PROJECT MANAGEMENT RECONCEIVED FROM A PRODUCTION PERSPECTIVE
Lauri Koskela¹, Glenn Ballard², Gregory Howell³

ABSTRACT
According to adherents of lean construction, project management theorists and practitioners have neglected the management of production. The consequences of this neglect are said to include poor control (low reliability) of handoffs between design, supply and construction specialists and a tendency to promote adversarial relationships—reducing value delivered and increasing waste. There is increasing agreement in the construction community that these problems must be solved and that the production perspective must be integrated into project management theory and practice. But how best to do so? Is it a matter of supplementing existing project management theory and practice with an additional perspective, or should we start from a conceptualization of projects as temporary production systems?

This paper explores the alternative of subordinating the economics-based theory of project management to the theory of production. A synthesis of economics-based project management approach is critically assessed, and an alternative, production-based approach is outlined. Traditional project management functions are speculatively reconceived from a production perspective. Guidelines are provided for managing risk, determining client requirements, structuring contracts, forming project teams and controlling performance.

KEY WORDS
contract management, project management, production, production management, risk management, theory of project, theory of production

INTRODUCTION
During the 1990’s, conventional project management has increasingly been criticized for lack of impact. One strand of the discussion has dealt with the theory of project management. Widely differing views have been presented.

Barnes (2002) concludes that a theory-based approach is needed for developing project management further:

We enthusiasts for project management have a choice. We can already manage projects well – not always, but we know how to do it. One route is for us to let the science stabilise and to concentrate on broadening its range of application – applying currently defined best practice. The other route is development of the science itself letting its application go where it will.

Choosing the first route is likely to lead to the end of project management. […]

A similar conclusion is presented by Koskela and Howell (2002b), who criticize the PMBOK Guide for deficiencies in its theoretical base. They conclude by claiming that the future of project management is dependent on its theory.

Simultaneously, other authors take very different positions. Morris (2002) concludes that there will never be an overall theory of project management. He contends that the very notion of a theory of project management is mistaken, even if admitting that there can be "some theories”, theories of particular aspects of project management. However, Morris sees that our knowledge on project management will always be personal and experimental. Thus, according to him, the

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best what can be done is to offer guidance in the form of tools, aids, heuristics, approaches, insights - and some scientifically established and tested theory.

Others are more willing to appreciate the role of theories, but they see the theoretical universe of project management differently. Moore (2002), for example, focuses on the organizational side of project management. Winch (2002) presents a major synthesis of organizational and managerial ideas for project management, based especially on economics.

The different conclusions can at least partly explained by the points of view selected. Morris approaches project management as part of general management and Moore and Winch as application of organization theory, whereas Koskela and Howell have approached project management as part of operations management.

The starkly contradictory views presented make it painfully clear that there is yet no scientific frontier regarding understanding of project management. Instead of several simultaneous monologues, a dialogue between these different positions is needed for defining such a frontier. The authors hope to start such a constructive dialogue by means of this paper, where the economics-based approach to projects, as presented in (Winch 2002), is critically examined and contrasted with a production-based approach to projects. This analysis is motivated not only by the significance of Winch's prescription, but also by the fact that in recent decades an economics-based approach to projects has been progressively diffused into the practice of construction. This development has not been based on any theory-based prescription - however they share several basic assumptions and major principles. Unfortunately, this industrial approach that equates project management with contract management has been devastating in terms of productivity, quality and industrial safety (Koskela, Ballard, Howell 2003). Thus it is important to gain insight into the critical shortcomings of the economics-based approach.

The paper is structured as follows. The next section presents the starting points and key prescriptions of the economic-based approach to projects, as advanced by Winch (2002). A critique of the foundational ideas of the economics-based approach is outlined in the following section. In the subsequent section, traditional project management functions are speculatively reconceived from a production perspective and contrasted with the economics-based prescription. Guidelines are provided for managing risk, determining client requirements, structuring contracts, forming project teams and controlling performance. At the end of the paper, conclusions from the analyses and suggestions for future research are provided.

THE ECONOMICS-BASED APPROACH TO PROJECTS AS PROPOSED BY WINCH

OVERVIEW

In our understanding, the key statement in the Winch approach is:

Process management is essentially an organizational innovation - the identification of a person or small team responsible for ensuring the effective delivery of the project mission for the client.

