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## PROCESS THEORIES CROSSDISCIPLINARY STUDIES ON DYNAMIC CATEGORIES

### 1. INTRODUCTION

Processes constitute the world of human experience – from nature to social reality to cognition itself. However, by and large, the centrality of processes does not appear to be reflected in theoretical descriptions of nature and the human domain. Frequently processes are represented in a reductive fashion – in terms of their results, input-output pairs, or sets of state sequences summarized by linear functions. Disciplines without quantitative, algebraic-geometrical tools make do with metaphorical, haphazard, and highly domain-specific classifications of occurrences. Perhaps most remarkable is the general neglect of dynamic entities among ontologists, with a few exceptions, notably Whitehead: dynamic entities are neither properly investigated nor employed as descriptive primitives. Throughout the history of ontological research, the world of human experience has been presented as an assembly of ‘static’ entities: substances, attributes, relations, facts, ideas – and more recently, tropes, temporally relativized property exemplifications, or four-dimensional expanses.

But the traditional fixation on the permanent is not a requirement of theory construction *per se*. This book contains a collection of thirteen articles showing the fertility of a process-geared perspective. Ten of these articles are based on talks presented at an interdisciplinary research meeting (*Processes: Analysis and Applications of Dynamic Categories*, Sandbjerg Gods, Denmark, June 5–8, 2002) which brought together researchers from widely different fields (formal ontology, cognitive science, linguistics, semiotics, ancient philosophy, ethics, philosophy of music, music theory, theoretical psychology, theoretical biology, philosophy of chemistry, and philosophy of physics). The Sandbjerg 2002 meeting was internationally the first interdisciplinary conference on processes without exclusive commitment to American process metaphysics (Whitehead, Dewey, James). Three further articles were included since they are apt further to contri-



bute to the overall theoretical purpose of the collection, namely, to present extant non-reductive theories of processes, and to identify theoretical motivations for the development of process-based or process-gearred theories in different areas of application. In contemporary ontology, A.N. Whitehead's 'philosophy of organism' certainly stands out as an example of a non-reductive theory of processes with impressive explanatory scope, and two of the following contributions demonstrate the fertility of Whiteheadian approach. But the collection is primarily aimed to draw attention to non-Whiteheadian research on process within and outside of philosophy.

Like research on 'complexity' and 'emergence', research on 'process' is a topic which calls for a cross-fertilizing interdisciplinary approach. It is certainly an overstatement to say, adapting the Kantian *dictum*, that process ontology must be 'empty' without process-gearred theories from other disciplines, or that the latter remain 'blind' without the former. But the most productive strategy for the development of a process-based category theory in ontology is to tailor such a scheme not only to the familiar problems in ontology but also to *descriptive tasks* in the natural and human sciences. And conversely, in order to revise basic assumptions in their field, researches in the natural and human sciences can benefit from new *descriptive tools* furnished by ontologists and philosophers of science. One of the focal points of such cross-fertilizing research is the development of (regional or general) *typologies of processes*, and several of the articles in this volume address this issue explicitly.

Following the two main objectives of the workshop, the contributions to these proceedings have been grouped under two headings: *analysis and application*. Of course, since in most of the following contributions dynamic categories are both analyzed and applied, the division is somewhat arbitrary and reflects merely a topical emphasis. Authors of Part I are mainly concerned with the semantic analysis of our ways of talking about dynamic entities (processes, events, changes, developments, actions, motions etc.); or with the ontological analysis of these entities. Authors of Part II constructively apply extant process-ontological frameworks to specific explanatory tasks (Parkan, Fortescue, Christiaens, Emmeche), or develop process-ontological tools for a specific domain of application (Needham, Manzotti), or show how certain research domains could gain from a process-gearred perspective and what kind of descriptive tools are needed for this purpose (Bickhard, W. Christensen). For production-technical purposes the contributions by Manzotti and Emmeche had to be put last, but otherwise the papers in each part are arranged in what appeared the most natural systematic order, and, in particular, with a view to the chronology of research programs reported. The reader should keep

in mind that many of the contributions to this volume of *Axiomathes* are primarily designed to serve as research reports; the full picture behind the sketch is to be found in the references.

Part I begins with an exposition of Aristotle's analysis of dynamic categories. This is, in fact, less for historical than for systematic reasons since Aristotle's analysis is not only the first in Western ontology but it is also by no means superseded (Aristotelian criteria for the difference between change and activity can be traced in almost any current formulation of this distinction in philosophy and linguistics). Mary-Louise Gill, one of the leading scholars in her field, presents a reading of the core of Aristotle's metaphysics that centers on Aristotle's analysis of *energeia* (activity). As one might rephrase Gill's main thesis, the primary task of metaphysics in Aristotle's view is to give an account of substance, and precisely this is possible only if the unity of a substance is understood as an activity of sorts. Gill sets out by sketching the problem that Aristotle's analysis of *energeia* is supposed to address. In order to accommodate dynamic phenomena, Aristotle suggests that both the alteration and generation (destruction) of substances can be modelled as the attainment of a form by an underlying subject (matter). As Gill highlights, this simple 'replacement model' of change cannot be combined with Aristotle's main criteria for 'substancehood', in particular the requirements that any substance should be (a) a 'separate this' and (b) unified. Particular objects and living organisms qualify with respect to (a) but as composites of matter and form they fail to be genuine unities. To regain the unity of substance, Gill argues, Aristotle refines his model of dynamic phenomena by introducing the technical terms of potentiality and actuality and distinguishing two senses of each. When someone learns Danish she undergoes a *change*: she actualizes a 'first-level potentiality' of becoming a speaker of Danish and *acquires* a second-level potentiality or capacity to speak Danish; when she *exercises* this capacity, i.e. when she actualizes the second-order potentiality to speak Danish, she engages in an *activity*. The presence of a form in a substance, Gill argues, is to be understood on the model of an activity, as the expression of a capacity. But this is not all. The capacities expressed in the being of Socrates, this plant, or this table, are highly specific capacities involving both 'formal' and 'material' aspects. The wooden sphere exercises the capacity of being a *wooden* sphere: not just the capacity of being spherical, but also a complex capacity that includes the functional aspects of woodenness which only a certain type of matter can afford. The forms or functional roles a substance can express depends on its matter, and this in turn stands in an "essential relation" to the entire functional role of the substance, as that which affords a certain functional role. On

