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Philosophy of interdisciplinarity. What? Why? How?

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Abstract

Compared to the massive literature from other disciplinary perspectives on interdisciplinarity (such as those from sociology, education, management, scientometrics), philosophy of science is only slowly beginning to pay systematic attention to this powerful trend in contemporary science. The paper provides some metaphilosophical reflections on the emerging "Philosophy of Interdisciplinarity" (PhID).

What? I propose a conception of PhID that has the qualities of being broad and neutral as well as stemming from within the (also broadly conceived) agenda of philosophy of science. It will investigate features of science that reveal themselves when scientific disciplines are viewed in comparison or in contact with one another. PhID will therefore generate two kinds of information: comparative and contactual. Comparative information is about the similarities and differences between disciplines, while contactual information is about what happens and why when disciplines get in contact with each other. Virtually all issues and resources within the philosophy of science can be mobilized to bear on the project, including philosophical accounts of models, explanations, justification, evidence, progress, values, demarcation, incommensurability, and so on. Given that scientific disciplines are institutional entities, resources available (and forthcoming) in social epistemology and social ontology will also have to be invoked.

Why? Establishing PhID is presently an obvious step to take for several reasons, including the following two. First, ID is an increasingly powerful characteristic of contemporary science and its management, and so it would be inappropriate for an empirically informed philosophy of science to ignore it. Second, contemporary philosophy of science happens to be particularly well equipped for addressing issues of ID thanks to the recent massive work in the more specialized fields of philosophies of special disciplines (of biology, of cognitive science, of economics, of engineering, etc).

How? Given the breadth and heterogeneity of its domain and tasks, the practice of PhID must be heavily collective. It must mobilize multiple competences and it must keep elaborating a systematic agenda (or perhaps several overlapping agendas in case there will be rival 'schools' of PhID). While a lot of new conceptual work is needed, the approach is bound to be emphatically empirical, with a cumulative and mutually complementary series of case studies to be conducted. Among the methods to be employed, good old textual analysis of scientific publications will be supplemented with interviews, 'experimental' techniques, participant observation as well as various interventionist approaches. The published work in PhID will often be authored jointly by philosophers and other scholars in science studies as well as practitioners in various scientific disciplines.

Introduction

Compared to other disciplinary perspectives to interdisciplinarity (those from sociology, education, administration, scientometrics), philosophy of science is only slowly beginning to pay systematic attention to this powerful trend in contemporary science. In what follows I will provide some metaphilosophical reflections on the emerging philosophy of interdisciplinarity (PhID). These reflections seek to outline answers to the three questions in my title. The constitutive *What?* deals with the sorts of phenomena, and the sorts of questions about them, that should be covered by PhID. The explanatory and justificatory *Why?* is about the reasons for which philosophers should take this theme on board. The methodological *How?* is concerned with the advisable methods and principles in the philosophical study of interdisciplinarity.

In outlining answers to these questions, I am advancing *a call for systematic collective research on the philosophical aspects of interdisciplinarity in science*. Such research should be *systematic*, addressing a number of interrelated issues and producing results that can be challenged and that can provide the basis for further inquiry – hence systematic research of this kind should be cumulatively progressive. This, together with the vastness of the task, requires that the research is to be *collective*. A larger number of philosophers than is the case now should spend more of their time investigating different facets of the theme, and they should do it in interaction with one another, based on a division of intellectual labour and at least partly overlapping research agendas. And finally, this research is to provide *philosophical* perspectives to, and analyses of, interdisciplinarity in science. This implies an invitation to some slight reconsideration of the research agenda and research strategy of philosophy of science itself. Let me call this composite invitation by the name *Call for PhID*.

Thus far, interdisciplinarity has attracted systematic and collective attention mainly from researchers in fields such as sociology, history, education, administration, and scientometrics. While it is clear that (especially if taken together) these disciplinary perspectives reach far beyond the domain of philosophy of science, on the other hand the image of interdisciplinarity they provide is often narrow, sometimes shallow. They often miss versions of interdisciplinarity that are easy for philosophy of science to recognize; they may provide mistaken diagnoses and doubtful recipes in promoting interdisciplinarity; and the accounts they offer may be lacking in conceptual clarity or depth of reasoning. It is time for philosophy of science to put this complex phenomenon on its collective agenda. Philosophy of science is to address issues that such other fields do not address – or address them insufficiently or deficiently -- while at the same time learning from them and expanding its own horizons regarding both the targets and tools of philosophical inquiry. Yet in contrast to some other programmatic statements for a philosophy of interdisciplinarity (e.g. Frodeman 2013), my proposal is to develop a PhID that stems from within the conventional agenda of philosophy of science. Doing so is not without conceptual and practical problems (including the issue of what we want to mean by 'philosophy of X'), so these too must be examined as part of

the *Call for PhID*.[1]

I will put my remarks in terms of a series of theses or observations. Some of them are factual claims while some others are more normative. Some of them are less controversial, while some others might be more so. In some cases the emphasis will be more on the articulation than on the defense of the observations. There is no smoothly flowing argument in the paper, but the points are hopefully organized in a sense-making manner in three sections. I will start with observations about the growth of the phenomenon of (hassle around) interdisciplinarity; then proceed to pointing out some of its complexities; and finally highlight the role of the philosophy of science in its analysis as well as the benefits for philosophy from engaging itself in the endeavor. What follows has the taste of a manifesto rather than being a survey of the literature, so it will be parsimonious with references.