This characterization focuses attention to two aspects, first, project as a transaction between the client and the project participants, and secondly, project as an organization. The first aspect is conceptualized by the transaction cost economics of Williamson. The second aspect is covered by the approach of organizations as information processing systems, advanced by Galbraith. In the framework of this conceptualization, projects are viewed in terms of reduction of uncertainty through time.

These foundational concepts do not seem to bear on the operational activities. To this, Winch says:

The process - the flow of water - cannot be directly managed, we have to manage the context in which it flows. The same, I suggest, applies to organizations and their flows of information, and much of the book will be about how we manage the project process through managing the organizational context of projects.
He calls this tectonic approach to organization: "the problem of management is the problem of continually shaping processes by manipulating the structure".

Further, Winch defines five generic project processes and discusses their management in the light of the foundational concepts. This becomes evident in the summary of the book, where he states:

The river metaphor […] shows how the information flows which initiate and control material flows are at the centre of construction project management, yet cannot be managed directly. It is through the structure of project coalition that these flows are governed, as uncertainty is reduced through time. The rest of the argument took various aspects of construction project management problem from this perspective.

To summarize, there are four conceptual or theoretical starting points: transaction cost economics; organization as information processing system; project as uncertainty reduction; and tectonic approach to organization.

In the following, the more detailed prescription presented by Winch regarding a number of key generic issues of project management is summarized. This introduction is aimed at giving the starting point for discussion in this paper, and does not give justice to the rich and insightful treatment of different topics in Winch's book

**DETERMINING CLIENT REQUIREMENTS**

Winch stresses the importance of delivering value to clients and specifically notes that the capital and O&M costs of a commercial building are small compared to the cost of the people using it during its life—8% versus 92%. (p.50) Slight increases in building costs, as for better air conditioning, could be recouped many times over from very small productivity improvements. He does not address how to determine what is truly of value to clients, so neither supports nor denies that value is something that emerges within the project definition process, rather than something lying complete but hidden, only needing to be revealed.

**STRUCTURING CONTRACTS**

Winch clearly understands the inadequacy of current contracts, which do not motivate providers to deliver value to customers. However, his theoretical constructs obscure the opportunities offered by a production perspective. He applies two economic concepts: owner-agent theory and information processing theory. He does wind up advocating alliancing arrangements and incentive contracts, but these are driven by the desire to overcome problems defined in terms of those theories as opposed to enabling work to be done in a way that radically changes the risk equation for the parties. He agrees that the fundamental assumption of adequate design before building is flawed, but does not appear to view that better design can be generated by involving downstream players in upstream decisions, and that an integrated team can better manage changes.

**FORMING PROJECT TEAMS AND MANAGING RISK**

Winch critiques the adequacy of competitive bidding as a means of selecting suppliers, then reviews alternative selection methods, specifically best value procurement and partnering (pp 110-114). This all from the perspective of the client, thus neglecting the issue of forming the provider team and linking the project to supply chains.

As for risk management, Winch thinks in terms of making sound decisions about taking on risks, and is especially concerned to overcome a propensity towards risk aversion. He stresses the importance of early identification of risk for effective management and lists alternative techniques for managing risk, including ‘accept, externalize (through subcontracting), mitigate (through changing plans), insure against and delay decision’ (p.324-5).
CONTROLLING PERFORMANCE

Winch first stresses the inaccuracy of early estimates and the narrowing of that inaccuracy as the project progresses. For example, trade packages are said to be completed within 5-10% of their budgets, while the cost estimate associated with a design brief might only be within 30% of actual costs. As for structuring budgets, he advocates using a product breakdown structure during design and moving from unit rates to priced bills of quantity as the design becomes more detailed. He mentions the practice of target costing as an attempt to have cost drive design decisions, but says it is not viable in construction currently because of “...the lack of basic knowledge on the construction supply side regarding costs and their drivers....” (p. 240). Work breakdown structure is to be used for budgetary control in the building phase. The WBS starts with the trade packages (contracts with specialists) but does not go down to the weekly level, which is left to the trade contractor. The ultimate cost control model is the cube structured by the intersections of product, process (work), and organization: PBS, WBS and OBS. This cube specifies for each product element and process element who is to do it. This database can then be costed to produce budgets for each node, and costs ‘controlled’ by monitoring actual costs against budget. Earned value analysis is to be used to relate spending to time. Cost overruns are said to be primarily the result of poor stakeholder involvement early on, especially as regards regulatory requirements, which tend to become an issue when projects attempt to innovate in new product components or production processes.

