



Internal use 846133

Application for a Grant

Identification						
This page will be made available to selection committee members and external assessors.						
Funding opportunity Insight Grants						
Joint or special initiative						
Application title Standards, Aims, and Values: Biological Explanation and Beyond						
Applicant family name Brigandt			Applicant given name Ingo		Initials	
Org. code 1480111	Full name of applicant's organization and department University of Alberta Philosophy					
Org. code 1480111	Full name of administrative organization and department University of Alberta Philosophy					
					Research Group 435-1	
Does your proposal require a multidisciplinary evaluation?						Yes <input type="radio"/> No <input checked="" type="radio"/>
Is this a research-creation project?						Yes <input type="radio"/> No <input checked="" type="radio"/>
Does your proposal involve Aboriginal Research as defined by SSHRC?						Yes <input type="radio"/> No <input checked="" type="radio"/>
Does your proposal involve human beings as research subjects? If "Yes", consult the <i>Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans</i> and submit your proposal to your organization's Research Ethics Board.						Yes <input type="radio"/> No <input checked="" type="radio"/>
Does any phase of the proposed research or research-related activity:						
A. Constitute a physical activity carried out on federal lands in Canada, as defined in sub-section 2(1), in relation to a physical work and that is not a designated project;						Yes <input type="radio"/> No <input checked="" type="radio"/>
B. Constitute a physical activity carried out outside of Canada in relation to a physical work and that is not a designated project;						Yes <input type="radio"/> No <input checked="" type="radio"/>
C. (i) Permit a designated project (listed in the CEAA 2012 Regulations Designating Physical Activities (RDPA)) to be carried out in whole or in part;						Yes <input type="radio"/> No <input checked="" type="radio"/>
C. (ii) Depend on a designated project (listed in the RDPA) that is, or will be, carried out by a third party?						Yes <input type="radio"/> No <input checked="" type="radio"/>
	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Total funds requested from SSHRC	<u>17,752</u>	<u>26,105</u>	<u>38,577</u>	<u>26,909</u>	<u>26,150</u>	<u>135,493</u>



Family name, Given name

Brigandt, Ingo

Participants

List names of your team members (co-applicants and collaborators) who will take part in the intellectual direction of the research. Do not include assistants, students or consultants.

Role

Co-applicant

Collaborator

Family name

Malaterre

Given name

Christophe

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Full organization name

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Department/Division name

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Role

Co-applicant

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Marc

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University of Calgary

Department/Division name

Philosophy

Role

Co-applicant

Collaborator

Family name

Green

Given name

Sara

Initials

Org. code

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Full organization name

University of Copenhagen

Department/Division name

Department of Science Education

Role

Co-applicant

Collaborator

Family name

O'Malley

Given name

Maureen

Initials

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Full organization name

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Department/Division name

Philosophy

Role

Co-applicant

Collaborator

Family name

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Given name

Heather

Initials

Org. code

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Full organization name

University of Waterloo

Department/Division name

Philosophy



Family name, Given name

Brigandt, Ingo

Participants (cont'd)

Role

Co-applicant

Collaborator

Family name

Fehr

Given name

Carla

Initials

Org. code

1351111

Full organization name

University of Waterloo

Department/Division name

Philosophy

Role

Co-applicant

Collaborator

Family name

Given name

Initials

Org. code

Full organization name

Department/Division name

Role

Co-applicant

Collaborator

Family name

Given name

Initials

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Full organization name

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Role

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Role

Co-applicant

Collaborator

Family name

Given name

Initials

Org. code

Full organization name

Department/Division name



Research Activity

The information provided in this section refers to your research proposal.

Keywords

List keywords that best describe your proposed research or research activity. Separate keywords with a semicolon.

explanatory aims; explanatory and methodological standards; epistemic values; social values; explanation; modelling; scientific practice; systems biology; evolution of complexity; gender and human evolution; biology education; metaphilosophy

Disciplines - Indicate and rank up to 3 disciplines that best correspond to your activity.

Rank	Code	Discipline	If "Other", specify
1	55014	Philosophy of Science and Technology	
2	55099	Other Philosophy	Feminist Philosophy
3	61299	Other Education	Science Education

Areas of Research

Indicate and rank up to 3 areas of research related to your proposal.

Rank	Code	Area
1	360	Science and technology
2	213	Gender Issues
3	342	Post-Secondary Education and Research

Temporal Periods

If applicable, indicate up to 2 historical periods covered by your proposal.

From	To
<p>Year</p> <p>_____ BC AD</p> <p>_____ ○ ○</p> <p>_____ ○ ○</p>	<p>Year</p> <p>_____ BC AD</p> <p>_____ ○ ○</p> <p>_____ ○ ○</p>



Family name, Given name

Brigandt, Ingo

Research Activity (cont'd)

Geographical Regions

If applicable, indicate and rank up to 3 geographical regions covered by or related to your proposal. Duplicate entries are not permitted.

Rank	Code	Region
1		
2		
3		

Countries

If applicable, indicate and rank up to 5 countries covered by or related to your proposal. Duplicate entries are not permitted.

Rank	Code	Country	Prov./ State
1			
2			
3			
4			
5			



Family name, Given name

Brigandt, Ingo

Response to Previous Critiques - maximum one page

Applicants may, if they wish, address criticisms and suggestions offered by adjudication committees and external assessors who have reviewed previous applications.

Empty response area for addressing criticisms and suggestions.



Family name, Given name

Brigandt, Ingo

Summary of Proposal

The summary of your research proposal should indicate clearly the problem or issue to be addressed, the potential contribution of the research both in terms of the advancement of knowledge and of the wider social benefit, etc.

Philosophy of science has traditionally construed and studied science in terms of representations of the natural world, such as data and theories. Yet as an additional dimension, my approach will emphasize values held by scientists, including explanatory and other investigative aims as well as methodological and explanatory standards. Particular aims and standards need to be philosophically made explicit to critically evaluate scientific frameworks and to understand the process of science and practice of scientists. For the specific aims and standards that come to be accepted by a group of researchers account for (changes in) their practice. Indeed, even though some of my project is framed in terms of 'scientific explanation,' I will show that this philosophical issue needs to be approached from the larger practice in which explanations are developed, with an eye on how the role of values in scientific inquiry is a matter of public concern.

My project will develop and illustrate this philosophical framework based on case studies from three biological domains. (1) In the context of systems biology, which mathematically models the operation of molecular and cellular systems, I will investigate how different models are used in a coordinated fashion. Attention will be paid to the modelling strategies used and the representational or explanatory aims that necessitate the joint use of several models. (2) In the case of the evolution of complexity, I will investigate some scientific disagreements about explanatory frameworks and standards. Models of the evolution of multicellular animals as well as multispecies microbial communities attempt to capture this complexity while still making various idealizations, and I will study what representational aims can justify such simplifications. (3) Apart from epistemic values (e.g., explanatory scope), there are social and environmental values. Philosophers have argued that also the latter matter in science, but I set out to articulate a stronger role for social values, exploring the implications for scientific objectivity. Focusing on feminist values, I will develop this position in the domains of human evolution and the social behaviour of non-human primates.

In the first three years of this 5-year project, I will investigate these three domains based on interactions with leading philosophers and biologists; and in year 3 I will host a collaborative research meeting that will bring together philosophers to discuss in-depth the role of epistemic, social, and other values across biology. In the last two project years, I turn to writing a book, as this is a compelling way to lay out my philosophical framework on values, aims, and standards in detail and to illustrate its fruitfulness by application to several case studies from different areas of biology. I will also use the collaborative activities to produce a guest-edited journal special issue, conference symposia, and other publications.

In parallel to the book manuscript writing and the editing, in the last two project years I will tackle two further subprojects, which will use my framework on aims and standards to have impact beyond philosophy of science. One subproject aims to contribute to science education scholarship, which by means of proposals for the teaching of evolution will show how to teach not only the content of science but the practice of science, including scientists' aims and standards. The second subproject is a metaphilosophy project contributing to analytic philosophy, which intends to show how the common philosophical practice of using intuitions can be improved by more explicit reflection on philosophical aims and standards, which I will illustrate in the context of philosophical debates about reference and concepts.

DETAILED DESCRIPTION OF PROGRAM OF RESEARCH

Objectives:

I will develop and apply to concrete biological cases a philosophical framework that views science not only in terms of various representations of natural phenomena (data and theories), but that also conceptualizes the values held by different scientists, e.g., the explanatory standards and methodological strategies used and the particular research aims pursued in a context. Some of the subprojects will take my research well beyond my past work in philosophy of biology, by setting up disciplinary connections to feminist philosophy, science education, and core analytic philosophy. My individual objectives are to:

- Understand how different mathematical models are combined in systems biology, and what explanatory aims mandate and what strategies guide the joint use of several models;
- Examine (divergent) explanatory standards in interdisciplinary studies of the evolution of complexity, and scrutinize what representational aims can justify simplifications in models of complexity;
- Articulate a role for social (e.g., feminist) values in the case of scientific theory appraisal, where such values matter even for human evolution and non-human primate behaviour research;
- Contribute to science education scholarship in the context of the nature of science by means of proposals for the teaching of evolution that beyond the content of evolutionary theory emphasizes scientists' changing practice based on explanatory aims and standards;
- Develop an improved method in analytic philosophy beyond the use of intuitions by viewing philosophical concepts as tied to philosophical aims and standards, and use this link to contribute to philosophical accounts of reference and concepts;
- Publish a book on standards, aims and values in biology, where interaction with leading researchers will contribute to developing the account for particular biological cases; and
- Use this collaboration to produce an edited collection (e.g., journal special issue) on epistemic, social, and environmental values across biology, other publications, and conference symposia.

Context and Significance:

In line with the diversity of scientific fields, nowadays philosophy of science uses a variety of epistemological notions to articulate scientific theorizing—including data, evidence, law statements, explanations, models of mechanisms, mathematical models, and theories. My starting point is that all these philosophical terms denote representations of nature. As an additional epistemological dimension, my approach will conceptualize different kinds of *values held by scientists*, including scientific aims and standards. For instance, a group of scientists may currently aim at explaining a certain phenomenon or have come to view an issue as a problem in need of solution. Methodological and explanatory standards are used to judge the adequacy of an explanatory framework or the completeness of a scientific account.

Scientific aims and standards are not representations of *nature*; they are values for *scientific practice and theorizing*. Going beyond representations of the natural world, scientists' values need to be philosophically conceptualized. Aims and standards have to be exposed in order to normatively *evaluate* the appropriateness of scientific endeavours and theories. Moreover, in addition to the products of science (e.g., explanatory theories), philosophy of science has recently come to study the process of science and the practice of scientists. Aims and standards also have to be made explicit to philosophically understand scientific practice, given that the aims pursued and methodological or explanatory standards endorsed guide scientists' practical activities. Indeed, even though some of my study is framed in terms of 'scientific explanation,' I will highlight how this issue needs to be

approached from the overall practice in which explanations are developed. Rather than overarching aims of science as a whole, I am concerned with very specific standards and local aims (e.g., creating a model of a certain molecular system that merely shows which system component most strongly impacts some system output to be technologically controlled). The reason is that new aims and standards that come to be accepted by a group of researchers account for changes in their practice. And how disagreements about aims and standards impact a scientific field is a matter to be investigated by philosophers.

