

# UNCERTAINTY, ORGANIZATIONAL STRUCTURE & COLLABORATION: QUESTIONS FOR RESEARCH

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## ABSTRACT

Lean Construction (LC) has changed the way construction projects are designed and constructed. The fundamental principles of LC, basic practices and common vocabulary, while well established continue to evolve. New developments call for new theories to describe and explain what works and why. This paper explores the difference between "Traditional CPM based Management" (TM) and LC in three domains: "operating system" from an activity based to flow based, "commercial terms" from transactional to relational contracts, and "organization" (authorities and communication protocols) from command and control to distributed and collaborative. These advances raise new questions and directions for research and create opportunities for new practices.

## KEYWORDS

Lean construction, Theory, Contract, Uncertainty, Organization, Collaboration, IPD.

## INTRODUCTION

This paper explores three related and connected issues at the edge of theory and practice. The first focuses on the nature, magnitude and management of uncertainty experienced on projects. The second connects the nature of interaction between people in project organizations within different team structures and management. The third challenges the effectiveness of economic incentives within Integrated Project Delivery (IPD) teams and their governance.

## THE CHALLENGE OF UNCERTAINTY

Uncertainty in TM on projects is generally understood as risk to be allocated by contract to one party or another. Each then protects their organization by adding contingency to absorb the uncertainty, insuring against potential loss, or finding a way to shift the risk to another party. A different perspective developed from research conducted for the Construction Industry Institute's Project Organization Task Force. (POTF-1991) That study reported surprising results as to the nature and magnitude of uncertainty on projects.

Initially, participants were asked to mark on a simple matrix the location of their typical project at the start of construction. The axis of the matrix ranged from

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completely uncertain objectives and uncertain means to clear and stable objectives and means.<sup>2</sup>

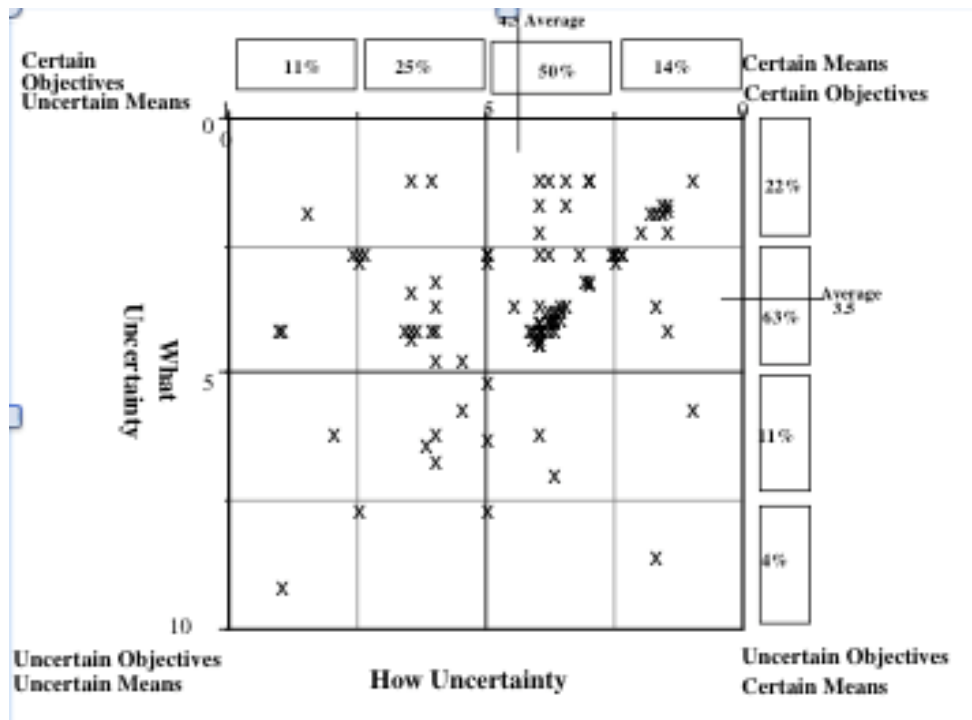


Figure 1. Assessment of Uncertainty: Typical Project.

The data was explored with those reporting to understand if there were patterns or clusters of points associated with industry segments or delivery methods at the start of construction. No pattern was discovered. All projects were reported to have some uncertainty as to ends and means as late at the start of construction and some reported a great deal. The second set of data in Figure 2., was collected for the "Most Recent Project". It showed both high levels of uncertainty and that 85% of project managers underestimated and less than 2% overestimated the magnitude of uncertainty as late as the start of construction. Arrows show how assessments had changed as projects progressed. The dots identify projects where there was no change between each manager's initial assessment and later.

