ON THE METAPHYSICS OF PRODUCTION

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ABSTRACT

Since the pre-Socratic period of philosophy, there have been two basic metaphysical views. One holds that there are substances or things, that is, atemporal entities in the world. The other insists that there are processes, that is, intrinsically temporal phenomena.

These metaphysical assumptions tend to strongly influence how the subject of the inquiry or action is conceptualized. The thing-oriented view seems to lead to analytical decomposition, the requirement or assumption of certainty and an ahistorical approach. The process-oriented view is related to a holistic orientation, acknowledgement of uncertainty and to a historical and contextual approach.

It can be argued that production is intrinsically a process oriented endeavour. However, an analysis of current conceptualizations and methods shows that it is the thing-oriented view on the world that has dominated the research and practice of production management. The resulting mismatch between the assumed nature and true nature of production has arguably led to major generic failures of production management.

As a conclusion, it is contended that the discipline of production management has to seriously address the metaphysical issues confronting both practitioners and scholars.

KEY WORDS

Metaphysics, Production, Substance, Process

INTRODUCTION

When describing the first philosophy, which only later was given the name metaphysics, Aristotle (2004) states[3]: "...that it is not a science of production is clear...". From the context, it is obvious that he means that metaphysics should be pursued for the sake of wisdom rather than for its practical usability. Without making any pretensions on contributing to philosophy, we contend that from the angle of production management, this view must be challenged in two respects. First, we contend that metaphysical choices are of considerable practical significance in the sphere of production. Second, while fully agreeing with the view that metaphysics is not a science of production, we claim this is by no means clear. Especially, we contend that in the traditional doctrine of operations management, the metaphysical assumptions tend to equate with the core theory of the field and thus, in a bizarre twist of the evolution of ideas, metaphysics has implicitly provided the very science of production almost throughout the last century.

The paper is structured as follows. First, the two major metaphysical stands, based on substance (or thing) view and process view, are explored and the practical significance of metaphysics is assessed. Then, understanding of production is considered, based on these two metaphysical stands. As an example of a method based on process metaphysics, the Cynefin classification is introduced. Next, the implications of the conventional metaphysical assumptions in production are discussed. To conclude, the significance of metaphysical choices in production is discussed

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3 Book I, Chapter 2.

and the related research and development tasks are commented upon.

METAPHYSICS

Metaphysics is an old branch of philosophy that investigates the fundamental nature of reality (Craig 2000). After having been considered an obscure and outdated field of philosophy for the major part of the last centrury, the study of metaphysics has recently started to flourish again (Price 1997).

Since the pre-Socratic period of philosophy, there have been two basic views (Roochnik, 2004) on the metaphysical (or ontological) question: What is there in the world? One holds that there are things, that is, atemporal entities in the world. The other insists that there are processes, that is, intrinsically temporal phenomena.

SUBSTANCE METAPHYSICS

Aristotle says in his treatise on metaphysics (Gamma 2): "…the fundamental duty of the philosopher: it is to gain possession of the principles and causes of substances." Even if Aristotle was not the first to take the metaphysical stand that the world consists of substance[4], and thus all our philosophical and scientific efforts should be focused on understanding substances, it was due to his huge influence up to the Middle Ages that this view came to dominate. The next push towards this stand came from Newton, and the whole movement of Enlightenment (Prigogine & Stengers, 1985). Classical mechanics, as developed by Newton, dealt with things and substances, and as physics was taken as a model for other sciences, substance based metaphysics tacitly gained even more foothold. Thus, the father of sociology, Durkheim, advised (Winch 1990):

The first and most fundamental rule is: Consider social facts as things.

What follows then from substance metaphysics? An idea intimately related to substance metaphysics—we could even call it the sharp operational end of substance metaphysics—is decomposition. Again, this has roots in antiquity. In Plato's Phaedrus, it is argued:

"First, the taking in of scattered particulars under one idea, so that everyone understands what is being talked about… Second, the separation of the idea into parts, by dividing it at the joints, as nature directs, not breaking any limb in half as a bad carver might."