To be sure, case studies of concrete biological research by philosophers of biology have implicitly addressed particular scientific aims and standards. But my project will argue for the importance of adding such concepts as ‘explanatory aim’ and ‘explanatory standard’ to the epistemological toolkit of general philosophy of science. Likewise, while social values have been addressed in philosophical accounts of the relation of science, society, and values and in feminist philosophy of science, I will tie social values to general philosophy of science topics such as explanation. In addition to this general philosophical framework, my account will provide insights by the detailed investigation of the role of aims and standards in several concrete instances from different biological domains, which to date have received only limited philosophical discussion.

Methodology and Research Activities:

In the first three years, my research will comprise three subprojects (detailed below), each of which addresses a different biological domain. Ideas will be generated in a collaborative fashion, involving the researchers detailed in the ‘Research Team’ section. Initially I will interact with the persons tied to a particular subproject, but in the 3rd project year all collaborators will be brought together at a research meeting to discuss the role of epistemic, social, and environmental values across the biological sciences.

While I plan to also publish individual papers stemming from this work (some in collaboration), a monograph is the most compelling way to lay out my general philosophical framework on standards, aims, and values in detail, and to demonstrate the framework’s fruitfulness by how it illuminates several case studies from different areas of biology. Consequently, in the last two years of this 5 year project I will write a book manuscript, resulting in the publication of my first book.

In parallel to the writing of the book, in years 4 and 5 I will work on two further subprojects, in which my framework on aims and standards will contribute to fields beyond philosophy of science—one subproject on science education and the other on method in analytical philosophy (see below for a detailed description). Using the momentum generated by the collaborative research meeting, I will also edit a collection of papers, preferably a journal special issue, on different values across biology.

1. Coordinating different models and strategies: systems biology

Systems biology studies the operation of complex molecular and cellular systems. Its characteristic method is the use of mathematical models and computer simulations (Boogerd et al. 2007, Klipp et al. 2010). In the last few years, systems biology has attracted the attention of philosophers of biology (Bechtel 2013, Bechtel and Abrahamsen 2011, Braillard 2010, Green 2013, Issad and Malaterre 2015, Levy and Bechtel 2013, Mekios 2015). Most of these discussions scrutinize the notion of mechanistic explanation, i.e., the causal explanation of a whole in terms of its organized and interacting parts. While enormously popular as an account of explanation in molecular biology and related areas (Bechtel and Abrahamsen 2005, Craver 2007, Darden 2005), accounts of mechanistic explanation have neglected the role of mathematical modeling and have sometimes been advocated as a replacement for the traditional view of explanation as the derivation from laws and quantitative principles (Craver 2006, Winther 2006). As a result, current discussions argue that only a broader or different philosophical conception of mechanistic explanation could capture the mathematical models of systems biology.

Germane to these ongoing explorations, I will investigate certain ways of mathematically analyzing

dynamical models, e.g., bifurcation analysis and sensitivity analysis. I aim at articulating how these analyses provide *explanatory* insights that go beyond showing that a phenomenon is produced by the mechanism's operation—and thus beyond 'mechanistic explanation' as understood even by philosophers who include mathematical modeling (Baetu 2015), typically under the label of 'dynamic mechanistic explanation' (Bechtel 2012, Bechtel and Abrahamsen 2010). Moreover, using recent arguments that there can be purely mathematical explanations of physical phenomena (Baker 2005, 2009, Baker and Colyvan 2011, Lange 2013), I will assess whether there can be *non-causal* explanations in molecular biology, by means of examining the modeling of molecular phenomena touching upon biochemical and biophysical domains, where part-whole mechanisms are unlikely to capture the phenomenon.

Yet the main focus of my subproject on systems biology goes beyond current philosophical discussions pertaining to causal-mechanistic explanation, and introduces my overarching theme of scientific aims, standards, and strategies. Given that a systems biology research project can use several different models—a model enabling the next research step using another model, or the joint use of several models at one research step—I will investigate how such a *coordinated use* of models works. Based on a series of systems-biology studies that use dynamical models (but may also include network topology models) to understand one cellular domain, I will discuss what contextual strategies and modeling aims motivate and justify the development of a mathematical model, which among all physical features pick out a 'system' by representing only certain (types of) molecular entities and interactions and makes specific modeling assumptions. I will also address what scientific aims and standards require and guide the coordinated use of several models. While in discussions of explanations philosophers have aimed to offer ideal standards for when a finished model is an explanation (Craver 2007), I lay out how in scientific practice models are developed and reworked and one model can be used for explanatory *and non-explanatory* aims, so that philosophical accounts of explanation need to broaden their scope.

2. Explanatory standards and idealization strategies: the evolution of complexity

Theory reduction, the idea that the knowledge of one scientific field can be deduced from a more fundamental theory, is philosophically outdated; instead, insights about the relation of fields can increasingly be gained by understanding how ideas from several different fields are integrated or at least coordinated (Bechtel 2006, 2013, Brigandt 2013c, Brigandt and Love 2012b, Craver and Darden 2013).

One interesting domain to philosophically study ongoing integration is the intersection of evolution and development ('evo-devo'), in particular the scientific problem of accounting for the evolutionary origin of novel structures. For in addition to major biological efforts being devoted to this, accounting for the evolution of novelty requires the resources of many biological fields, including phylogeny, paleontology, developmental biology, morphology, and evolutionary genetics. Given that the evolution of novelty is a complex set of several related questions, Alan Love has introduced the notion of a 'problem agenda' (Love 2008). In collaboration, we have argued that a shared problem agenda not only motivates, but structures integration, as a problem agenda is tied to criteria of explanatory adequacy that entail which intellectual contribution (and what disciplines) are needed, and because problem agendas have an internal structure that foreshadows how the various contributions are to be integrated (Brigandt 2010a, Brigandt and Love 2012a, Love 2013c). This recent account of integration illustrates the fruitfulness of my overall theme of philosophically conceptualizing aims, standards, and other values, given that a problem agenda is a scientific aim and criteria of explanatory adequacy are standards.

Even though evolutionary developmental biology is an integrative approach, there are some disagreements about the adequacy of different explanatory frameworks, e.g., some prefer an account of evolutionary novelty in terms of changes in gene regulation while others insist on a framework that includes more than genes (Love and Lugar 2013). There are also open issues as to how evo-devo's focus on structure fits with mainstream evolutionary biology's focus on selection and population genetics. I will investigate such *divergent explanatory standards*, and given that some of them are held tacitly, in

my interactions with biologists I will work to make them more reflective about the standards and values used by them and other biologists, so as to contribute to resolving scientific discord.

But beyond past accounts of individual novel structures, most of my investigations will move to the evolution of complexity. The latter adds a mathematical component, e.g., to capture the operation of large gene regulatory networks and complex cell signaling networks (Green et al. 2015a, Soyer and O'Malley 2013). Moreover, despite the traditional focus on multicellular animals, the evolution of complexity also includes the surprisingly sophisticated interaction in multispecies microbial communities and between microbes and humans (Cryan and Dinan 2012, Klitgord and Segrè 2011, Philippot et al. 2010), which philosophers have just come to recognize as a domain in need of study (Ereshefsky and Pedrosa 2013, O'Malley 2013a). I will investigate how such models combine changes across physiological-developmental time and across evolutionary time. Even in the presence of copious data, such computational models must make simplifications (Norton 2012), and researchers attempt to capture complexity and emergent phenomena by making idealizing assumptions (Batterman 2009, Weisberg 2007, Wimsatt 2007) or partitioning the system spatially or temporally. My focus will be on understanding what representational or explanatory aims can *justify such simplifications*, and to which extent a model is valid in its context only, where relative to other aims a different model is needed.

3. How social and feminist values impact theory appraisal: primatology and human evolution

The first two subprojects address epistemic standards, aims, and values, but my project will also discuss the role of *social and environmental values*. In addition to granting that such non-epistemic values obviously may be used in the choice of research projects and the application of scientific knowledge, there is a prominent argument that non-epistemic values matter even in the context of theory acceptance: The more severe the social consequences of accepting and acting on a reasonably supported, but actually false theory would be, the higher an evidential threshold is to be demanded before accepting the theory (Brown 2013, Douglas 2000, Elliott 2011, Rudner 1953, Steel 2013). Douglas (2009) articulates this in terms of an 'indirect role' for values: social values modulate the evidential threshold, but they do not replace evidence or lead to a theory being accepted because it aligns with one's social agenda. While this is intended as safeguard against the improper use of values, my project is to argue for a stronger role for social values—even in the case of theory appraisal—and address worries about scientific objectivity.

Arguments for social values like the above presuppose a segregation of different research steps, as social values may play a direct role at most steps (e.g., research project choice), but only an indirect role in the context of theory acceptance (Douglas 2009). Using concrete examples, I will criticize any philosophical strategy that assumes that the illicit use of a value can be articulated in terms of an isolated step of research. One possible objection is that sometimes a critical evaluation of research cannot assign blame to an individual research step regardless of the outcome it only yields in combination with other steps. I will also investigate instances from biology and climate science where scientific concepts and categories embody implicit value judgments, and categories used affect all steps of research.

Douglas (2009) endorses the idea that the relevance of social values decreases to nil when the amount of evidence increases, given that upon sufficient evidence any evidential threshold is met. In contrast, I set out to develop an account that accords social values a stronger role, by arguing that a scientific theory's conditions of adequacy are determined not only by epistemic values, but also social values. Conditions of adequacy include what makes a theory explanatory, complete and unbiased (Anderson 1995), and/or practically applicable. I will develop this account based on theories of human evolution and primate social behaviour, which in the past have exhibited strong androcentric biases, e.g., a focus on the social role of male primates and men's innovations in the course of becoming modern humans (Fehr 2011, Lloyd 1993, 2005, Schiebinger 1999). While it is controversial whether some scientists used a feminist agenda when remedying some of the bias (Fedigan 1997, Kourany 2010, Wylie and Hankinson Nelson 2007), I will explore the interesting question of whether a normative case

can be made that feminist values pertaining to humans (e.g., gender equity) matter even in the case of theories about *non-human* primates. My innovative idea that epistemic and social values can jointly determine the adequacy conditions of scientific theories would provide new reasons to doubt the dichotomy between epistemic and non-epistemic values (Longino 1996). Theory acceptance depends on the particular conditions of adequacy, which stem from the purpose for which a theory is being developed and used. Given that on my approach theory appraisal is also influenced by social aims, I have to discuss why (or when) this does not undermine scientific objectivity.

