NECESSARY AND UNNECESSARY COMPLEXITY IN CONSTRUCTION

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ABSTRACT

The nature of complexity varies as construction progresses. This paper presents concepts and practices with which project (knowledge) management must foster complexity when it is necessary and dampen complexity when it is unnecessary in order to generate value and control time and costs. Complexity management has to be adjusted to the current state of the project.

Before and during programming the building as a solid object can not be predicted; the user activities, extent, mass and materials are unknown. We might renovate, build a new building or we might not invest at all. The problem is inductive since there are several correct answers, not right or wrong but good or poor. After design and before on-site construction we know the object and its performances, the single “right answer” for construction. The system is deductive. The building process is initially inductive and becomes predominantly deductive, being complex all the time.

The destruction of an inductive system can be avoided only if there is enough variety in the controller. Only a management system which contains variation can produce alternatives in a creative way to keep to goals in spite of disturbance. It is called necessary or requisite variety. If a problem “do we need an activity?” is dealt with simultaneously as the question “where would it be located in a plan?”, there are limitless possible alternatives. If we first answer “no” to the first question, there are no alternatives left. Does the “Where it will be” answer create more valuable information to the question “do we need it”? If not, the variables are orthogonal. Combining orthogonal variables causes more iterations and can be called unnecessary complexity.

In the beginning of construction the building as an object can be predicted. However, due to the peculiarities of construction, there is a lot of complexity confronting the production phase. The issue is to consider whether any peculiarity could be eliminated or at least reduced. In operations management, three different conceptualizations should be simultaneously used: production as transformation, flow and value generation. From these, the transformation model is in an auxiliary position, whereas the flow model addresses the time-dependent complexity and value generation addresses the time-independent complexity. In the framework of these conceptualizations, the insights and principles of complexity thinking should be applied as appropriate.

KEYWORDS
Complexity, project management, knowledge management, workplace planning.

PERSPECTIVES TO COMPLEXITY

Complexity theories state, in contrast to the conventional production theory (that holds production to be a transformation), that complex systems are not simply the sum of their parts. Whereas details of components can often be ignored while studying their interactions in the whole system, the short-run behaviour of the individual subsystems can often be described in detail while ignoring the interactions among subsystems. In economics we can study the demand for iron ore, pig iron, sheet steel etc. But studying these subsystems a central bank cannot predict fluctuations and control interest rates. The evolution of self-organizing systems cannot be precisely managed through linear steps, optimizing strategies work well only when operating in precisely known environments (Simon 1996). But by developing complex system theories, management concepts can be found that direct evolution to possible or rather acceptable areas.

Observer's point of view vs. participant's point of view

We can study complexity from outside of the system as an observer, or from inside of the system as a participant. A meteorologist studies weather in order to understand its complexity and limitations to predict it. A construction manager does not study the complexity of construction only in order to understand it, he/she has to survive, often by affecting the system. From the participants point of view it is important to understand complexity, but, in addition, we have to perform theories and methodologies to manage complexity.

Complexity of deductive systems

Those problems, for which a correct answer can be found, have been named, for example, deductive problems (Nicolis 1998: 15). The answer to a deductive problem can be deduced from given information through steps of linear regression (gather information, analyze, solve).

No new or unique information is produced during the deductive process since the arguments are known. Deductive problems can be, for example, mathematical problems (implicit, as well as explicit theorems). Furthermore, many systems limited by human participation are deductive. For example, the accounting system of a company is deductive, as the chaotic outer world is kept outside the boundaries of the base information in the accounting system (Pennanen 2004).

Sometimes solving a deductive problem can be difficult, even impossible, even though we can verify the solution as true or false.

A solution can be unattainable when

1. the system is too complex in the meaning that it requires information which is difficult to obtain (Ruelle 1991). It is difficult to make a weather prediction a month in advance because there are so many variables; the movement of air particles in different areas and in different air layers, their directions, differences in temperature, pressure differences, the shape of the earth …
2. the system is complex in chaotic meaning. Chaos is solid mathematics, but the variables have an effect on each other. A minute change in one variable can throw the equilibrium out of balance. (Lorenz 1963). The classic example of this is the flutter of a butterfly's wings, that can, weeks later, cause a storm on the other side of the world.