Growth of interdisciplinarity

1. There is a simple argument in support of the *Call*, explaining why philosophy of science should meet it.

> *Premise 1:* It is part of the agenda of philosophy of science that it should be informed about, and should produce information about, major features of contemporary science.
> *Premise 2:* Interdisciplinarity plays an increasingly central role in contemporary scientific research and its governance.
> *Conclusion:* Philosophy of science should meet the *Call for PhID*.

While I think it will be important to critically and open-mindedly examine any allegations about the agenda of philosophy of science, I take Premise 1 to be beyond question. Further elaborations are needed (e.g about the kind of information philosophy of science is supposed to need as input and to create as output), and some of these will be provided in the course of this paper, including Section 3 below. The present section deals with aspects of Premise 2. If indeed interdisciplinarity is growing in a way that has relevance to the issues studied by philosophy of science – or issues that it had better study – then obviously philosophy of science must take phenomena of interdisciplinarity on board.

Other disciplinary perspectives have already responded to the growth of interdisciplinarity and have generated empirical and theoretical work on the phenomenon, providing advice for design, mostly to promote interdisciplinarity. These perspectives include those from sociology and history, education and pedagogics, administration and management scientometrics and library studies.

[1] The study of interdisciplinarity from a philosophy of science vantage point has been on the TINT agenda since 2006 (see http://www.helsinki.fi/tint). Several workshops and conferences have been organized, and many of the papers have been published in special issues of journals such as *Biology and Philosophy* (Weisberg, Okasha, Mäki 2010), *Perspectives on Science*, (Grüne-Yanoff and Morgan 2012), *Studies in History and Philosophy of Science* (Grüne-Yanoff and Mäki 2014). Other similar activities include a special issue of *Synthese* (Hoffmann, Schmidt and Nersessian 2013).

These are to be supplemented and enriched by philosophical perspectives, for the benefit of all parties.

2. *Talk about* interdisciplinarity is different from interdisciplinarity present *in scientific practice*. The two may be (and often are) out of phase with one another. On the one hand, there is quite some empty, pretentious or misguided talk about interdisicplinarity; on the other, there is much unrecognized or misunderstood genuine interdisciplinarity in the actual practice of science. One should therefore not uncritically draw straightforward inferences from the talk to the thing in making observations about the structures of interdisciplinarity or about changes in its prevalence, and one should also be earnestly cautious with normative recommendations, both in giving and judging them. The ways in which the two – talk and practice - are connected are to be examined separately. Even if different, and sometimes independent, talk and practice share something important in common: presently they both grow.

3. Talk about interdisciplinarity has been growing especially since the 1970s. This shows, for example, in the enlarging number of published books and articles dealing with various facets of interdisciplinary research and education. This trend has reached the point of publishing handbooks, such as *Handbook of Transdisciplinary Research* (Hirsch Hardon et al. 2008) and *Oxford Handbook of Interdisciplinarity* (Frodeman et al. 2010). But publications don't drive the phenomenon, they manifest it while naturally also facilitating it. Importantly, the growth of talk about interdisciplinarity shows in the declarations and calls for proposals by research funding agencies. This phenomenon ranges from the local to the national to the multinational levels (such as from particular universities to the European Research Council). In responding to these calls, scholars and their groups do their best to advertise their proposed research as interdisciplinary. On both sides, talk about interdisciplinarity may be just a matter of wishful programmatic declaration or of truthful factual description, or something in between. The *rhetoric of interdisciplinarity* – whether truthful or merely pretentious or wishful -- is an important relatively new part of contemporary academic practice and should be on the agenda of philosophy of science as well as other fields looking into the actualities of scientific practice. Philosophical scrutiny of this talk could be of some help in distinguishing between, say, adequate promise and wishful pretension.

