INTERDISCIPLINARITY AND BRIDGING KNOWLEDGE

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This volume is part of the ‘Worldviews, Science and Us’ series of proceedings and contains several contributions on the subject of bridging knowledge and its implications for our perspectives of the world. It represents the proceedings of the interdisciplinary stream of the international workshop *Times of Entanglement*, 21-22 September 2010 at the Minsheng Art Museum in Shanghai, People’s Republic of China in the context of the Shanghai World Expo 2010 and, related material from discussion panels organized by the Leo Apostel Center for Interdisciplinary studies within the framework of the ‘Research on the Construction of Integrating Worldviews’ research community set up by the Flanders Fund for Scientific Research. Further information about this research community and a full list of the associated international research centres can be found at http://www.vub.ac.be/CLEA/res/worldviews/

The first contribution to this volume, by Robrecht Vanderbeeken, is entitled ‘What about interdisciplinarity within philosophy?’. Vanderbeeken focuses on an ongoing split in contemporary Western philosophy between so-called continental philosophy and analytic philosophy. From a meta-philosophical stance, the common and prima facie response to this split is the encouragement of merging inclinations: a plea for unification in order to overcome the tension, to achieve a ‘jenseits’ of the distinction, a beyond, a post-condition. Vanderbeeken argues that there are good reasons to believe that unification coincides with a loss of authenticity and hence will blur the intellectual potential of both traditions. Vanderbeeken elaborates on these differences and takes them to be arguments in favour of a pluralist stance that resists the typical tendency of philosophers to bypass a theoretical impasse by means of a transgression to a new order.
The second contribution is by Steffen Ducheyne and is entitled ‘History and philosophy of science: from peaceful coexistence to Golden Age of interdisciplinarity?’ In his essay, he points to both the need for and the nature of interdisciplinarity between the history of science and the philosophy of science. Steffen Ducheyne argues that, while the history of science might benefit from the tools or models provided by the philosophy of science, the philosophy of science must take the facticity of the history of science seriously for fundamental reasons.

In the next paper, by Liane Gabora, entitled ‘Can an understanding of how culture evolves awaken a sense of meaning in life?’, the author discusses how biological form generally cannot transmit traits acquired over a lifetime. Since acquired traits are wiped out at the end of each generation, most of our actions (other than giving birth, saving or ending lives, and so forth) have little effect on biological evolution. But culture evolves differently; there is nothing to prohibit the transmission of traits acquired over a lifetime. Any act can affect the worldviews of others, which affects their acts, and so forth, thereby affecting how culture unfolds. Thus, whereas our impact on biological lineages is limited to a narrow domain of behaviour that includes giving birth and acts of violence, almost anything we do can affect cultural lineages. While in the past it was common to think that the most meaningful thing in life was to bear children, in the current era of overpopulation the most meaningful contribution may be made by having a positive impact on how human worldviews evolve through the ages. Liane Gabora draws the conclusion that a better understanding of culture as an evolutionary process gives one something to strive for and puts one’s existence in a broader perspective.

In her paper ‘An interdisciplinary focus on the concept of causation: what philosophy can learn from psychology’, Leen De Vreese argues how, among philosophers of science, it is still mainstream practice to search for the ‘truth’ about fundamental scientific concepts in isolation, overlooking knowledge achieved in other domains of science. Leen De Vreese focuses on the topic of causation and argues that it is worthwhile for philosophers of science to integrate knowledge from other domains where empirical research on causal reasoning is carried out, such as psychology. She demonstrates what psychologist Peter White’s theory on the origin and development of causal reasoning can impart to the philosophy of causation. It concerns different but interrelated subjects with respect to the philosophy of causation: conceptual pluralism, a core causal concept of causation, the analysis of ‘what causation is’, epistemological pluralism, causation as a secondary
quality and weak causal realism. As her arguments show, the divide between metaphysical and epistemological approaches to causation — and hence between philosophy and psychology — may be much smaller than is often presupposed.

The next contribution, by Liesbeth De Mol, bears the title ‘Refocusing undecidability: questioning the use of the notion of formal undecidability in other domains’. After clarifying the work of Emil Post, Alonzo Church, Alan Turing and Kurt Gödel in mathematical logic and theoretical computer science on relatively undecidable propositions (UP) and unsolvable decision problems (UDP), Liesbeth De Mol discusses two classes of examples of the extension of UP and UDP to other domains, namely in physics, where it is applied to argue for the existence of non-recursive phenomena in nature; and secondly, an extension of UDP and the notion of computability to the domain of real computation. She shows how, in the work of Stephen Wolfram and Gregory Chaitin, UP and UDP are reinterpreted in terms of such notions as randomness, incompressibility and complexity, and opposes their theoretical assumptions and conclusions. To conclude, the author discusses the necessity of an interdisciplinary approach in order to establish a theoretical framework that may help solve the problems related to these extensions and that can be used to generalise undecidability to these domains.