In turn, Descartes (1637) defines his second rule as follows:

"The second (was) to divide each of the difficulties that I was examining into as many parts as might be possible and necessary in order best to solve it."

Thus, the general direction of research, underpinned by substance metaphysics, is in going into even smaller parts of the whole and searching explanations at the lowest possible level. Of course, the success of science since Newton's seminal ideas proves that this is a powerful method.

There are two related assumptions[5] playing an important role in connection to decomposition: similarity and independence of decomposed elements or parts. The similarity assumption takes it for granted that the parts are, by nature, similar to the whole and thus also mutually similar. The assumption of the independence of parts follows from the similarity assumptions. Namely if our unit of analysis is an idea, problem or thing in itself, so will all decomposed parts also be ideas, problems or things in themselves. Again, this has been mostly a tacit assumption. However, Simon (1969) has defined it as near decomposability—this is accepted as a starting point, for example, in transaction cost economics (Williamson 2000):

In a nearly decomposable system, the short-run behavior of each of the component subsystems is approximately independent of the short-run behavior of the other components;

In the long-run, the behavior of any one of the components depends in only an aggregative way on the behavior of the other subcomponents.

PROCESS METAPHYSICS

The first major proponent of process metaphysics was Heraclites, who held that "*τα παντα ρει*[6] in that "everything flows" and the world "is" change (Axelos 1962). Heraclites' thinking[7] continued to inspire philosophers and scientists such as Leibniz and Hegel even during the dominance of substance metaphysics. In the first half of the 20th century, Whitehead (1933) was the primary representative of process metaphysics. A further push

4 Instead of *substance metaphysics*, the terms *thing metaphysics* and *matter metaphysics* are also used.

5 For space reasons, the claim that both assumptions are tightly rooted in the Newtonian physics is not elaborated further—see Burtt (1925) and Whitehead (1933).

6 The phrase was coined by Burnet (1919) and cannot actually be attributed to Heraclites, but is popularly used to reflect his thinking.

7 Depicted in approximately 130 fragments.

towards process metaphysics was given by the inventions of Einstein (1916) on relativity theory and quantum theory. Similarly to the situation after Newton's new physical theories, other sciences have now also started to orient themselves according to the newest findings of physics, drifting thus to process metaphysics (for example, complexity science). According to some (Chia 2002), the movement of post-modernism also ultimately depends on process metaphysics.

According to contemporary understanding of process metaphysics (Rescher 2000),

- time and change are among the principal categories of metaphysical understanding,
- processes are more fundamental than things for the purposes of ontological theory,
- contingency, emergence, novelty and creativity are fundamental categories of metaphysics.

Rescher (2000) defines process as a structured sequence of successive stages or phases, having three characteristics:

- That a process is a complex—a unity of distinct stages or phases. A process is always a matter of now this, now that.
- That this complex has a certain temporal coherence and unity, and that processes accordingly have an ineliminably temporal dimension.
- That a process has a structure, a formal generic format in virtue of which every concrete process is equipped with a shape or format.

Thus, the basic direction of research, in the spirit of process metaphysics, is to look for the context, the larger process where the unit of consideration is part, and to search for explanation at that level. Another consideration is that phenomena are not necessarily universal, but rather attached to specific time and space. The common feature to both approaches is that time is elevated to a major position in the scheme of explanation.

DOES METAPHYSICS COUNT IN PRACTICE?

It is perhaps opportune to first justify at a generic level why we think that metaphysics should be focused on not only for the sake of the pursuit of wisdom, but also for practical considerations.

Let us first note that it is easy to pinpoint pairs of concepts where the distinguishing feature is the metaphysical underpinning (Table 1). Even if substance metaphysics has dominated, it has always been necessary to have and use process concepts. Thus, at the level of language, both metaphysical assumptions seem to be well justified.

