SOCIAL CONSTRUCTION: UNDERSTANDING CONSTRUCTION IN A HUMAN CONTEXT

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ABSTRACT

As lean construction has evolved as a practice, efforts have been made to develop theoretical foundations for understanding it. These efforts have been informed by our understanding of lean manufacturing, a source of many of the seminal ideas for lean construction. One key insight has been the shift from the understanding of a process as the transformation of materials from inputs to outputs to the view of a process as a flow of materials through a sequence of steps or operations. Another has been the recognition that value must be considered from the customer perspective. More recently, several authors have proposed more general contexts for understanding the entire construction process. These proposals have included observing the essential role of language in the conduct of projects, recognizing the limitations of a purely economic context, and adopting a more comprehensive flow perspective. In this paper, we propose a framework for situating the construction process in the world of human concerns. We show that consideration of the human being as actor within a world of concerns provides a necessary context and foundational explanation for all subsequent discussions of process, flow, value, and commitment. We also suggest a new perspective for understanding and addressing the issue of risk.

KEY WORDS

Theory, Process, Project, Flow, Value, Language action perspective, Commitment, Risk

CONSTRUCTION PHYSICS AND THE FLOW PERSPECTIVE

Starting in 2006, Koskela, Rooke and others began a series of papers which introduced the concept of *construction physics* as "a more comprehensive way of understanding the construction process from a flow perspective" (Bertelsen et al, 2006; Bertelsen et al, 2007; Rooke et al, 2007; Henrich et al, 2008). Here, we begin by examining both the appropriateness and the limitations of this flow model as a way of understanding what happens in a construction project.

Physics is a science which explains the natural world in terms of matter, energy, and time. Physicists have discovered laws of motion which explain the movements of planets, automobiles, ice skaters, and rainwater. The concept of flow as movement comes from this scientific world. When we talk of flow in other contexts, we must

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be careful to note when we begin to speak in metaphors and whether our analogies hold.

What is the relevance of physics to construction? Engineers study the natural laws of physics because they form the boundaries of what is physically possible. Physics is the context for engineering. Structural engineers need to know the maximum load that can be supported by a beam. Soil technologists determine what is required to create a solid foundation. Designers need to know what it will take to craft a structure that can withstand an earthquake, a hurricane, or an ice storm. The natural world and its laws constitute some of the design constraints within which projects are delivered.

The materials, tools, and equipment used in a construction project are all subject to the natural laws of physics. The load capacity of a crane must be established before a lift is attempted. The bodies of human beings are also subject to these laws – we have our own limits of strength and speed. Yet, if we view human beings only in terms of their physical capacities, we will miss important aspects of what they can do.

CONSTRUCTION IN THE CONTEXT OF HUMAN CONCERNS

Constrained by the laws of the natural world, human beings perform their activities, including construction work. Much of construction work is observable as the physical movement of bodies and things. Workers lift and carry materials, place them into position, and use tools to fasten and install them. These physical activities constitute our traditional view of work. However, if we observe work only from the perspective of the motions of bodies and things, we will be severely limited in our ability to explain it. We need a richer account of what is happening when human beings work. To complete our understanding, we must place these activities in the context of human concerns. The workers are engaged in building a structure for some human purpose and in doing so, must negotiate their relations with each other as human beings.

Human beings experience the world in terms of their concerns (Flores, 1982). They, as observers, make distinctions about their world which are relevant to the satisfaction of their concerns. For example, they distinguish between plants that are poisonous and ones that are good to eat. They take action, individually and collectively, to provide for their future. Knowing that winters are long and cold, they collect a store of food and build a shelter which will protect them from rain and snow. The practice of construction, as projects and as processes, arises out of the human concern to create structures as environments for human activities. For the sake of this discussion, we will consider "concerns" to be synonymous to the term "interests", which has been used in other papers.

Introducing the distinction of human concerns opens up the possibility of observing the activities of human beings not just as physical movements but as various actions on behalf of their concerns. Instead of viewing what people do simply as labor, the moving and carrying capacity of their bodies, we can view what they are doing as purposeful action.

LINGUISTIC ACTION COORDINATES PHYSICAL ACTIVITY

People act both individually and collectively on behalf of their concerns. Observing a person alone, we may deduce a direct connection between their activities or actions and the concerns they are taking care of. For example, we may observe a person pick an apple off a tree and eat it, and infer that they were satisfying their hunger, addressing their concern for feeding themselves.

In a project environment, people act collectively to address concerns that they cannot deal with alone. How do we coordinate the activities of this diverse collection of participants with their multiple concerns? In this paper, we explore how the phenomenon of language provides an answer to this question.

