THE VALUE UNIVERSE: DEFINING A VALUE BASED APPROACH TO LEAN CONSTRUCTION

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ABSTRACT

Value is the end-goal of all construction projects and therefore the discussion and agreement of value parameters is fundamental to the achievement of improved productivity and client/user satisfaction. The word 'value' tends to be used rather loosely in daily practice. Similarly, terms and interpretations vary within construction management literature. The aim of this paper is to put forward a number of definitions that may be used in a common language for discussing and implementing value through lean construction. Value creation and value delivery are clearly defined within a four-stage model that maps key process functions. Mapping the process provides a framework in which to highlight the differences between value-based management, value management and value engineering activities. The concept of external and internal values is also introduced. The model described is being implemented on pilot projects in Denmark, by consultants NIRAS and contractors MTHøjgaard. The model is grounded in extensive practical work and underpinned by theoretical constructs.

KEYWORDS

Boundary conditions; Communication; Culture; Definitions; Value based management.

INTRODUCTION

Lean Construction has been a topical subject in Denmark since consulting engineers NIRAS (via Sven Bertelsen) and contractors MTHøjgaard introduced the IGLC work/methods in Denmark in 1998/99 in the urban renewal project 'Eskildsgade 3-5' in Copenhagen. Since then lean thinking has spread to a growing number of companies, universities, clients and unions forming the subject of academic debate and being implemented in a variety of ways. The growing interest of the conceptual thinking behind lean lead to the creation of Lean Construction Denmark (LC-DK), initiated and promoted by the Danish Technological Institute with assistance from the Lean Construction Institute. Presently LC-DK has more than 40 members. It is evident that the interpretation of lean construction differs in Denmark, with different approaches used by different contractors and consultants. However, LC-DK forms the basis for achieving a common understanding—a common language—and a forum for improvement and evolution of future application.

This paper builds on work presented at IGLC12 (Emmitt et al. 2004), which explained the creative workshop approach being used by the two organisations. Our aim in writing this paper is not to argue for a theory for lean construction, nor is it to argue for a best practice model, even though the methods presented in this paper in many aspects represent what is currently seen as best practice in the Danish construction sector. Instead the paper aims to describe the value-based approach taken by a large consulting company and contractor working towards the realisation of a common goal to improve the building process for both clients and industry. Critical evaluation of the methods described is about to commence, but is not addressed in this paper. The context of a small country with a construction sector dominated by a handful of large consultants and contractors and a large number of small and medium sized companies should also be noted. So too should the fact

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that ideas imported from elsewhere, e.g. USA and UK, do not always translate easily to the Danish language and culture. Lean construction was originally interpreted very narrowly, represented by the Danish term *trimmet byggeri* (trimmed building), which relied almost entirely on the early 1990 experiences from the project Sophienhaven in Hillerød (Buildinglogistics #1 and #2, 1993 and 1994) using logistics, primarily in the flow of materials and activities, and the Last Planner System (LPS) (Ballard 2000) and the seven flows (Koskella 2000). Over the last three to four years the thinking has evolved and moved further up stream to include the entire design and construction process in the lean approach. The realisation was that without being able to specify the best value for the client it is meaningless to define waste. Such developments should also be set against the Danish emphasis on (project) partnering as the 'solution' to the sector's problems. This has resulted in some confusion of terminology and mixing of terms and concepts when debated, without a clear understanding of what partnering or lean really means. Similarly, the manner in which partnering concepts and lean ideals interact, if they do at all, needs further exploration.