Although solving a deductive problem can be difficult, because of complexity in the system, we can verify the solution as true or false. For a functional requirement "controlling internal temperature of the room within +-1 degrees" there are numerous design solutions. The system is complex; it is disturbed by varying external and internal thermal loads, moisture differences and interactions between technical solutions. However, it is afterwards easy to verify whether the solution meets the requirement.

Nam P. Suh (Suh 2005) defines complexity as follows:
“measure of uncertainty in understanding what we want to know or in achieving a functional requirement"

In this definition “what we want to know” represents the observer’s point of view and “achieving a functional requirement” represents the participant’s point of view. As Suh links his definition to his axiomatic design concept, he is mostly interested in the participant’s point of view.

Functional requirements (FRs) are defined, in axiomatic design, as a minimum set of independent requirements that completely characterize the functional needs of the product in the functional domain. An FR is specified in terms of its nominal value with allowable variations or desired accuracy (design range). All possible values (or probability density function of values) of the chosen system to satisfy FR is called the system range. The FR is satisfied only if the design range and system range have a common area; common range. When the system range is not completely in the design range, there is a finite uncertainty that the FR may not be satisfied. Therefore the system has a finite complexity (Suh 2005).

As Suh requires a defined functional requirement to define complexity, he operates with complexity of deductive problems; the correct answer is known although it might be difficult to achieve. Suh also introduces powerful methodology to manage deductive complexity. The methodology is based on two axioms; the independence axiom and the information axiom. Suh’s methodology applied to construction is shown later.

Complexity of inductive systems

In the previous example, predicting weather on a long-term basis is difficult, even impossible. However, if rain has been forecast for Monday a week from now, and it then rains, we can congratulate the forecaster on his accuracy; a correct answer. If the problem is to define the best movie ever made, the discussion could go on for tens of years (Citizen Kane??) (Pennanen 2004).

There may be several correct solutions to inductive problems. Not all the information needed for the solution can be found in the given initial information. And old information is not always recorded and some knowledge disappears forever (Nicolis 1998). What is the most suitable location for the proposed Helsinki home for drug abusers? The way the problem has been formulated does not include all the information necessary for the solution. When the urban planner is solving the problem, it becomes apparent, that in the locale of the proposed site there is an extremely powerful residents association and in the area there also live lawyers (”not in my backyard”). Most of the members of the council will end up supporting the decision that the treatment of drug abusers should take place away from populated areas in the interests of efficiency. In recently held elections the political party concerned lost its majority, and the party now in power has stated that drug abusers should not be ”hygienically” hidden, but treated in an authentic social environment, within normal residential areas. The proposed national budget will cut Helsinki municipal tax revenues and the Finnish Exchequer proposes that the home should not be built. The problem is inductive; whilst solving the problem the system generates new information, part of the old information loses its meaning, there is no right or wrong, the nature of the problem changes from the original one, it is not possible to know whether the problem actually has been solved (Pennanen 2004).

In complex situations the inductive system is self-organizing, and produces new information and states during the process. In inductive problems the answer is not right or wrong, but deemed good or poor. (Nicolis 1998: 15). When referring to inductive systems in problems of planning, Rittel uses the term ”wicked problem” (Rittel & Webber 1972). The problem is wicked, if it follows, for instance, these commandments:

- Wicked problems have no stopping rule.
- Solutions to wicked problems are not true-or-false, but good-or-bad.
- There is no immediate and no ultimate test of a solution to a wicked problem.
- The planner (designer) has no right to be wrong.