4. Data would also seem to suggest that interdisciplinarity in actual scientific practice is growing. Scientometricians have sought to measure degrees of interdisciplinarity and their changes, for example by counting the numbers of citations across disciplinary boundaries. It is important to see that such data are limited in their informational contents; for example, they typically do not reveal important facts about the reasons and cultures of citation practices nor the institutional nuances of scientific practice in general. The institutions and practices of science are not uniform across disciplines. One consequence is that the claim about the growth of interdisciplinarity must be heavily qualified by considerations of heterogeneity. First, science overall is heterogeneous in this respect. Disciplines relate to interdisciplinarity differently. The phenomenon of growth is more prevalent in some areas than in others (see e.g. Levitt, Thelwall,

Oppenheim 2011). Second, interdisciplinarity itself is heterogeneous. There are great many variations of it, and they have different histories and conditions of realization. Some are as old as disciplines themselves, while the popularity of some others are of more recent origins.

Discplinarity and interdisciplinarity – and their heterogeneity

5. It is commonplace to define interdisciplinarity rather richly in end-means terms. Interdisciplinarity in these characterizations manifests the ambition to solve broad or complex problems by combining and integrating two or more disciplinary perspectives, themselves alone too narrow or simple for the task (e.g. Klein and Newel 1996). Such ideas are echoed in the mission statements of many research funding agencies, such as the NSF and ERC and many others. Here is an example that captures the spirit: "Horizon 2020 should stimulate a break-down of the silos of different research disciplines and stimulate integration in order to maximize impact." (Horizon 2020, 2014, 6)

The above and many similar characterizations provide intensionally rather thick concepts of interdisciplinarity, and so excluding from their extensions many important types of interdisciplinary encounter or relationship. My preference is for an intensionally much thinner and thereby extensionally broader concept of interdisciplinarity that I suggest putting simply in terms of *whatever relevant relationship between two or more scientific disciplines or their parts*. This keeps silent about the ambitions driving it (e.g. seeking to solve complex problems) and the forms and means adopted (e.g integration of conceptual frameworks). This results in a more encompassing notion that also has the nice advantage of giving PhID more work to do!

6. Interdisciplinarity is dependent on disciplinarity, both conceptually and causally. The conceptual dependence is obvious: the concept of the former must be defined in terms of that of the latter. This reveals, for example, that without disciplines, interdisciplinarity would be inconceivable. If disciplines were to fade away – as some enthusiasts of interdisciplinarity sometimes would seem to wish – the very idea of interdisciplinarity would become inconceivable. Regarding the causal connection, calls for, and actual implementations of, interdisciplinarity often (but not always) appear as reactions to disciplinarity. In these situations, specialization (narrowing) and disciplining (tightening of disciplinary "law and order") engender needs for broadening the perspectives by trespassing and transgressing disciplinary boundaries in attempting to serve some otherwise hard to serve goals or needs – such as the epistemic needs of novel theoretical innovation, or of reliable and accurate prediction; or the practical needs of finding solutions to some challenging complex social problems.

7. Interdisciplinarity (just as disciplinarity) is far from uniform, but no agreed-upon and perfectly well designed typology of kinds of interdisciplinarity is available. Categories such as multi-, inter-, cross-, pluri-, trans-, and other kinds of X-disciplinarity have received multiple definitions in the literature, but they often lack sufficient analytical rigour. They allow for further divisions into subcategories, their boundaries remain vague, and the underlying dimensions

have not been elaborated with sufficient care. The more primitive concepts in terms of which these typologies are construed include those of complexity, integration, division of research tasks, collaboration, participation, transfer, expansion, unification, triangulation, pluralism, and much more. The relevant dimensions these concepts can be used for creating are many, such as less to more integration, less to more collaboration, less to more extra-academic involvement, and so on. A variety of typologies have been suggested, but there is plenty of room for conceptual sophistication. Given the convolutions of this conceptual landscape, I don't expect the efforts to be completed very soon, so any rushed attempt to stabilize the terminology would be premature. My methodological advice for this project is to make conceptual and empirical work interact: we need more, and more kinds of, empirical case studies on interdisciplinary practices in science; and the expanding range of case studies should inform, and be informed by, our attempts to bring conceptual order in the rich variety of interdisciplinary scientific practices. My expectation is that this project, when implemented well, will not converge into a single superior typology capable of encompassing all relevant kinds, but rather a family of typologies, each based on a distinct underlying dimension, or a small set of such dimensions.

8. In order to fully appreciate the immense heterogeneity of interdisciplinarity, it is important to be aware of the heterogeneity of disciplinarity. Scientific disciplines constitute quite a varied assortment. There are many sources and many kinds of this heterogeneity, among them the fact that many disciplines are inherently interdisciplinary in that their characteristic activities include a lot of interdisciplinary traffic or collaboration, and that this is encouraged by the local conventions and reward structures within these disciplines. This comes in two versions. First, the disciplinary identity of some hybrid disciplines may be based on continuous *importation* of items -- such as theories, techniques, evidence, results of research – from other disciplines and on modifying them and combining them with one another within the home discipline. Just think of archaeology, cognitive science, systems biology, medical humanities, astrobiology, human geography, and development studies as (among themselves different) examples. Second, inherent interdisciplinarity may be *exportation*-based, such as in the case of game theory or computational science (or economics or evolutionary theory) that are on a constant lookout for further applications in new domains and disciplinary contexts. Naturally, the transfer of an item across disciplinary boundaries may be a result of efforts of both importation and exportation that pull in a sufficiently similar direction on the map of disciplines. And sometimes the interaction may take on the ambitious form of research collaboration.