CRITIQUE OF THE ECONOMICS-BASED APPROACH

TRANSACTION COST ECONOMICS

The novelty of transaction cost economics is in the argument that a buyer should not select a supplier, ceteris paribus, based on the price offered, but taking also the transaction costs into account. Transaction costs are associated with search and information costs, bargaining and decision costs, policing and enforcement costs (Dahlman 1979).

From the point of view of modern production/operations management, this can be interpreted as minimizing a few particular cost categories or particular form of waste (i.e. non value-adding activity). Unfortunately other kinds of waste are not recognized by the transaction cost theory, because it views production as a series of transfers (i.e. changes of ownership of goods and services from one individual/unit to the other). Thus, transaction cost economics provides a very narrow view of production that, for instance, disregards the flow aspect of production. However, it is fully compatible with the decomposition principle of the transformation model of production (Koskela 2000), while production is conceived as the purchase of decomposed tasks or goods.

There are two or three major conceptual flaws in the approach of the transaction cost minimization as the organizing principle of production. First, purchasing labor and material is one function is production, but it does not equal to production: thus a conceptualization of purchasing cannot substitute for a conceptualization of production. The question arises, why production should be organized just on the basis of purchasing costs. Instead of minimizing a specific type of waste associated with one activity type in production, the objective should rather be to organize production in such a way that all kinds of waste are minimized. The selection of an organizational form of production should also focus on the general objective of value maximization

Unfortunately, this basic idea of production as essentially purchasing is widely spread in construction practice (even if transaction costs are not taken into account, but we do not see that their inclusion would make much difference). Seeing production as purchasing implies a neglect

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4 In contradiction to this, Winch later notes - based on Last Planner - the importance of planning at the weekly level.

5 This is suggested by Galbraith (1995): “In my view, organizational designs should make it simple for the customer to do business with the organization. Designs should also make it easy for employees with customer and product contact to execute their roles.”
of management of productive processes. The consequences of this neglect are found to include poor control (low reliability) of handoffs between design, supply and construction specialists and a tendency to promote adversarial relationships—reducing value delivered and increasing waste (Ballard & Howell 1998).

Second, it is hardly possible to isolate water-tightly transaction costs from production costs, as assumed in transaction cost economics. Instead, the transaction behavior of the supplier (for example, reliability of materials deliveries) impacts the production costs in many ways, but this is not taken into account in transaction cost economics, because production costs are considered constant. In fact, we hypothesize that the veridical situation is often the opposite to the prescription of transaction cost economics: the need for minimizing supplier-caused disturbances in production may lead to a situation that a consideration of production costs dictates the mode of purchasing.

Thus, conceptually, transaction cost economics cannot be held as a plausible theoretical base for organizing production, unless we accept the tail wagging the dog - purchasing dictates production. This said, it has to be stressed that we do not deny the significance of transaction cost economics in understanding phenomena and providing useful prescription in its proper domain, i.e. purchasing.

ORGANIZATION AS INFORMATION PROCESSING SYSTEM

Whereas the transaction cost economics describes what happens with regard to transactions, the theory of organizations as information processing systems is clearly intended to tackle the phenomena not covered by transactions, i.e. production, or at least management of production. Namely, if we view organization as only an information processing system, the production of goods and services, the *raison d'être* of the organization (in normal cases), is abstracted away, and only information processing managerial activities are left for consideration.

We contend that this is at least a partial and at most a misdirected approach in the case of construction projects. A construction project, as a temporary organization, is characterized by physical production - it is a materials processing system, too. Materials processing is the core element of a substantial share of organizations in construction; it simply cannot be abstracted away when discussing project management in construction.

UNCERTAINTY REDUCTION

The definition of the project process as the dynamic reduction of uncertainty through time is inspiring but obtuse regarding application. The definition is using the many-faceted concept of uncertainty but does not differentiate various aspects of it. Also, this conceptual definition lacks a connection to practice.