Suh’s definition of complexity is not very useful when inductive complex systems are dealt with. For instance, in socio-economical systems each stakeholder is committed to his/her own interests, and it is not clear whose values will appear to be chosen. Suh names that complexity of socio-economical systems is “time-dependent combinatorial complexity”, meaning that the system range may drift away from design range with time. Suh points out that the complexity of such a system can be decreased if the social system can agree on the common set of FRs (Suh 2005). But that is the point, in social systems the functional requirements are often unclear. The possible requirements form the complex system to be managed. In a complex social organization there are many participants with many values. The different values may all be “right” but when combined they cause disturbance to production (Pennanen 2004). As functional requirements drift (as illustrated in the previous example “home of drug abusers”), it is then no use to define the system range at all and the definition of complexity loses its base.

There are numerous solutions in a socio-economical inductive system that can be considered acceptable. What is the criterion that differentiates the chosen solution from the bad ones and from the other good ones? It is the commitment of the participants to something achieved. We need a methodology to weight participant’s values and identify common values. The product of the value identification process for the rest of production is the stakeholders’ commitment to common values and requirements. It is a crucial part of production (Pennanen 2004). If we define that the stakeholders commitment is the first FR of the social system, it seems then that to reduce complexity of socio-economical systems we have to concentrate on adaptive systems management and learning processes.

Necessary complexity in management

If there is large variety in the controlled system, its destruction can be avoided only if there is large variety in the controller (Ashby 1956). If a species survival is a goal and there is a large variety in its environment in time and space, there should be a large variety in its gene-pattern. This is how nature works.

In an inductive system the result cannot be predicted, there is no right answer. In such conditions management can-not be based on a simple model that measures the difference to the desired state and plans the corrections. Only a management system which contains enough variation, whose information content is big, can produce alternatives in creative way to keep to goals in spite of disturbance. It can be called necessary or requisite variety. As the system alters to contain less variety, so the controller should become simpler.

When seeking for stakeholders’ commitment, there is a great diversity among stakeholders’ initial values and interests. In such conditions the variety of the controller must be large. This will be explained later in the chapter “ programming”.

Unnecessary complexity in management

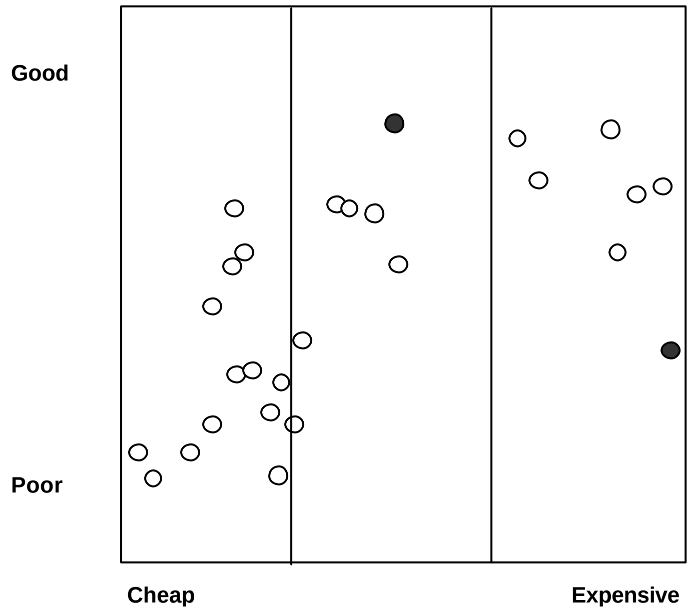
There are two inductive problem areas in construction; programming problems and design problems. If in a building process a problem “do we need to invest in an activity?” is dealt with simultaneously as a question “where would it be located in a plan?”, there are limitless possible alternatives. If we first answer “no” to the first question, there are no alternatives left. Does a “Where it would be” answer create more valuable information to the question “do we need it”? If not, the variables are orthogonal. Combining those variables causes more iterations, more waste and more rework as initial assumptions appear to be wrong. In reality there are numerous solutions for each programming problem and design problem and mixing those problems will expand complexity enormously. Combining orthogonal variables cause more iterations and can be called unnecessary complexity (Pennanen 2004). In Suh’s axiomatic design this is formulated “customer needs and functional requirements must be determined in a solution-neutral environment (Suh 1990)”.