9. More generally, regarding the ease, propensity, and direction of crossing disciplinary boundaries, some disciplines are characteristically *inward-open*. They have a high propensity to adopt items from other disciplines; such an activity of borrowing or importing is highly valued as disciplinarily appropriate intellectual conduct. Some other disciplines are more *outward-open*, they are disposed to expand the reach of their own theories and techniques to ever new domains and disciplines. Yet other disciplines are far more closed and self-

sufficient, so there is much less cross-border interdisciplinary activity in which they are characteristically involved, either inwards or outwards.

10. *Philosophy of science itself* manifests both kinds of openness. The popular "naturalist" claim that there should be a close connection or continuum between philosophy and science is a thesis about interdisciplinarity. It recommends philosophical theorizing about science to proceed on the basis of inward-open interdisciplinary structures. There are two versions of this. The *external* version suggests that science (eg history and sociology) of science should impose evidential constraints on philosophical claims about scientific practice in that philosophical theories are to be informed by, or tested against the evidence produced by the scientific study of scientific practice. The *internal* version suggests that relevant parts of science (eg cognitive science, evolutionary theory, economics) should provide inputs to the construction of the contents of philosophical accounts of science, so that there be continuity between the contents of philosophical theories and those of the relevant scientific theories.

On the other hand, *philosophy in general* is perhaps the most outward-open discipline of all, a highly expansionist intellectual endeavour without hardly any limits whatsoever. The possible domain of philosophy seems to contain just anything, from space and time to mind and society, from religion and science to love and language, from sports and sex to wine and war, from being and beauty to health and history, from music and money to dance and wisdom – and on we go. It is in this expansionist spirit that we propose enlarging the domain of philosophy of science so as to include interdisciplinarity!

11. Some of the urge for interdisciplinarity originates from an *intellectual concern*: the feeling that the unity of science has been lost due to the specializations and divisions within science having been taken very far. Relative to these concerns, interdisciplinarity manifests a dream of a regained unity in science. Another major reason - I'd say the main reason - for the current call for interdisciplinarity is a *practical concern*: science is divided into disciplines and sub-disciplines, but most of the most pressing real-world problems (from climate change to global poverty) aren't so divided – so successfully addressing the latter requires crossing disciplinary boundaries and combining intellectual and other resources regardless of their disciplinary origins and sub-disciplinary home grounds. This is in line with science being embraced by the current culture of accountability and practical relevance.

12. In *explaining* the recent growth of interest in interdisciplinarity, it is advisable to consider *extra-academic versions of transdisciplinarity* in separation from other versions. The current rushed fuss around interdisciplinarity is largely – but not only – motivated by the increasing pressures on science to serve extra-scientific needs (such as solving practical problems recognized as significant by political or commercial forces) by way of reducing the power and autonomy of scientific disciplines (and so, perhaps, of science) in setting research goals and standards of research quality. The challenge of this sort of extra-academic transdisciplinarity is to bridge the gap between narrow scientific puzzles and broad extra-scientific problems. This is what is often called the "applicability

gap" between deep but narrow disciplinary expertise and complex real-world problems.

The increasing social demand for this version of transdisciplinarity also shows in the dominant contemporary images of interdisciplinarity, those that are put in terms such as integration, collaboration, and participation. Since the real world is rich and complex, disciplines must join forces: the specialized disciplinary competences and practices as well as the simple and idealized disciplinary theories must be joined or integrated in order to get hold of the real-world complexity. And because people living their real lives in that complex real world are faced with various practical problems – some of which are both very important and very difficult – scientific disciplines must join forces with extra-scientific agents, engaging their cognitive and practical competences, interests and contributions, in order to be able to solve such problems.

13. However, the range of interdisciplinarities is much broader (and older) than just those deriving from the new societal pressures towards bringing science closer to meeting practical challenges such as business innovation and environmental policy. The goals and needs that interdisciplinarity may serve are numerous, and many of these are more purely epistemic and academic, and so transcend the current transformation of the structures of the governance of science that seek to bring science closer to practical concerns and thereby to make it socially more relevant. Naturally, the socially and epistemically driven versions often intermingle.