4. Science education and the value-based nature of science

While my first three subprojects cover philosophy of science issues in three different domains of biology and form the basis for my book project, in the last part of the overall project I will use my standards, aims, and values framework to contribute in two areas beyond the philosophy of science. The first one is science education scholarship. I will provide guidelines for science instruction that makes students more reflective about the *nature of science* and develop proposals on the teaching of evolution.

While some science educators proceed from a ‘consensus view’ about the nature of science that generically covers all disciplines (Lederman 2007, McComas et al. 1998, Osborne et al. 2003), others caution that this fails to capture the heterogeneity of science and the distinctive features of actual research (Allchin 2011, Rudolph 2000, Tala and Vesterinen 2015, van Dijk 2011). My strategy will be to develop teaching guidelines that use general notions (e.g., ‘explanatory aim’), but illustrate them in the concrete context of evolutionary biology. While science education focuses on the *content* of theories, I will include aspects of the *practice* of science, including diverse and historically changing methods and standards, and other value-related considerations. My focus will be on how explanatory aims originate in an empirical context and how new methodological and explanatory resources are developed for the purpose of a particular problem. Beyond teaching about the nature of science, my emphasis on explanatory aims is meant to enhance student engagement by making students see explanations not just as scientific facts, but as addressing an interesting problem, and to connect different explanations found in the biology classroom as addressing the same problem.

I will make this concrete by means of lesson plan suggestions for evolution in grade 11 and 12, which will cover different cases from the current practice and recent history of evolutionary biology. I may include examples of how collaborative and interdisciplinary biology operates and how trust within science works, so as to promote trust in scientific results that one cannot comprehend. I also plan to develop suggestions on how to explain cellular and organismal systems without the common though problematic use of machine and information metaphors (e.g., favoured by intelligent design proponents).

5. Metaphilosophy: beyond the use of intuitions

There are many central philosophical concepts (e.g., knowledge, reference, intentional agency, and causation), and the task is to develop the best account of each such concept. Across different fields of philosophy, a common method is to use *intuitions* to defend and criticize philosophical accounts (Nagel 2012). For instance, the intuitions elicited by Gettier cases were used to reject the traditional analysis of knowledge as justified true belief, and motivated alternative accounts of knowledge (Gettier 1963). Kripke (1972) used his famous Gödel/Schmidt case to criticize former descriptive theories of reference and to argue for his causal theory of reference. Intuitions about cases of causal pre-emption have been used to argue against analyses of causation in terms of counterfactuals (Lewis 1973, 2000).

In my view the primary—yet often ignored—problem with relying on intuitions is this: All that can be achieved by considering various cases that elicit one’s intuition about how a philosophical concept applies to these cases is to reveal one’s *current* conception. The philosophical aim, however, should not be to explicate one’s current concept of, say, knowledge, but to put forward an improved account of knowledge. Note that this issue is not addressed either by the currently popular approach of

experimental philosophy. Instead of being destructive by showing that intuitions vary so strongly among persons as to be useless (Machery et al. 2013, Mallon et al. 2009, Weinberg et al. 2010), experimental philosophy could show when intuitions are reliable (Nadelhoffer 2006, Nadelhoffer and Nahmias 2007). But even this falls short of indicating how to revise and improve philosophical concepts.

To this end, I will use my recent work on how *scientific* concepts are changed, which argues that in addition to embodying beliefs about the natural world, concepts are used to pursue specific scientific aims (Brigandt 2010b, 2012a). In analogy to this, I suggest viewing philosophical terms as tied to philosophical aims, as well as standards that determine what counts as an adequate account. Apart from using intuitions, philosophical practice may already be guided by such aims and standards, but those need to be made explicit and discussed; and I will articulate such a self-reflective philosophical method. Moreover, I will illustrate my method's fruitfulness by contributing to debates on two issues: reference and concepts. In the first case, I will focus on natural kind term reference, where despite strong intuition-based arguments for a causal theory of reference (Kripke 1980, Putnam 1975), a descriptive theory of reference dubbed 'causal descriptivism' is claimed to capture the same considerations (Chalmers 2006, Jackson 1998b, Lewis 1984). In addition to discussing whether one of them can be judged to be more adequate, I plan to assess whether there are cases where different tenets about what an utterance's referent is can be legitimate, i.e., an utterance having no unique referent (Bishop and Stich 1998, Burian et al. 1996). In the second case, the question is whether my approach can be applied to the philosophical concept of a 'concept.' While semantic atomists argue that reference is all there is to concepts (Fodor 2004, Fodor and Lepore 1991, Margolis 1998), it is usually assumed that conceptual content is more fine-grained than reference (Block 1986, Brandom 1994, Harman 1987, Peacocke 1992). To the previously recognized aims of a philosophical account of concepts I will add the aim of accounting for semantic change and variation, and assess whether a theory of concepts that acknowledges a richer structure of conceptual content is more successful in meeting these philosophical aims.

Timeline of Activities:

I have recently become a Tier 2 Canada Research Chair. My university does not allocate any of the money coming from the CRC Program as research funds for me, but uses it to grant me teaching release, where I have only half of the regular teaching load. Consequently, I will have sufficient time to complete all of the different subprojects within 5 years.

Year 1: Subproject on systems biology, in collaboration with Christophe Malaterre (Université du Québec à Montréal), Sara Green (University of Copenhagen), and in interaction with biologist Thomas Hillen (University of Alberta)

Year 2: Subproject on the evolution of complexity, in collaboration with Maureen O'Malley (University of Sydney), Marc Ereshefsky (University of Calgary), and interaction with biologist Sergio Peisajovich (University of Toronto)

Year 3: Hosting of *collaborative research meeting* on epistemic, social, and other values in biology.
[half-year sabbatical] Subproject on the role of social values in non-human primatology / human evolution, in collaboration with Carla Fehr and Heather Douglas (both University of Waterloo)

Year 4: Drafting of *book manuscript*.

Subproject on science education and the nature of science

Year 5: Guest-editing of *journal special issue* on values in biology. Completion of book manuscript.
 Subproject on intuitions and standards in philosophy

In addition to the book manuscript and journal special issue, I will also publish papers on the individual subprojects (some publications in collaboration) and present at conferences. For more details, see the 'Expected Outcomes Summary' and the 'Knowledge Mobilization Plan.'

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KNOWLEDGE MOBILIZATION PLAN

In addition to interactions with my graduate student research assistants, I will collaborate with the researchers detailed in the ‘Research Team’ section. These are philosophers, primarily from Canada but also beyond, as well as some biologists, who are intellectual leaders on the issues my project addresses. Given that for different subprojects I will interact with different groups of researchers, my overall 5-year project will engage researchers from different specialties. The collaborative activities serve both the generation and dissemination of ideas. While the major part of the project concerns philosophy of biology and feminist philosophy of science, I also have subprojects on science education and method in core analytic philosophy, so that in the dissemination of knowledge I will address quite diverse audiences. I also aim at connecting different scholarly communities, for instance by making discussion in feminist philosophy germane to traditional issues in philosophy of science (e.g., scientific explanation).

In the first two project years I will analyze philosophical issues in (online) discussions with the scholars named in the ‘Research Team’ section, establish contacts with others, and begin to present initial ideas at conferences. In the 3rd year, at a collaborative research meeting at the University of Alberta, I will bring together a total of 9 philosophers in person, to discuss extensively the role of epistemic, social, and environmental values in different parts of the biological sciences. Later this collaborative interaction will transition to activities that disseminate new ideas. Together with these colleagues, in year 4 and year 5 of the project, I plan to jointly organize symposia at scholarly conferences, for instance the annual meetings of the *Canadian Society for the History and Philosophy of Science* and the *Canadian Philosophical Association*, and the biannual meetings of the *International Society for the History, Philosophy and Social Studies of Biology* and the *Philosophy of Science Association*. There should also be the opportunity for persons connected to the project, including the graduate student research assistants, to individually present at conferences.

Publication will be the primary way of disseminating ideas and results. I intend to publish the papers growing out of the collaborative research meeting as a journal special issue, or alternatively as an edited volume. (*Studies in History and Philosophy of Biological and Biomedical Sciences* is a relevant venue that publishes guest-edited special issues, and the *Canadian Journal of Philosophy*, of which I am an Executive Editor, publishes about once a year a supplementary volume edited by one of its executive editors.) Moreover, I plan to individually publish on project-related topics, and to initiate joint papers with my graduate student research assistants or with the project collaborators.

The project’s central outcome will be a book, tentatively titled *Standards, Aims, and Values: An Account of Biological Explanation and Beyond*. For a book-length discussion will be the most convincing way to articulate my framework on standards, aims, and values in detail and to illustrate its fruitfulness by means of several case studies from distinct domains of biology. The half-year sabbatical in the first part of the 3rd project year will give me the opportunity to make good progress toward the manuscript, so that the book can be finished within the 5-year duration of the project.

The project component on science education conducted during the 4th project year will mobilize knowledge in a further way. In addition to general guidelines on teaching about the nature of science (that emphasizes how scientific practice is guided by aims, standards, and values), I will develop proposals for the teaching of evolution in grade 11 and 12 (made concrete by some lesson plan suggestions), to be published in the science education literature. I also intend to communicate with the media and general public on issues at the intersection of science, social-environmental values, and society. The ongoing ‘death of evidence’ issue in Canada (protests against the silencing of government scientist who want to speak about their research on the environment and public health) provides one way to leverage public interest in the role of science within society.



Family name, Given name

Brigandt, Ingo

Expected Outcomes

Elaborate on the potential benefits and/or outcomes of your proposed research and/or related activities.

Scholarly Benefits

Indicate and rank up to 3 scholarly benefits relevant to your proposal.

Rank	Benefit	If "Other", specify
1	Enhanced theory	
2	Enhanced research collaboration	
3	Student training/skill development	

Social Benefits

Indicate and rank up to 3 social benefits relevant to your proposal.

Rank	Benefit	If "Other", specify
1	Enhanced professional practice	
2	New or enhanced partnerships	
3	Training and skill development	

Audiences

Indicate and rank up to 5 potential target audiences relevant to your proposal.

Rank	Audience	If "Other", specify
1	Academic sector/peers, including scholarly associations	
2	International audiences	
3	Students	
4	Postsecondary institutions	
5	General public	



Family name, Given name

Brigandt, Ingo

Expected Outcomes Summary

Describe the potential benefits/outcomes (e.g., evolution, effects, potential learning, implications) that could emerge from the proposed research and/or other partnership activities.