Table 1: Pairs of concepts based on substance/process dichotomy.

Concepts related to substance metaphysics	Concepts related to process metaphysics
being	becoming
product, outcome	process
state	behavior
reductionism	holism
mechanistic	organistic
structure	agency
atomicity	continuity
noun	verb

But if we then look at bodies of knowledge in different domains, we realize that frequently there are cases where a domain splits into two parts[8] based on the metaphysical assumption adopted and concepts used (Table 2).

Table 2: Pairs of alternative knowledge domains, based on substance/process dichotomy.

Knowledge domains related to substance metaphysics	Knowledge domainsrelated to process metaphysics
Roman law	common law
contract	relation(al contract)
planned strategy	emergent strategy
rational decision making	coherentist decision making
knowledge as thing	knowledge as relation
action as plan realization (push)	action as response to context (pull)
learning organization	organizational learning

In summary, we are tempted to draw the conclusion that both types of metaphysical assumptions—substance and process—are extraordinarily potent and in a somewhat dialectical relation—if we subscribe to one, the other anyway tends to emerge for filling the gaps left by that one[9]. It is thus of great practical significance to deliberately select the metaphysical stand(s) to be applied when encountering the world.

METAPHYSICS OF PRODUCTION

Production seems, *sui generis*, related to change and becoming—how can it be tackled otherwise than by process metaphysics? However, the conventional production view has subscribed to substance-based metaphysics.

8 For space reasons, no further justification or references can be given here.

9 For example we can consider the "becoming of being".

SUBSTANCE-BASED METAPHYSICS OF PRODUCTION

As argued earlier (Koskela 1992, 2000), the conventional doctrine of production management subscribes to the view of production as transformation. However, what is transformation, in metaphysical terms? Superficially, transformation is related to change and becoming, but let's take a closer look. Transformation, as defined in economics, is a relationship between input and output. Both input and output are usually understood as things or matter. The transformation itself is a black box, except that we can decompose it into further transformations. Thus, the transformation model overcomes the difficulty of representing change by *jumping over it*, from one instance of time, represented by a set of things, to another instance of time, represented by another set of things.

Also, in the doctrine of operations management, we find the idea of decomposition into independent parts, similar by nature to the whole (Slack & al. 1995):

> *"Look inside most operations and they will be made up of several units or departments, which themselves act as smaller versions of the whole operations of which they form a part."*
>
> *"If micro operations act in a similar way to the macro operation, then all, or most, of the ideas relevant to the macro operation are also relevant to the micro operation."*

In project production, the idea of decomposition is embodied in the method of Work Breakdown Structure (WBS). The following quotes from contemporary literature perfectly illuminate the role assigned to WBS (Garcia-Fornieles & al 2003):

> *"The WBS is probably the single most valuable tool for project management"*
>
> *"The WBS provides a way of decomposing the work required to achieve the final project deliverable. This is done in a hierarchical fashion, decomposing the work from major tasks to smaller ones. By doing so, the complexity of the project tasks is reduced as the tasks are broken down until they reach a manageable size".*

However, the idea of decomposition is not only used for keeping track of what should be done, but is also used in time and cost management. In a Gantt chart, the total duration is decomposed with regard to individual work packages and tasks. Here, the practical decision rule is: If each task keeps its start and end date, the whole project will be completed on schedule. Furthermore, in a budget, the total cost is decomposed with regard to individual work packages and tasks. The practical decision rule is: If each task is kept within its budgeted cost, the whole project will be completed in budget.

Thus, the traditional conception of production is—implicitly[10]—based on, and practically equates to thing-based metaphysics. Unfortunately, among the problematic features associated with this conceptualisation of production, attributable directly to the underlying metaphysical assumptions, are the following: (1) tasks are considered as black boxes, (2) tasks are considered similar by nature; (3) tasks are considered (nearly) independent and therefore can be predicted accurately. Let us treat each in turn.