THE VALUE UNIVERSE

Lean construction literature has mainly focused on dealing with problems and challenges that arise on the construction site. We argued in our earlier work that this was missing the point. To take a holistic and integrated approach to the design and construction of buildings within a lean framework means getting everything right at the start—or at least getting the costumer values as right as possible—thus trying to avoid unnecessary and costly changes/re-work loops later in the production process. This is the case in lean manufacturing, where considerable effort is put into the design and planning stages before production starts, and where considerable attention is given to customer values and implementation of a zero defect production process. Early planning stages consume considerable amounts of resources, but when production starts there is complete certainty because everything has been meticulously planned (hence saving considerable resources downstream). We argue that this should be the case with construction. There are many differences between manufacturing and construction activities, but that does not mean that the same approach and philosophy cannot be applied to the process. This means giving more time to the early phases and subsequently shortening the construction phase. A new value-based building process model/understanding has been developed through a series of trials, starting with the HABITAT consortium managed by NIRAS (Bertelsen 2000) and further evolved in the publication *The Client as the Changing Agent* (Bertelsen et. al. 2002), based on experiences from HABITAT and a pilot project William Demant Dormitory in Lyngby (Christoffersen et al. 2003). The current approach is that the lean philosophy (minimising waste, maximising value) should be applied as early as possible. It is here that decisions concerning value, design, procurement routes, timescale and budget conspire to set the scene for everything that follows (in line with the ideals promoted and popularised by Womack *et al.* 1991*,* Womack and Jones 1996). Combined with a clear set of values the briefing exercise (also known as 'programming' in Denmark and 'architectural programming' in the US) and early design operations can be managed in such a way as to reduce downstream uncertainty and associated waste. The value design thereby forms an essential base for the following waste reducing efforts. Furthermore value is a part of the economists definition of productivity:

$$Productivity\ (P) = Value\ (V)/Resources\ (R)$$

and therefore the essential question to ask is "how much value did I get out of my resource investment?"

If value is as crucial to define as we think, we need to answer the questions: (1) Value to whom? And (2) what is value? Both questions are difficult to give an exact and precise answer to. Is it the value to the owner, the user or the society we mean, or maybe even the value to the architect, engineer or contractor? And in what time perspective do we define value, when we construct, when we use or when we demolish and recycle? We could also ask if value is only connected to the building (product) or is it also connected to the processes that lead us to the product?

VALUE TO WHOM?

This seems to be an 'easy' question to answer, but it becomes increasingly difficult as we investigate the interests of the participants in a project. Going back to the definition of productivity, it must be the client/customer/society that defines the value. We tend to spend our money where payback is highest, and so usually it is the buyer who decides what is most valuable, not the participants of the delivery team (Architect, Engineer and Contractor). Clearly the delivery team members have values as well, but they are (or should be) concerned with delivering the best value to their

client, otherwise (in a perfect market) the client will look elsewhere. So we separate the value of the interests into:

- External value, which is the client/customer value, and the value that the project should end up with and the delivery team focusing on achieving.
- Internal value, by and between the participants of the delivery team.

This definition helps us to keep on track when differentiating between values of the client and of the delivery team, and these are not to be mixed. It gets increasingly complicated when we investigate the external value because the definition of the client is not clear. The client often represents a lot of different stakeholders (the users, the investor, the owner etc.), and furthermore when we build we affect our neighbour and the surroundings (city/landscape etc.). And they all have a different set of values and interests in the project. When we know that the perception of value is subjective and individual, and that it changes over time, how do we map the values and satisfy all the stakeholders? The 'thinking' of values in the process method reflects the client complexity and provides the background for further investigation of the client complexity. When we go through our value-based method, we have in mind the value landscape represented by:

- Stakeholders (owner, user and society).
- Time perspective (when we design and construct, when we use and then recycle).

WHAT IS VALUE?

The distinction between client values as the focus and end goal of our efforts and internal values of the delivery team is made as mentioned above. The external value is separated into (i) process value and (ii) product value. Process value is about giving our customers the best experience during the design and construction of the project. It comprises:

- 'Soft values' such as work ethics, communication, conflict solving etc. between the client and the delivery team.
- 'Hard values' such as the delivery teams ability to keep agreed time limits, cost estimates, quality of the product and workers safety etc.
- Values that come from the actual design and construction process. As an example of this kind of value, renovation works in a kindergarten could be used to teach the children about safety, creativity etc and thus generates process value that might not have been evident when the project started out. Learning from participating in the process is another value in this category.

The soft and hard values are—when agreed between the client and the delivery team members—defined as the partnering values for the project. In this sense partnering has meaning and is an essential part of the value universe. It is all about how to work together, and how to keep agreements between the client and the delivery team. Internal values of the delivery team are of course present and influence the manner in which the actors work together. Product values are mainly derived from Vitruvian values (firmness, commodity and delight), combined with harmony with the surroundings, environmental issues and buildability. These can be broken further down in a value tree, not to loose the overview, but to make sure that the client is guided through the entire value spectrum. Thus the delivery team can map the client values in the best possible way. Product and process values can interact, and especially when the product becomes visible, it could mean changes in the values or rather the interpretation of the values.