The central outcome will be a book, tentatively titled "Standards, Aims, and Values: An Account of Biological Explanation and Beyond." It will lay out a philosophical framework that in addition to representations of the natural world (as emphasized by traditional philosophy of science) articulates the role of scientists' values, including scientific aims and explanatory and methodological standards. My account will contribute to philosophically understanding scientific practice and the formation of scientific theories, by detailing how different values held by a group of scientists guide their research activities. Conceptualizing standards, aims, and values will also put one in a position to philosophically assess scientific agendas and debates about different explanatory standards.

The book's general framework will gain traction by being employed in detailed case studies from different biological domains. In the context of systems biology, among other things I will lay out how particular aims necessitate the employment of several mathematical models and what strategies guide their development and coordinated use. In the case of the evolution of complexity, I will shed light on conflicting explanatory standards and frameworks preferred, and provide an analysis of which representational and explanatory aims justify simplifications and idealizations in mathematical models of complexity. Based on recent theories of human evolution and primate social behaviour, I will argue for a stronger role for social and other non-epistemic values in the context of theory acceptance (in this biological case feminist values), and connect the traditional philosophy of science issue of scientific explanation to ideas in feminist philosophy. (In addition to the new case studies developed as part of the project, the book will be strengthened by ideas from my past research, e.g., conceptual change and semantic variation being guided by epistemic aims and standards.)

Given that the project involves collaboration among several philosophical experts (and some biologists), an edited collection of about 9 papers will be published, which taken together discuss the role of epistemic, social, and environmental values in different areas of the biological sciences. (This will preferably be a journal special issue guest edited by me, possibly in *Studies in History and Philosophy of Biological and Biomedical Sciences* or the *Canadian Journal of Philosophy*.) Single authored papers and papers co-authored with the research assistants or the project collaborators, as well conference presentations and conference symposia are intended to result from the project.

My overall project results will impact different scholarly communities: philosophy of science, feminist philosophy, science education, and core analytic philosophy. I will contribute to science education by providing proposals for the teaching of evolution that emphasize the nature of science in terms of its practice, guided by changing explanatory aims and the development of new scientific standards and strategies. Beyond philosophy of science, I will contribute to core analytic philosophy by developing recommendations on philosophical method beyond the mere use of intuitions, methodological recommendations which will highlight philosophical aims and standards and be applied to debates about 'reference' and 'concepts.'

My graduate student research assistants will gain concrete benefits in their academic training, in particular by acquiring important dialectical skills such as presenting new ideas in oral and written form and responding to criticism, by interacting with other scholars (e.g. as part of the project's collaborative research meeting), by collaborating on papers, and by presenting at conferences.

RESEARCH TEAM, PREVIOUS OUTPUT, AND STUDENT TRAINING

A. Research Team:

As the major part of my 5-year project investigates the role of aims, standards, and values in three areas of the biological sciences (considering different specific issues in each context), a collaborative approach that involves experts on these different areas will be the most effective way of achieving the project aims. In addition to my graduate student research assistants (see below), I have 6 philosophers as official collaborators and will interact with biologists, who all are recognized leaders on the issues addressed by my project, and who have a track record of collaborating with other scholars.

During the first 3 years, I will interact with those persons that are relevant to the subproject on which I focus in a given year (see the timeline of activities in the ‘Detailed Description’). We will take a look the respective biological domain and analyze the specific philosophical issues on the role of standards, aims, and values detailed in the ‘Methodology and Research Activities’ section. While most of these initial interactions are online, in the 3rd project year all philosophers tied to the project will be brought together at a collaborative research meeting at the University of Alberta, so that we can discuss the role of epistemic and social values across biology in person. This in-person interaction and generation of ideas forms the basis for subsequent collaborations and in the last project year publications (including a journal special issue or edited volume). All of the 6 philosophers listed as collaborators have expressed their interest in interacting with me during one year, attending the research meeting, and contributing to subsequent collaborations. (Two additional philosophers, to be determined as my project goes along, will be invited to this discussion meeting and included in further collaborations as well.)

The subproject on systems biology (Year 1) will include collaborator **Christophe Malaterre** from the Université du Québec à Montréal. A philosopher of biology, he has recently co-edited a collection on explanation in biology (Braillard and Malaterre 2015). In addition to directly discussing systems biology (Issad and Malaterre 2015, Malaterre 2009), he has published on related issues, including emergence and downward causation in molecular biology, synthetic biology, self-organization, microbial diversity and the origin of life (Malaterre 2010a, 2010b, 2011, 2013a, 2013b, 2013c, 2013d). The other collaborator is **Sara Green**, who is a postdoctoral fellow at the University of Copenhagen. Her dissertation concerned system biology’s search for general principles about the organization of biological systems (Green 2014), and she has (co-)authored several articles concerning systems biology (Andersen and Green 2013, Green 2013, 2015a, 2015b, Green et al. 2015a, Green et al. 2015b, Green and Wolkenhauer 2013). She is currently editing a collection titled *Philosophy of Systems Biology* (for Automatic Press / VIP). I also plan to interact with **Thomas Hillen**, a mathematical biologist at my institution, who develops mathematical models of molecular and cellular systems (Delitala and Hillen 2014, Engwer et al. 2015, Hillen et al. 2010, Hillen et al. 2013, Painter and Hillen 2013).

Given that the subproject on the evolution of complexity (Year 2) includes the origin of complex interactions within multispecies microbial communities, as a leading philosopher on these issues, **Maureen O’Malley** from the University of Sydney will be instrumental as a collaborator. In addition to having published a book on the philosophy of microbiology (O’Malley 2014), she has (co-)authored papers on both evolutionary issues (Dupré and O’Malley 2009, O’Malley 2013b) and ecological aspects of microbial taxa, including metagenomics (Dupré and O’Malley 2007, O’Malley and Dupré 2007). My subproject addresses the role of simplifications in mathematical models of complex systems, and Maureen O’Malley has published extensively on system modeling (O’Malley 2012, O’Malley et al. 2014, O’Malley and Dupré 2005, O’Malley and Soyer 2012, O’Malley et al. 2015, Soyer and O’Malley 2013). I will also collaborate with **Marc Ereshefsky** from the University of Calgary, who in addition to his many publications (including a book) pertaining to issues in the context of evolution and systematics, has been among the few philosophers who have begun to scrutinize the previously neglected role of

microbes, including the impact on our views of individuality and sociality (Ereshefsky 2010, Ereshefsky and Pedroso 2013, 2015, Pedroso and Ereshefsky in press). I anticipate interactions with biologist **Sergio Peisajovich** from the University of Toronto, who works on evolution on different scales from the molecular level to complex networks, and uses synthetic biology to shed light on evolutionary issues (Bashor et al. 2010, Peisajovich 2012, Peisajovich et al. 2010, Thattai and Peisajovich 2014).

The subproject on the role of social values, including feminist values (Year 3), will involve collaborator **Carla Fehr**, who holds the Wolfe Chair in Scientific and Technological Literacy at the University of Waterloo. She is a renowned expert in feminist philosophy of biology (Fehr 2008, 2011), and has recently advocated for a socially relevant and socially engaged philosophy of science (Fehr and Plaisance 2010, Plaisance and Fehr 2010). For the purposes of my subproject that takes a look at the role of gender in past accounts of human evolution and primate social behaviour, Carla Fehr will be particularly important given her published work on the evolution of sex and evolutionary psychology (Fehr 2001, 2006, 2012). Also at the University of Waterloo is collaborator **Heather Douglas**, a philosopher holding the Waterloo Chair in Science and Society. Apart from publishing on traditional issues in philosophy of science, she is a leading scholar on the role of epistemic, ethical, and social values in science and the intersection between science and society, including the use of science in policy-making. In addition to her book *Science, Policy, and the Value-Free Ideal* (2009), she has published extensively on these issues (Douglas 2000, 2004, 2007, 2010, 2011, 2013, 2014).

B. Previous and Ongoing Research Results:

The recent work of my collaborators that is relevant to this proposed project has been laid out in the ‘Research Team’ section above. My past work and activities have given me the necessary tools to lead this new project, both intellectually and in terms of my ability to collaborate. The project will involve interactions with other philosophers and with biologists, and include a collaborative research meeting and the subsequent editing of a journal special issue. I am poised for this, as evidenced by the success of my 2008–2012 SSHRC Standard Research Grant project “Integrating Different Biological Approaches: A Philosophical Contribution.” While I was the principal investigator, the project was collaborative, consisting of a research team of philosophers and biologists from Canada and the US.

In Nov. 2009 and Nov. 2010, I organized two research meetings, which brought together project-affiliated philosophers and biologists and involved a substantial amount of discussion on integrative explanatory frameworks of evolutionary novelty and on evo-devo as an interdisciplinary approach. Based on the workshop papers, I guest-edited the special issue “Perspectives on Evolutionary Novelty and Evo-Devo” of the *Journal of Experimental Zoology: Molecular and Developmental Evolution*, which is open for contributions on conceptual issues in biology (Brigandt 2012b). Several of the project members organized a two-session symposium at the July 2011 meeting of the *International Society for the History, Philosophy, and Social Studies of Biology*. The project culminated in a third workshop held in Sept. 2011, at which several philosophers who have worked on issues pertaining to integration and non-reductive unification across different areas of biology presented. Six of the workshop papers and three additional articles appeared as a special section of *Studies in History and Philosophy of Biological and Biomedical Sciences*, titled “Integration in Contemporary Biology: Philosophical Perspectives on the Dynamics of Interdisciplinarity” and guest-edited by me (Brigandt 2013c; for a journal special issue previously co-edited by me see Brigandt and Griffiths 2007). These recent collaborative activities, including my experience with organizing research meetings and editing journal special issues, will prove beneficial for the corresponding activities of the proposed project on standards, aims, and values.

Regarding my intellectual readiness for the new project, my approach to philosophy of science has always been to not only ask ontological questions, but to combine them with epistemological issues about scientific theorizing and practice (Brigandt 2003a, 2003b, 2015a). My future project is to

emphasize epistemic as well as social standards, aims, and values. Epistemic aims have extensively figured in my recent work on conceptual change and variation in biology. On my framework, apart from a concept embodying knowledge about its referent—as recognized by traditional philosophical accounts of concepts—scientific concepts are tied to epistemic goals, in that a particular concept may be used to pursue a specific inferential, explanatory, or methodological goal. A concept’s epistemic goal guides the change of this concept and it justifies its revision (including the redefinition of the associated scientific term), so that philosophically recognizing an epistemic goal puts one in a position to account for the rationality of semantic change. Moreover, if a scientific term comes to be used to pursue somewhat different epistemic goals by different fields, semantic diversification across these fields can result. I have used this framework to account for semantic change and semantic variation in the case of the gene concept and the homology concept (Brigandt 2007, 2010b, 2011b, 2012a), and discussed the concepts of developmental constraint and evolvability from the perspective of epistemic aims (Brigandt 2015c).