The transformation model implies that tasks, at the lowest level of consideration (where we do not decompose them further into subtasks), are black boxes. Thus, tasks in themselves are not managed in terms of production management. It can be theoretically argued that there are varying amounts of inefficiency inside the tasks, which should be tackled. However, if it is not conceptually covered, it will remain invisible and consequently be neglected. From an empirical viewpoint, corroborating evidence is given by Ballard & Howell (1998):

> *The construction model of control is actually a model of project control, not production control. Direct control of production itself is conceived as occurring only within the production unit, and is not addressed by the disciplines of project or construction management.*

In the transformation model, all the tasks are similar by nature. This means that inherent differences of various tasks or stages are not visible. For example, we have the theoretical argument that there are stages that are not transformations—also called waste. That there is considerable waste in production is now generally known.

This conceptual flaw was recognized by Shingo in 1945. The prevailing erroneous view is explained by Shingo as follows (1988):

> *Process refers to an analysis of production in large units, and operation refers to an analysis of production in small units. Here apparently, processes and operations are*

10 That metaphysical choices are implicit in the discipline of production/operations management is not surprising as not even the underlying theories of the discipline are usually made explicit. Some authors move even further by denying the role of theories. Thus, Morris (2002) claims that the WBS, i.e. the idea of decomposition, falls into the domain of best practices, rather than into the domain of science and theory: "We can also identify good/best practice principles—for example, it is helpful to break the project into its component "work packages" when planning it—although there is little that is scientific or even theoretical about such statements".

considered only categories differing in size of units of analysis. Since processes and operations are perceived as phenomena that can be expressed on the same axis, there may be an unconscious assumption at work, that improvements made in small-unit operations necessarily lead to improvements in collective processes.

Instead, Shingo (1988) observes dissimilar phenomena in production:

Production is a network formed by intersecting axes of process (y axis) and operation (x axis). The two phenomena lie on different axes and their flows are, by nature, dissimilar.

The point of this distinction was the following (Shingo 1988):

It follows from this that the improvement of operations requires an approach that uniquely responds to the characteristics of operations. Similarly, process improvements must be carried out from a point of view that corresponds to the characteristics of processes.

Shingo (1988) ends up explicitly challenging the idea of decomposition[11]:

The West, therefore, ended up imagining that processes and operations are nothing more than overlapping phenomena lying on a single axis....We can see where this led. Some people thought that production as a whole would improve once you improved operations, the smallest units.

In the transformation model, all tasks are independent transformations, and task interaction is not considered. However, in practice we realize there two types of interaction. Firstly, tasks set requirements to each other; secondly, tasks are part of a logistical queue, where the variability (uncertainty) of the previous tasks impacts any task, and the variability of that task impacts later tasks. One of the first observations of this conceptual flaw was in the Tavistock report (1966). It put forward, as the root cause of problems in construction, the disparity of the characteristics of the formal and informal systems in relation to the needs of the real task with which they are concerned. According to Tavistock, the formal system (contracts, plans, etc.) does not recognize the uncertainty of and interdependence between the operations of the building process. An informal system of management emerges for handling uncertainty and interdependence, but it produces a climate of endemic crisis, which becomes self-perpetuating.

Thus, the consequences of all these three conceptual shortcomings of the transformation model have been observed by reflective practitioners and researchers. However, a failure to see the connectedness of these three problems and the related lack of an explanation of the common cause—commitment to substance metaphysics—has hindered effective action to remedy the situation.

PROCESS BASED METAPHYSICS OF PRODUCTION

A key consideration in production is the issue of time. Process metaphysics at its core considers that time invariantly exists, regardless of what we do, in an endless continuum. We can start conceptualising production as a process which is not the sum of activities but a continuum where the product (in its broad sense) changes states, which are defined by human expectation, ability and technological capability, until its interface with the customer or end user. By conceptualising production in such a way the focus is not only on the activity but on the interactions between activities, people and technology which form a pattern that is governed by a multitude of factors.