An important factor in the approach described in this paper is the establishment of common values, or at least the discussion between the stakeholders of the 'value universe.' Getting to know each other and thus establishing common values and/or knowing why values differ between the stakeholders is crucial to the method. Often the result of the value work will be the best compromise between stakeholders. Establishment of common objectives and common values are important objectives in the drive for greater cooperation and reduced conflict in construction projects (e.g. Kelly & Male 1993). Value is *the* end-goal and therefore the establishment of value parameters at the outset of a project are key to the achievement of improved productivity and client/user satisfaction. The purpose of this paper is not to try and define value in an academic sense, nor to present a tight definition of the term. In practice the term value is used very loosely, and we will retain that approach in this paper. The word value has two characteristics (Christoffersen 2003):

- The perception of value is individual and personal, and is therefore subjective. Indeed, agreement of an objective best value for a group will differ from the individuals' perception of value
- Values will change over time

We view value as: an output of the collective efforts of the parties contributing to the design and construction process; central to all productivity; and providing a comprehensive framework in which to work. Value must be established before doing anything else. Emphasis is on value creating activities as the initial framework for the

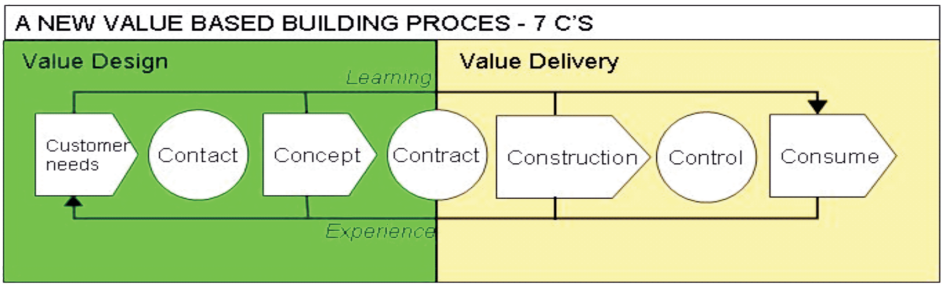

Figure 1: A value-based building process (source, NIRAS)

entire building process and thus the reduction of waste in the later value delivery phases. We are concerned with value-based management and the control of values through value management in the early stages of the project and through value engineering to deliver value in production.

VALUE THINKING THROUGHOUT THE ENTIRE BUILDING PROCESS

A new understanding of the building process based on value thinking has emerged from the work and projects performed in Denmark. The process is illustrated in Figure 1, which separates the value thinking into two mental phases:

1. Value Design, where the client value landscape is found and reflected in the conceptual design alternatives before entering the 'production phase' of the process—value management.
2. Value Delivery, where the 'winning' design alternative that maximizes the client/customer value is transformed into a production design and constructed with the aim to deliver the specified product in the best way and with minimum waste—value engineering.

The building process consists of:

- Four main phases (Client/customer needs and Concept phases in Value Design and Construction and Consume in Value Delivery).
- Three formal main activities Contact, Contract and Control.

VALUE DESIGN

CUSTOMER NEEDS

In this phase the client is 'alone' in making their first thoughts of the project needs. In this phase it is important to address the client organisation and make a stakeholder analysis, in order to map the interests in the project. In this phase, the basic values of the client organisation can be mapped, together with the contractual framework represented as time and cost budgets. This mapping helps to form the basis of a value-based design brief.

CONTACT

Here the client takes contact to the delivery system in the way that reflects the preferred basic organisation of the project. From a value perspective it is preferable that all stakeholders (including representatives from the owner, the user, the operation and management organisation, the society—typically represented by the authorities) are present and that all competences in the delivery system (architects, engineers, contractors and suppliers) are also present—but of course seen in the context of the actual project.

CONCEPT

In this phase the client needs (represented with all chosen stakeholders) is specified and formulated into a basic value document. This document is a specification of client needs, not solutions. The conceptual design shall then seek to reflect these needs. The way of performing the conceptual design phase is described in the workshop method. All actors are influenced and equally interdependent on others for the realisation of tasks and projects within the temporary social arrangement of the construction project. This interconnectivity places additional pressures on the ability to communicate and share information and knowledge. Interpersonal communication, intra-organisational and inter-organisational communication is particularly pertinent to the establishment of an effective project communication network, and also for enabling learning to take place within the project, helping to improve the end value on this and subsequent projects. Interactions within groups are an extremely complex issue and contradictory views exist as to the ability of a group to reach its defined goals (Emmitt and Gorse 2003).