14. Another distinction that will be useful for understanding versions of interdisciplinarity is in terms of whether it is initiated and driven primarily by science managers or by practicing scientists. These may be called *managerial top-down* interdisciplinarity and *practitioner bottom-up* interdisciplinarity, respectively. Many scientists may have the feeling that the latter comes more naturally while the former has a great deal of forced artificiality in it. However, it is obvious that sometimes the internal social dynamics of (inter)disciplinarity create intellectually harmful frictions and obstructions that may be best to remove by external intervention (for instance by manipulating external incentives such as research funding schemes or job structures). On the other hand, the top-down version seems to have generated specific rhetorical practices related to interdisciplinarity. Indeed, it tends to be around the top-down versions that *the rhetoric of interdisciplinarity* flourishes, both by funding agencies and administrators in calling for proposals for interdisciplinary research or education; and then by researchers and educators when responding to such declared demand, trying to persuade the former agents to grant resources for supposedly suitable interdisciplinary activities.

What's there for philosophy of science, and how to capture it?

15. How does the agenda of philosophy relate to disciplinarity within science – and within philosophy itself? Mainstream philosophy of science (as disciplinary practice) is largely a pro-science endeavour, an attempt to reconstruct and explain *science as a success story* in terms of its conduct as rule-bound – that is, *as*

disciplined activity. It is in virtue of scientific practice being governed by certain rules of conduct – including the so-called scientific method, whatever its details – that science can be celebrated for its epistemic and technological achievements. Much of philosophy of science has taken as its task to clarify and prescribe such rules and to explain these achievements as consequences of rule-bound conduct.

So there is a sense in which philosophy of science depicts scientific practice as disciplined – and hence disciplinary – activity. Yet 'disciplinary' here must be understood in the generic sense of being disciplined, so this alone should not imply anything about any given specific disciplinary division or interdisciplinary relationship in science. On the other hand, versions of interdisciplinarity in science may be viewed as a risk for rule-bound conduct (the presumed key to scientific success) and thereby for the popular agenda of philosophy of science (to explain and prescribe that success). This is because much of interdisciplinary activity is supposed to be unconstrained by disciplinary rules and principles, and thus it lies beyond the agenda of standard philosophy of science: there are no rules or principles recognizable as ordinary disciplinary rules that could be invoked for explaining interdisciplinary pursuit and success. There are exceptions to this, including those versions of interdisciplinarity that promote (disciplined) unity of science; these can be seen simply as extensions of ordinary disciplinary aspirations. Nevertheless, much of interdisciplinarity appears to lie beyond the reach of philosophy of science's typical agenda. This needs to be rectified.

16. On the other hand, important recent developments in the philosophy of science reinforce its chances to successfully address issues of interdisciplinarity right now. One such development is related to the rise and establishment of various *philosophies of special sciences*. Let me narrate a stylized history, according to which philosophy of science used to be designed so as to be generally about all (good) science, dealing with supposedly general principles of adequate explanation and sound justification, for example. In the last few decades, a number of new more specialized fields have arisen within philosophy of science, each of them dealing with a particular scientific discipline or family of similar disciplines. So we now have, in an institutionalized form, specialized fields such as philosophy of biology, philosophy of chemistry, philosophy of cognitive science, philosophy of economics, philosophy of engineering, etc. The next natural step to take, enabled and facilitated by the previous one, is PhID, the philosophy of interdisciplinarity. On this streamlined history, the overall development in the philosophy of science hence proceeds in three stages:

> *First:* General philosophy of science (dealing with science at large, or science in general, without paying systematic attention to disciplinary specialties).
> *Then:* Philosophies of special sciences (such as philosophy of biology, of cognitive science, of economics).
> *Next:* Philosophy of the relations between such scientific disciplines, that is, of interdisciplinarity.

This should not be seen merely as a one-way linear development. Indeed, once

philosophies of special sciences and of interdisciplinarity have advanced sufficiently, the contents of general philosophy of science should be reconsidered and revised, based on the new more local information that will have been generated.

17. It is now easier to see what kinds of information can be acquired by philosophies of interdisciplinarity. There are roughly two kinds of such information.

> *Comparative information*: This is information about the *similarities and differences* between two or more disciplines or families thereof, regardless of what happens (or fails to happen) between them. As philosophies of special sciences are producing ample information about the characteristics of those sciences separately, comparative information is easier to generate, and it will be far more nuanced than ever before. So we may learn about the similarities and differences between, say, experimental and historical sciences, or between how economics and ecology model phenomena in their respective domains.
>
> *Contactual information*: This is information about *what happens* (or fails to happen) when two or more disciplines are brought in contact with one another. The production of contactual information requires going beyond mere combinations of bodies of disciplinary information generated by philosophies of special sciences. One must analyze the large variety of ways in which disciplines can be in consequential contact with one another – such as collaboration, inspiration, transfer of models or methods, evidential support or criticism, integration and unification, and so on. In some cases, one may be interested in generating information also about the reasons for failure to be in contact in these ways.

