity – that drives reflective philosophy of science to be interdisciplinary *at the level of reflective disciplines*. Philosophy of science might even collaborate with fields from the natural sciences that contribute to an understanding of the process of science, e.g. when cognitive sciences study scientific reasoning, when developmental psychology studies how children experiment, or when evolutionary biology provides evolutionary models of scientific change. In other words, because of the interdisciplinary relations *between* reflective philosophy of science and other reflective disciplines that study the same object (e.g., a certain scientific activity such as scientific reasoning, experimenting, etc.), reflective philosophy of science can be interdisciplinary in the collaborative sense. Interdisciplinarity here occurs at a higher level, at the reflective level, which is why we refer to this subtype of collaborative interdisciplinarity as *reflective-level interdisciplinarity*.

Second, reflective philosophy of science can also be collaborative-interdisciplinary between philosophy of science and the science that is its *subject matter*. As mentioned above, scientists themselves do not raise reflective questions as a rule, especially if these questions are general. Yet, there are such cases where scientists themselves "move up" to the reflective level, creating the space for a common problem that marks interdisciplinarity of the collaborative sort. Such *interdisciplinarity* occurs *with respect to reflective problems* (rather than *at the level of* reflective disciplines). One example is the reflection of medical scientists about causal inferences particular to specific fields, e.g., epidemiology, where the move from correlation to causation faces particular issues and where particular explanatory values are used to make causal inferences (e.g., Hill 1965). In addressing a reflective issue, scientists here create an opportunity for interaction that amounts to a collaborative relation between disciplines and can result in interdisciplinarity if philosophers of causation and medical scientists tackle different aspects of the *same* reflective problem with complementary skills. Even if overall progress might not always be monitored in such cases, results are accumulated collaboratively in the sense that citation across disciplines takes place. In such a case, the role of philosophers might even be to generalize the insights or problem of that particular science and apply them in a reflective manner to other fields, which thereby blurs the boundary between general and particular philosophy of science. However, in most cases, a reflective problem that becomes shared will be addressed at the level of the particular sciences. Our claim that philosophy of science can be interdisciplinary with respect to reflective questions thus mainly holds for philosophies of the particular sciences.

Finally, as mentioned above, there certainly are philosophies of the particular sciences that are reflective but *not* interdisciplinary in one of the ways that we have just outlined. It is important to note that this need not mean that in such cases *no* fruitful interaction takes place between philosophy and the particular sciences studied. Even if the problems are reflective and there is no move "upward" from the scientists toward a common reflective problem, there can still be intense interactions between philosophers and scientists that may also have an influence on the work of the scientist and may eventually lead to a reflection of the scientists upon philosophical questions. But as long as the latter is not the case, these types of interaction are not interdisciplinary in the above-defined sense, because there is no common problem that the philosopher and the scientist share.

The main reason on the side of philosophers for engaging in such non-interdisciplinary interaction is that it is now commonly required that philosophical theories about a particular science be descriptively adequate (we elaborate on this in Section 2.4). In other words, they must account for how science *actually* works and why it is successful. This requires that philosophers working in a reflective style must acquire detailed knowledge *about* the sciences they study (e.g., how explanations are developed, which methods are used, which experiments are conducted, how the empirical results are interpreted, etc.) as well as theoretical knowledge *from* the sciences.

For instance, a philosopher of science who develops a philosophical theory about the characteristics of topological explanations in ecology and their differences to mechanistic explanations (e.g., Huneman 2010) must acquire a great deal of very specific ecological knowledge. Besides his or her interest in the concepts of topological and mechanistic explanation (an issue often not explicitly addressed by ecologists, since it is a reflective issue *about* ecology), the philosopher might also address *some* of the same questions that working ecologists address (e.g., how a specific ecological phenomenon can be adequately explained) and thereby directly deal with issues or knowledge stemming *from* ecology. The latter part of the project is then interactive, but not reflective and not interdisciplinary. It all depends on the goal or problem addressed. Even if such interaction might be intense, symmetric and fruitful, the relation between the two disciplines does *not* count as interdisciplinary (given the terminological choices introduced above) as long as philosophers and scientists address *different* problems (e.g., the philosopher aims at clarifying the concept of a topological explanation, whereas the ecologist seeks to explain particular ecological phenomena). Despite the reflective orientation of such a project, the project can still be fruitful. If the results of the philosophical analysis are reported back to the scientists and if they take these results to be relevant, then such a project may even change the standards of explanation operative in a given discipline – in this example, ecology.