The reports of uncertainty in both figures suggest that regular assessment of the nature and extent of uncertainty is important to keep people's attention on the unknown. People mark where they mark for a reason and usually can explain what information or decision would allow them to change their assessment and improve their ability to complete their work. A careful, patient public discussion with each person's view of the state of project teams is worth the time.

The idea that risk can be allocated fairly by contract is challenged by the extent of uncertainty and the tendency of managers to underestimate it. By contrast, in LC/IPD projects, the teams jointly explore risk and develop strategies to reduce or mitigate the

<sup>2</sup> Note that the top right corner is not "Project Complete" but rather the objectives and means to achieve them are clear and stable.

uncertainty that cannot be eliminated. This sort of joint enquiry is particularly important on complicated, fast moving projects with rapid changes in technology.

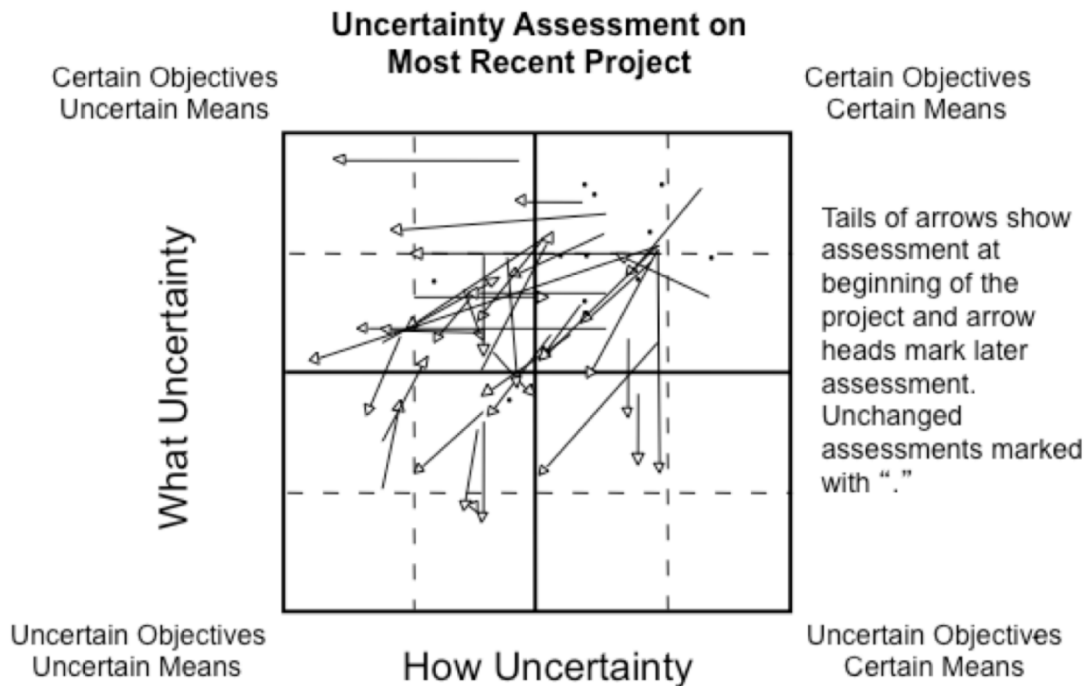


Figure 2: Assessment of Uncertainty: Most Recent Project

Table 1: First Comparison

	<b>Traditional Project Management</b>	<b>Lean Construction/IPD</b>
<b>Uncertainty</b>	Risk can be minimized and allocated: The owner knows what they want, the designer represents this in the drawings and contractor builds it.	Managed and reduced by the project team to maximize shared gain

**ARE WE ORGANIZED TO PLAY THE GAME WE ARE PLAYING?**

Robert Keidel proposed in *Game Plans* (Keidel 1985) that organizations were more successful when the "game" they were playing was appropriate for the situation. He presented three games distinguished by the ends and means relationships at the corners of the triangle in Figure 3. Football, the North American sort, is a game sequential dependence, a game of control. Scoring results from a series of planned events. Winning occurs when teams make and stay on their plan and force the other team off theirs. Adjustments to the plan are literally top down: observers high in the stadium relay instructions to the coach on the ground. Coaching develops the skills of individuals, the ability to make precisely timed movements and to respond to changes with preplanned adjustments.