Unnecessary complexity can also be explained in relation to Suh’s Axiomatic Design’s information axiom (Suh 2005). The information axiom states that to succeed in planning the information content should be decreased. Information content is defined (referring to Shannon’s information theory) as follows: I = log (1/P), where P is the probability of success (the bigger P is, the smaller I is). “Where would it be” information does not increase the probability of success in solving a problem “do we need it?”, latter is related to business strategy and the previous information to the building site, themes in design, connections between activities etc. Previous information will increase information content as it increases complexity. Information content would be locally decreased if we don’t deal with previous information when focusing to solve the latter. Programming and sketch design must be separated (Pennanen 2004).

Soft values vs. hard values

One reason why a socio-economic inductive system easily moves into a chaotic state is that some of the driving functional requirements are measurable (internal temperature in a room must be 24 +-1 degrees) and some are based on “soft” values, e.g. beauty. As soft values (or evaluating them) are culturally bound in time and space and among individuals (Pennanen 2004), it is very usual to produce DPs (sketch- design proposals) while defining FRs (when programming). There are numerous design solutions for each set of hard FRs; evaluating soft values of design proposals (applicability, beauty…) together with stakeholders’ opinions is very complex and variation in design solutions affect to one important FR, namely life-cycle costs. It is very complex, slow and expensive iteration. To decrease such unnecessary complexity we have to study the correlation between hard and soft values and try to find an area in where the hard functional requirements could be defined without affecting the soft requirements. This is in concordance with Suh’s independence axiom. It states that when there are two or more FRs, the design solution must be such that each of the FRs can be satisfied without affecting any of the other FRs.

Suh’s methodologies do not give tools to handle complexity related to soft values. To handle that problem we have to study factors correlating to architectural quality. Architect Niukkanen has studied the correlation of architectural quality and building costs (Niukkanen 1980). The population of the study was design & build competitions in Helsinki City residential building production. The competitors competed with architectural design solutions and price tenders. The architectural quality (external beauty, internal comfort, habitability) was analyzed by a delphi-group and value analysis matrix. The result of the study can be seen in the following figure.



Architectural quality and building costs in Helsinki City residential building production (Niukkanen 1980).

If we aim at a minimum price, it might lead to poor quality. But very soon when moving to average price production, the correlation between quality and costs disappears. The most expensive design solution was quite poor in terms of quality and the best quality was achieved with a reasonable price (of course, high price did not prevent good quality). When moving from minimum to reasonable costs the quality can-not be assured by allocating more resources to production, indeed, this may just as well lead to a poor quality solution as a high quality one. It seems that architectural quality is linked to creativity and artistry of the design group in interpreting our culture and its changes rather than to money (Pennanen 2004). If we operate within a reasonable cost area the building costs don't affect to quality and it is not necessary to take into account information from possible future design solutions.

COMPLEXITY MANAGEMENT IN A BUILDING PROJECT

There is much uncertainty and much iteration in programming and design and a lot of uncertainty in construction (Koskela 2000). Complexity management can be improved if the nature of complexity is identified and unnecessary complexity decreased. The building process appears to be an inductive problem in the initial stage and turns into a deductive problem before construction on site. But it is complex all the time.

Complexity management can be simplified by partitioning the project so that in those parts information content is low. The information content of the whole project is then the sum of the parts. Partitioning can be done by observing internal customer relationships in production. The rest of the production can be considered as a customer of the programming process. The next internal customer would be design. In design, the project requirements are translated into a design solution for the next internal customer, production-on-site. In production, this solution is realized. Vague requirements of the stakeholders harm design (and production). Design (and production) requires the elimination of uncertainty regarding stakeholders' requirements. Furthermore, uncertainty in design solutions harms production, production thus requires the elimination of uncertainty concerning the stakeholders' commitment in the design solution (Pennanen 2004).