While natural kinds have nearly always been discussed as a purely ontological issue, I have tied this to epistemic aims by arguing that philosophers also need to pay attention to the epistemic purpose for which particular natural kinds are studied (Brigandt 2009, 2011c). Similarly, while recent philosophical discussions of biological individuality have used ontological considerations in attempts to defend a unique account of individuality, my work highlights how different specific epistemic aims shape how biologists use more than one construal of individuality (Brigandt submitted-a, Love and Brigandt submitted). Moreover, building on prior work by Alan Love (2008), my joint publications with him have appealed to explanatory aims and standards to understand interdisciplinarity and the integration of explanatory resources across several biological fields (Brigandt 2010a, Brigandt and Love 2010, 2012a, 2012b). In the context of the problem of accounting for the evolutionary origin of novelty, we have argued that such an explanatory aim (‘problem agenda’) not only motivates an interdisciplinary approach, but also structures integration, given that a problem agenda is tied to standards of explanatory adequacy, which entail which ideas and thus fields are needed, and has an internal structure of component questions, which foreshadows how the ideas are to be integrated.

One of my subprojects will study systems biology, focussing on how scientific aims and strategies guide the joint use of several models. In my recent work I have investigated systems biology, e.g., how it integrates mathematical modeling with mechanistic modes of explanation (Brigandt 2013e, 2015b, O’Malley et al. 2014, O’Malley et al. in preparation). Another subproject will deal with the evolution of complexity. My previous work on the evolution of novelty (mentioned above) primes me for some of this research. My core question will be how simplifications and idealizations are made and justified in mathematical models of complexity; and my prior work on systems biology has touched upon abstraction and idealization in mathematical models. My third project deals with the role of social values in science. In addition to my past focus on epistemic values, my writings on evolutionary biology vs. the intelligent design movement have addressed social values and the social dimensions of science (Brigandt 2011a, 2013d), and a very recent publication of mine on science and values discusses feminist values (Brigandt 2015d). I have also edited a symposium forthcoming in the *Canadian Journal of Philosophy*, which will contain three papers on the topic of science, values, and the ‘death of evidence’ issue in Canada (the selective underfunding of areas of science and censoring of government scientists).

A further subproject deals with science education. I have previously published in science education venues, addressing the nature of explanation or focusing on evolutionary biology and contrasting it with intelligent design creationism (Brigandt 2013b, 2013d, submitted-b), which will help me with developing the proposals for the teaching of evolution (including lesson plan suggestions) at which my proposed project aims. My final subproject is on philosophical method and the use of intuitions. I have only programmatically published on metaphilosophy (Brigandt 2011b) and only recently on Jackson and Chalmers’ program of armchair conceptual analysis (Brigandt 2013a), but given that my approach to philosophical method and the improvement of philosophical concepts (emphasizing aims and standards)

is modeled on my detailed work on the revision of scientific concepts, I am in a position to tackle this subproject. Moreover, the concrete philosophical notions I plan to address are ‘reference’ and ‘concept,’ and I am acquainted with the relevant philosophical positions due to my work on conceptual change.

Finally, while my new project is to lead to the publication of my first book, I also anticipate that journal articles (single authored or jointly authored) will result from it. I have previously published in different venues, including biology journals, prestigious philosophy of science venues (e.g., *Philosophy of Science* and *Biology and Philosophy*) and journals read by philosophers beyond philosophy of science, such as *Erkenntnis*, *Synthese*, and the *Canadian Journal of Philosophy*.

C. Proposed Student Training Strategies:

In each of my subprojects, my philosophical questions pertain to the theorizing and practice of a given area of the biological sciences, so that I have to find relevant biological literature and scrutinize it with an eye toward my philosophical issues. Consequently, the initial task of my graduate student research assistants will be to find literature, guided by me, and to analyze it. We will regularly meet to jointly discuss their findings. In the later stages of the project, the research assistants will be vital to criticize my ideas about the role of aims, standards, and values in the concrete cases studied, and the general impact for previous philosophical debates. They will also participate in the collaborative research meeting (held in the 3rd project year, and attended by the philosophers that are part of the ‘Research Team’). Finally, the research assistants will be encouraged to collaborate with me on individual papers, and in the last two project years will be expected to comment on my book manuscript draft chapters and possibly the papers of the edited collection to which the other philosophical collaborators will contribute.

In addition to their contribution to the project, the activity as research assistants will benefit their own training in our graduate program. For the purpose of the literature search I will teach them various options for fruitfully using various online databases (e.g., citation searches), for both philosophical and biological content. Our literature analysis and discussion will increase both the depth and breadth of their philosophical and biological knowledge, and I will select research assistants and the literature they work on with an eye toward material that will also benefit their own dissertations. Vital for research in philosophy of biology, they will learn how to find and read biological literature with a philosophical question in mind, and how to relate it to existing philosophical literature. The graduate students will also acquire essential dialectical skills, such as adjudicating among rival positions based on philosophical and empirical considerations, and learn to relate different ideas, as a first step in the generation of original work. The students will likewise become prepared for professional interaction with other scholars. They will learn to adequately respond to criticism (in our joint project discussions and in discussions at the 3rd year research meeting), to engage in collaborative research, to comment on manuscripts (both in terms of content and academic style), and to write or at least co-author publishable papers. Ideally, based on their project involvement my graduate students would publish papers before entering the job market.

I will encourage my students to present at scholarly conferences (including the *Canadian Society for History and Philosophy of Science* and the *Canadian Philosophical Association*), and in this application have budgeted for student conference travel. I will also encourage them to work toward submitting papers, and assist them by commenting on their drafts. Whenever possible, my publications stemming from this project will be co-authored with the research assistants. (I have published two papers jointly with graduate students: Assis & Brigandt 2009 and Wilson, Barker & Brigandt 2007.)

One of my PhD students works in philosophy of biology and feminist philosophy, and the other has interests in philosophy of mind and cognitive science, experimental philosophy, and feminist philosophy of science. So both are relevant to different parts of my project and their graduate training will benefit from it. In addition to an MA student of mine, who has interests in philosophy of biology and has just entered our MA program, I will also consider involving PhD and MA students entering in the future.



Family name, Given name

Brigandt, Ingo

Funds Requested from SSHRC

For each budget year, estimate as accurately as possible the research costs that you are asking SSHRC to fund through a grant. For each Personnel costs category, enter the number of individuals to be hired and specify the total amount required. For each of the other categories, enter the total amount required.

Personnel costs	Year 1		Year 2		Year 3		Year 4		Year 5	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Student salaries and benefits/Stipends										
Undergraduate										
Masters										
Doctorate	1	17,752	1	18,284	1	18,833	1	19,398	1	19,980
Non-student salaries and benefits/Stipends										
Postdoctoral										
Other										
Travel and subsistence costs										
	Year 1		Year 2		Year 3		Year 4		Year 5	
Applicant/Team member(s)										
Canadian travel		0		2,270		16,589		2,335		2,395
Foreign travel		0		3,726		1,680		3,296		1,840
Students										
Canadian travel		0		1,825		1,475		1,880		1,935
Foreign travel										
Other expenses										
Professional/Technical services										
Supplies										
Non-disposable equipment										
Computer hardware										
Other										
Other expenses (specify)										
Total		17,752		26,105		38,577		26,909		26,150

BUDGET JUSTIFICATION

Personnel Costs: Students

I am requesting funds for a doctoral research assistant for a total of 10 terms (8 months during each year of the project). A full-time assistantship is 12 hours a week, but if the available graduate students and my research topic in a given year make it advantageous, it would engage two students by splitting this into two half-time assistantships. The students will search for relevant literature, analyze it, and discuss it and my ideas in progress with me. They will also attend the collaborative research meeting and comment on draft manuscripts, including my book chapters. See the “Proposed Student Training Strategies” for a justification and more detail on the particular activities of the student(s).

In the 2015–2016 academic year, the University of Alberta pays a doctoral student \$8,617.26 for a one-term, 12h/week assistantship, including all benefits. This means \$17,235 per year, according to 2015–2016 figures. Assuming an estimated annual salary increase of 3%, in total I am requesting:

Year 1: **\$17,752** Year 2: **\$18,284** Year 3: **\$18,833** Year 4: **\$19,398** Year 5: **\$19,980**

Collaborative Research Meeting

Upon having interacted online with the researchers named in the ‘Research Team’ section (w.r.t. to particular subprojects), in the 3rd year of the project I will host a 1½ to 2 day research meeting at the University of Alberta, to be attended by the applicant, the 6 philosophers named, and two additional philosophers who will be determined at the beginning of the project. This will bring together leading scholars who have addressed epistemic values and/or non-epistemic (i.e., social or environmental) values in the biological sciences, and who as group cover various biological domains and kinds of values. Since this collaborative research meeting is devoted to in-depth discussion of various previously prepared issues, its initial function is to generate ideas. But this in-person interaction will also set the stage for subsequent collaboration, and I plan to edit a journal special issue (or edited volume) to which all research meeting participants are expected to contribute.

While most of my official collaborators are from Canada (Heather Douglas, Marc Ereshefsky, Carla Fehr, Christophe Malaterre), Sara Green is currently at an institution in Denmark, and Maureen O’Malley travels from Australia. The two scholars yet to be determined will come from Canada or the USA. On my estimate, the current cost for such a research meeting is \$13,420; see below for a breakdown and justification of this figure. Assuming an inflation rate of 3% per year, I am requesting $1.03^3 \times \$13,420 = \mathbf{\$14,664}$ for the meeting in the **third year** of the project.

Since at this point I do not know yet exactly how many of the 8 participants will be from outside of Canada, in the budget this sum is included in the ‘**Canadian** travel’ portion of ‘Travel and subsistence costs’ for ‘Applicant / Team member(s)’.

Estimate of current cost of the research meeting:

Airfares	6 x \$780 + \$1500 (DK) + \$2000 (AUS)	\$ 8180
Transport to and from airports	8 persons x 4 routes x \$40	\$ 1280
Meals during travel and at research meeting	8 persons x 3 days x \$45 (per diem rate)	\$ 1080
Accommodation	8 persons x 2 nights x \$180	<u>\$ 2880</u>
		\$13420

Given Edmonton’s geographical location, flights from the US to Edmonton often are not more expensive than from Eastern Canada to Edmonton. I based my airfare estimate on current webfares (expedia.ca), averaged across different times of the year.

Travel and Subsistence for Dissemination of Results: Applicant

I am not requesting funds for travel in the first project year, so that the funds requested cover the years during which my conference papers will definitely present project results, starting in Year 2 with talks on the subproject on systems biology (conducted in the 1st year). I will present at the annual meetings of the *Canadian Philosophical Association* (CPA), which are at the same location as and partially overlap with the annual meeting of the *Canadian Society for the History and Philosophy of Science* (CSHPS), so that on one trip I can give an additional paper to a philosophy of science audience. In alternating years I will also present at the biannual meetings of the *Philosophy of Science Association* (PSA) and the biannual meetings of the *International Society for the History, Philosophy, and Social Studies of Biology* (ISHPSSB).

