# Minding the Gap that Matters

## The lack of theory.

Greg Howell ghowell@micron.net
Lauri Koskela lauri.koskela@vtt.fi

1

There was a lot of talk at the NSF/CEM meeting about the gap between practitioners and academics, about the need to market research results, the low tolerance for risk among contractors, that sort of thing. We take a different view of the gap. We see the gap as the direct result of a lack of theory for production in construction.

In this brief presentation, we want to make the case that developing theory is essential both for narrowing the gap with practitioners and for construction as a discipline to gain standing as an academic discipline.

# 3 Gaps

- Between Academics and Practitioners
  - Belief in both houses that theory is
    - in opposition to practice (mostly by academics)
    - hypothetical, ie, without confirmation by experience (mostly by practitioners)
- Within the academy
  - Arguments about the nature of the model
- Construction and related fields of production
  - "this isn't manufacturing, son."

2

Theory, the "T", word is something we simply don't like to talk about in construction. Academics think it is what they do that is different or in opposition to what practitioners do, and practitioners think a theory is a hypothetical idea untested in practice.

Theoretical discussions are rare between academics but when they do occur they often degenerate into a battle of models. Of course there are theories applied to construction problems from other fields - legal theories (Contract formation), motivational (Maslow et al.) , engineering (Stress Strain), economic (cost of labor), organizational (open or closed systems). But we don't offer any explicit theory for how work is done, how things are produced, choosing instead to apply these imported ideas. And some of them work and are used everyday - particularly the science based engineering theories about materials and how forces are collected and carried to the ground. What we lack is a theory of production.

But as eager as we are to appropriate general ideas from other fields, advances in thinking from related fields that design and produce things just haven't made any impact in construction.

## What do we mean by theory?

- Underlying cause and effect model
- More formally
  - Concepts, laws, principles, range of validity
    - Drucker, Schon, Deming, Senge
- Theory-in-use drives thought and action
- Closing the gap would mean aligning academic (science based?) theories with those used in action.

3

Part of the problem is lack of a common definition of "theory." We mean cause and effect models. Gravity is a great theory because it provides just such a model and we can count on it to work. Don Schon said, "There is nothing more practical than a good theory." Theories have concepts, laws, priniciples and a range where they can be counted on to work.

Schon, Drucker, Deming, Senge and others speak of theory-in-use or mental models in the same way we describe theory. Senge suggests a hierarchy of events, patterns of behavior, systems, and mental models, and asks what is available for change?

Mostly we complain about behavior in the face of events. Working on underlying systems can help but the real power for change comes when mental models are exposed, challenged and redefined. But it is hard to see through to theory and to state it clearly. The result is events appear to happen for reasons mysterious and most of us believe that we are not responsible.

## The Implication

- If we want to change action, we must change theory.
- BUT…..
  - Current theory is not clearly stated.