If a person who is not a slave picks apples all day for the owner of an orchard, we may surmise that he does so because he has made an agreement to exchange his labor for compensation. The making of the exchange agreement, which happens in language, provides the impetus for the physical activity of the laborer. We see that we must explain the interplay between linguistic and physical actions to build a satisfactory narrative for making sense of the work we are observing.

Building on the work of Austin (1976) and Searle (1969), Flores (1982) introduced the *request* as one of several fundamental distinctions for observing what people do in living and working together. A request is an action that a person takes by speaking (Austin, 1976). A person makes a request in order to take care of a concern that they have, usually because something is missing, something is broken, or something is in the way. Human beings learn to make requests as they learn to speak their languages, but they do not always learn to observe them as such. However, we can learn to observe them by listening, and we can teach another observer to observe them. We can also observe that a request can be made by gesture, remotely via telephone, or by a commonly accepted symbol, such as a stop sign or prohibition symbol (\). Moreover, a request can be embodied in an artifact, such as a letter, an e-mail, a want-ad in a newspaper, or a request for proposal (RFP) posted on the Internet.

For a request to be effective, there must be another person present to hear it and potentially respond to it. The speaker and the listener are both essential elements for making a request that will be acted on. One possible response to a request is a promise, another linguistic action. For all but trivial requests, the requestor and the promisor engage in a process of negotiation in which they discuss and clarify what it will take to fulfill the request and reach an agreement on what the promisor (performer) must do to satisfy the requestor (customer).

We can define a transaction as a mutual promise. Such mutual promises may or may not involve the exchange of money. The key thing to note is that both the parties to the transaction have concerns to be satisfied and they negotiate to align these concerns. For example, an electrician may say to a plumber, “if you give me half a day to work in this space by myself, I can be out of here with all my stuff and give you space to work.” In a commercial transaction, such as a purchase or an offer of employment, the customer makes a promise to the performer to compensate them financially. Most commercial transactions are mutual promises.

When the performer makes a promise to the customer, he or she commits to perform the future action which will bring about the conditions of satisfaction. Now that we as observers have made the distinction between linguistic action and physical activity, we can begin to see their relationship. Typically, in a project environment, physical activity takes place to fulfill a promise. Of course, the future action specified in a request or promise may also be another linguistic action, as in the request “would you please ask the painters to move their stuff so we can use that space?” or “would you please ask him to call me tomorrow?” A community of speakers and listeners, such as a project team, creates an entire network of commitments which becomes the context for the activities of project work.

Now we have the basis for understanding work as the making and fulfillment of commitments (Flores, 1982). The performance of work can include both physical activity and linguistic actions. In fact, a request by an owner is what usually initiates a construction project. The initial listener, who may be a designer or a builder, in turn makes other requests to those with the wherewithal to fulfill them, thus creating the network of commitments which constitutes the project.

In conclusion, we can see that physics is sufficient to explain motion, but not human activity and the coordination of action. In order to explain these aspects of work we need the additional distinctions of human concerns and linguistic action. We understand a project as a network of commitments activated by an initial request. We will return to the relationship between linguistic action and flow later.

CONCERNS AND VALUE

Koskela (2000) has introduced the concept of value as a component of his Transformation-Flow-Value framework. In earlier theories of economics, value was understood as an inherent quality which resided within an object, the product of a production process. Koskela quotes Johnson and Kaplan (1987) as saying, "…value of any commodity, service, or condition, utilized in production, passes over into the object or product for which the original item was expended and attached to the result, giving it its value."

In a more sophisticated view, value arises out of the fulfillment of customer requirements. Incorporating Flores' view of linguistic action and human concerns, we can now understand value as an assessment made by a customer that the conditions of satisfaction they are requesting will take care of their concerns.

This understanding leads to the immediate realization that the customer in a transaction is not the only one with concerns to be satisfied, and not the only one to receive value from a transaction. All human beings act on behalf of their concerns, in their work as well as in other contexts. The performer must also assess that there is value for him or her in taking action to fulfill their promise.

All the participants on a construction project, from the project managers, architects, and engineers to the ironworkers, plumbers, and electricians, are satisfying such concerns as making a living, developing their expertise at their trades and professions, and maintaining their reputations for reliability and craftsmanship. Every participant in a construction project brings their concerns and values to the effort. We see that we must expand our view of a worker from that of a passive resource to that of a human being with his or her own set of concerns to be satisfied.

At this point, we can return to the flow model and consider how the suggested components fit into our new context.

WHAT ARE THE COMPONENTS OF A CONSTRUCTION PROJECT?