In the below figures, airfares are estimated based on current costs (expedia.ca) plus adjustment for inflation, where travel includes \$150 of ground transportation. Accommodation includes a per diem for meals of \$45 (Canada, US) or \$66 (International). Registration is based on current fees, augmented by \$10 per year to reflect likely future increases.

				Travel & ground transp.	Accomod. & meals	Registr.	Total
Year 2	CPA + CSHPS	June 2017	Toronto, Canada	\$830	5x\$230	\$290	\$2270
	ISHPSSB	July 2017	São Paulo, Brazil	\$2000	6x\$251	\$220	\$3726
Year 3	CPA + CSHPS	June 2018	Regina Canada	\$450	5x\$235	\$300	\$1925
	PSA	Nov. 2018	Seattle, USA	\$780	3x\$235	\$195	\$1680
Year 4	CPA + CSHPS	June 2019	Canada	\$825	5x\$240	\$310	\$2335
	ISHPSSB	July 2019	International	\$1550	6x\$261	\$230	\$3296
Year 5	CPA + CSHPS	June 2020	Canada	\$850	5x\$245	\$320	\$2395
	PSA	Nov. 2020	USA	\$900	3x\$245	\$205	\$1840

Summary:	Year 1	Year 2	Year 3	Year 4	Year 5	
Canadian travel	\$0	\$2,270	\$1,925*	\$2,335	\$2,395	*Funds requested lists \$15,568, as it includes the research meeting
Foreign travel	\$0	\$3,726	\$1,680	\$3,296	\$1,840	

Travel and Subsistence for Dissemination of Results: Students

I will encourage my research assistant(s) to present on project-related topics, and am requesting funds for four instances of conference travel (one per year, except for the first year of the project). These conferences will most likely be the meeting of the *Canadian Philosophical Association* and the overlapping meeting of the *Canadian Society for the History and Philosophy of Science*. I calculated the student travel figures similarly to the CPA + CSHPS figures above, but used a reduced student registration rate (½ of the above) and a lower cost of accommodation (\$60 less per night) that at the very least covers stay in a student residence.

Year 1: \$0 Year 2: \$1,825 Year 3: \$1,475 Year 4: \$1,880 Year 5: \$1,935



Suggested Reviewers

List Canadian or foreign specialists whom SSHRC may ask to assess your proposal.

List keywords that best describe the assessor's areas of research expertise. Please refer to the Suggested Assessors section of the detailed instructions for more information on conflicts of interest.

Family name Walsh		Given name Denis		Initials	Title Dr.
Org. code	Full organization name University of Toronto		Keywords Philosophy of evolutionary biology and evolutionary developmental biology		
Department/Division name Institute for the History and Philosophy of Science and Technology			Address Victoria College, Room 316A University of Toronto 91 Charles Street West		
	Country code	Area code	Number	Extension	City/Municipality
Telephone number	1	416	978-5847		Toronto
Fax number	1	416	978-3003		ON
E-mail denis.walsh@utoronto.ca			Postal/Zip code M5S1K7		
Country		CANADA			
Family name Kourany		Given name Janet		Initials	Title Dr.
Org. code	Full organization name University of Notre Dame		Keywords Science and values, Feminist philosophy		
Department/Division name Department of Philosophy			Address Department of Philosophy University of Notre Dame 100 Malloy Hall		
	Country code	Area code	Number	Extension	City/Municipality
Telephone number	1	574	631-6864		Notre Dame
Fax number	1	574	631-0588		IN
E-mail jkourany@nd.edu			Postal/Zip code 46556		
Country		UNITED STATES			
Family name Bechtel		Given name William		Initials	Title Dr.
Org. code	Full organization name University of California, San Diego		Keywords Philosophy of molecular, cellular, and systems biology		
Department/Division name Department of Philosophy			Address Department of Philosophy UC San Diego 9500 Gilman Drive # 0119		
	Country code	Area code	Number	Extension	City/Municipality
Telephone number	1	858	822-4461		La Jolla
Fax number	1	858	534-8566		CA
E-mail bill@mechanism.ucsd.edu			Postal/Zip code 920930119		
Country		UNITED STATES			



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Internal use	CID (if known)
135379	179881

Identification
Only the information in the Name section will be made available to selection committee members and external assessors. Citizenship and Statistical and Administrative Information will be used by SSHRC for administrative and statistical purposes only. Filling out the statistical and Administrative Information section is optional.

Name			
Family name	Given name	Initials	Title
Brigandt	Ingo		Dr.

Citizenship - Applicants and co-applicants must indicate their citizenship status by checking and answering the applicable questions.

Citizenship status	<input type="radio"/> Canadian	<input checked="" type="radio"/> Permanent resident since (yyyy/mm/dd)	<input type="radio"/> Other (country)	Have you applied for permanent residency?
		2009/05/25		<input type="radio"/> Yes <input type="radio"/> No

Statistical and Administrative Information

Birth year	Gender	Permanent postal code in Canada (i.e. K2P1G4)	Correspondence language	Previous contact with SSHRC? (i.e. applicant, assessor, etc.)
1975	<input type="radio"/> F <input checked="" type="radio"/> M	T6G2P3	<input checked="" type="radio"/> English <input type="radio"/> French	<input type="radio"/> Yes <input checked="" type="radio"/> No

Full name used during previous contact, if different from above

Contact Information
The following information will help us to contact you more rapidly. Secondary information will not be released by SSHRC without your express consent.

Primary telephone number				Secondary telephone number			
Country code	Area code	Number	Extension	Country code	Area code	Number	Extension
1	780	492-9030		1	780	999-6944	
Primary fax number				Secondary fax number			
Country code	Area code	Number	Extension	Country code	Area code	Number	Extension
1	780	492-9160					
Primary E-mail brigandt@ualberta.ca							
Secondary E-mail brigandt@gmail.com							

Personal information will be stored in the Personal Information Bank for the appropriate program.

Checked

Web CV

2015/10/14

Identification

PROTECTED B WHEN COMPLETED





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Family name, Given name

Brigandt, Ingo

Current Address Use only if you are not affiliated with a department at a Canadian university. (If you are affiliated with a department at a Canadian university, the department's mailing address will be used.) If you wish to use another address, specify it under the Correspondence Address.			Correspondence Address Complete this section if you wish your correspondence to be sent to an address other than your current address.		
Address			Address		
City/Municipality	Prov. / State	Postal/Zip code	City/Municipality	Prov. / State	Postal/Zip code
Country			Country		
Temporary Address If providing a temporary address, phone number and/or E-mail, ensure that you enter the effective dates.			Permanent Address in CANADA		
Address			Address		
City/Municipality	Prov./ State		City/Municipality	Prov./ State	Postal/Zip code
Country			Country		
Start date (yyyy/mm/dd)	End date (yyyy/mm/dd)	Temporary telephone/fax number			
		Country code	Area code	Number	Extension
Temporary E-mail					



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Family name, Given name

Brigandt, Ingo

Research Expertise (optional)

The information provided in this section refers to your own research expertise, not to a research proposal. Filling out the following 4 sections is optional. This page will not be seen by selection committee members and external assessors. This section will be used for planning and evaluating programs, producing statistics, and selecting external assessors and committee members.

Areas of Research

Indicate and rank up to 3 areas of research that best correspond to your research interests as well as areas where your research interests would apply. Duplicate entries are not permitted.

Rank	Code	Area
1	360	Science and technology
2	213	Gender Issues
3	140	Education

Temporal Periods

If applicable, indicate up to 2 historical periods covered by your research interests.

From	To
<p>Year</p> <p>_____ 1820 BC AD</p> <p>_____ ○ ●</p> <p>_____ ○ ○</p>	<p>Year</p> <p>_____ 2014 BC AD</p> <p>_____ ○ ●</p> <p>_____ ○ ○</p>

Geographical Regions

If applicable, indicate and rank up to 3 geographical regions covered by your research interests. Duplicate entries are not permitted.

Rank	Code	Region
1	1000	North America
2	3000	Europe
3		

Countries

If applicable, indicate and rank up to 5 countries covered by your research interests. Duplicate entries are not permitted.

Rank	Code	Countries	Prov./ State
1	1100	CANADA	
2	1200	UNITED STATES	
3	3225	UNITED KINGDOM	
4	3206	GERMANY	
5	3205	FRANCE	



Family name, Given name

Brigandt, Ingo

Curriculum Vitae

Language Proficiency

	Read	Write	Speak	Comprehend aurally	Other languages
English	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	German (native), Latin (read)
French	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

Work Experience

List the positions, academic and non-academic, you have held beginning with the current position and all previous positions in reverse chronological order, based on the start year.

Current position		Start date (yyyy/mm)
Canada Research Chair (Tier 2)		2014/4
Org. code	Full organization name	
1480111	University of Alberta	
Department/Division name		
Philosophy		
Position type	<input checked="" type="radio"/> Tenured <input type="radio"/> Non-tenure <input type="radio"/> Tenure-track <input type="radio"/> Non-academic	Employment status
		<input checked="" type="radio"/> Full-time <input type="radio"/> Part-time <input type="radio"/> Non-salaried <input type="radio"/> Leave of absence
Position	Start date (yyyy/mm)	End date (yyyy/mm)
Associate Professor (with tenure)	2012/7	
Org. code	Full organization name	
1480111	University of Alberta	
Department/Division name		
Philosophy		
Position	Start date (yyyy/mm)	End date (yyyy/mm)
Assistant Professor	2008/7	2012/6
Org. code	Full organization name	
1480111	University of Alberta	
Department/division name		
Philosophy		
Position	Start date (yyyy/mm)	End date (yyyy/mm)
Postdoctoral fellow or associate	2006/8	2008/6
Org. code	Full organization name	
1480111	University of Alberta	
Department/Division name		
Philosophy		

Personal information will be stored in the Personal Information Bank for the appropriate program.