Some projects in philosophy of science – those that are *mainly* or even *completely* non-reflective – rely even more on knowledge from their respective disciplines. We call such a style "embedded philosophy of science" and elaborate on its interdisciplinary character in Section 2.3.

To conclude: reflective philosophy of science can be collaborative-interdisciplinary *at the level of reflective disciplines* or *with respect to reflective problems*. Actual interaction between philosophers and scientists can (but need not) be connected to a style of philosophy of science that is reflective. If philosophy of science is not reflective and oriented toward particular sciences, we call it embedded philosophy of science. If it is not reflective and general, we call it synoptic general philosophy of science. Synoptic philosophy of science has already been addressed above. The following section deals with embedded philosophies of particular sciences.

### 2.3 Embedded philosophies of particular sciences

If philosophies of particular sciences address methodological or conceptual issues in the particular sciences (for instance, the method of genetic analysis or the concepts of function or species in biology, or the concepts of space and time in physics), then they engage in the investigation of complex problems posed by the subject matter of the particular sciences and are *embedded* in that sense.

These problems can be complex in at least three different ways. First, they can exhibit ontic complexity – for instance, along the lines of Mitchell's kinds of complexity (see Section 1.3). Second, scientific problems typically involve an intricate relation of the dimensions mentioned in Section 2.2 (conceptual, material, social etc.). Third, such problems can be subject to various interests by different parts of society, which may introduce the kind of ambiguity of central terms that we addressed as semantic complexity before. For these reasons, the problems of the particular sciences provide opportunities for the fruitful application of philosophical approaches. These are mainly, though certainly not exclusively, conceptual analysis and the articulation of methodological rules adequate to the specific tasks of the particular science.

If philosophers deal with the problems of the particular sciences, i.e., problems as they are posed within the sciences, they nonetheless focus also on the conceptual implications or the methodological aspects of these problems. Therefore, even though embedded philosophy is not reflective, it is still different from the respective science.

This type of philosophy typically involves more, or at least more specific, scientific knowledge than general philosophy of science, and even more than reflective philosophy of the particular sciences. In this respect, embedded philosophers of the particular sciences can benefit from methods such as participant observation, but often they also hold a degree in the science in question. Some graduate programs in the philosophy of science even require students to at least minor in one of the sciences.

For an example where philosophers truly share, in a nonreflective manner, a problem with theoretically minded scientists and converge on a solution (even if the arguments stem from the different disciplines, i.e., philosophy and biology), consider a biologist's (Ghiselin 1974) and a philosopher's (Hull 1976) suggestions to treat species as individuals. Biologists might even use genuinely philosophical arguments – for instance, when Pigliucci (2003) applies Wittgenstein's family resemblance concept to the species problem, or when etiological and causal role theories of function are used in the ENCODE project (Graur et al. 2013). Sometimes, philosophers and biologists even work together on a problem – for instance, Sober and Lewontin (1982) in their work on units of selection. Depending on the degree of actual cooperation (e.g., whether the disciplines deal with different aspects of a problem or whether the insights of one discipline directly contribute to the other), such cases can be subclassified as shared, cooperative or integrated interdisciplinarity. Finally, if philosophers find a home in theoretically oriented biology departments, or if biologists work in specialized centers for philosophy of biology, seeds for hybrid disciplines or at least interdisciplinary personas are sown.

Figure 2 depicts how the above distinction regarding styles of philosophy of science relates to the distinctions of interdisciplinarity from Section 1.

Fig. 2: General and particular style superimposed on kinds of interdisciplinarity

### 2.4 Normative philosophy of science

Finally, we want to address another distinction commonly made with respect to styles of philosophy of science, namely that between normative and descriptive approaches (see, e.g., Godfrey-Smith 2003; Bechtel 2008). The distinction is relevant to questions of interdisciplinarity, because there is an inverse relation between normative philosophy of science and interdisciplinarity: the more normative philosophy of science is, the further away from actual scientific practice and the less interdisciplinary it is.