The model illustrated in Figure 2 shows a very simple line of workshops, starting with the agreement of common process values followed by client intentions and discussion of abstract ideals and working through workshops to a complete set of information prior to commencement of production. Niras refer to this as the 'Walt Disney

Model' in recognition of the filmmaker's approach to process management. The term 'workshop' is used, although in practice this will comprise a series of related workshops that deal with a particular issue, or value stage. Workshops continue until agreement has been reached by all parties, thus a degree of flexibility in programming is required to accommodate the inherent uncertainty in knowing exactly how many workshops will be required. When problems with understanding and attitudes exist, further workshops are convened to help explore the underlying values and tease out creative input. Thus from the very start the whole process is consensus based. Bringing people together and facilitating workshops is time consuming and hence expensive, but have been proven to be cost effective over the life of the project. The workshops are an essential tool to maximise value and to reach agreement, which helps to reduce uncertainty in production, thus reducing waste. Different cultures will exist from concept through to production and the workshops provide a vehicle for the addressing potential difficulties. The workshops are also continued at the production phase to better involve the subcontractors.

The workshop model in the conceptual phase has four stages, from Workshop 0, which is concerned with getting the right people together and agreeing on the process values resulting in a partnering agreement before proceeding further, through Workshop 1 to Workshop 3. The workshops are seen as 'value generators' (or value drivers) with the delivery of client value being achieved between the main workshops within the delivery team. Workshops are concerned with problem framing, the problem solving takes place between the workshops. Design alternatives are presented on the realism and criticism workshops reflects the client values. Project team meetings are used between the formal workshops to discuss and agree progress. The number of participants present in the meetings varies between projects and stages, however numbers typically range from between 15 and 30 people, although the organisational format can be changed to accommodate more people if necessary by dividing into sub-groups. It is a 'demand' of the project philosophy that the entire panel of participants is in place from the start to the finish. Using the journey metaphor the design and construction process is a change process (and a learning process as well), driven by the workshops.

A standard value agenda is used as a framework for decision-making in the workshops. The 'basic value structure for buildings' is based on the six key areas of value, mentioned earlier (Beauty; Functionality; Durability; Suitability (for the site

