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EDITORIAL ARTICLE

Interdisciplinarity in action: philosophy of science perspectives

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Interdisciplinarity has become a dominant research policy imperative[1] – exercised by European Research Council and other funding agencies at different scales – and a substantial topic in science studies fields outside philosophy of science, including science education, research management (particularly team management) and scientometrics. Philosophers of science have only recently begun to dedicate more attention to this feature of contemporary science. The present collection of studies aspires to promote this line of philosophical inquiry in terms of case studies on various aspects of interdisciplinarity in science, and to bring philosophical concepts and principles to bear in its analysis. While much current philosophical work has focused on the possibility of conceptual and methodological unification and integration amongst specific fields, we aim to widen the scope of philosophical treatment of this issue by mapping out the broader landscape of philosophical issues that emerge from interdisciplinary interactions, and by identifying the points where philosophical analysis can make important and relevant contributions. The guiding observations and principles in this endeavour include the following.

[1] There are many more varieties of interdisciplinarity than suggested by typical popular conceptions, which tend to require of interactions that they be integrative and

[1]See for instance National Science Foundation (2008), Impact of Transformative Interdisciplinary Research and Graduate Education on Academic Institutions. Workshop Report; National Academy of Sciences (2006), Facilitating Interdisciplinary Research. Report; European Union Research Advisory Board (2004), Interdisciplinarity in Research.

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collaborative to count. Yet there are varieties of effective and productive interactions across disciplinary borders in which neither integration nor collaboration are substantially involved, but can be just as likely to spur scientific innovation and progress. These types of interaction create important contrast classes for comparing with the currently more conventional models of interdisciplinarity to explore how different scientific practices come into contact and modify each other in different ways. Likewise interdisciplinary interactions, as all scientific engagements, contain multiple processes (e.g. project planning, model development or discovery, model validation) that can be studied distinctly at different scales (from individual projects to the operation of whole fields). The important dimensions along which to study interdisciplinary research and group interdisciplinary processes are still not well understood, so they require further investigation.

[2] It is not the case that interdisciplinarity is intrinsically recommendable, thus normative warrant of interdisciplinary work, as well funded as it tends to be, is an open question. The normative status of any particular item or episode of interdisciplinarity depends on further contingencies, such as the institutional and cognitive situation in the participant disciplines, the ways in which they are related, the practical difficulties of doing interdisciplinary work, and the specific normative standards believed to be appropriate to impose. Philosophy of science is well positioned for the task of developing tools for particularized normative assessment of interdisciplinary methods and practices, as well as the principles and conditions under which it might be warranted and favored to succeed.

[3] Given the above two judgements, it is obvious that the philosophical study of interdisciplinarity must be a study of interdisciplinary processes *in action*, through empirical and case study based techniques (in addition to applying the traditional methods of philosophical analysis, of course). Interdisciplinary interactions and influences are likely to be complex engagements involving a varied range of interpretation and instigation, negotiating and decision-making, as well as frequent misunderstandings, miscommunications and disputes, in which conceptual and methodological challenges are entangled with institutional and emotional issues that lead to a great variety in the manners through which interdisciplinary interactions make (or fail to make) a difference. It is unwise to think that we can understand their scope and variety without a good spread of cases across a variety of fields scrutinized by fine-tuned empirical investigation. Philosophy must consult research done in the history and sociology of science, cognitive science as well as that in scientometrics and the study of science education and science administration; and it must itself be open to applying a variety of (perhaps unconventional) approaches, including varieties of case study as well as ethnographic and experimental methods.

The papers presented here exemplify these principles. In the first paper Mäki offers the first metaphilosophical attempt to lay out what a systematic philosophical investigation of interdisciplinarity should look like, taking into account the broad scope and heterogeneity of interdisciplinary phenomena. After a period of focused efforts in the philosophies of various special disciplines (biology, chemistry, cognitive science, economics, and so on), time is ripe for the next step for which there is strong current demand, that of philosophy of interdisciplinarity (PhID). PhID will produce comparative information about the similarities and differences between fields and disciplines as well as contactual information about what happens when disciplines are brought in contact with one another. In addressing the broad range of issues in interdisciplinarity,

PhID will mobilize a wide array of tools in philosophy of science as well as other parts of philosophy, such as social ontology and political philosophy – thus PhD will also promote interfield interactions within philosophy.