Let us consider the problem of uncertainty in the framework defined by Winch, namely as a problem of lacking information when decisions are made. Winch presents a graph showing that at the start of the project, uncertainty is high, the amount of information practically nil, whereas at the end of the project, there is full certainty. It is indeed true that there is much more information available on the facility after it has been constructed than in earlier phases of the project.

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6 Of course such an extreme situation might exist, but it cannot be viewed as the baseline case.
7 The dangers of excessive abstraction are commented by Feyerabend (1999): “Abstractions remove the particulars that distinguish an object from another, together with some general properties such as color and smell. Experiments further remove or try to remove the links that tie every process to its surroundings – they create an artificial and somewhat impoverished environment and explore its peculiarities. In both cases, things are being taken away or “blocked off” from the totality that surrounds us. Interestingly enough, the remains are called “real”, which means they are regarded as more important than the totality itself.”
8 In fact, the common occurrence of latent defects signifies that in practice, no full certainty is being reached at the hand-over of the constructed facility.
However, can this be regarded as a problem, the solution of which is the primary task of the project organization?

In practice, decisions in a project are ordered so that each decision is based on information produced in earlier decisions, and produces, in turn, information for subsequent decisions. The project proceeds from general issues to details and from ends to means. Thus in the ideal case, each decision can be made based on all information needed, without any uncertainty. In practice, there are complications. There are intrinsically coupled decisions, where a later decision gives information backward to an earlier decision. Also, decisions may be taken in wrong order, causing self-inflicted uncertainty.

All in all, uncertainty as lack of information seems manageable, although not unproblematic, in a project. However, the reduction of such uncertainty seems to happen as a side-product, rather than as a primary goal.

Another issue is then that the framework of decision-making as a conceptualization of a project is restrictive: it does not directly cover the realization of all decisions made. Uncertainty is not related only to decisions, but also to their realization. Here, the framework of information and material flows (or processes) is more appropriate. Especially, the queuing theory based "Factory Physics" (Hopp & Spearman 1996) gives a precise prescription on where to focus the efforts towards reducing uncertainty, in the meaning of random variation - or variability in the parlance of queuing theory. Indeed, in Factory Physics, reduction of variability rises to a main prescription of production management.

All in all, when compared with the particular theories of production (T, F and V) (Koskela 2000), it must be concluded that reducing uncertainty (in the meaning defined by Winch) in and of itself is not the objective, but is rather a means for getting the facility built, generating value and reducing waste. These theories imply a more accurate and operational prescription on uncertainty in its various forms than the theory of organizations as information processing systems. The last mentioned theory provides an interesting angle to projects, but project management theorizing cannot be based solely on it.

**TECTONIC APPROACH TO ORGANIZATION**

The tectonic approach to organization implies "continually shaping processes by manipulating the structure." The underlying assumption is that the process cannot be directly managed. In practice, the tectonic approach means that the focus is on organizational and contractual structures.

The tectonic approach to organization is tempting: it simplifies management into creating organizational and contractual structures. In the case of a temporary project organization, the primary thrust is understandably on contractual structures.

Unfortunately, such an approach neglects the management functions of (production) system operation and improvement. Especially, it denies the very existence of the discipline of production control, geared at directly managing processes. We can see little justification for this denial. We agree that structure is important. However, having a structure (production system) at hand, we must operate it. Having operated and observed the production system, we can improve it. Thus, there are three generic management functions: designing, operating and improving the production system. The organization is one embedded aspect in the production system.

However, there are situations where a tectonic approach is appropriate, namely when the task/situation is so complex and vague that only the structure of the organization can be designed in advance: this is the *adhocracy* organization as defined by Mintzberg (1983). There are phases in a construction project that are appropriately organized as adhocracy, but this must be seen as an exception to the rule.
THE PRODUCTION-BASED APPROACH TO PROJECTS

GENERAL CONSIDERATIONS

In the production-based approach, projects are conceptualized as temporary production systems. Project management equals thus to production management. The crucial question is: what are the most fundamental theories and principles covering production management, and consequently project management (Koskela & Howell 2002a,b)? Regarding the theory of project (production), the (partial) models of operations as flow and value generation add the consideration of time, variability and customer to the conventional conceptualization provided by the transformation model (Koskela 2000). Similarly, the theoretical foundation of management has to be extended. Regarding planning, the conventional theory, management-as-planning implies that planning is the core task of management. The approach of management-as-organizing adds the idea of human activity as inherently situated (Johnston & Brennan 1996). Thus, planning should also focus on structuring the environment to contribute to purposeful acting. Concerning managerial execution, in the language/action perspective, described by Winograd and Flores (1986), action is triggered by explicit commitments (promises) resulting from two-way communication, instead of the mere one-way communication (orders) of the classical communication theory. The scientific experimentation model of control of Shewhart (Shewhart & Deming 1939) focuses on finding causes of deviations and acting on those causes, instead of only changing the performance level for achieving a predetermined goal in case of a deviation, as suggested by the thermostat model of control. The scientific experimentation model adds thus the aspect of learning to control.