Bertelsen et al, in their 2007 paper "Construction Physics", have proposed that we can expand the idea of flow to include various components of a construction project. Here is their list of things which flow, which we have taken from their model:

1. **Resources**
    a. **Equipment**
    b. **Space**
    c. **Crew**

2. **Prerequisites**
    a. **Work**
    b. **Materials**
    c. **Design and specifications**
3. **Directives**
    a. **Agreements**
    b. **Decisions**
    c. **Instructions**
4. **External Conditions**

In our discussion of physics above, we saw that the natural world constrains the construction process. However, natural laws are not the only ones we must take into account. Human beings also create laws which must be respected. We must abide by the laws of the jurisdictions under which we will be working. We need to know the local building codes, environmental regulations, safety requirements, and work rules. These laws, rules, requirements, and prohibitions also define the boundaries of what is possible and what is necessary. We acknowledge that culture, including customs and traditional practices, also plays a role here, but is outside the scope of this paper.

What is different about these socially-created rules and laws? They exist because some person or group of people exercised their authority to bring them into being. For example, a state legislature has the authority to pass laws, and the Environmental Protection Agency has the authority to make regulations which apply in the United States. When a designated person or group exercises its authority to say what is and is not legally possible or morally acceptable, we distinguish this as the linguistic action of making a declaration (Flores, 1982).

So we see that in describing the external conditions of a construction project, we encounter both natural and socially-created constraints, those which arise as part of the natural environment, for example, the weather, and those which are invented by human beings in their life together, such as laws and regulations.

A NEW SET OF CATEGORIES

Using the distinctions we have introduced so far, we propose a different way to categorize the list of components shown above, as follows: (we have left the items from the above list in bold.)

1. Physical things (wherewithal)
    a. **Equipment** (tools made by people)
    b. **Space** (created by moving things around or leaving things out)
    c. **Work** product (previously completed intermediate product)
    d. **Materials**
2. Human beings (customers and performers)
    a. **Crew**
3. Linguistic Commitments (Requests, promises, and declarations)
    a. **Design and specifications**

b. **Agreements**

c. **Decisions**

d. **Instructions**

e. **External conditions** (socially constructed – laws, regulations, economic, cultural and political constraints)

4. **External conditions** (physical reality – weather, ground conditions, climate, earthquakes, floods, and fires, laws of physics)

These categories arise out of the above discussion. The laws of physics and the resulting natural phenomena appear as external conditions outside the control of human beings. We have separated the crew, who are human beings, from the physical things (equipment, materials, and so on) that they need to do their work. We also put the linguistic commitments made by human beings in a separate category.

Now we must reconsider the relationship between the linguistic commitments that we have distinguished and the human beings who make and receive these commitments. The only human beings we see on the list above are the crew. We realize that other important project participants are missing.

Consider a design, in the form of a set of drawings. It can be understood as the result of a conversation between an owner (customer) and an architect (performer) in which they negotiate an agreement on what will be built. The drawings represent the conditions of satisfaction in symbolic form. In the discussion, the customer and performer align their concerns, such as cost, functionality, and beauty. (We realize that this is an over-simplified portrayal of the design process, which typically includes multiple people forming a network of commitments. Consideration of the design process is outside the scope of this paper).

The design document may then serve as the conditions of satisfaction for a request by the owner to an engineer, who will then, in conversation with the architect, develop a set of specifications, again embodying their agreement on concerns such as cost and structural soundness. At this point, the owner may take the design and specifications to a builder and negotiate a contract (agreement) which takes care of their mutual concerns for cost, constructability, risk, and so on. Once the construction begins, the conversations between builders and crews continue on the topic of how the structure will be built.

We see the need to include several additional participants in the construction process. Our list can now be expanded as follows: (Original items are still bolded).

1. Physical things (wherewithal)

a. **Equipment** (tools made by people)

b. **Space** (created by moving things around or leaving things out)

c. **Work** (previously completed intermediate product)

d. **Materials**

2. Human beings (requestors and promisors)

a. End customer and owner

b. Designers (Architects and Engineers)

c. Builders

d. Planners and managers (People who decide how the work will be done)

   e. **Crew** (People who decide how to build the structure and build it)

3. Commitments (Requests, promises, and declarations)

   a. **Design and specifications** (documentation of requests and promises)

   b. **Agreements** (including contracts – mutual promises)

   c. **Decisions** (declarations by persons or groups about how things will be done)

   d. **Instructions** (requests)

   e. **External conditions** (socially constructed reality – laws, regulations, economic and political constraints)

4. **External conditions** (physical reality – weather, climate, earthquakes, floods, and fires, laws of physics)

In this framework, all human beings appear with their full capabilities and autonomy, able to make, accept and decline requests and negotiate to take care of their concerns. In previous discussions, labor or crew has been depicted only as the recipient of instructions or directives. (Ballard, 1999)

FLOW

Now we can return to the topic of flow and consider the question of how physical flows relate to the exchange of commitments.