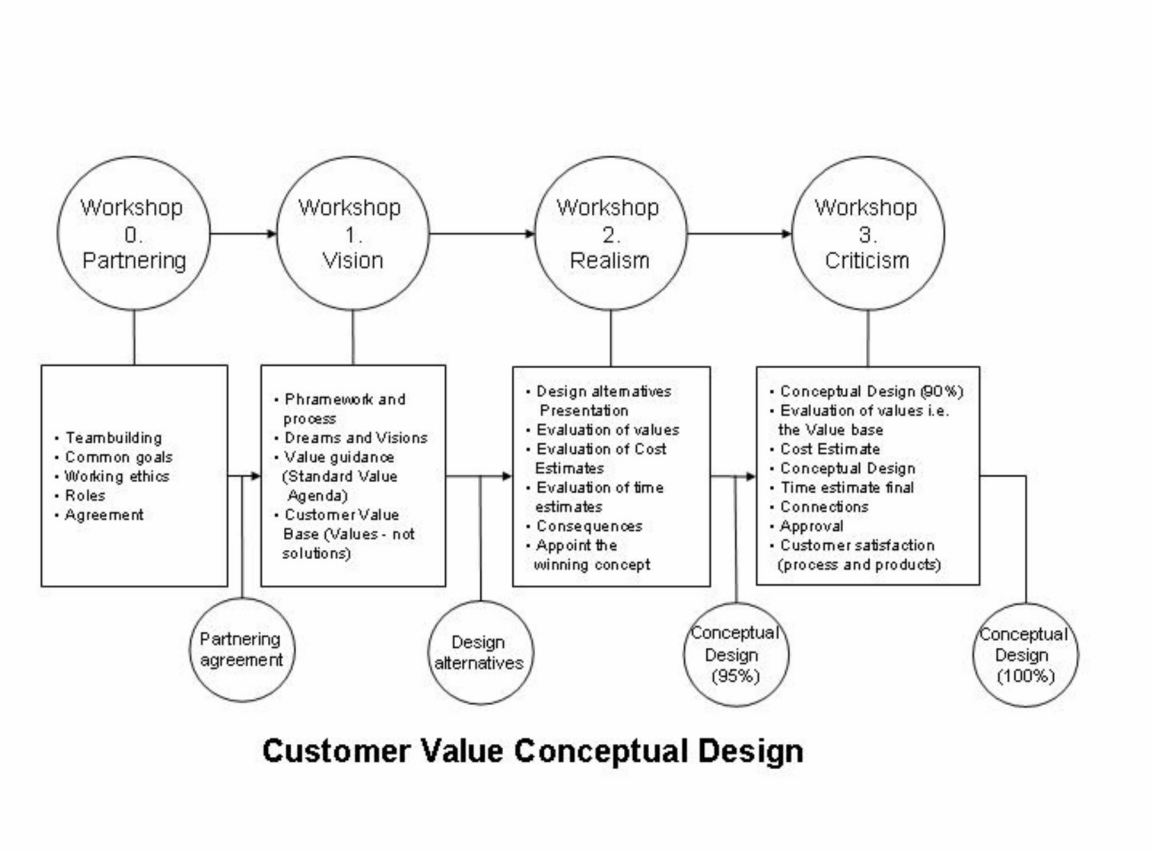

Figure 2: Creative workshop model

and the community); Sustainability (respect for the environment); and Buildability. This value hierarchy addresses the primary project objectives and breaks them down into further sub-objectives as part of an iterative process carried out within the workshops. Each area explored until the value parameters have been mutually agreed through the use of the Value Tree and tools like quality function deployment (QFD) can be used, essentially a tool that allows values (options) to be weighted in a decision matrix to find the solution that provides the best value in the view of the workshop actors. Workshop participants need guiding through the discussion of values in a systematic and objective way, which is done by a process facilitator. The workshops are:

Workshop 0: (Partnering) Building effective relationships

The function of the preliminary workshop is to bring various actors together to engage in socialising and teambuilding activities. The intention is to build the communication structures, the system architecture for the project, thus allowing actors to engage in open and effective communication during the life of the project, the architectural dialogue. In addition to setting the stage for the events that follow the 'outcome' of the first workshop is the signing of a partnering agreement between the participants. This confirms the process values for cooperation on the project.

Workshop 1: Vision

This workshop is concerned with discussion of basic product values and the establishment of product value parameters. It is not possible to know the values in depth at the start of a project, so workshops are primarily concerned with exploring values and establishing a common vision. Knowledge and experience from other projects is brought into the workshop, for example facilities management values to better inform the whole life approach to design and construction. The main focus of the effort is the establishment of client values (value-based parameters); on the basis that the better these are known the better the team can deliver. Collective dialogue helps to explore and develop relationships that can (or conversely cannot) develop into effective and efficient working alliances, essentially the preparation for the construction of efficient communication networks. Critical connections between decision-making are explored so that everyone is certain before going into production, thus reducing downstream uncertainty. The result of Workshop 1 is the establishment of basic values for the project; a very pragmatic document that does not contain any drawings. These values are prioritised.

Workshop 2: Realism

Workshop 2 aims to discuss how the basic project values may be fulfilled by presenting various design alternatives that reflect how they meet the basic value parameters, while at the same time addressing the contractual framework of the project—time and cost. Project economy is consequently introduced here along with restraints imposed by, for example, authorities and relevant codes. A number of alternative proposals are worked through and ranked according to value. Architects are encouraged to produce at least three schemes that can be presented and discussed at the workshop. During the realism phase normally at least two to three workshops are required, simply because there is a lot of material to work through. The basic project values and project economy are respected in this process and any changes justified within the value parameters. The outcome of the realism phase is the selection of the 'best suited' proposal.

Workshop 3: Criticism

This workshop(s) is designed to criticise the proposed design solution chosen in the previous workshop. The solution is criticised; is it really the 'best' solution? Could it be 'better'? Detailed discussion is centred on the chosen solution and its improvement within the value parameters. Uncertainty and urgency is high on the agenda prior to the scheme entering the production phases. Client (stakeholders) satisfaction with the process value and the product value is measured on the base of the partnering agreement and the basic product value parameters. Then the project is approved for production and the contractual delivery specifications fixed.

TRANSFORMATION FROM VALUE DESIGN TO VALUE DELIVERY

CONTRACT

This transformation is executed first when the Value Design work is done thoroughly and properly, i.e. when the mental phase of the stakeholders and the delivery team participants has evolved to a stage where everybody agrees that no more/no better value can come out of the project within the framework or alternatively when no more time is available. Then the focus changes from value design to value delivery where mini-

mising waste in the delivery process is essential and value engineering activities are executed. The *Contract* activity (which represents the actual client signing of the delivery of the agreed project including the remaining detailed design and construction) represents the transformation between the value design and the value delivery phases.