PROGRAMMING

Nature of complexity

Before and during programming the building as a physical object can not be predicted. We might sell the present building and build a new one, we might renovate the existing building, we might rent spaces or we might find out that we simply don't need more spatial resources. The activities that require spatial investments, the extent of the building, mass and equipment are unknown. The variables that often are known are the customer, the customer's business strategy and the customer's business environment. There are numerous stakeholders and decision makers in the building process. Therefore, in the initial stage of programming, there are a lot of values, specifications and wishes. Most of them can be considered "right" or "entitled to", many of them are in contradiction to each other and, when combined, they are generally in serious competition for the resources available (Pennanen 2004). In programming we deal with inductive complexity.

Complexity management

Suh's Axiomatic Design states that good planning requires reduction of information content. Therefore customer needs and functional requirements must be determined in a solution-neutral environment (Suh 1990). Information of possible states of the design (possible design solutions) for each possible programming result would increase unnecessary complexity. When dealing with orthogonal, complex and temporally hierarchical information, the information flow in decision making should be one-way. Unnecessary complexity would be reduced if the valuable spatial investments for activities based on customer strategy are defined first, the functional requirements of the working environment for those activities are determined then. The architectural and technical design solutions should be investigated for after these decisions. The complexity of programming has to be resolved and the complexity has to be reduced before the complexity of design will be met (Pennanen 2004).

The system of programming is inductive and complex, there are numerous right solutions; two random groups in the exactly same business field would define different briefings. Management must incorporate the customer stakeholders directly to production as a controller to ensure required variety and creativity concerning customer needs (necessary complexity of controller). The theory of workplace planning (Pennanen 2004) maps the factors affecting spatial requirements and the general conditions for resource allocation and commitment to programming:

- a spatial investment in an operation competes for the same resources as the other investments in the operations (salaries, raw materials, education…)
- the size of the space is dictated by the operations taking place within that space
- spaces are the scene of a temporal flow of operations and non-use-time. The number of the spaces is due to the utilization of the spaces
- spatial investments in operations that are not needed for the organization's strategy are not value-adding and therefore are waste
- the operations time is value adding whereas non-use time is not value adding
- if waste of spaces unneeded for operations and waste of non-use-time can be reduced, more resources would be available for other investments, spatial or non-spatial

Programming is resource allocation in relation to the working environment, its users and organizations strategy. It is possible to plan the allocation through a transparent dialogue process between strategic and operational management that is supported by feedback of information of the desired state (need of spaces, life-cycle costs, utilization degrees) due to wants and wishes (Pennanen 2004). The management system can be understood as a knowledge management architecture that supports knowledge creation for project definition. After observing the workplace planning management system in action on a number of projects, there is evidence of collaboration to generate client and stakeholder purpose (Whelton (2004).

The result of dialogue is commitment of the stakeholders to common values and a single specification. The commitment, program, can be described in a measurable way, e.g.

- customer activity description:	library for 15 000 volumes is valuable for strategy
- workplace requirement description:	library requires 240 m2 spaces, including shelving areas 125 m^2, pc:s for inquiry 12 m2…
- performance requirement descrip.	internal temperature within +- 2 degrees, load 10 kN/m2…
- use-of-resource description	the library will be in good use (utilization degree 75 %), life-cycle costs of the library are 54 000 €/year. Library is still valuable for the strategy.

If we set the life-cycle cost target (capital + maintenance) in the minimum-cost area, it might lead to poor quality (soft requirements). But in average price production, there is no correlation between quality and costs. If we have methodologies to set the target cost by using quantitative functional criteria and set the target cost in a reasonable area, then the costs can be considered in design as a fixed variable (one criterion among the others) and the architectural quality is the variable that is managed. And upside down, it is not necessary to pay regard to future design solutions to in programming.