This means that I am proposing *a rather broad conception of what the philosophy of interdisciplinarity would cover*. Not only do I suggest enlarging the domain of PhID to encompass comparative investigations, but I also believe these investigations are important for the acquisition of contactual information too. The specific characteristics of distinct scientific disciplines make a difference for what happens when they are brought in contact with one another. *Disciplines are both similar and different* with one another, and these similarities and differences are important to understand since success (and failure) in interdisciplinary contact typically requires both. If science were *perfectly homogeneous* across all relevant properties, there would be no hard issues or pressing challenges of interdisciplinarity; and if science were *too heterogeneous*, there would ne little hope for interdisciplinary contact. Indeed, the familiar challenges and troubles that often accompany interdisciplinary contact are manifestations of disciplinary heterogeneity. These two classes of information are vital also for possible *normative* purposes. For example, comparative information may enable one discipline to learn from another, from what are perceived as (perhaps more) successful disciplinary principles and practices. Episodes of interdisciplinary learning are targets of contactual information that may be used for enhancing further interactive improvements.

18. There is an obvious analogy between comparative philosophy of interdisciplinarity and a branch of *historical epistemology*. Just as historical epistemology acknowledges and examines historically successive variation in scientific styles of reasoning and notions such as observation and objectivity, the comparative branch of PhID takes as its task the identification and analysis of the differences (and similarities) between various disciplines and their families regarding their styles of inquiry and argumentation, and their collectively held (yet possibly contested) ideas about excellence, novelty, rationality, objectivity, and knowledge, as well as more narrow notions such as theory, evidence, and unity. Philosophy of interdisciplinarity and historical epistemology are natural allies.

19. There is another development in the philosophy of science that, even though not yet materialized to a satisfactory extent and richness, is supportive of the called-for philosophy of interdisciplinarity. This is the recent work in *social ontology* and *social epistemology*, and their applications to the study of science. Since disciplines are institutional entities, interdisciplinarity has both epistemic and social aspects, and so its study implies a call for philosophy of science to go social. This will encompass looking into norms and conventions, status and authority, epistemic trust and recognized expertise, collective identity and emotion, collaboration and conflict, agreement and disagreement, consensus and dissensus, designed as well as spontaneous disciplinary structures, and more. Philosophy of inter*disciplinarity* – whether in search for comparative of contactual information – will have to look into the ways these things play out their roles in disciplinary and interdisciplinary practices. Meeting the challenge of incorporating such elements in philosophical accounts of science will promote the much-awaited *institutional turn in the philosophy of science*.

20. 'Interdisciplinarity' is an element in popular contemporary slogans for the practical urge of doing interdisciplinary research and of doing research policy that supports such research. PhID therefore also must – and naturally does -- go along with the recent call for *more practically relevant philosophy of science*. Practical relevance comes in many varieties: relevance to scientific practice; relevance to science policy (and research management, research funding etc); relevance to society (science-society relations as in extra-academic transdisciplinarity). In principle, PhID has the capacity to be of relevance with respect to all these realms of practice. PhID will be appreciated by science policy makers who presently have rather limited understandings of the intricacies of interdisciplinarity and yet are hard pressed to promote it. PhID will be appreciated by practicing disciplinary scientists who are often rather confused when faced with the challenge of connecting their expertise with that in neighbouring disciplines. They can be helped by philosophers who are able to serve as interpreters and bridge builders between disciplines, invoking their characteristic expertise in examining broad general patterns as well as minute but significant details. It is not far fetched to suggest that there is growing hidden demand for the services of PhID and that this will create an opportunity of making philosophy of science practically more relevant than ever.

21. Naturally, philosophy of science has a history of dealing with issues that have interdisciplinary dimensions. To these belong themes such as the idea of the unity (and disunity) of science; reduction of theories and their ontologies; metaphysical issues of emergence and supervenience; "Kuhnian" issues of incommensurability and the "essential tension"; the arguments for and against methodological dualism between the natural and social sciences. The debates over these and other issues will be valuable for the future philosophy of interdisciplinarity; they typically highlight its logical, semantic and ontological aspects. What has been largely missing in these investigations and debates is the rich and complex institutional dynamics of disciplinarity and interdisciplinarity. These investigations will therefore be enriched by being brought in contact with the systematic study of interdisciplinarity.