There are thus two issues addressed by a process metaphysics inspired consideration of production: What is happening in time? What is happening at a particular time?

Actually, there are two theories of production (Koskela 2000) that focus on these issues, but do not exhaust them, namely the flow model[12] (production is a flow—in time and space—of material towards the output) and the value generation model (production is conversion of a—particular—customer's requirements into products which fulfill them). The continued success of managerial templates based on these theories, namely, respectively, the Toyota Production

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11 Shingo views both processes and operations as temporal phenomena. These, of course, fall into the domain of process metaphysics. It is somewhat doubtful whether he ever came to realize that the Western idea of decomposition, which he rejects, is based on a concept of production where time is abstracted away.

12 Note that the powerful modelling approach of queueing theory, although generally falling into the domain of flow conceptualization, still subscribes to the idea of clear-cut jobs (i.e. things and recipes for their transformations) traversing through the production network. Thus it is partially based on thing metaphysics. Unfortunately, this has directed attention away from making-do as one type of waste (Koskela 2004). The concept of making-do, leaning to process metaphysics, allows tasks to be emerging phenomena, for example, possibly starting without all prerequisites.

System[13] and the quality methodology, can be seen as a proof for the claim that process metaphysics is an appropriate basis for theories of production and has to be fully embraced.

However, in production, there are changes (becoming) we want to be predictable and clear-cut, and changes we want to be open-ended and emergent. We want our car to be as specified in the brochure, however, at the same time, we want a car that is fun and novel in ways we can not specify in advance. While the flow and value generation models have productively catered for the former processes, the latter processes have been facilitated to a lesser extent. It is here that the ideas developed in the framework of complexity science potentially become significant.

EXAMPLE OF A COMPLEXITY SCIENCE BASED APPROACH: CYNEFIN

How are process metaphysics and complexity science related? The Einsteinian physics has stimulated both of them, and both address issues neglected in the Newtonian physics. While process metaphysics addresses the issue of time, in contrast to substances or things, complexity science focuses on the issue of complexity, in contrast to simple phenomena. At the risk of oversimplification, perhaps it could be said that complexity science subscribes to process metaphysics, but restricts itself only to the case of complex situations.

As an example of a complexity science based method, this section briefly presents the 'Cynefin' framework, as well as its relationship with process metaphysics, within the context of production.

Cynefin

The 'Cynefin' framework is a phenomenological framework that provides a decision support tool to enable classification of perceived phenomena and situations by challenging the universality of basic assumptions of order, rational choice and of intent (Kurtz and Snowden, 2003). At the root of those assumptions, it can be argued, lies the modernist attitude of predictability as a consequence of knowledge acquisition and causal relationships, rational decision making based on complete knowledge of a system, process or setting, and of calculated actions based on premeditated initiatives and an indication of intent. Those assumptions, although applicable in a number of settings, are not adequate in describing dynamic, adaptive and pattern forming settings where, for example, the results of a number of factors in a system are known but not how the different factors interact both in terms of linkages and magnitude, to produce a result. More fundamental to this is the issue of time in pattern forming, which will be discussed later.

It becomes apparent that a new understanding is needed to allow the abandonment of old accepted norms and to enable the adoption of a more 'relaxed' (in relation to order, predictability and management) approach that aims to classify situations as they are perceived by individuals (hence the 'real' world) both in isolation and through their interactions. The Cynefin framework aims at addressing this classification issue by the introduction of four domains (non sequential in logical terms) of:

- known
- knowable
- complex, and
- chaotic.

