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## Introduction

### Introduction—Grand Challenges and small steps

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#### ABSTRACT

This collection addresses two different audiences: 1) historians and philosophers of the life sciences reflecting on collaborations across disciplines, especially as regards defining and addressing Grand Challenges; 2) researchers and other stakeholders involved in cross-disciplinary collaborations aimed at tackling Grand Challenges in the life and medical sciences. The essays collected here offer ideas and resources both for the study and for the practice of goal-driven cross-disciplinary research in the life and medical sciences. We organise this introduction in three sections. The first section provides some background and context. The second motivates our take on this topic and then outlines the central ideas of each paper. The third section highlights the specificity and significance of this approach by considering: a) how this collection departs from existing literature on inter- and trans-disciplinarity, b) what is characteristic about this approach, and c) what role this suggests for the history and philosophy of the life sciences in addressing Grand Challenges.

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*Intelligent practice is not the step-child of theory.  
On the contrary theorizing is one practice amongst others  
and is itself intelligently or stupidly conducted (Ryle, 1963, p. 27).*

*Life scientists have to acknowledge and accept  
that society is co-shaping their agenda.  
Scientists should also realise that vice versa they co-shape society,  
rather than just offering knowledge and tools.  
In other words, science and society co-evolve  
(Swierstra, Vermeulen, Braeckman, & van Driel, 2013, p. 2)*

#### 1. Why should historians and philosophers of biology and biomedicine care about Grand Challenges?

Readers of this journal have already been introduced to the challenge of integration in the life sciences by a special issue which appeared in 2013 (vol. 44, issue 4, part A). While that issue focused mainly on integration *within* the biological and biomedical

sciences, the present issue focuses primarily on integration with other disciplines and with stakeholders outside academia. The previous special issue was mainly an answer to the transformations effected on the biological sciences by the emergence of synthetic biology and integrative biology. This new collection addresses the growing demand that the sciences direct their efforts to the problems faced by contemporary societies and individuals. This tendency critically affects the biological and biomedical sciences, both because there is a widespread belief that their growing importance and impact makes this the century of biology and biotechnology (Dwyer, 2008; Dyson, 2007; Rifkin, 1998; Rose, 2007; Venter & Cohen, 2004) and because the life sciences and medicine have a fundamental role to play in addressing many urgent human, social and ecological problems (Losos et al., 2013; National Research Council, 2009; Robinson et al., 2010; Wake, 2008). The papers collected here offer a good sample of domains of research where biological and biomedical sciences meet key issues of our times: the concept of *wellbeing* considered by Efstathiou and that of *integration* scrutinised by O'Rourke, Crawley and Gonnerman, the fields of *sustainability science* examined by Thorén & Breian, *conservation biology* analysed by Brister and *public health* discussed by De Grandis.

Grand Challenge-based funding calls have their origins in quite focused funding programmes, such as the Bill and Melinda Gates

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<sup>1</sup> The editors are joint first editors and listed alphabetically; both contributed in equal measure to the completion of this collection.

Foundation “Grand Challenges for Global Health” programme.<sup>2</sup> Such specific Grand Challenges soon became popular among biologists too (Fernie, 2012; Gilroy, 2011; Halanych & Goertzen, 2009; Mykles, Ghalambor, Stillman, & Tomanek, 2010; Schwenk, Padilla, Bakken, & Full, 2009).<sup>3</sup> But now the concept of Grand Challenges is becoming more ambitious: it increasingly indicates the great problems of our age, which can be understood and tackled only through engaging both scientific knowledge and reflections on the goals of societies and on the forms of good human lives (for an example of this broader meaning of Grand Challenges in the biological literature see Frommer, 2010; for an analysis that distinguishes narrow and ambitious uses of the notion of Grand Challenges see Efstathiou, 2016).

Take for instance Horizon 2020, the European Commission’s current research framework. Horizon 2020 allocates 31,748 million euro to “Tackling Societal Challenges” several of which cut across life and medical science and social sciences domains.<sup>4</sup> For instance:

- health, demographic change and wellbeing,
- secure, clean and efficient energy, or
- climate action, environment, resource efficiency and raw materials.

Such challenges are to be addressed by collating expertise across academic disciplines, industry and policy arenas and by producing outcomes that span research to market outputs and are accepted and endorsed by the public.

Grand Challenge calls are the latest expression of a consolidated trend in science policy: namely directing scientific research towards tackling problems that appear urgent and important, instead of waiting that the benefits of research have a spontaneous spillover (see Frodeman, 2016). Such policy trends are the proper subject of critical scrutiny on many levels. Which criteria are used in framing problems as worthy of special attention, how resources are to be allocated among different programmes, what kinds of research are privileged, but also whether funding research is actually an effective, worthwhile and equitable strategy for mitigating grand, cross-cutting and at times urgent problems are all important questions to raise (cf. Bos, Walhout, Peine, & van Lente, 2014; Brooks, Leach, Lucas, & Millstone, 2009; Edwards, 2008; Sarewitz, 1996; Zachary, 2013).