The following paper, by Erik Weber, entitled ‘Can economics become a purely experimental science? A comparative study’, puts forward the observation that the role of experiments in economics is increasing, and deals with the philosophical question whether economics can become a purely experimental science. Erik Weber answers this question by comparing economics with a branch of biomedical science. He argues that, given the ethical restrictions on randomised field experiments, economists have to use one of the following alternatives to back up causal claims: (1) the first possible way out is to perform a non-random experiment (prospective or retrospective design) with real people in real economic contexts; (2) the second possibility is to perform a simulation, i.e., a randomised experiment with real people in an artificial context (laboratory); (3) the third possibility is to follow a ‘bottom up’ approach, i.e. to derive causal claims at the macro-level (socio-economic system) from rationality assumptions at the individual level. After investigating the limitations of the first two alternatives, Erik Weber concludes that economists will always need analytical reasoning because some problems cannot be tackled with the other methods, which makes it impossible for economics to become a purely experimental science.
In his paper entitled ‘Metaphysics and cinema’, Wim Christiaens distinguishes between two kinds of metaphysics: classical metaphysics, like the mainstream Christianity that dominated Europe in earlier times or the mainstream materialism that is dominating it now; and experiential metaphysics, which is also referred to as ‘heretical empirism’ or two-fold vision. He goes on to discuss how film has two contrary characteristics: on the one hand its visceral–mystical (in any case non-logocentric) homogeneity with the pre-rational multiplicity-flow of experience, on the other hand its narrative structure, where a narrative is “a chain of events in cause–effect relationship occurring in time and space”. Wim Christiaens argues that there exist two kinds of cinema: one that has a proneness for logocentric causal closure which pushes the viewer towards classical metaphysics through narrative closure; and another that is dominated by a subversion and transgression of a nonetheless inevitable logocentrism, a film praxis which pushes towards a vision that is neither subjective nor objective, neither rational nor entirely irrational, the concrete possibility of a form of thought that does not reify itself or what it is about. Wim Christiaens’s aim is to delineate a concept of film, a species of manifold or multiplicity that can be the site for heretical empirism.

In his paper entitled ‘On the role of contextuality in the integration of worldviews’, Bart D’Hooghe argues that, while scientific knowledge has become more and more sophisticated and specialised, it has also become increasingly fragmented. To find new, innovative ideas and lines of research now requires an integrative approach to science. D’Hooghe argues for the view that important progress in this respect is possible if we adopt theoretical insights and mathematical techniques from the field of quantum physics, much like chaos and complexity science has been used in the last one or two decades to model self-organisation and emergent phenomena in many domains of science. Chaos and complexity theory is currently the main approach used to describe the evolution of complex systems. However, the standard chaos and complexity approach is based on intrinsically classical concepts, without making any reference to context. In social sciences, the role of context has been acknowledged, e.g. in opinion polls, where the interaction between interviewer and interviewee may influence the results and actualise potential outcomes. To describe such phenomena, one needs to adopt a contextual theory which can model the dynamical evolution of a system as the actualisation of potential properties under probabilistic interaction with its context. Quantum mechanics is the archetypical theory capable of modeling such contextual systems. More specifically, D’Hooghe
proposes a quantum paradigmatic shift so as to conceive of reality as consisting of many layers, where quantum nature is not necessarily restricted to the microphysics domain but is also present in other layers of reality characterised by contextuality and potentiality, including but not limited to cognitive sciences, concept theory, linguistics, biology, culture, decision theory and economics.

In his paper ‘Quantum interference and superposition in cognition: a theory for the disjunction of concepts’, Diederik Aerts elaborates a theory for the modeling of concepts using the mathematical structure of quantum mechanics. Concepts are represented by vectors in the complex Hilbert space of quantum mechanics, and membership weights of items are modeled by quantum weights calculated following the quantum rules. Aerts applies this theory to model the disjunction of concepts and shows that experimental data of membership weights of items with respect to the disjunction of concepts can be modeled accurately. It is the quantum effects of interference and superposition, combined with an effect of context, that are at the origin of the effects of overextension and underextension observed as deviations from a classical use of the disjunction. Aerts puts forward a graphical explanation of the effects of overextension and underextension by interpreting the quantum model applied to the modeling of the disjunction of concepts.