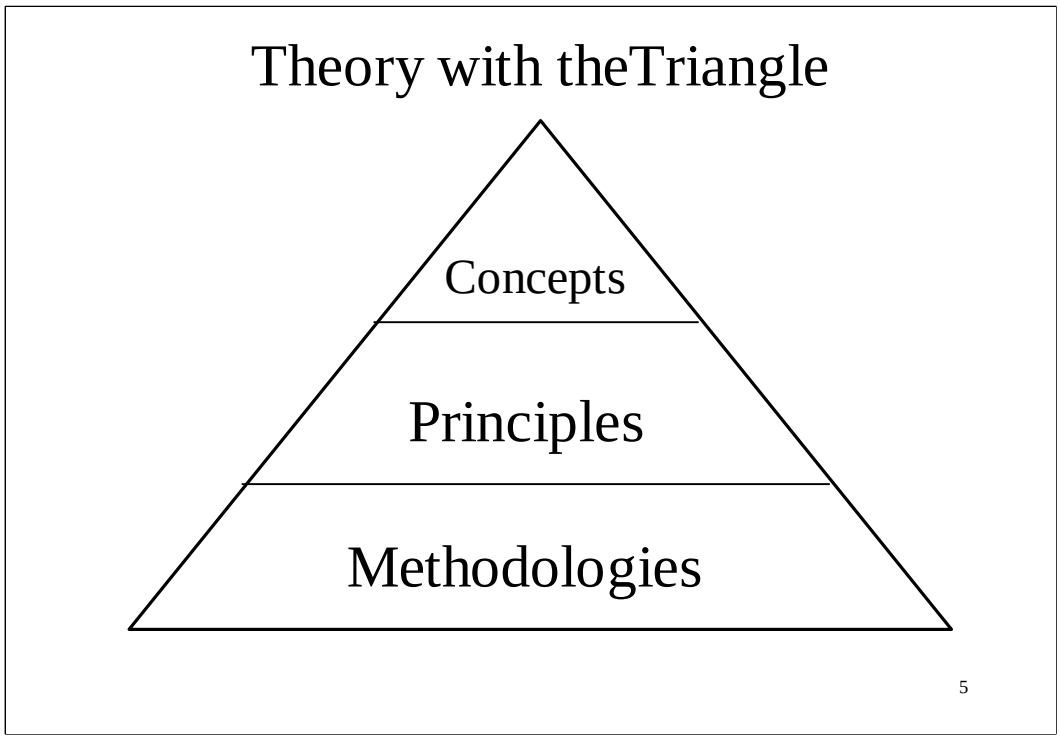
4

Our actions are in response to the the systems in which we participate and those systems rest on our own personal theories or those held widely in our companies. So theory drives thought and thought drives action. Want to change action? Change how people think.

There is little gap between academic theory and theory-in-action in fields like electrical and structural engineering; Ohm's law and Young's modulus are understood and applied at the university and by practitioners because they explain how things happen.

The exact nature of the gap is harder to see in construction. Academics are not explicit about their theoretical basis and practitioners cannot explain their response to problems because they lack a conceptual basis and language. But you can hear their cause and effect models in stories they tell. "The project got all screwed up because the owner didn't know what they wanted." This is of course true, but it gives us no leverage or deeper understanding. It leaves little to learn except to choose better clients.

Sometimes theory is hidden in the solutions offered - for example information systems. Underneath these solutions must be some idea that communications is the problem, or lack of data; "If we just had access to data on everything then things would work". But do we need to know how many right handed red haired first born sons are on our projects? Maybe, but the real question remains tied to theory, "What information matters?"




We propose a hierarchy of concepts, principles and methodologies. The concepts provide an answer to the question: What is it? The principles provide the causality that makes prediction possible and answer thus to the How? question. Based on the principles, it is possible to create methods, tools, etc. for controlling the phenomena covered by the theory.

However, an explicit theory of production will serve also other functions than *predicting* and providing *a platform for methods*. A theory provides an *explanation* of observed behavior, and contributes thus to understanding. A theory, when shared, provides a *common language* or framework, through which the co-operation of people in collective undertakings, like project, firm, etc., is facilitated and enabled. A theory gives *direction* in pinpointing the sources of further progress. A theory can be seen as a condensed piece of knowledge: it empowers novices to do the things that formerly only experts could do. It is thus instrumental in *learning*. When explicit, it is possible to constantly *test* the theory in view of its validity. Innovative practices can be *transferred* to other settings by first abstracting a theory from that practice and then applying it in target conditions.

## Theory w/o Triangle

- Concepts
  - Activities
- Principles
  - Bounded, sequential dependence, optimization of individual tasks leads to optimization of the project
- Methodologies
  - CPM, Subcontracting

6

Here is an example, actually we think, "THE EXAMPLE." We believe that current construction theory is activity or transformation centered. That construction is a series of activities that transform inputs to outputs. Manage the activities and you have it licked.

This formulation of work flows from the task management of Taylor and the earlier description of production by Walras. It has been supported by commercial contracting theory, that is buying the product of a transformation, and linked to the rise of craft workers who do some particular set of activities.

The activity model rests on the belief that activities can be bounded and put in a logical order. The assumption of simple sequential dependence and low uncertainty is the essential to the application of the critical path method and supports by commercial contracts for sections of work. The same assumptions buttress the idea that improving performance of each activity leads to improved project performance.