Philosophy of science can be said to be *normative* if it includes normative claims – for instance, about how a certain scientific concept like the concept of a gene, an organism or fitness *should* be understood or about how science should be pursued, that is, about which methods should be applied or how adequate explanations should be developed. Examples of normative approaches are Ken Schaffner's (1993) account of how to conceive reduction in the medical sciences and Robert Brandon's (1996) theory of adaptation explanations in evolutionary biology. Normative philosophies of science typically construct *regulative ideals* that may be only "peripheral" (Schaffner 1974) to how science in fact works. Sometimes the development of normative approaches proceeds without taking into account the content and practice of the actual science and restricts itself to toy examples. In these cases, it is hard to see how normative philosophies of science can be interdisciplinary in any of the senses explained above. In the cases where philosophers construct regulative ideals about how science should work without paying attention to how science in fact works, interdisciplinary collaboration between philosophers and scientists and non-interdisciplinary intense interaction would both seem to be rather negligible in the development of such approaches.

In contemporary philosophy of science, however, most authors agree that philosophical theories about science (including, and in particular, normative ones) must take into account empirical information about scientific practice itself (i.e., about which investigative strategies are applied, which experiments are performed, how empirical findings are interpreted, etc.) as well as detailed scientific knowledge. Philosophers of science who pursue a normative project that is descriptively grounded will work in a bottom-up fashion and be in tune with the actual scientific practice. Actual science, after all, sets constraints for normative philosophy of science. As a consequence, normative projects are often based on, or closely linked to, descriptive projects. They are then not purely normative, but "jointly normative and descriptive" (Mitchell 2009), as illustrated by philosophical accounts of what the norms of mechanistic explanations should be (i.e., how the adequacy of particular mechanistic explanations should be assessed). The answers to these questions are grounded in a "description" (or reconstruction) of how scientists in a certain field *in fact* evaluate the adequacy of mechanistic explanations – that is, in a description or reconstruction of the norms of mechanistic explanation that are actually accepted in scientific practice. The mere description or reconstruction of epistemic or social norms that *are* in fact accepted in a certain discipline does not render a philosophical account normative (at least not in a strong sense). Only if philosophers also make prescriptive claims about which norms or values *should* be accepted in science will their account be normative.

## 3. Conclusion

We have distinguished general philosophy of science from the philosophies of the particular sciences. The former can be synoptic or reflective, while the latter can be reflective or embedded. Interdisciplinarity here is often *inversely related* to the degree of normativity of the approaches. In cases where collaborative interdisciplinarity occurs (reflective or not), it can be further specified according to the degree of collaboration that is realized. Furthermore, the following four points have to be taken into account when interdisciplinarity in the philosophy of science is discussed.

First, the question of whether or not philosophy of science has an influence on actual scientific practice depends not only on the style but on how exactly the style is carried out (the more philosophers pay attention to actual scientific practice, the more relevant their work will be for sciences) and on the extent to which the respective scientific work depends on reasoning about more general, conceptual, methodological or argumentative issues.

Second, the goal of improving the organization of the scientists' work or of justification of the particular style of argumentation or research is less likely to be cooperative since it is more removed from the individual problems addressed by the scientists. But, if successful, it leads to a more profound influence than merely contributing to the scientists' understanding of the particular phenomena they work on.

Third, reflective philosophy of science can have interdisciplinary relations (with various degrees of collaboration) with *other reflective disciplines* that have sciences as their object of study, such as history, sociology or cognitive studies of science. In the last 50 years or so, this kind of interdisciplinarity has led to new institutes, societies and study programs dedicated to realizing an integrative approach, aimed at interdisciplinary careers in the narrowest sense.[6] It can also – but less obviously so than synoptic philosophy of science or embedded philosophies of the particular sciences – enter into collaborative relationships with the respective sciences studied, if the scientists themselves start to address a reflective problem.