Methodologies

Though customer needs must be determined in a solution-neutral environment, some information that is realized in construction–on-site would be crucially needed in very the early phase for making commitment, namely the life cycle costs that will be caused by stakeholders' decisions. When deciding whether an activity would deserve spatial investment, it would be worth knowing if the activity can afford it. Power must be linked to accountability. Methodologies must flexibly provide the customer with this information before the design stage. When constructing such methodology, the information flow must be one-way, but upside-down in relation to a workplace production process. Product models require information what is the use of resources due to the design solutions, how the spaces and their performances are usually designed, with what spaces the activities are usually supported and what activities are usually required for business. Use-of-resource information must then to be traced to activities for activity based management. This kind of standard helps in handling life cycle costs in relation to the activities but does not tie future design solutions. Such methodologies are, for instance, Strategic Workplace Planning (Pennanen 2004) and Target Costing (Haahtela 1980 and Pennanen, Haahtela, Väänänen 2005) product models.

CONCEPTUAL DESIGN

Nature of complexity

In the beginning of design the building as a physical object can not be predicted; there are numerous design solutions for a specification. As the project progresses, more and more about the building as an object becomes to be known. the design process can be divided into three orthogonal perspectives (Pennanen 2004);

- theme
- shape and connections
- materials, details, equipment

Theme sets the strategy with which the building will be connected to the local environment, use of the site and the strategy with which mass, materials, details and colours will be solved. If the aim is “homelike”, then steel and glass are not first alternatives. The society’s (defined in a city plan) theme might be “low, not more than three floors”. When defining the connections of the activities and the mass of the building, the materials are not important to know yet. But finally, before constructing, the materials, equipment and details have to be determined. After design and before construction-on-site we know the physical object even though it does not exist yet. In conceptual design we deal with inductive complexity.

Complexity management

The initial information is the program where the stakeholders are committed. After reducing the complexity of the programming it can be considered as a “right solution of programming”. Conceptual design deals with connections between necessary activities and theme and mass of the building that connects it to the environment. The next internal customer is design-for-production. Information from design-for-production (brick wall, hollow core slab, cooling beams) would increase unnecessary complexity as they don’t bring more information to connections, theme or mass. The lines in sketch can be considered as lines without more information (even now when we have product model cad systems in use).

The building costs do not affect the architectural quality if we operate within a reasonable cost area. Therefore the costs have already been fixed in programming and the quality is the variable that is managed. The system is inductive as there are numerous design solutions for the briefing.

It helps to evaluate an inductive problem if the measuring subject can be determined. As construction is concerned the client can be used, the controller has still to consist dialogue of customer stakeholders to ensure required variety (necessary complexity of the controller) and prevent failure. Because the consequences of failure are often huge and paid for by the client, “the planner (designer) has no right to be wrong” (Rittel & Webber 1972). In this context architecture is rather more artistic than art Pennanen 1999).

Methodologies

Building costs are caused by distributions of building elements (bill of quantities) and material specifications of those elements (unit costs). Distributions are to be fixed in conceptual design, unit costs later. Methodologies must provide the architect with building costs of proposed solutions in conceptual design in order to manage the distributions of the quantities. The shape of the building is easy to change now but very difficult after half-a-year. Cad systems produce some of the quantities, but not all (they count external walls but not suspended ceilings or foundations since they are not completely designed in conceptual design). The problem is that they produce absolutely exact information of what has been designed but their share of entity is unknown. Cad systems should be supported by modelling systems that model all quantities and unit prices from actual functional requirements (Haahtela 1980). Elemental estimating would then be replacing model-information with cad-information.

DESIGN-FOR-PRODUCTION

Nature of complexity

In the design-for-production the building as a physical object can already be predicted. The design must be prepared and produced in a form that is understandable for production. Since design-for-production is carried out by several social organizations, there is uncertainty and complexity in this phase. But as “the right answer” is already known, the nature of complexity becomes be deductive.

Complexity management

The initial information consists of connections, theme and mass of the building. The next customer is production on site. Variety concerning requirements is reduced so much that the designers and project management include enough creative variety to handle the complexity (as controller). The result is the building as known, but not as an existing object. Complexity management of a deductive system is explained in the next chapter (production).