In the next paper, entitled ‘Compatibility and separability for classical and quantum entanglement’, Diederik Aerts, Christian de Ronde and Bart D’Hooghe study the concepts of compatibility and separability and their implications for quantum and classical systems. They illustrate these concepts describing a macroscopic model for the singlet state of a quantum system of two entangled spin 1/2 with a parameter reflecting indeterminism in the measurement procedure. By varying this parameter, the authors describe situations from quantum, intermediate to classical, and study which tests are compatible or separated. They prove that, for classical deterministic systems, the concepts of separability and compatibility coincide, but for quantum systems and intermediate systems these concepts are generally different. More specifically, equal physical constraints in the model, which for classical deterministic measurements lead to non-separability and non-compatibility of the measurements, give rise to compatible measurements that are non-separated whenever indeterminism is introduced. As a consequence, compatible measurements that are non-separated, and hence violate Bell’s inequalities, can only be realised in the presence of indeterminism.
In her paper ‘Quantum programming’, Ellie D’Hondt focuses on the development of quantum programming paradigms. Through historical arguments she shows that the first important step in paradigm development is the establishment of a basic layer, a low-level programming language. On top of this, a formal elaboration of the components of such a language is particularly useful in the absence of associated hardware. Ellie D’Hondt argues that this basic layer already exists, as the measurement calculus for input-output algorithmic quantum computations, and as the distributed measurement calculus for reactive distributed quantum computations. What needs to be done now is to lift these low-level languages to a higher level by identifying programming concepts that can be abstracted away to provide higher-level constructs in the next-generation quantum programming languages. Since quantum computation remains dauntingly counter-intuitive, as is apparent from the lack of results on fundamentally new algorithms and protocols, this is quite a difficult task. Ellie D’Hondt proposes two future directions to take this research further. The first is the development of virtual models. The second is the investigation of entanglement as a computational primitive in broader contexts than quantum computation alone.

The next contribution is from Diederik Aerts, Stan Bundervoet, Bart D’Hooghe, Marek Czachor, Liane Gabora, Philip Polk and Sandro Sozzo, and is entitled ‘On the foundations of the theory of evolution’. They show how Darwinism conceives of evolution as a process of random variation and natural selection, hence that it is based on a materialist, i.e. matter-oriented view of science inspired by classical physics. However, at a microscopic level, matter and energy are no longer retained within their simple form, and quantum mechanical models are proposed considering potential form in addition to actual form. The authors propose an alternative to standard Neo-Darwinian evolution theory by suggesting that the starting point of evolution theory cannot be limited to actual variation whereupon is selected, but to variation in the potential of entities according to the context. They develop a formalism referred to as Context driven Actualization of Potential (CAP), which handles potentiality and describes the evolution of entities as an actualisation of potential through reiterated interaction with the context. As in quantum mechanics, lack of knowledge of the entity, its context, or the interaction between context and entity leads to different forms of indeterminism in relation to the state of the entity. This indeterminism generates a non-Kolmogorovian distribution of probabilities that is different from the classical distribution of chance described by Darwinian
evolution theory, which stems from an ‘actuality focused’, i.e. materialist, view of nature. The authors also present a quantum evolution game that highlights the main differences arising from this new perspective and show that it is more fundamental to consider evolution in general, and biological evolution in particular, as a process of actualisation of potential induced by context, for which its material reduction is only a special case.

The following contribution is by Diederik Aerts, Jan Broekaert, Bart D’Hooghe and Sandro Sozzo and is entitled ‘Quantum structure in economics: Risk versus ambiguity’. The expected utility hypothesis is one of the building blocks of classical economic theory and founded on Savage’s Sure-Thing Principle. It has been put forward, e.g. by situations such as the Allais and Ellsberg paradoxes, that real-life situations can violate Savage’s Sure-Thing Principle and hence also expected utility. The authors analyze how this violation is connected to the presence of the ‘disjunction effect’ of decision theory and use their earlier study of this effect in concept theory to put forward an explanation of the violation of Savage’s Sure-Thing Principle, namely the presence of ‘quantum conceptual thought’ next to ‘classical logical thought’ within a double layer structure of human thought during the decision process. Quantum conceptual thought can be modeled mathematically by the quantum mechanical formalism, which is illustrated by modeling the Hawaii problem situation, a well-known example of the disjunction effect. It is shown how the dynamics in the Hawaii problem situation is generated by the whole conceptual landscape surrounding the decision situation. The authors analyze the Ellsberg paradox situation, taking into account the hypothesis of the presence of quantum conceptual thought. They put forward a model for the conceptual landscape surrounding the decision situation of the Ellsberg paradox by making use of the data they gathered by conducting an experimental test of the Ellsberg paradox situation. They conclude by showing how this gives rise to the violation of Savage’s Sure-Thing Principle and explains its dynamics. The contextual landscape leads to uncertainty with existing probability measures, but such that the probability measures depend on the measurement situation, which makes them contextual again and therefore similar to ambiguity.