VALUE DELIVERY

Value Delivery comprises the final (detail) design and the construction of the project introducing 'production thinking' as well as the knowledge and experience from using (consuming) the building.

CONSTRUCTION

In this phase production of the agreed project is the focus, and the client plays a less active role. A lot of decision making still remains related to production activities, which are dealt with by the main contractor, working closely with the sub-contractors. The client role (supported by professional advisors) is to deliver detailed decisions as scheduled and to check that the specified value is delivered. Client and delivery team common process values (partnering values) are primarily concentrated on fulfilling contractual terms (time, cost, quality and accidents rates etc.) but of course still with respect to the 'soft' process values agreed earlier. Internal values of the organisations and persons working together in the delivery team are used to achieve a common focus when working on project delivery.

In order to achieve an optimal communication between the participants in the delivery team, a series of production workshops is executed focusing on waste reduction in the process as well as in the product by value engineering activities and by introducing LPS thinking/logistic thinking SCM as well in the final design stages (in modified version) as in the construction activities. The production workshops are:

Workshop 4: Design planning

In this model it is here that there is a shift in thinking, as the more abstract work turns into production information. Values are concerned with delivery. The designers, contractor and sub-contractors interface most here as value management techniques turn more toward value engineering and a process management tool, Last Planner in a modified version, is introduced to help guide the planning of the process and results in a process layout of the design process similar to the process plan in construction. This approach was taken for the first time on the DELTA project and deemed a successful innovation it was used on NIRAS´ project for additional office space in their Allerød headquarters and in MTHøjgaard's Gefion project in Frederikssund.

Workshop 5: Buildability

Here the focus is on improving the constructability of the project, while trying to reduce waste in the detailed design and construction phases by having the designers and the foremen/craftsmen meeting with this specific value in mind giving their input to improving the design or focus it on the competences of the actual production capability and capacity.

Workshop 6: Planning for execution

These workshops involve interaction between the main contractor and the sub-contractors. A process plan is produced that helps to map the various production activities and help identify missing information. Information flow is an important consideration at this stage in the workshop model. On completion of the construction schedule, in an ideal world, the information should be complete and there should be 'no scope' for uncertainty of the delivered value at the production phases.

CONTROL

The Control activity represents the finalisation of the project ready to be handed over to the building owner and the users going into the Consume phase of the project. The Control is executed with two goals in mind. First, to check that the product is perfect without any errors: second, to check that the product fulfil the client value specification agreed upon when writing the product delivery contract.

CONSUME

This phase is not discussed in this paper, other than to note its importance for feedback into future projects. It consists of facility management and operational & management activities, which help to give the knowledge and input to the experience loop. This forms part of the Value Design process on the next project and forms part of the experiential learning/knowledge transfer between projects.

CONCLUDING COMMENTS

NIRAS and MTHøjgaard have piloted the lean design method in a project called DELTA and

based on the promising results from this project both companies have further tested and developed the lean design method. Improvements brought about by the model have been confirmed in an independent study carried out by the Danish Research Institute (SBi), which found improved performance across a whole range of performance parameters (By og Byg 2004; SBi 2005). Although the lean design method slightly differs from company to company and further knowledge is needed in implicating the lean thinking in the final design stages, both NIRAS and MTHøjgaard is convinced that it is a way to improve the design and the efficiency/communication of the team members. Early feedback from actors and clients would tend to support this view.

The model presented is a simple design management tool that employs a value-based approach and incorporates the lean thinking philosophy. The creative workshops encourage open communication and knowledge sharing while trying to respect and manage the chaotic nature of the design process. Cooperation, communication, experience and learning as a group contributing to the clarification and confirmation of project values. Further work is required to investigate the effectiveness of, for example, the workshop method in terms of the realisation of group goals. In particular, the role of the workshop method in promoting and delivering creative solutions would be a logical extension of this case study. So too would some reflection on lean production systems thinking in the detailed design phase. It is the intention of the authors that ongoing pilot schemes will be researched in an objective manner in an attempt to measure the success of the approach outlined here. A new project ('Telefonvej') using the process model by NIRAS and MTHøjgaard will be independently monitored and evaluated.

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