Fourth, philosophy of science need not be reflective. It can also address the problems of the scientists and help them in solving these, as is the case with synoptic general philosophy of science and embedded philosophies of the particular sciences.

To come back to the question raised earlier: Is philosophy of science only interdisciplinary if there is more science (how much?) and less philosophy in it? We can now say that philosophy of science does not need to address problems as raised within the sciences in order to be interdisciplinary. What we termed reflective philosophy of science is concerned with genuinely philosophical questions, but it can still be involved in reflective-level interdisciplinarity or interdisciplinarity with respect to reflective problems. On the other hand, reflective philosophy of science, whether it is normative or descriptive, does benefit from detailed knowledge about the content and practices of science. Finally, there is obviously much science in the embedded philosophies of the particular sciences, and they are clearly of an interdisciplinary character.

In sum, there are different ways in which philosophy of science can stand in interdisciplinary relations to other reflective fields or to the sciences it studies. We have argued that there are different forms of interdisciplinarity in the philosophy of science, resulting from various possible relations between disciplines (synoptic, reflective and collaborative). Interdisciplinary relations can involve general or common goals. But there are also asymmetric relations between philosophers and researchers in other fields. Some reflective and/or normative investigations in general philosophy of science might not be of immediate use for scientists, but philosophers will still often need first-hand access to science and therefore depend, if not on collaboration, then still on some openness and support from scientists.

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6 The Institute for Interdisciplinary Studies of Science ($I^2SOS$) at Bielefeld University is one such example.

Acknowledgements

In March 2013, the interdisciplinarity of philosophy of science was the subject of a workshop and a panel discussion at the first conference of the German Society for Philosophy of Science (*Gesellschaft für Wissenschaftsphilosophie*) in Hanover, Germany. The focus was on the situation for early-career researchers. The workshop and panel discussion was funded by the Andrea von Braun Foundation (see http://www.wissphil.de/index.php?site=gwp2013&subsite=panel, last access August 6, 2013). We would like to thank the Andrea von Braun Foundation for its great support, as well as the workshop participants and the panelists, who are listed on the above-mentioned page, for the stimulating discussions. We would also like to thank the colleagues and students who organized the conference in Hanover and made it possible that the event could take place in such a fruitful atmosphere. This paper is the theoretical counterpart of a paper that addresses the practical implications for early-career researchers and research-related institutions with respect to funding and job profiles in interdisciplinary contexts in philosophy of science (Kaiser, Kronfeldner, Meunier (forthc.), "Problems and Prospects of Interdisciplinary Philosophy of Science: A Report from the Workbench," to appear in *Briefe zur Interdisziplinarität*).