PRODUCTION

In the beginning of construction the building as an object can be predicted. However, due to the peculiarities of construction (Koskela 2000), there is a lot of complexity confronting the production phase. First, as construction usually is one-of-a-kind production, the production phase corresponds to prototype realization, which in other fields is aimed at eliminating defects and inconsistencies of design solutions and documentation. Secondly, there is usually a temporary organization operating on site. Lack of established communication patterns and the short time horizon add thus to the problems. Thirdly, the question is about site production, at least regarding the final assembly of the facility. Among other things, site production implies a lack of sheltered place for work. Fourthly, the sub-contractors on site have responsibilities to the other sites at the same time and therefore don’t share exactly the same interests. As the project manager coordinates several subcontractors on site, a subcontractor coordinates his/her work in regard to several sites. Thus there is a lot of uncertainty concerning the timetable, final costs and the achieved quality.

Complexity management

The first issue to consider is whether any peculiarity could be eliminated or at least reduced. Thus, one could use pre-designed (or otherwise tried-out) design solutions for reducing the problems of one-of-a-kind production. Configurations of subcontractors that have a history of formal or informal collaboration may be used for encountering the problems of temporary organization. Evidently, prefabrication provides a means for attacking the problems of site production. However, every peculiarity has its reasons, and its elimination may bring other penalties. Thus, the rule is really not to accept any peculiarity – and the related complexity - unless necessary and appropriate (Vrijhoef & Koskela 2005).

After this, the remaining complexity has just to be embraced through appropriate managerial concepts and tools. It has been argued that in operations management, three different conceptualizations should be simultaneously used: production as transformation, flow and value generation (Koskela 2000). From these, the transformation model is in an auxiliary position, whereas the flow model addresses the time-dependent complexity (as defined by Suh 2005) and value generation addresses the time-independent complexity. In the framework of these conceptualizations, the insights and principles of complexity thinking should be applied as appropriate (Bertelsen 2004).

Methodologies

Various methodologies and methods exist for mastering complexity in production. First, there are methods for representing the product and the process from the point of view of different conceptualizations. Such tools cover Work Breakdown structures, estimate (bill of quantity) modelling, 4D CAD, requirements modelling etc. Second, there are methodologies on how to structure and operate the physical processes of production, such as critical path network or critical chain. Thirdly, there are methods that involve the social system on site. Some methods, such as the Last Planner™ System of production control, operate in all these three areas (i.e. representation, rules on processes, and structuring conversations in the social system) (Koskenvesa & Koskela 2005).

SUMMARY

Complexity in the building process appears to be partly deductive (a correct answer exists) and partly inductive (answers are not right-or-wrong but good-or-poor). Thus, complexity management can be improved if the nature of complexity is identified, necessary complexity accepted and unnecessary complexity decreased.

There is a lot of complexity in on-site construction. Since the final goal, the building as an object (including functional requirements and design solutions), is mostly known, the nature of complexity is deductive. Complexity may cause unwanted differences in the outcome and the goal. In general, production would be more efficient in a deductive system if complexity can be eliminated or reduced. If (and as) not, complexity management can (at least partly) be based on a model that rapidly measures the difference to desired state and plans the corrections. It order to improve operations management, three different conceptualizations should be simultaneously used: production as transformation, flow and value generation.

In the programming and in the early design, the building as an object can not be predicted. The user activities, extent, mass and materials are unknown, they are a result of complex commitment process of the stakeholders. Complexity is inductive since there are several correct answers, not right or wrong but good or poor.

The destruction of an inductive system can be avoided only if there is enough variety in the controller. Commitment of the stakeholders will not be achieved by measuring current state to required since there is not a single required state. The whole variety of stakeholders' values must be in use in a well organized commitment making process. It can be called necessary complexity.

If a problem "do we need an activity?" is dealt simultaneously with a question "where would it be located in a plan?", there are limitless possible alternatives. If we first answer "no" to the first question, there are no alternatives left. Does "Where it will be" answer create more valuable information to the question "do we need it"? If not, the variables are orthogonal. Combining orthogonal variables cause more iterations and can be called unnecessary complexity. Unnecessary complexity would be eliminated if programming and sketch design would be separated.

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