Table 1. Ingredients of a production-based approach to project management.

<table>
<thead>
<tr>
<th>Subject of theory</th>
<th>Relevant theories</th>
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<tbody>
<tr>
<td>Project</td>
<td>Transformation</td>
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<td></td>
<td>Flow</td>
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<td>Value generation</td>
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<tr>
<td>Management</td>
<td>Planning</td>
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<td></td>
<td>Management-as-planning</td>
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<td></td>
<td>Management-as-organizing</td>
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<tr>
<td>Execution</td>
<td>Classical communication theory</td>
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<td></td>
<td>Language/action perspective</td>
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<tr>
<td>Control</td>
<td>Thermostat model</td>
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<td></td>
<td>Scientific experimentation model</td>
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Due to space limitations, the production based project management system is not described systematically, but rather selected aspects are discussed in the following and contrasted with corresponding features of the economics-based approach to project management.

DETERMINING CLIENT REQUIREMENTS

The key distinction in the determining of client requirements is whether those requirements are understood to preexist or to be produced in the project. If the former, which is the traditional view, the task of determining client requirements is like mining. The ore is in the ground. All that remains is to dig it out. On building projects, this is traditionally done by the architect ‘debriefing’ the client, and capturing the findings in a design brief that specifies what the client requires. If, by contrast, requirements are understood in terms of purposes, and value to be what allows realization of purposes, then the task is rather to challenge self understanding, reveal conflicts between client constituencies, confront desire with its consequences, and explore alternatives not previously considered. Requirements may be ‘determined’ in the sense of revealed and specified, but the purposes for which they are means are created in the project definition process.

This shift is part of the expansion of the project boundary that goes hand in hand with structuring supply chains, incorporating indirect stakeholders, and considering the interests of future generations. This expansion, in turn, is driven by the shift from conceptualizing projects as
special forms of organization instrumental to the achievement of predetermined goals to seeing projects as the fundamental form of production system.

**Structuring Contracts**

What counts as a good contract? The traditional practice of contract formation assumes that the fundamental problem is the conflict between the client’s desire for unlimited access to specialists’ resources and the specialists’ need to restrict access. Consequently, a ‘good’ contract would presumably be one that, all else being equal, fairly balances those conflicting needs. As an alternative, suppose the objective of contracting was to make it in the interest of specialists to pursue the TFV goals. We suspect that few contracts now achieve that objective. They fail not because the objective is unachievable, but because it is not pursued.

A further consequence of this TFV approach is that contracting should not be restricted to a single project, otherwise the lack of a future with one client might prejudice a specialist to serve the interests of other clients with whom there is assurance of a future relationship. This consequence alerts us to the need to reexamine the underlying conceptualization of the ‘exchange’ between the parties. Should that be understood as a transaction and contracts be understood as the agreements governing that transaction? We propose, following MacNeil, that relational contracts, with their many possible futures, are appropriate for construction project contracting (MacNeil 1974). Purchasing is an inappropriate conceptualization of the contracting process, which is rather dedicated to the design and formation of the production system.

**Forming Project Teams and Managing Risk**

The prevailing wisdom concerning what Winch calls “integrated coalitions” is that they should be used on projects with known and stable objectives, with few challenges to successful delivery. One basis for this thinking is the claim that clients cannot know with whom to contract until they know what is to be built. However, that assumes that the coalition cannot or will not facilitate project definition as previously described, presumably because they will not be disposed to consider alternatives of no project at all or a project the coalition is incapable of delivering. Obviously, this assumes a one-off relationship between client and coalition, which need not be the case. It may also assume that coalitions have no concern for their reputation, or that their treatment of one client will not be transparent to other potential clients—both unlikely assumptions. Further, while some clients may be considering whether to build a tunnel, a building or a bridge, most will be considering only one product type, trying to decide if to build and what to build. So the choice is more likely to be between a steel or concrete structure than between a building and a bridge. Integrated coalitions may easily span both types of building structure. (The economic model and associated view of projects as investments may have influenced Winch to think of the prototypical client as a financial investor willing to consider any ‘game’ with an acceptable ROI). From a production perspective, integrated coalitions are the most capable of dealing with uncertainty, speed and complexity precisely because they are teams experienced in working together, with connections to power within a larger network of specialists, and as such can benefit maximally from learning and improvement over time.