Gill's reading, then, the concept of an activity (*energeia*), or a capacity's being exercised, allows us to conceive of an essential mutual correlativity of form and matter. The being of substances is the *interaction* between the performance of a certain functional role and that which affords that functional role – an interaction that results in the required type of unity.

The ontological tradition has read Aristotle's investigations into substance in different, simpler ways, largely disconnecting the thesis of the primacy of countable enduring particulars from his analysis of dynamic phenomena. (Mis)guided by the category dualism of predicate logic, early analytic ontologists implemented the most simplistic version of the substance-ontological tradition – an illusory snapshot view of the world sporting particulars connected to universals by mysterious 'ties of exemplification' – which continues to influence theory construction in analytical ontology to the present day. While Whitehead opted for an (almost) wholesale replacement of traditional presuppositions, proponents of so-called 'revisionary' analytical ontologies by and large still pursue the snapshot view, even if this time based on tropes or states of affairs. But recently at least two formal frameworks have been advanced which treat processes as a fundamental category or even as the fundamental category in terms of which other categories are defined. The second and third contribution introduce these two new ontological frameworks.

Seibt's contribution presents a sketch of Free Process Theory (FPT) which she has been promoting since 1990. She begins by briefly setting out the methodological and heuristic background of FPT. First, she suggests that the tasks of ontology are best described if we conceive of ontologies as model theories of certain material inferences ('categorical inferences'). When ontologists offer an 'account' of persons (or relations, properties, states of affairs etc.) they axiomatically define certain entities whose inferential space matches with the inferential space of our commonsense reasoning about persons (or relations, properties, states of affairs etc.). Throughout its history the ontological tradition has preferred construction principles and entities geared to model the inferential space of our concept of things. In order to model the inferential space of our concepts of dynamic entities, she claims, the construction principles of the 'myth of substance' must be dispensed with. To support this claim she presents the inferential space of our talk about activities. Reviewing extant proposals in philosophy and linguistics for a classification of occurrence types denoted by verb phrases or sentences, she suggests that activities (along with the familiar 'Vendler-categories' of accomplishments, achievements, and states) are best conceived of as complex verbal aspects, defined by networks of aspectual implications. Our concept of an activity (accomplishment etc.)

is a way of ‘packaging’ a predicative content according to its *mode* of occurrence. The inferences that characterize the ‘activity mode’ imply that our talk about activities should be modeled by ontological entities which are concrete, dynamic, *non-particular* individuals, which Seibt calls ‘free processes.’ She then sketches the monocategoreal framework called FPT, a mereology with non-transitive part-relation, and outlines a typology of processes. Simple and complex free processes are classified according to (a) their pattern of spatio-temporal automerity (recurrence within a spatial or temporal region); these patterns play a prominent role in the definition of process-ontological correlates for basic common sense categories (activities, things, events, stuffs, heaps). Other classificatory parameters relate to (b) the components of complex free processes (‘participant structure’), (c) the type of dynamic composition (including weak and strong emergence), (d) the type of dynamic flow (‘dynamic shape’), and (e) the dynamic context of a process.

Heller and Herre outline the relevant part of a comprehensive ontological framework (formulated in the general language GOL) that supports data base maintenance and knowledge representation in a large variety of domains of application, and, in particular those of medical science, where short-term changes and long-term developments are traced over time in variable dynamic contexts. One of the distinctive features of this multicategoreal framework consists in the assumption of ‘chronoids’ and ‘topoids,’ i.e., portions of time and space, respectively, which are here treated as entities *sui generis*. Processes are *projected* onto disconnected or connected portions of time and space (rather than *identified* with filled spatio-temporal regions in the style of recent, four-dimensionalisms). Processes are the basic sort of ‘occurents’; other sorts of occurents such as histories, states, changes, and locomotions are defined in terms of certain conditions on the temporal and spatial projections of processes. Even though the framework countenances ‘substances’ and ‘moments’, these notions designate dependent and derived entities: both substances and moments (called ‘endurants’) are momentary entities, namely, the ‘time boundaries’ (three-dimensional cuts of four-dimensional projections) of processes. There is nothing in this framework that is identical through time. Persistence is a matter of momentary entities instantiating a certain universal. Nevertheless, the categorial distinction between enduring entities (endurants) and processes is specified in familiar terms as a difference in the way in which these entities relate to time. Endurants are ‘wholly present at a time-boundary’, they are ‘in time’, while processes are ‘extended in time’ and ‘have temporal parts’. Of particular philosophical interest might be the analysis of locomotion where the authors undercut

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