Furthermore, it includes the area of un-order, where the classification (individual or collective) according to the above is not evident. True to its phenomenological nature, the framework can help in sense-making of situations both as a result of personal reflection and collective brainstorming and in enabling decision making (either exploratory, explanatory or decisive). The four domains can be defined as follows (for detailed descriptions see Kurtz and Snowden, 2003):

Complex:	**Knowable:**
Cause and effect are only coherent in retrospect and do not repeat	Cause and effect is separated over time and space
Chaotic:	**Known:**
No cause and effect relationships are perceivable	Cause and effect relations are repeatable, perceivable and predictable

This categorisation is thus heavily dependent on the perception of situations by individuals or groups—justifiably as this often determines how individuals and organisations/firms react and plan to and for situations. It is this feature that already positions Cynefin into the domain of methods supported by process metaphysics.

13 According to Fujimoto (1999), the Toyota Production System is based on three capabilities: (1) routinized manufacturing capability (static & routine); (2) routinized learning capability (dynamic & routine); (3) evolutionary learning capability (dynamic & non-routine). Taking into account that even the routinized manufacturing capability is arguably based on the flow model (Koskela 2000), all these capabilities seem to be based on process metaphysics.

The four domains can be further grouped into two main areas: order (known and knowable) and un-order (complex and chaotic). The power of Cynefin lies in enabling the discourse between groups in sense-making of situations and in adopting strategies for dealing with those situations in terms of strategy and the application of tools and techniques in managing such situations. For example, if a situation is firmly rooted in the complex domain then attempts can be made to probe a situation to make explicit and more visible interconnections and some causal relationships.

The significance of the categorisation of Cynefin and its relation to process metaphysics lies in the understanding that situations can be conceived as 'belonging' at any of those domains at any one time and that this positioning can change as a result of decisions made and action taken, e.g. a complex political situation resulting in societal conflicts (often chaotic) can be 'resolved' by military law in bringing order (at the extreme bringing a situation to the known domain from the chaotic), as opposed to adopting a longer term strategy of allowing patterns to form that are knowable and develop into known situations (hence following the path of chaotic—complex—knowable—known).

Production and Cynefin

At a conceptual level the domains of Cynefin can map across the production process in terms of predictability of output and understanding of relationships within the process. For example, high variability within a process, and therefore high uncertainty, can be understood in terms of a complex or knowable situation which, when it becomes controlled, i.e. low variability, can be firmly positioned within the known domain.

Conceptualising construction as a type of production with high variability as the constant, brings validity to the consideration of construction under the principles governing complexity (see for example Bertelsen 2004). Furthermore, the Last Planner system aims or can be conceived to aim to reduce that variability and increase predictability (importantly, as this is perceived by the actors in the process) through frequent discourse and conversations of the parties involved.

Production can also be conceptualised to be characterised by all four domains of the Cynefin framework where some parts or instances of production can be perceived to be, respectively, chaotic, complex, knowable and known. Different approaches to managing production can then be adopted that are relevant to the setting under investigation. Although usually the aim should be to bring the process to the known domain, it is likely that improvements in the process itself are more likely to occur by explorations in the knowable and complex domains and at the extreme, particularly in relation to new technologies and methods, in the chaotic domain (see Snowden 2002 and Kurtz & Snowden 2003 for examples). This conceptualisation challenges current management practices in production where normally tools and techniques used are conceived in terms of enforcing predictability and certainty rather than fostering innovation through variety and emergence.

DISCUSSION

The picture emerging from the analyses made is as follows: The conventional practice of production management has been based on substance based metaphysics, in the main. The resulting mismatch between the assumed nature and true nature of the situation has led to misunderstandings[14] and misconceptions about phenomena and their context. Such examples, amongst many, include:

- The focus on productivity as a measure and explanation of the efficiency of production; the underlying assumption is that the total productivity can be increased by increasing the productivities of all the parts of production. Unfortunately, it goes unnoticed that the concept of productivity does not recognise one input to production, time, and is therefore fatally flawed.
- The development of detailed and rigid new product development (NPD) processes which assume that as soon as an idea enters the process, this process execution and the outputs can be predictable and can be managed to deliver a product. Practice and many cases have demonstrated that serendipity and innovation in the process itself can be identified as critical factors for success (Koen et al. 2002).