Web CV



Family name, Given name

Brigandt, Ingo

Work Experience (cont'd)

Position		Start date (yyyy/mm)	End date (yyyy/mm)
Teaching Assistant		2001/1	2005/12
Org. code	Full organization name		
9933104	University of Pittsburgh		
Department/Division name			
History and Philosophy of Science			
Position		Start date (yyyy/mm)	End date (yyyy/mm)
Teaching Assistant		1996/1	1998/12
Org. code	Full organization name		
9147136	Universität Konstanz		
Department/Division name			
Mathematics, Philosophy			
Position		Start date (yyyy/mm)	End date (yyyy/mm)
Org. code	Full organization name		
Department/Division name			
Position		Start date (yyyy/mm)	End date (yyyy/mm)
Org. code	Full organization name		
Department/Division name			
Position		Start date (yyyy/mm)	End date (yyyy/mm)
Org. code	Full organization name		
Department/Division name			



Family name, Given name

Brigandt, Ingo

Academic Background				
List up to 5 degrees, beginning with the highest degree first and all others in reverse chronological order, based on the start date.				
Degree type	Degree name	Start date (yyyy/mm)	Expected date (yyyy/mm)	Awarded date (yyyy/mm)
Doctorate		2000/08		2006/08
Disc. code	Discipline	Did SSHRC support enable you to get this degree?		
99999	History and Philosophy of Science	<input type="radio"/> Yes <input checked="" type="radio"/> No		
Org. code	Organization			
9933104	University of Pittsburgh			
Country UNITED STATES				
Degree type	Degree name	Start date (yyyy/mm)	Expected date (yyyy/mm)	Awarded date (yyyy/mm)
Master's		2005/01		2005/04
Disc. code	Discipline	Did SSHRC support enable you to get this degree?		
55000	Philosophy	<input type="radio"/> Yes <input checked="" type="radio"/> No		
Org. code	Organization			
9933104	University of Pittsburgh			
Country UNITED STATES				
Degree type	Degree name	Start date (yyyy/mm)	Expected date (yyyy/mm)	Awarded date (yyyy/mm)
MA Equiv.	Diplom	1995/10		1999/07
Disc. code	Discipline	Did SSHRC support enable you to get this degree?		
80100	Mathematics	<input type="radio"/> Yes <input checked="" type="radio"/> No		
Org. code	Organization			
9147136	Universität Konstanz			
Country GERMANY				
Degree type	Degree name	Start date (yyyy/mm)	Expected date (yyyy/mm)	Awarded date (yyyy/mm)
Disc. code	Discipline	Did SSHRC support enable you to get this degree?		
		<input type="radio"/> Yes <input type="radio"/> No		
Org. code	Organization			
Country				
Degree type	Degree name	Start date (yyyy/mm)	Expected date (yyyy/mm)	Awarded date (yyyy/mm)
Disc. code	Discipline	Did SSHRC support enable you to get this degree?		
		<input type="radio"/> Yes <input type="radio"/> No		
Org. code	Organization			
Country				

Personal information will be stored in the Personal Information Bank for the appropriate program.



Family name, Given name

Brigandt, Ingo

Credentials

List up to 6 licences, professional designations, awards and distinctions you have received and feel would be the most pertinent to the adjudication of your application. List them in reverse chronological order, based on the year awarded.

Category	Name	Source or Country	Duration (Months)	Value / Year awarded
Fellowship	Canada Research Chair in Philosophy of Biology	Social Sciences and Humanities Research Council CANADA	60	\$500,000 2014
Academic Prize	Martha Cook Piper Research Prize	University of Alberta CANADA		\$3,000 2011
Academic Prize	Research Award of the Faculty of Arts	University of Alberta CANADA		2011
Fellowship	Research Time Stipend (granting teaching release)	Social Sciences and Humanities Research Council CANADA		\$24,000 2008
Academic Prize	Dorothy J. Killam Memorial Postdoct. Fellow Prize	University of Alberta, Killam Trusts CANADA		\$2,500 2006
Postdoctoral Fellowship	Izaak W. Killam Memorial Postdoctoral Fellowship	University of Alberta, Killam Trusts CANADA	23	\$84,000 2006

Research Expertise

The information provided in this section refers to your own research expertise, not to a research proposal.

Keywords

List keywords that best describe your areas of research expertise. Separate keywords with a semicolon.

philosophy of biology; philosophy of science; philosophy of mind; epistemology; philosophy of language; history of biology; logic

Disciplines

Indicate and rank up to 5 disciplines that best correspond to your research interests. Duplicate entries are not permitted.

Rank	Code	Discipline	If Other, specify
1	55014	Philosophy of Science and Technology	
2	55006	Epistemology	
3	55002	Analytical Philosophy, Linguistic Philosophy	
4	51012	History of Science and Technology	
5	80600	Biological Sciences	



Family name, Given name

Brigandt, Ingo

Funded Research

List up to 8 grants or contracts you have received from SSHRC or other sources. List them in reverse chronological order, based on the year awarded. If you are not the applicant (principal investigator), specify that persons' name.

Org. code	Full name of funding organization	Year awarded (yyyy)	Total amount (CAN\$)
1	Killam Research Fund, University of Alberta	2015	\$5,000
Role	Applicant	Completion status <input type="checkbox"/> Complete	
Project title	Standards, Aims, and Values: Biological Explanation and Beyond		
Applicant's family name		Applicant's given name	
		Initials	
Org. code	Full name of funding organization	Year awarded (yyyy)	Total amount (CAN\$)
1	Faculty of Arts, University of Alberta	2012	\$3,000
Role	Applicant	Completion status <input checked="" type="checkbox"/> Complete	
Project title	Systems biology and the integration of mechanistic explanation and mathematical explanation		
Applicant's family name		Applicant's given name	
		Initials	
Org. code	Full name of funding organization	Year awarded (yyyy)	Total amount (CAN\$)
1	University of Alberta	2011	\$7,500
Role	Applicant	Completion status <input checked="" type="checkbox"/> Complete	
Project title	Philosophical method: beyond armchair intuitions and experimental philosophy surveys		
Applicant's family name		Applicant's given name	
		Initials	
Org. code	Full name of funding organization	Year awarded (yyyy)	Total amount (CAN\$)
1	Endowment Fund for the Future, University of Alberta	2009	\$6,200
Role	Applicant	Completion status <input checked="" type="checkbox"/> Complete	
Project title	Change in biologist's views about proper explanation in morphology and evolutionary biology, 1840-1920		
Applicant's family name		Applicant's given name	
		Initials	



Family name, Given name

Brigandt, Ingo

Funded Research (cont'd)

Org. code	Full name of funding organization	Year awarded (yyyy)	Total amount (CAN\$)
3010325	Social Sciences and Humanities Research Council of Canada	2008	\$66,652
Role	Applicant		Completion status <input checked="" type="checkbox"/> Complete
Project title	Integrating different biological approaches: a philosophical contribution		
Applicant's family name	Applicant's given name	Initials	
Org. code	Full name of funding organization	Year awarded (yyyy)	Total amount (CAN\$)
1	Killam Research Fund, University of Alberta	2007	\$1,700
Role	Applicant		Completion status <input checked="" type="checkbox"/> Complete
Project title	Integrating different concepts of homology		
Applicant's family name	Applicant's given name	Initials	
Org. code	Full name of funding organization	Year awarded (yyyy)	Total amount (CAN\$)
1	Konrad Lorenz Institute for Evolution and Cognition Research, Altenberg, Austria	2002	\$3,280
Role	Applicant		Completion status <input checked="" type="checkbox"/> Complete
Project title	The innate/learned distinction in the early work of Konrad Lorenz		
Applicant's family name	Applicant's given name	Initials	
Org. code	Full name of funding organization	Year awarded (yyyy)	Total amount (CAN\$)
Role			Completion status <input type="checkbox"/> Complete
Project title			
Applicant's family name	Applicant's given name	Initials	

RESEARCH CONTRIBUTIONS OVER THE LAST SIX YEARS

1. Refereed contributions:

- 2015, “Social values influence the adequacy conditions of scientific theories: beyond inductive risk.” *Canadian Journal of Philosophy*. doi:10.1080/00455091.2015.1079004 (14,600 words, published online in advance of print)
- * 2015, “Evolutionary developmental biology and the limits of philosophical accounts of mechanistic explanation.” In: *Explanation in Biology: An Enquiry into the Diversity of Explanatory Patterns in the Life Sciences*. P.-A. Braillard and C. Malaterre (eds), Springer, Dordrecht, pp. 135–173.
- 2014, “Multilevel research strategies and biological systems” (with Maureen O’Malley, Alan Love, John Crawford, Jack Gilbert, Rob Knight, Sandra Mitchell, and Forest Rohwer; O’Malley, Brigandt, and Love wrote the paper in equal parts). *Philosophy of Science* 81: 811–828.
- 2013, “Systems biology and the integration of mechanistic explanation and mathematical explanation.” *Studies in History and Philosophy of Biological and Biomedical Sciences* 44: 477–492.
- * 2013, “Explanation in biology: reduction, pluralism, and explanatory aims.” *Science & Education* 22: 69–91.
- * 2013, “Intelligent design and the nature of science: philosophical and pedagogical points.” In: *The Philosophy of Biology: A Companion for Educators*. K. Kampourakis (ed), Springer, Dordrecht, pp. 205–238.
- * 2012, “Conceptualizing evolutionary novelty: moving beyond definitional debates” (with Alan Love, both authors contributed equally). *Journal of Experimental Zoology Part B: Molecular and Developmental Evolution* 318: 417–427.
- * 2012, “Reductionism in biology” (with Alan Love, both authors contributed equally). *The Stanford Encyclopedia of Philosophy*. <http://plato.stanford.edu/entries/reduction-biology> (24,300 words for this revised version, first version from 2008 had 20,600 words)
- * 2011, Review essay of *Evidence and Evolution: The Logic Behind the Science* by Elliott Sober, Cambridge University Press, 2008. *Canadian Journal of Philosophy* 41: 159–186.
- * 2011, “Essay: Homology.” *The Embryo Project Encyclopedia*. ISSN: 1940-5030. <http://embryo.asu.edu/view/embryo:124921> (5,900 words)
- * 2010, “Beyond reduction and pluralism: toward an epistemology of explanatory integration in biology.” *Erkenntnis* 73: 295–311.
- * 2010, “The epistemic goal of a concept: accounting for the rationality of semantic change and variation.” *Synthese* 177: 19–40.
- * 2010, “Scientific reasoning is material inference: combining confirmation, discovery, and explanation.” *International Studies in the Philosophy of Science* 24: 31–43.
- * 2010, “Evolutionary novelty and the evo-devo synthesis: field notes.” (with Alan Love, both authors contributed equally). *Evolutionary Biology* 37: 93–99.
- * 2009, “Accounting for vertebrate limbs: from Owen’s homology to novelty in evo-devo.” *Philosophy & Theory in Biology* 1: e004. (6,000 words)
- * 2009, “Homology: homeostatic property cluster kinds in systematics and evolution” (with Leandro Assis, both authors contributed equally). *Evolutionary Biology* 36: 248–255.

2. Other refereed contributions:

- * 2013, *Integration in Biology: Philosophical Perspectives on the Dynamics of Interdisciplinarity*. Special section of *Studies in History and Philosophy of Biological and Biomedical Sciences* (Volume 44, Issue 4, Part A, pp. 461–571). Edited by Ingo Brigandt. (9 refereed contributions)
- * 2014, “Social values influence the adequacy conditions of scientific theories: beyond inductive risk.” 2014 meeting of the *Philosophy of Science Association*. Chicago, USA. November 6, 2014.