In his paper ‘Measuring meaning on the World-Wide Web’, Diederik Aerts introduces the notion of the ‘meaning bond’ of a word with respect to another word by making use of the World-Wide Web as a conceptual environment for meaning. The meaning of a word with respect to another word is established by multiplying the product of the number of web pages containing both words by the total number of web pages of the World-Wide
Web, and dividing the result by the product of the numbers of web pages found for each of the single words. Diederik Aerts illustrates the approach by calculating the meaning bonds for several words and analyzes different aspects of these by looking at specific examples.

In the next paper, entitled ‘Potentiality States: Quantum versus Classical Emergence’, Diederik Aerts and Bart D’Hooghe identify emergence with the existence of states of potentiality related to relevant physical quantities. They show how the concept of ‘potentiality state’ can be introduced in an operational way and show how it reduces to ‘superposition state’ when standard quantum mechanics can be applied. The approach is illustrated in three examples by defining the potentiality states giving rise to emergence in each example. Bell inequalities are violated by the potentiality states in the examples, which experimentally indicates the presence of quantum structure in emergence. In the first example emergence arises because of the many ways water can be subdivided into different vessels. In the second example, a full quantum description of the Liar paradox is discussed, and the potentiality states in this case are the superposition states of standard quantum mechanics. In the third and final example of soccer teams playing a game, the authors clarify further the difference between classical emergence as a stable dynamical pattern and emergence defined by a potentiality state, and demonstrate how Bell inequalities can be violated in the case of suitably chosen experiments in which context and potentiality play a primary role.

The subsequent contribution is by Pieter Meurs and is entitled ‘The bodily excess of a worldview: beyond a theoretical account of the world’. Meurs considers how structures of knowledge are incorporated (in corpus) within an embodied encounter of the world. The article investigates the limits of a mere theoretical account of the world. If these limits open onto an excess (beyond a cognitive account) of a view by which the world is what is seems to be, the question arises how we should understand or grasp this way of being. By means of the critical philosophy of Michel Foucault and Maurice Merleau-Ponty, Meurs investigates the space and meaning of the body for our thought of the world. With Foucault he argues that a worldview is captured within a certain discourse or power-disposition and that as a consequence of this, the primary way to encounter the world is the mind, and by extension the body becomes reduced to an instrument: the body is something that is merely a means, the body does not have a meaning or purpose in itself. Meurs will investigate the philosophy of Merleau-Ponty to address the meaning of the body. This will result in a
fundamental critique as well as a broadening and deepening of the classical view of the world.

In the final contribution entitled ‘My Heart Will Go On’, Karen De Looze analyzes how conceptualizations of ‘self’ affect feelings people have when they engage in practices of organ exchange. Referring to concepts borrowed from intercultural philosophy – ‘being’, ‘inter-being’ and ‘non-being’ – she illustrates how the interplay of different conceptions of self-understanding in medical settings may be the cause of tensions arising. De Looze argues that aside from tensions between these concepts that may become visible in overt patterns of social stratification that interfere with the availability of organs for certain groups of people, hidden theories of affliction play a crucial role as well. To uncover these hidden tensions she builds on Hogle’s concept of a ‘residue of personhood’. This residue may, after transplantation from a brain dead donor, provoke the generation of a symbolic ‘donor immortality’ and/or induce the experience of ‘bewitchment’ in a host body. De Looze demonstrates that it is bewitching exactly in the sense that it crosses boundaries between the three different concepts of self-understanding that are otherwise well-guarded. She argues that because of the combination with the desire of the recipient to attain a ‘second life’, there is a conjunction of regeneration and mortuary ritual at play in the practice of organ exchange that can at times be experienced under the form of ‘crisis’.