Basketball is an interdependent sport; teams win by managing the flow. Cooperation is a spontaneous response to the unfolding situation. Scoring is almost continuous as players see and adjust to take advantage of momentary overlaps. Baseball is a game of pooled dependence: each player contributes independently to team performance. Filling out the game roster, the lineup, is the key planning decision made by coaches. Planning in then sense of predicting a series of actions is relatively, rare, short term and situational; scoring a statistical improbability. Teams with the best pitchers and hitters usually win the World Series.

Keidel use triangle to help companies diagnose the situation in terms of their interaction and then shaping their "play" to fit the circumstance. For example in Figure 4, he asked managers to mark their organization's current location, where it would be more effective, and then identifying actions needed to align the organization to situation.

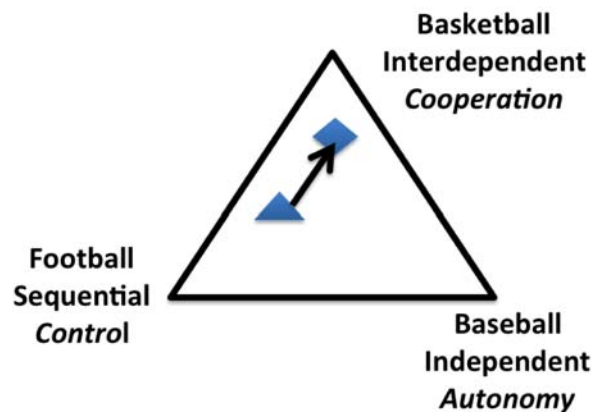


Figure 3: Organizational Design

In the design and construction of projects, different parts of organizations may be playing different games. Design might begin in the mind of a single signature architect working alone and then become more like basketball as disciplines join to solve interdependent problems. The organization moves toward football, becoming more plan and control driven as work shifts moves to site. Managing the transitions, bringing the leadership appropriate for the circumstance is important as is the ability to shift back into basketball when plans central to success begin to fail.

More recently, Keidel has extended his thinking and added new distinctions to the basic graphic. (Keidel 2003). (Figure 4 combines several graphics from the book.) The labels near each corner suggest behavior at the extreme with the others suggesting the style that works best in the situation in relationship to the ranges along each side - for example from "Consistency" to "Flexibility". The graphic gives leaders a way to think about and discuss their situation, behaviors needed, and the structure of the organization. Keidel suggests today's business challenges call for organizations somewhere along the double-headed dotted arrow inside the triangle.

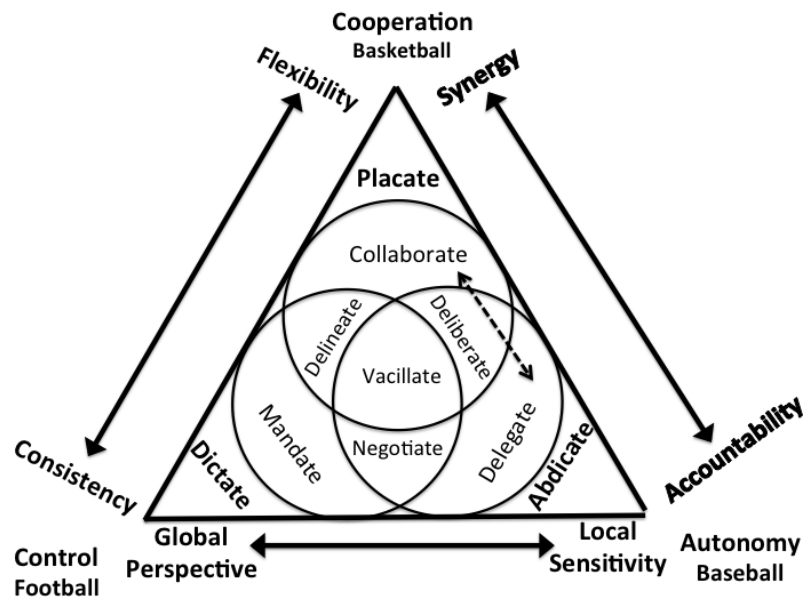


Figure 4: Are We Organized for the Game We are Playing?

People working in IPD projects are likely to work in a variety of locations well outside the boundaries of the corporate structures common in the industry of today. Jim Carroll observed during the CII Project Organization Task Force's deliberations, "We need to learn how to play basketball in the middle of a football game." Keidel would add another challenge, "How do we organize baseball stars to play basketball in the middle of a football game?"