22. Reinforced by the manifoldness of interdisciplinarity and the issues it generates, a broad *multitude of philosophical resources* can and should be mobilized in its investigation. There is something in it for almost every area of philosophical expertise. The following lists just a few examples.

a. The *language* customarily used for speaking about disciplines and their relationships require clarification, and this is where much of philosophy excels. This language is often heavily metaphorical or otherwise ambiguous. It begins with 'discipline' itself, fortified by the proposed analogies with things such as nation states and guilds. Interdisciplinarity is often characterized in terms of geographical metaphors, such as 'boundaries' between 'areas' and 'fields' that are 'crossed' and 'bridged' etc. 'Integration' is another popular term desperately in need of analysis.

b. Since the core concepts of discipline and interdisciplinarity denote institutional realities, their study will mobilize the tools of *social ontology and social epistemology*. Institutional facts such as disciplinary convention and disciplinary identity as well as epistemic trust and expertise await examination.

c. *Model-based accounts* of science facilitate the study of interdisciplinary transfer. Models conceived as templates or otherwise abstract or generalized tools that are not tightly connected to some specific target or subject matter are easily seen as transportable across disciplinary boundaries.

d. *Erotetic approaches to science* are well suited for highlighting interdisciplinary relations by focusing on the *questions* asked in disciplinary practices. For example, contrastive accounts of explanation are useful for dealing with situations of explanatory complementarity versus rivalry across disciplinary boundaries, by way of analyzing the contrastive questions they seek to answer.

e. Philosophical accounts of *mechanisms and mechanistic reasoning* will be helpful in clarifying certain kinds of interdisciplinary relation. Different (families of) disciplines may entertain different notions of mechanism. Different disciplines may highlight different levels of organization in a vertical hierarchy of mechanisms, thereby complementing one another. And research fields may deal with horizontally parallel mechanisms that may coalesce variously, from reinforcing to confounding one another.

f. Philosophical accounts of *evidence and evidential support* will offer important perspectives to and tools for examining situations in which evidence generated in one discipline is – or is not – used in another discipline to support

or criticize theories and explanations.

g. The good old issue of *scientific discovery* will be firmly back on the agenda of the philosophy of science. Interdisciplinary interactions have been advertised as an indispensable source of scientific creativity and innovation, and no doubt they do promote the development of new ideas, by ways such as analogy and even fusion. The principles and conventions that govern short-term interdisciplinary projects of a collaborative kind are often negotiated within the context of discovery.

h. Philosophical accounts of *unity, unification, and integration* will be very important in the future study of interdisciplinarity; after all, much of the fuss around interdisciplinarity is motivated by worries about specialization and fragmentation in scientific practice having gone too far.

i. Issues of *incommensurability* will make a comeback, whether semantic, methodological or some other variety, responding to the recurrent complaint that the desired communication between disciplines is difficult to generate and sustain. Different disciplines often use the same terminologies in different meanings, and they may apply different styles and strategies in posing research questions and looking for answers to them as well as in assessing the credentials of the answers given.

j. Old issues of *demarcation* between what is and what is not science - or good science – will make a reappearance as scientific disciplines, possibly with very different epistemic and social status, are brought together, and disciplinary prejudices and pecking orders start shaping the attitudes; or as questions arise about the epistemic quality and status of extra-academic bodies of belief that are supposed to be joined with academic knowledge and procedures. Indeed, I anticipate a *new problem of demarcation* to be put on the philosophical agenda for dealing with issues prompted by extra-academic transdisciplinarity.

k. Various dimensions in *science-society relations* will be more firmly on the agenda of philosophy of science. These have to do with the governance of science as well as the production and application of knowledge insofar as these are extra-academically constrained and facilitated. The role of values, their kinds and their ways of entering research will be burning issues, and so will issues of democratization and commercialization of science.

23. Concerning the *normative evaluation* of disciplinary and interdisciplinary research, one should caution against hasty generalized claims. One cannot justifiably claim that, overall, one of these is good, bad, better, or worse than the other. The popular generalized notion that disciplinarity is constraining and conservative, an obstacle to progress and practical relevance, is often as incorrect as the related belief that interdisciplinarity is progressive and emancipatory and useful. It all depends on further contingencies. In general, there is a shortage of refined criteria usable for normative assessment. This is where philosophers should be of help.

24. Putting interdisciplinarity in all its richness on the agenda of philosophy of science requires and enables the latter to *reconsider its own methods and principles of inquiry*. This is a great opportunity for meta-philosophical reflection – and for turning philosophical practice itself into a more interdisciplinary direction. The methods and methodological principles of philosophies of

interdisciplinarity must be broadly based, so as to enable generating sufficiently detailed information about the numerous facets of the dynamics of interdisciplinary relationships. Given the weak or non-existent guidance of much of interdisciplinary activity by conventional disciplinary rules (as suggested above in 15), the role of various empirical studies of scientific practice becomes particularly important in PhID. The methods and principles applied, and the results they yield should complement and cross check one another. They include at least the following.

a. Good old analysis of published scientific texts, dealing with issues such as meanings of terms, styles of reasoning, structures of arguments, ontological commitments, composition of scientific articles.

b. Observation and participant observation of shop floor disciplinary and interdisciplinary practices. These can produce information about what lies behind the façade of textual facts.