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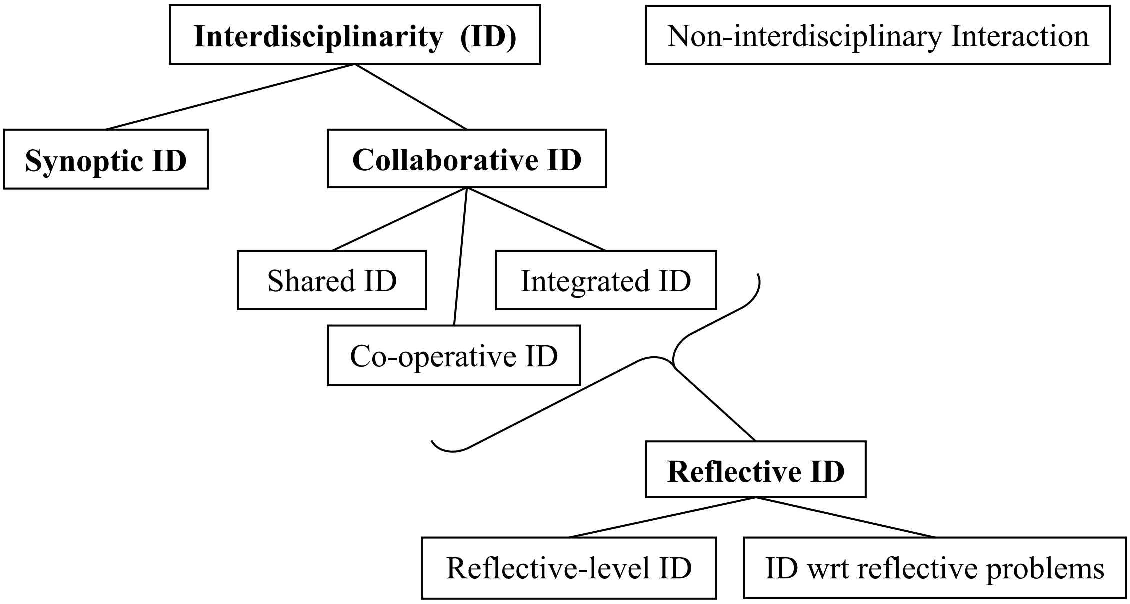
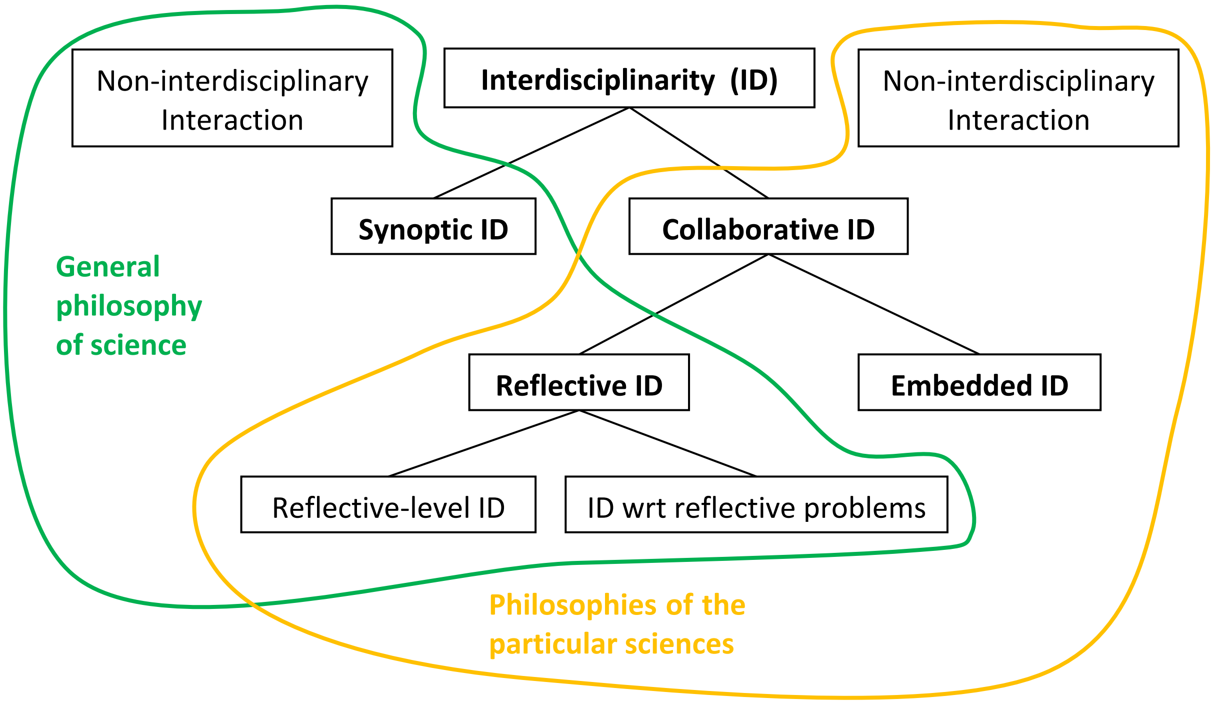

Interdisciplinarity (ID)
Non-interdisciplinary Interaction
Synoptic ID
Collaborative ID
Shared ID
Integrated ID
Co-operative ID
Reflective ID
Reflective-level ID
ID wrt reflective problems



Non-interdisciplinary Interaction
Interdisciplinarity (ID)
Non-interdisciplinary Interaction
Synoptic ID
Collaborative ID
General philosophy of science
Reflective ID
Embedded ID
Reflective-level ID
ID wrt reflective problems
Philosophies of the particular sciences