When things go wrong, activity based thinking leads to an immediate assumption that someone somewhere failed to do their job. Sometimes this is true but more often, the behavior that caused the problem was the logical consequence of the activity model and the related emphasis on local optimization to simple criterion.

## Is it adequate?

- Inability to assure outcomes
- Contradictions
  - Difficulty to define boundaries
  - Partnering
  - Buy on price but ignore real costs (because they aren't our costs)

7

Do systems resting on the activity model lead to behavior that works in terms of project success? We think not based on persistent and unpredictable overruns and delays. Certainly construction is a risky business but our research shows that uncertainty is injected into the flow of work by "modern management practices." We have met the enemy…..Pogo

There are contradictions and patches to current practice. For example, breaking a project into pieces is an early step in project management. But how do you break projects into to the sequential pieces? Boundaries must be set but they are often artificial or commercial rather than related to the way work itself is preformed. As a result activities start in bits and pieces before the precursor is complete.

Partnering is an interesting movement. In many ways it is a patch because it tries to overcome the adversarial consequence of activity thinking. Adversarial battles protecting narrow self interest are the logical consequence when commercial contracts drive people to optimize their part of the project at the expense of others. Partnering accepts the underlying activity premise and then tries first to change relationships by developing common goals. But common goals mean changing the unit to be optimized from the activity to project. Only rarely do partnering sessions go beyond relationship and communication to work directly on the way work is planned and completed.

We all know that buying on low price offers no assurance that the project will be completed quickly or inexpensively. How could it when lower prices demand that each party must focus on their activities and ignore or shift costs to others.

## What is missing

- Consideration of
  - Uncertainty
  - Interdependence (complexity)
    - waste
  - Time (as an intrinsic feature of production)
- Essential Concepts
  - Flow
  - Value

8

So what is missing in current production theory in construction? The simple sequential model abstracts away uncertainty and complexity. Uncertainty may be environmental or caused by deficient performance. Complexity, that is a variety of interactions and reciprocity between activities, cannot be represented in the activity model. Likewise waste that might arise within the system because of the behavior of others or from the design of the production system cannot be portrayed. Accounting practice reflects the activity model because it requires that all cost associated with an activity arise within the activity. So a the costs of a maintaining a pipe lay down yard are charged to piping. But uncertainty in the supply and use of piping materials makes the yard necessary. Nothing in the piping installation activity itself requires the facility.

Here we can see that one key weakness in the activity model is the inability to describe and influence the flow of materials and information between activities. Flow concepts have a long history. The core idea of the flow concept is to look what happens in production in the timeline, in other words, production is viewed as a physical process. Ford is often considered to be the father of mass production when his real contribution was flow management. These ideas were further elaborated by the Gilbreths.

Value and its development are another missing element. In the activity model, value is the result of design. In practice value is discovered and delivered throughout the construction process.

We need a theory that encompasses activities, flow and value. Of course CPM is a valuable tool for identifying what needs to be done. But it can't manage flow, it can't create or deliver value.

## Next steps

- Invite you to develop a statement regarding current theory, make it explicit.
- Structure the process to make new theory explicit and tested
- Bring alignment between Theory-in-use and "Academic theory."
- Base education on theory.

9

Lack of explicit construction theory invites muddy thinking and writing. The problem is that the important functions of a theory, as outlined above, are not being realized neither from the viewpoint of research or practice. A lacking theory does not provide understanding or help in communication; it does not give direction in search of further progress; it can not be used in education; it is not possible to test it.

So the first step is to try to describe our existing models of cause and effect. Then we can step back and see what is missing and extend our thinking. We will know we are on the right track when we can accurately describe what happens on a project in ways that people can rely on to complete projects. Academic theory and theory-in-use will converge as they both become clearer. This will require academics to test their understanding against the real world and have it judged on the extent to which it widens our ability to understand and manage.

Theory based education that prepares people for work in the real world, remember Ohm's law, will be possible and construction will finally claim a place in the larger academic community.