But this is not a collection of critical examinations of current science policy. Although we are fully convinced that such critical work is extremely important and badly needed, here we consider the impact of these policies on how research is carried out: the opportunities and challenges that transdisciplinarity generates for researchers and for their non-academic partners (cf. a recent Special Issue of *Nature* that appeared in September 2015). Funding schemes like Grand Challenges are with us: they exemplify what scientific research is becoming in the post *laissez faire* science policy regime and, more mundanely they make significant resources available. It is therefore of the greatest relevance to illustrate and understand which research practices they assume or mandate.

<sup>2</sup> Bill and Melinda Gates Foundation, “Grand Challenges” available at: <http://grandchallenges.org>; “Grand Challenges Canada” available at: <http://www.grandchallenges.ca> (last accessed: 05.07.2015).

<sup>3</sup> The first three papers are part of a long series of articles on Grand Challenges in the Journal *Integrative and Comparative Biology*.

<sup>4</sup> Horizon 2020 “Societal Challenges” available at: <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges> (Last accessed: 05.07.2015). The UK Research Councils similarly specify six “big challenges” as in need of cross-disciplinary research several of which would also involve work spanning the life sciences; see <http://www.rcuk.ac.uk/research/xrcprogrammes/> (last accessed: 05.07.2015).

To put it another way, science policies are interesting and important in two ways. We can enquire both 1) how policies are produced in order to expose and assess their assumptions, values and justification, and 2) what research opportunities, practices and challenges they create. The first kind of inquiry can be described as the philosophy of science policy (see for instance Frodeman, 2014; Guston, 2000; Guston and Sarewitz, 2006; Sarewitz, 1996), the second as the philosophy of science in practice (Ankeny, Chang, Boumans, & Boon, 2011). Adopting this latter perspective, this collection focuses on how Grand Challenges and interdisciplinary integration change the practices of the biological and medical sciences and in so doing gradually reshape their methods and ethos. However, we want to insist that our focus should not be taken to suggest that this task should be given priority over a critical appraisal of science policy formation, nor as a sign of uncritical acceptance of the rhetoric of Grand Challenges. We believe that both are necessary and they often overlap.

## 2. The content of this collection

### 2.1. Two hurdles for cross-disciplinary work on Grand Challenges: translation and integration

The contributions in this volume suggest that working successfully across scientific disciplines, public sectors and civil society on socially relevant issues can itself be a Grand Challenge. The first challenge is how to address problems that arise in ‘wild’, uncontrolled environments in systematic and principled ways. Grand Challenges may resist neat causal analysis because they are neither isolated, nor static, and furthermore they are altered by human interventions, which in turn are influenced by a bewildering arrays of factors: emotional, cognitive, cultural and so on and so forth. The second challenge is that different scientific disciplines have profoundly different subjects, objectives and ethos and thereby very different epistemic cultures, standards and values. We thus identify two hurdles for cross-disciplinary work on Grand Challenges<sup>5</sup>: 1) a problem of adaptation that following a trend coming from the clinical sciences we call a problem of **translation**<sup>6</sup>—i.e. of adapting knowledge about some “controlled” environment to “wild” environments and 2) a problem of cultural-epistemic **integration**—i.e. how to enable disciplines in the biological and medical sciences to

<sup>5</sup> We use the term cross-disciplinary to encompass multi-, inter- and trans-disciplinary work. For the purposes of this collection the most important concepts are those of interdisciplinarity and transdisciplinarity. Most of the historical and theoretical work on the obstacles of crossing boundaries and methods for bringing together people with different expertise has used the concept of interdisciplinarity (cf. e.g. Frodeman et al., 2010; Klein, 1990). Recently transdisciplinarity has increasingly been used to identify research that includes extra-academic partners (industry, NGOs, public sector, civil society). In this particular, but now popular, understanding it is clearly central to Grand Challenges.

<sup>6</sup> We borrow the word ‘**translation**’ from what is called ‘translational clinical science’ (or ‘translational medicine’), an enterprise well explained by the slogan ‘from bench to bedside’, i.e. by the process of trying to bring basic research to use in real-world circumstances. In philosophical terms this is the problem of external validity, or of how to extrapolate results that are validated in a controlled but specific environment to a new target context. The problem is further complicated by what philosophers call “unstable enablers”, and by variables that cannot be controlled and/or operationalised into parameters. A further useful concept here is the biological concept of **exaptation**, which refers to the use of something for a purpose different from the one for which it had evolved. While translation emphasizes an intentional effort, exaptation captures the random and unintended path of some discoveries to their practical application. Adaptation of research to reality happens in both ways—deliberately and erratically—but we have decided to use ‘translation’ because it is becoming a familiar term—beginning to appear also in environmental science and science policy—while exaptation still sounds rather esoteric. Furthermore, the process is becoming increasingly planned and intentionally driven.

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