14 The paucity of substance metaphysics becomes also evident when it is used for understanding a production model based on process metaphysics. This can be illustrated by the 'quest' of decoding the Toyota production system (Liker, 2004) by breaking down the manufacturing process into its elements and attempting to optimise those elements in isolation with little regard of the interactions and interdependencies of those elements. Current 'decoding' efforts are attempting to do so by looking at the human behaviour of production operatives and self-determination as a means of increasing performance (Spear, 2004; Spear and Bowen, 1999), but importantly not predictability.

- The assumption of planning as a mechanism and tool for predictable outputs, in particular taking long timescales into consideration.
- The assumption that requirements capture is something that takes place in a particular moment in time and should be the same for all people (Koen et al. 2002); the old ticking the box attitude.
- The consideration of knowledge as an object that can be universally codified, moved, stored, transmitted (importantly in the same form as originally captured) and embedded in attitudes, behaviours and practices; IT implementations of knowledge management are often good examples of this approach.
- The conception of pre-determined budgets as an appropriate method of management for organizations and their subunits, as well as for projects, even when the environment is unpredictable.

CONCLUSIONS

We have challenged Aristotle's notion of metaphysics regarding two aspects. First, we have forwarded arguments and observations to support the claim that metaphysics, or to be accurate, the metaphysical stand taken, counts in practice. Especially, in the sphere of production, we have contended that it is not sufficient to consider production in terms of things *being*, but we have also to address the *becoming* of things. Second, we have endeavoured to show that it is not clear at all that metaphysics is not a science of production. Here, our argument is based on the observation that the core of the conventional doctrine of production management, being based on the transformation model, hardly goes beyond the metaphysical stand adopted. In this way, metaphysics has factually, although implicitly and erroneously, been given the role of production science.

Thus, our central conclusions are, first, that it is the inappropriate metaphysical choice that is at the root of many of the problems of production, and, secondly, that the neglect of explicit metaphysical considerations has effectively concealed this situation. Of course, these conclusions are not surprising in view to Whitehead's (1933) argument: "No science can be more secure than the unconscious metaphysics which tacitly it presupposes".

In much of the work on lean construction, the significance of theories for the practical affairs of construction, and production in general, has been stressed. In this paper, this position is suggested to be augmented as follows. It is not only theories that count, but also the metaphysical assumptions on which our theories are based (see Figure 1).

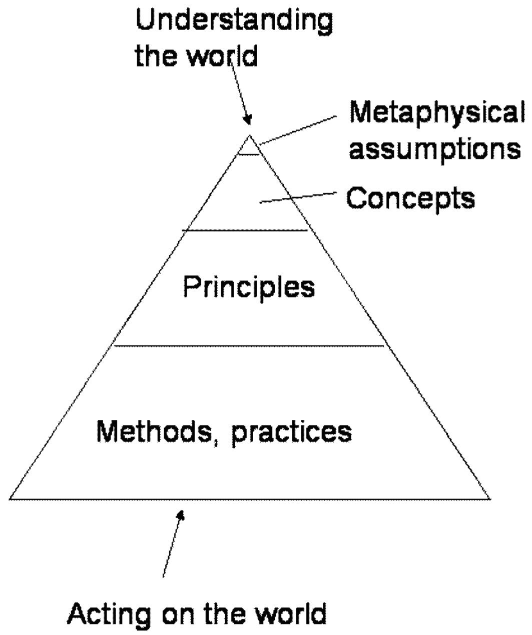

Figure 1: The position of metaphysics and theories (concepts and principles) in relation to methods and practices.

An overall implication is thus that production management has to seriously address the metaphysical issues confronting both practitioners and scholars. A new understanding on how to match the metaphysical assumptions with the characteristics of the context has to be created. Indeed, for overcoming the failures experienced hitherto, production (and operations) management has to be built up anew both regarding the theoretical foundation and its metaphysical underpinnings.

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