Table 2: Second Comparison

	<b>Traditional Project Management</b>	<b>Lean Construction/IPD</b>
<b>Uncertainty</b>	Risk can be minimized and allocated: The owner knows what they want, the designer represents this in the drawings and contractor builds it.	Managed and reduced by the project team to maximize shared gain
<b>Structure</b>	Sequential Relationship set by contract.	Fit for the circumstance: Autonomy, Interdependence and Sequence.

**MOTIVATION IN HIGH PERFORMANCE TEAMS**

Many organizations claim to have invented IPD, produced guides and draft contracts and delivered projects without adopting the LC operating system. For these organizations, IPD is primarily a collaborative contract aimed at optimizing the project and not the piece. These organizations overlook both the IPD™ trademark

process created by Owen Mathews of Westbrook in Orlando and the relational contract produced by William Lichtig in 2003. That contract was later adopted by Consensus Docs, a coalition of member associations, and published as Consensus Docs 300.

Mr. Lichtig's objective for the contract was "to create a relationship durable to withstand the inevitable conflicts and challenges that would arise during project delivery." The document includes "Team members will be expected to share information and cooperatively collaborate for the benefit of the Project." The language require the parties to work together for the benefit of the project and to share in its success or failure; it calls on "the better angels of our nature" (Lincoln 1861) to assure those involved cooperate for the benefit of all.

Common sense tells us that the best solutions to complicated or complex problems arise when teams are structured for the situation at hand. Alternative solutions develop when individuals or interdependent teams propose competing solutions and cooperate to refine, improve and select the alternative offering the greatest advantage to the larger project organization.

How is the balance between cooperation and competition to be governed in teams made up of members with different histories, backgrounds and capabilities? Economic motivation within these project-serving teams is set aside by the commercial terms binding their corporations. As a consequence, the extent to which a person contributes to the success of the joint endeavor success may have no direct relationship to money made or lost by their employer.

Theories of individual motivation, Bentham's "Carrot and Stick" (Bentham 1789), Maslow's "Hierarchy of Needs" (Maslow 1943), Herzberg's "Hygiene" (Herzberg 1959), or the Pink's "Self Development Theory" (Pink 2010) miss the powerful influence of the sense of equity or fairness in teams described by Bowles of the Santa Fe Institute and others. Individuals (not sociopaths) have and act from an innate sense of fairness. Adam Smith understood both the power of both self interest, "It is not from the benevolence of the butcher, brewer, or the baker that we expect our dinner, but from the regard to their own interest." (Smith 1776), and our concern for others "How selfish so'ever man may be supposed, there are evidently some principles in his nature, which interest him in the fortune of others, and render their happiness necessary to him, though he derives nothing from it, save the pleasure of seeing it." (1759)

Professor Bowles builds on the latter view and demonstrates how the drive for fairness is more powerful among individuals working together than financial motivations or the other theories listed above. People cooperate for self-interested reasons and because they are genuinely concerned about the well being of others, try to uphold social norms, and value behaving ethically for its own sake. People punish those who exploit the cooperative behavior of others for the same reasons. "Contributing to the success of a joint project for benefit of one's group, even at a personal cost, evokes feelings of satisfaction, pride, even in relation. Failing to do so is often a source of shame or guilt." (Bowles 2008) And he supports these claims with well-designed experiments, "The Ultimatum Game" with both individuals and groups that demonstrate this mechanism in action. ([Bowles Ultimatum Game](#))

This simple simulation shows that economic motivators are less powerful than a personal sense of fairness. This simulation has been run in cultures around the world,

with larger and smaller amounts of money involved. The results are much the same in every setting. A larger version of the simulation has been conducted with groups of people who stand to gain from cooperation. In this version, it is possible for one participant to maximize their gains by not contributing anything to the success of larger group. Bowles calls these people, "Free Riders", those who take advantage of the situation and maximize their gain at the expense of others. One variation of the simulation allows participants to "punish" free riders by confronting them with their failure to support the success of the larger group.