The next paper in the issue also tries to broaden the scope of what we consider interdisciplinarity to be. One widespread view in current interdisciplinarity scholarship is that "proper" interdisciplinarity and "integration" are closely associated to the point that interdisciplinarity is often implicitly defined in terms of the latter to distinguish it from multidisciplinarity, which is considered non-integrative and thus a less substantial form of interaction. This attitude may derive from a unificationist normative expectation that the success of an interdisciplinary project flows from the degree of integration achieved between the fields involved. Grüne-Yanoff uses the cases of evolutionary game theory and hyperbolic discounting to show that this view is shortsighted. Non-integrative interactions took place across disciplinary borders in both these cases, principally the exchange of models and concepts, prompting innovation and success according to the usual measures we apply to science like explanatory success. Treating "integration" as constitutive of interdisciplinarity, and the central reason for desiring and promoting cross-border interactions, is too narrow a view, restricting us from recognizing other potentially epistemically desirable or productive cross border interactions as valid forms of interdisciplinarity.

As already emphasized, the modes through which fields and disciplines might productively interact to common advantage are broad and various, and different epistemological principles may underlie these interactions, and these principles are in need of clarification. Kuorikoski and Marchionni look at the case in which fields combine different evidential techniques as a potential case of triangulation. They consider specifically the use of neuroeconomic experiments for the triangulation of economically relevant phenomena, arguing that the principle of independence governing triangulation poses limits to external validity of neuroscientific evidence. This investigation demonstrates the role of philosophical analysis in describing the conditions under which interdisciplinary interactions can offer affordances to different research communities.

A common non-collaborative channel through which interdisciplinarity happens is the sharing of mathematical model templates (Humphreys 2004). Template exchange gives rise to its own complex interdisciplinary interactions, and the degree to which links can be made between the fields involved may help determine the success of an exchange. Indeed while we might be accustomed to thinking of model templates as formal easy to adapt structures, this may not always be the case. Knuuttila and Loettgers show in the case of transfer of the Ising model into economics that computational or formal features of the model are not always the sole determinant of how a template is received and applied. The conceptual content the template brings from its original field (in this case physics) matter as well, which complicates the reception of the template when disciplinary boundaries are being crossed. Disciplines need to make use of conceptual content from the original field in order to incorporate and interpret the template, and thus need to harmonize this content with their own conceptual frameworks. Inability to do so may produce, as Knuuttila and Loettgers argue in this case, relatively thin analogue models that lose a lot of their original insight and justification. Template exchange offers an opportunity to further investigate the role that disciplinary constraints play in the success and failure of interdisciplinary interactions.

MacLeod and Nersessian pursue another relatively under-studied dimension of interdisciplinary interactions, which is the discovery or problem-solving processes that take place during collaboration. These processes are hard to study, and likely require fine-tuned empirical investigation like ethnography to unearth as well as cognitive, philosophical and sociological perspectives to interpret. Yet the rewards of doing so is that we can begin to understand how interdisciplinary problem-solving contexts might diverge from disciplinary one when disciplinary constraints are less in force. Using the results of a 5-year ethnographic study of labs in systems biology, they find a considerable divergence in the way research takes place in this collaborative field (involving engineering and molecular biologists) from disciplinary forms, requiring novel techniques of problem-solving. These techniques have various costs, but can be rationalized as normatively desirable given the circumstances and other cognitive and collaborative constraints researchers in the field must operate with, and serve as general lessons for particular types of collaborative interdisciplinary approaches.

Lastly Koskinen and Mäki expand the horizons beyond the academic sphere and address issues in a powerful trend in research and research policy, that of extra-academic transdisciplinarity. Here academic and extra-academic contributions are called to join forces and to pursue solutions to pressing practical problems in society, from alleviating global poverty to designing ecologically and socially sustainable urban environments. The situation exhibits a plurality of viewpoints, those from various scientific disciplines as well as from extra-academic participants such as business firms, indigenous communities, and NGOs. Those endorsing scientific pluralism in philosophy of science (Kitcher, Longino, Wylie and others) should welcome this plurality, but the authors show that challenging complications arise as the extra-academic participants may bring a variety of beliefs and standards to the epistemic blender such that they are not in harmony and smoothly reconcilable with their scientific counterparts. Moreover, there may be power asymmetries in place, and there is no guarantee that science has an upper hand in these situations; this means that possible conflicts may not always be resolved in ways that are acceptable in terms of scientific standards.

The sample of studies collected in this special issue provides just a small selection of examples of the sorts of issues that interdisciplinarity keeps generating for philosophy of science to adopt onto its agenda. There is a vast and fertile ground here awaiting an unlimited number of further studies. It is easy to anticipate that the analysis of interdisciplinarity in its various guises will be one of the major directions of future philosophy of science.