- * 2012, *Perspectives on Evolutionary Novelty and Evo-Devo: Integrating Explanatory Approaches in Biology*. Special issue of the *Journal of Experimental Zoology Part B: Molecular and Developmental Evolution* (Volume 318, Issue 6). Edited by Ingo Brigandt. (9 refereed papers)
- * 2011, “A critique of two-dimensional semantics.” Presented at the 2011 meeting of the *Canadian Philosophical Association*. University of New Brunswick & St. Thomas University, May 30, 2011.

3. Other contributions:

Invited journal articles and book chapters

- 2015, “Do we need a ‘theory’ of development?” *Biology & Philosophy*. doi:10.1007/s10539-015-9493-z (7,600 words, published online in advance of print)
- * 2015, “From developmental constraint to evolvability: how concepts figure in explanation and disciplinary identity.” In: *Evolution, Development, and Conceptual Change*. A. C. Love (ed), Boston Studies in the Philosophy and History of Science, Springer, Dordrecht, pp. 305–325.
- 2013, “A critique of David Chalmers’ and Frank Jackson’s account of concepts.” *ProtoSociology* 30: 63–88.
- 2013, “Integration in biology: philosophical perspectives on the dynamics of interdisciplinarity.” *Studies in History and Philosophy of Biological and Biomedical Sciences* 44: 461–465.
- * 2012, “The dynamics of scientific concepts: the relevance of epistemic aims and values.” In: *Scientific Concepts and Investigative Practice*. U. Feest and F. Steinle (eds), de Gruyter, Berlin, pp. 75–103.
- * 2011, “Philosophy of biology.” In: *The Continuum Companion to the Philosophy of Science*. S. French and J. Saatsi (eds), Continuum Press, London, pp. 246–267.
- * 2011, “Natural kinds and concepts: a pragmatist and methodologically naturalistic account.” In: *Pragmatism, Science and Naturalism*. J. Knowles and H. Rydenfelt (eds), Peter Lang Publishing, Berlin, pp. 171–196.
- * 2010, “Jenseits des Neodarwinismus? Neuere Entwicklungen in der Evolutionsbiologie” [Beyond neo-Darwinism? Recent developments in evolutionary biology]. In: *Evolution: Ein interdisziplinäres Handbuch* [Evolution: An Interdisciplinary Handbook]. P. Sarasin and M. Sommer (eds), J. B. Metzler Verlag, Stuttgart, pp. 115–126.
- * 2010, “Kreationismus und Intelligent Design” [Creationism and intelligent design]. In: *Evolution: Ein interdisziplinäres Handbuch* [Evolution: An Interdisciplinary Handbook]. P. Sarasin and M. Sommer (eds), J. B. Metzler Verlag, Stuttgart, pp. 350–358.
- * 2010, “Anpassung” [Adaptation], “Egoismus, Altruismus” [Selfishness, altruism], “Homologie” [Homology], and “Instinkt und Intellekt” [Instinct and intellect]. In: *Evolution: Ein interdisziplinäres Handbuch* [Evolution: An Interdisciplinary Handbook]. P. Sarasin and M. Sommer (eds), J. B. Metzler Verlag, Stuttgart, pp. 5–7, 12–14, 30–32, and 32–33, respectively.
- * 2009, “Natural kinds in evolution and systematics: metaphysical and epistemological considerations.” *Acta Biotheoretica* 57: 77–97.
- 2007 (published in 2010), “When traditional essentialism fails: biological natural kinds” (with Robert Wilson and Matthew Barker, all authors contributed equally). *Philosophical Topics* 35: 189–215.

Book reviews

4 book reviews over the last six years (not listed individually due to space limitations), in: *The Philosophical Review*, *The Philosophical Quarterly*, *Isis*, and *Science & Education*.

Papers presented based on refereed abstract

10 presentations over the last six years (not listed individually due to space limitations).

Other papers presented to academic audiences

23 presentations over the last six years (not listed individually due to space limitations).

4. Forthcoming contributions:

revised and resubmitted, “How the difference between explanation and argument matters to science education.” *Science & Education*. (14,000 words)

submitted, “Bodily parts in the structure-function dialectic.” In: *What Is an Individual?* L. K. Nyhart and S. Lidgard (eds), University of Chicago Press, Chicago. (11,400 words)

submitted, “Philosophical dimensions of individuality” (with Alan Love). In: *What Is an Individual?* L. K. Nyhart and S. Lidgard (eds), University of Chicago Press, Chicago. (12,800 words)

OTHER RESEARCH CONTRIBUTIONS

Executive Editor of the *Canadian Journal of Philosophy*, since 2013.

Associate Editor of the *Journal of Experimental Zoology Part B: Molecular and Developmental Evolution*, since 2012.

Refereeing in last 6 years: **5** grants, **79** articles and chapters, **2** encyclopedia entries, **16** conference papers, and **2** book manuscripts.

Editorial Board Member of *Bionomina: International Journal of Biological Nomenclature & Terminology* (since 2010) and of the *Annals of the History and Philosophy of Biology* (since 2014).

Co-organizer of two symposia at the 2015 meeting of the *International Society for the History, Philosophy and Social Studies of Biology*. Université du Québec à Montréal. July 5–10, 2015.

Organizer of workshop *Integration in Contemporary Biology: Philosophical Perspectives on the Dynamics of Interdisciplinarity*. University of Minnesota, September 23–25, 2011.

Co-organizer of two symposia at the 2011 meeting of the *International Society for the History, Philosophy and Social Studies of Biology*. University of Utah, July 10–15, 2011.

Organizer of workshop *Perspectives on Evolutionary Novelty and Evo-devo: Integrating Explanatory Approaches in Biology*. McGill University, November 7–8, 2010.

Organizer and host of workshop *Integrating Different Biological Approaches*. University of Alberta, November 13–15, 2009.

MOST SIGNIFICANT CAREER CONTRIBUTIONS

- 2008, “Reductionism in biology” (with Alan Love, both authors contributed equally). *The Stanford Encyclopedia of Philosophy*. <http://plato.stanford.edu/entries/reduction-biology> [Cited 135 times to date, within 7.5 years; updated in 2012, resulting in encompassing 24,300 word article.]
- 2007 (published in 2010), “When traditional essentialism fails: biological natural kinds” (with Robert Wilson and Matthew Barker, all authors contributed equally). *Philosophical Topics* 35: 189–215. [Cited 104 times to date, within 5 years. Account of natural kinds, defended by biol. case studies.]
- 2009, “Natural kinds in evolution and systematics: metaphysical and epistemological considerations.” *Acta Biotheoretica* 57: 77–97. [Cited 81 times to date, within less than 6.5 years. Shows how the notion of scientists’ epistemic aims is relevant to accounts of natural kinds.]
- 2010, “Beyond reduction and pluralism: toward an epistemology of explanatory integration in biology.” *Erkenntnis* 73: 295–311. [Cited 61 times to date, within less than 5 years. An account in terms of explanatory aims that structure the formation of interdisciplinary explanatory frameworks.]
- 2013, “Systems biology and the integration of mechanistic explanation and mathematical explanation.” *Studies in History and Philosophy of Biological and Biomedical Sciences* 44: 477–492. [Cited 31 times to date, within less than 2 years. Shows why a broader philosophical notion of mechanistic explanation is needed, which takes into account the role of mathematical modeling.]

CONTRIBUTIONS TO TRAINING

Co-Supervisor of Postdoctoral Fellow: Joyce Havstad, April 2014 – August 2015

Thesis Supervisor:

Zi Huang, topic in philosophy of biology. M.A. in Philosophy, in progress

Danielle Brown, topic in philosophy of mind and cognitive science and experimental philosophy. Ph.D. in Philosophy, in progress

Esther Rosario, topic on sex and gender (philosophy of biology and feminist philosophy). Ph.D. in Philosophy, in progress

Ernest Howe, *Critical Thinking, Philosophical Theories of Testimony, and the Challenge of Wikipedia Knowledge Claims*. Ph.D. in Theoretical, Cultural and International Studies in Education, August 2015

Emma Kennedy, *Sexual Orientation and Social Construction: Toward a Progressive Politics of Natural Kinds*. M.A. thesis supervisor until student left program due to personal reasons

Taylor Murphy, *Cognitive Homology: Psychological Kinds as Biological Kinds in an Evolutionary Developmental Cognitive Science*. M.A. in Philosophy, September 2012

Sara Weaver, *A Crossdisciplinary Exploration of Essentialism about Kinds: Perspectives in Feminism and the Philosophy of Biology*. M.A. in Philosophy, September 2011 (co-supervision)

Tony Liane-Tsun Horn, *Omne ex mechina? The Challenge of Organized Complexity for Mechanistic Explanation in Biology*. M.A. thesis supervisor until student left program due to personal reasons

Taylor Murphy, *Concepts and Counterfactual Reasoning*. B.A. (Honors) in Philosophy, May 2010 (co-supervision)

Graduate Thesis Supervisory Committee Member:

Cheryl Mack, *Death as a Fuzzy Concept: Implications for the Definition and Confirmation of Death Utilizing Brain-based and Cardiopulmonary Criteria*. Ph.D. in Philosophy, in progress

Jonathan Simmons, *Identity and Lifestyle in the Skeptical Movement*. Ph.D. in Sociology, in progress

Emma Peng Chien, *Philosophical Issues of Autism: Mind, Science, and the Social*. Ph.D. in Philosophy, in progress

Nicolas Bullot, *Target Identities: A Psycho-Historical Theory of the Identification of Human Agents and Artefacts*. Ph.D. in Philosophy, September 2015

Andrew Ball, *Virtue in Context*. Ph.D. in Philosophy, January 2015

Jeff Fedorkiw, *Semantic Compositionality and the Metaphysics of Meaning*. M.A. in Philosophy, August 2011

Michael Flood, *Eternalism, Presentism, and Change*. M.A. in Philosophy, June 2011

Andrei Buleandra, *The Prescriptivity of Conscious Belief*. Ph.D. in Philosophy, April 2011

Aristotle Hadjiantoniou, *Many-Sorted Free Logic*. M.A. in Philosophy, January 2009

Independent Study Supervisor: 6 times since 2009 (3 graduate students and 3 advanced undergrads)

Undergraduate Research Project Supervisor: Camilla Zhang, Summer 2014

Interim Supervisor: 2 M.A students (2012–2013 and 2010–2011) and 1 Honors student (2009–2010)

Graduate Thesis External Examiner: Stephen Speake (PhD in Sociology, 2015), Katelyn Petersen (PhD in Germanic Languages, Literatures and Linguistics, 2013), Brian Dupuis (M.Sc. in Psychology, 2012), and Janet Grynás (M.A. in Translation Studies, 2012)

Ph.D. Candidacy Arm's Length Examiner: James Bachmann (Philosophy, 2012) and Michael Lockhart (Philosophy, 2010)

Ph.D. Specialization Examiner: Jeffrey Andrews (Resource Economics & Environm. Sociology, 2013)