The concept of flow has been used to understand material production processes. Due to the innovation of Shingo (1985) as an observer, this view lets us observe a material process as a series of activities which can be categorized as transformation (or assembly), waiting, transport, and inspection. However, flow is not valuable in itself. It is useless if it is not producing value for a customer. A production line which is producing defective products must be stopped.

The participants in a process perform each activity as the completion of a promise which then enables the start of the next activity. Wasteful activities are those which do not contribute to, or get in the way of, the fulfillment of promises. The concepts of waste as waiting, unnecessary transport, and inspection for defects carry over into this view.

Our attention has expanded from a view of production as a flow of materials to include the flow of work in the sense of activities performed to fulfill promises, and as the creation of value by taking care of the concerns of both parties. How can we minimize waste in a work flow process? For work to flow smoothly without interruption, we want to create the situation where no worker will ever be delayed in proceeding to their next task because all of the prerequisites will always be in place. The presence of these prerequisites depends on the fulfillment of all the promises to produce them (and favorable external conditions). Each worker’s ability to proceed depends on the reliable fulfillment of prior and concurrent promises. The Last Planner® System[5] orchestrates a continuous renegotiation of these promises to keep the work flowing so work is never waiting for workers nor workers waiting for work.

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[5] Last Planner is a registered trademark of the Lean Construction Institute.

In a project situation, physical flows result from, and are initiated by, commitments (requests and promises). Promises create flow and promises sustain flow. Material flows because someone makes a request for the material to be delivered and agrees to pay for it and someone promises to deliver it. In order to achieve a smooth, continuous flow of a material, the concerns of the party delivering it, the party paying for it, and the workers using the material, as well as external conditions, must all be taken into account. In order to make a reliable promise (Macomber & Howell, 2003), both the customer and the provider must consider whether they have access to everything they will need to fulfill the promise.

RISK

Whenever any person makes a promise, he or she assumes a risk, the risk of not being able to fulfill the promise. At the outset of a project, both the initial customer and the initial performer must realize that they are facing an uncertain future, and that they cannot at this moment anticipate all the contingencies that they will have to deal with. They must make their initial agreement in the face of this uncertainty.

Lean project delivery has several ways of reducing the inherent risk of a large, complex process: iterative planning, public commitment, and the Integrated Form of Agreement (IFOA).

Planning must begin with incomplete knowledge of the future. Plans are made for the short term with an agreement to revisit them as time goes by. Planning can be understood as a conversation in which the interests and concerns of all parties are articulated, discussed, and aligned and commitments to action are made. These concerns will shift and evolve as the project proceeds and as constraints become evident. At each stage, the participants must renegotiate their agreements based on what they now see.

The Last Planner System calls for milestone planning, make-ready planning, weekly planning, and daily standup planning sessions in the field. At the weekly planning sessions, participants make commitments in public. They stake their reputation, or public identity, on their ability to deliver on their promises. This underlying interest or concern is fundamental to the success of the system. As project team members strive to fulfill their commitments, they build trust with one another and improve their chances of success. As their promises become more reliable, the Last Planner System reduces risk by making workflow more predictable. This predictability reduces both duration and cost by reducing the amount of time workers wait for work.

Traditional forms of contract in the construction industry attempt to minimize risk by one party at the expense of another. The IFOA is an innovation which enables participants to work together to minimize total risk and to share the remaining risk equitably from the beginning to the end. A contingency fund is identified, and a way of dividing it upon successful completion is decided in advance. This form of agreement provides incentives for project participants to cooperate and to make mutual promises for their mutual benefit as the project proceeds.

WHAT WE THINK AND WHAT WE KNOW

The human world we create together includes what we know, what we care about, and what we make. We express what we know by making assertions, statements which we claim to be true. The science of physics is a domain in which we can establish what we know by providing evidence for our assertions. We can assert that F = MA, that if I drop an apple from a tower, it will fall. Through observation, measurement and experiment, we can establish the strength of materials and the speed of trucks.

What we care about is an assessment, an opinion. This is the domain of what we think and how we feel rather than what we know. We assess what is of value to us based on how it will help us take care of our concerns.

When we act, we take into account both what we know and what we care about. We must always act in the face of an unknown future, yet we can build trust and collaborate to address our concerns.

CONCLUSION

This paper has explored some of the basic concepts proposed to understand construction projects and has presented some new explanations of their relationships. Our key points are as follows:

1. Physics alone is an inadequate model to explain what happens on a construction project. Human concerns are the appropriate context.
2. The work of human beings must be understood as making and keeping of commitments and the physical activity needed to deliver on them.
3. Commitment provides the initiative for material flows.
4. In the face of uncertainty, trust can grow out of the repeated, reliable fulfillment of promises.

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