c. Questionnaires and interviews with practitioners in scientific research. While the self-understanding and its verbal expressions (especially in rhetorically intricate situations) of practicing scientists is often limited and sometimes biased, they are a valuable additional source of information about scientific practices and their preconditions – including the possible biases they may exhibit.

d. Interventionist techniques for generating interdisciplinary encounters with the aim of squeezing out information about disciplines and/or interdisciplinarities that would otherwise remain hidden or would be hard to acquire. By provoking such encounters we can force the disciplinary practitioners reveal facts that linger concealed in ordinary disciplinary practices. (This is the hard to achieve ideal of AID; see www.helsinki.fi/tint/aid).

e. Philosophy of interdisciplinarity must itself be an interdisciplinary and inter-field endeavour – it must welcome contributions from the social, historical and cognitive sciences as well as from other branches of philosophy, such as metaphysics, social epistemology, and political and moral philosophy.

Concluding remarks

25. There may be understandable concerns about *whether the very idea of philosophy of interdisciplinarity is justified*. One type of concern derives from perceptions of heterogeneity: interdisciplinarity comes in a huge variety of stripes and colors, it is nothing but a motley rummage of features of scientific practice, so it fails to provide a sufficiently stable and uniformly structured domain for specialized philosophical study. My response would start like this: Given that science at large is tremendously heterogeneous and that particular scientific disciplines are variously internally heterogeneous, the very idea of philosophy of interdisciplinarity is as warranted as are the notion of philosophy of science in general as well as the notion of the philosophy of any particular discipline, such as of biology or economics or archaeology.

Another obvious line of defense is to be explicitly permissive about how to interpret the very idea of PhID. There is a stronger sense of 'philosophy of X' according to which the goal is to develop a *general philosophical theory of X* providing a body of descriptive and/or normative statements and principles that

organize our thoughts about X in a systematic manner. And there is a weaker sense on which the goal is not to develop a systematic general theory of X but rather to conduct *philosophical studies of X* that provide illuminating insights into X by way of applying philosophical concepts and tools to the examination of facets of X. It is evident that PhID must start out with such weaker ambitions. Only the future can tell whether this will lead to PhID in the stronger sense. This depends on the empirical discoveries and theoretical inventions to be made, so should not be based on any a priori commitment.

26. To summarize the justification for the *Call for PhID* that was put forth in the introduction above, philosophy of interdisciplinarity will not only be a most natural next step to take, but it will be *very useful for philosophy of science itself* in several ways, such as these:

> a. PhID will generate more, and more up-to-date and more precise, information about contemporary science in general and specific disciplinary and interdisciplinary practices in particular. Philosophy of science will be more closely connected to science as actually practiced, and empirically better informed. In particular, PhID will help highlight the immense multiplicity and heterogeneity of science. Past philosophy of science has largely focused on what have been conceived as representative cases, often radically streamlined and idealized. PhID will require adding to the domain of philosophy of science further fields and disciplines, their multifarious interrelations, and kinds of scientific activity largely ignored thus far. The inclination of much of philosophy of science to be fascinated by the successes of science and to reconstruct them as consequences of neat disciplined conduct will be reconsidered. Paying attention to the less neat and less disciplined, and much of the time unsuccessful – yet massive and essential -- parts of scientific practice will help in broadening the domain of philosophy of science and in rethinking its own principles of conduct. The resulting image of science will be more nuanced, complex, and variegated.
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> b. PhID will facilitate the much needed *institutional turn* in the philosophy of science simply because disciplines and their dynamic relations – both within academic science and between academia and extra-academic parts of society -- are institutional realities. It will also facilitate a related *cognitive turn* since interdisciplinary dynamics typically involve situations of distributed and extended cognition among various disciplinary experts and technological artifacts. These turns require philosophy of science to become a more interdisciplinary and interfield activity itself.
>
> c. PhID will improve the *practical relevance* of the philosophy of science. This will be particularly beneficial in the conditions of the new regime of accountability – governed by the same forces that drive versions of interdisciplinarity itself, extra-academic transdisciplinarity in particular. Because interdisciplinarity is such a trendy buzz word in contemporary science and science policy, and because both practicing scientists and science policy makers are frequently at a loss when dealing with

interdisciplinary situations, philosophy of science will receive some extra leverage by systematically addressing these issues and by showing the usefulness of its own disciplinary perspectives and methods in illuminating some intricate aspects of interdisciplinarity in contemporary science.

27. However, the self-promotion of philosophy of science by means of launching the philosophy of interdisciplinarity as a research field must happen without compromise and corruption. It must be combined with both critical self-scrutiny and proud self-defense. Philosophy of interdisciplinarity must examine the discipline of philosophy itself by generating relevant comparative information about its peculiar and valuable characteristics – those that must not be sacrificed under the pressure of the new regime of accountability. Philosophy should not be for sale. The standards of measuring the value of its services are not those of biomedicine or geoengineering.

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