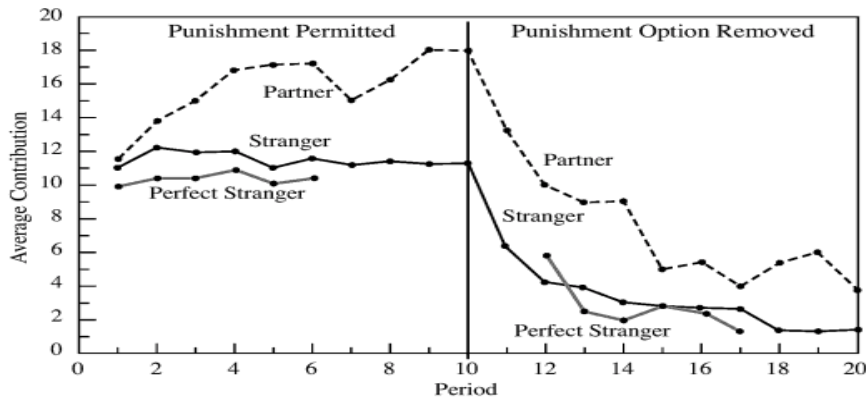


Figure 5: Punishing Free Riders Effect on Contribution to Group Performance (Bowles 2008)

"Punishment" begins by privately confronting the Free Rider and asking for a change in behavior. Direct and public confrontation is the next step. When this fails to produce an improvement the Free Rider should be replaced. Teams working in an Integrated Project Delivery should be introduced to these concepts and develop an agreed protocol for identifying and coping with free riders. Person-to-Person, the sense of fairness is more powerful than economic gain.

A caution: both Keidel and Bowles are wary of cooperation in the sense of giving in, placating others. Figure 3 places extreme and dangerous behaviors at each corner of the triangle. The danger of Free Riders is that they placate others by going along and not entering the competition of ideas.

Table 3: Third Comparison

	<b>Traditional Project Management</b>	<b>Lean Construction/IPD</b>
<b>Uncertainty</b>	Risk can be minimized and allocated: The owner knows what they want, the designer represents this in the drawings and contractor builds it.	Managed and reduced by the project team to maximize shared gain
<b>Structure</b>	Sequential Relationship set by contract.	Fit for the circumstance: Autonomy, Interdependence and Sequential.
<b>Motivation</b>	Financial	Shared financial gain for corporations. Equity within teams & punishing free riders.

## SUMMARY

The paper has introduced three connected sets of ideas. Uncertainty on projects is high and frequently underestimated. Keidel's characterization of teams offers leaders a powerful way to diagnose the situation and a better way to fit teams to task. People have a sense of fairness. At the individual level the sense of fairness is more powerful than the economic theory of behavior. Teams achieve highest performance when Free Riders are identified and punished by revealing their lack of contribution and then challenging them to do join the conversation or find other work.

Today's construction industry has evolved from its historic structure. It has been shaped by the development and application of the Critical Path Schedule. Now comes Lean Construction, a set of principles and practices about 20 years old. We can already see its impact in the way work is managed, commercial contracts are structured and organizations behave. The Last Planner<sup>®</sup> System has brought cross-trade collaboration deep inside projects reducing uncertainty and all that goes with it. Likewise, Target Value Design has raised and extended collaboration reducing uncertainty and risk; "Choosing By Advantages" gives project organizations "a decision-making system for yielding sound, reliable, grounded choices (Suhr. These developments have changed where we stand, what we can see, how we think. Now we can ask questions that were impossible or nonsensical.

## RESEARCH QUESTIONS

- 1) Descriptive Research
  - a) How do IPD teams develop -
    - i) a sense of shared purpose?
    - ii) a way to reveal and cope with the emerging state of uncertainty?
    - iii) a way to diagnose the nature and extent of uncertainty, organize and invest wisely in its reduction, and hold open decisions to maximize project performance?
    - iv) a "referee" to assure equity and fairness on IPD projects?
    - v) a way to identify Free Riders?
      - (1) How do we get individuals and organizations back in the game or off the field?
    - vi) How is the nature and amount of contingency determined within project organizations?
    - vii) How is the amount invested in design and planning established to maximize project performance.
  - b) How do leaders -
    - i) match team structure to the nature and extent of uncertainty and the task at hand?
    - ii) adjust the "game" they are playing to fit the circumstance?
  - c) How does this work when collocation is continuous? Intermittent? Occasional? Virtual?
- 2) Theory Development
  - a) Developing a rational approach to sizing and allocation of contingency to maximize project performance.
  - b) Developing a rational learning-based approach to investing in planning.



- c) Simulation based research to explore how specialty contractors invest in planning to achieve optimal workflow predictability.
- 3) Implementation (Descriptive Research would be very helpful here)
  - a) What is the best way to teach LC?
    - i) Develop simulations
  - b) Which organizational change theories work best in practice?
  - c) How can academics learn from industry experience?
- 4) What will a transformed industry look like and how can companies position themselves to succeed?

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