Given slow, certain and simple projects, the received wisdom advises selection of integrated coalitions as a means of shifting risk from client to coalition. The underlying thinking is that risk cannot really be shifted as long as the project objectives are subject to change. Consequently, project design should be predictable and cookie cutter, with no emergent phenomena. In short, risk can only be effectively shifted to the contractor when there is little risk to shift. When risk is high, the client cannot get rid of it; at least not by contractual means—a conclusion we endorse.

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9 In the case of a single project, the client should consider hiring and organization which itself is built on longstanding internal relationships and has demonstrated performance in the sort of circumstances presented by the project.
We suggest that risk is best managed through competent management of production, including changes in objectives and conditions, and that contracting with integrated coalitions is consequently the most effective method of managing risk. Traditional risk management does not appear to include risk reduction, as opposed to offsetting the consequences (cf Winch, p.322). This is much like conceiving buffer management without regard to reduction of the variability that is to be buffered.

Yet another aspect of economics-based thinking is the focus on the principal-agent relationship and the assumption that the problem is to prevent the agent exploiting the principal. But Winch (P. 321) advocates “incentive contracts” because traditional contracts have more risks than rewards for contractors, suggesting the reverse problem; i.e., the principal exploiting the agent. This is simply the issue of aligning interests, but conceived in a way that allows no solution other than assignment of 3rd party police. It should be noted that such 3rd parties are the same organizational solution to coordination as Mintzberg’s “liaison mechanisms”. Neither are very effective and both add costs and complexity.

CONTROLLING PERFORMANCE

Against what is performance controlled? A changing objective to which the project reshapes and rededicates itself opportunistically, or standards previously established in contract, schedule or budget? The difference between a production-based view and a economics-based view is the difference between looking forward and looking backwards. Traditional project management logs actual performance and looks backward to assess the fit between actual and plan. By contrast, what is critical for production-based project management is having goals the achievement of which deliver most value and having an acceptable plan to deliver. The objective is continuously replotted, and a route or routes to completion devised.

CONCLUSIONS

Based on the analyses presented, the essential foundational differences between the economics-based and production-based approaches are summarized in Table 2. Given these foundational differences, it is no surprise that the prescriptions flowing from these two approaches differ regarding the key issues of practical project management.

The foundations and prescription of the economics-based approach have been critically assessed, and it has been contended that the foundations and prescription of the production-based approach are more appropriate. It must be added that although the foundations seem to be very distant from each other, these approaches overlap in their peripheral, maybe implicit assumptions: even in the economics-based approach, production is somehow managed, and in the production-based approach, realities of economic life are taken into consideration. Thus, even if a production-based approach is preferred, it is a future task is to integrate the economics-based elements into it and explicate them. It is hoped that this paper contributes to a constructive dialogue needed in such an endeavor.

Table 2. Comparison of the foundational issues of the economics-based and production-based approaches to project management.

<table>
<thead>
<tr>
<th></th>
<th>Economics-based</th>
<th>Production-based</th>
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<tbody>
<tr>
<td>Fundamental assumption on the ontological nature of projects</td>
<td>Organizations integrated through transactions</td>
<td>Production system</td>
</tr>
<tr>
<td>Conceptualization of project</td>
<td>Information processing system</td>
<td>Transformation, flow, value</td>
</tr>
<tr>
<td>Intrinsic goal</td>
<td>Uncertainty reduction (i.e. elimination of lack of information)</td>
<td>Getting the facility produced, eliminating waste, increasing value</td>
</tr>
<tr>
<td>Nature of management</td>
<td>Creating the (contractual and organizational ) structure</td>
<td>Designing, operating and improving the production system</td>
</tr>
</tbody>
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REFERENCES


