Provocation 1 - Barriers to Innovation in AEC Project Delivery

AIA Project Delivery Knowledge Community 2020 Symposium – Workshop

03.09.2020

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Associate Dean and Senior Lecturer
Yale School of Architecture
History
The evolution of project delivery models, 1970–2020

Economic context
- High Interest Rates
- High Energy Costs
- Liability Crisis
- Savings + Loan
- Worldwide Downturn + Early Sustainability
- Digital Design Data + Interconnectivity
- Digital Fabrication + Big Data

Project delivery model
- 70s: Design Bid Build
- 80s: Fast Track + Original CM
- 90s: Design Build + Flavored CM
- 00s: Integrated Design + Construction / Building Lifecycle
- 10s: Measured Performance + Outcomes
- 20s:...

Evolution of design technology
- 70s: Tracing Paper
- 80s: Layered Production
- 90s: Computer-Aided Drafting
- 00s: Building Information Modeling
- 10s: Connected Systems
- 20s:...

Decade

O Owner
A Architect
C Constructor
CM Construction Manager
D Designer
B Builder

Sources of Project Uncertainty

Top Causes of Overall Uncertainty for Owners, Architects and Contractors

<table>
<thead>
<tr>
<th>Causes of Uncertainty</th>
<th>Owners</th>
<th>Architects</th>
<th>Contractors</th>
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<tbody>
<tr>
<td>Unforeseen Site or Construction Issues</td>
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<td>Design Errors</td>
<td>2(tie)</td>
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<tr>
<td>Design Omissions</td>
<td>2(tie)</td>
<td>7</td>
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<td>Contractor-Caused Delays</td>
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<td>6</td>
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<td>Owner-Driven Changes</td>
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<td>Accelerated Schedule</td>
<td>5(tie)</td>
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<tr>
<td>Construction Coordination Issues</td>
<td>7</td>
<td>5</td>
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</table>

Ranking of Causes by Player

Top Factors That Cause Uncertainty


Frequency With Which Projects Meet Expectations


Evolution Towards BIM

1. Single firm implementation
   - Production
   - Coordination
   - Visualization

2. Design team implementation
   - Production
   - Analysis

3. Supply chain implementation
   - Integration

Source: “Digital Building Process Business Practice Evolution: Your Paradigm or Mine?” Autodesk/Stanford CIFE Study 1/31/05
U.S. BIM Adoption Timeline – Key Events (2012)

Cumulative Seat Adoption Curve


Industry Events

Product Events

3/00 ADT V 2001  4/02 Revit acquisition  2/08 GBS acquisition  10/10 Project Vasari

3/03 GSA BIM Standard  8/04 CURT Paper  6/02 Term “BIM”  10/08 AIA BIM Protocol

7/04 WSJ Freedom Tower article  5/05 AIA Conv  6/06 Revit Structure release  09/07 AIA IPD Guide

12/07 National BIM Standard  07/08 Ecotect acquisition  6/06 Revit MEP release  3/06 Revit MEP release
Legal
Aspiration

AGENCY
Services
Contract

Intention

C

D

B

PRODUCT
Construction
Contract

Execution
“Architects, doctors, engineers, attorneys, and others deal in somewhat inexact sciences and are continually called upon to exercise their skilled judgment in order to anticipate and provide for random factors which are incapable of precise measurement. The indeterminable nature of these factors makes it impossible for professional service people to gauge them with complete accuracy in every instance.... Because of the inescapable possibility of error which inheres in these services, the law has traditionally required, not perfect results, but rather the exercise of that skill and judgment which can be reasonably expected from similarly situated professionals.”


AIA says “…by architects practicing in the same or similar locality under the same or similar circumstances.”

Source: Leslie King, Esq.
Sources of Liability: Non-Technical Risk (from AIA HPP 15th Ed)
Business Models
Traditional Compensation Calculations

**Top Down**

\[ \text{GSF} \times \text{Cost/GSF} = \text{estimated cost of construction} \times \text{fee \% multiplier} = \text{gross fee (GF)} \times \text{NAF multiplier} = \text{net architectural fee (NAF)} \]

**Bottom Up**

- overhead \| contingency \| profit
- cost/hour
- team size/phase
- schedule

Markups
Salaries
Staffing
Timing

\[ \text{GSF} \times \text{Cost/GSF} = \text{estimated cost of construction} \times \text{fee \% multiplier} = \text{gross fee (GF)} \times \text{NAF multiplier} = \text{net architectural fee (NAF)} \]
Selected Business Strategies

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<th>Variable Fees</th>
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<td><strong>Cost Plus Fixed Fee</strong></td>
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<td><strong>Outcome-based</strong></td>
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- Efficiency (productivity)
- Expansion (add services)
Selected Business Strategies

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<td>Unit Cost</td>
<td>Outcome-based</td>
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NAF

Price (charge higher rates)

Expansion (spend time)
### Selected Business Strategies

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<tbody>
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<td>Unit Cost</td>
<td>Outcome-based</td>
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</table>

**NAF**
- **Efficiency** (productivity)
- **Expansion** (add services)

**Price**
- **Expansion** (spend time)
Social / Cultural
### The Building Supply Chain

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<th>Design Professionals</th>
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#### SUPPLY INTEGRATION PRACTICES (SCIP)

- Modular v. systemic
- Systemic (project)
- Systemic (segment)
- Systemic (industry)

Source: "Identifying the Role of Supply Chain Integration Practices in the Adoption of Systemic Innovations" (Hall, Levitt, Algiers)
Supply Chain Integration Practices

Collaborative governance
Project co-location
Local owner representation
Fiscal transparency
Interorganizational BIM
Multiparty incentivized contracts
Early involvement
Inter-firm board
Target value design
Last planner

Source: "Identifying the Role of Supply Chain Integration Practices in the Adoption of Systemic Innovations" (Hall, Levitt, Algers)
Impact of Team Integration and Group Cohesion on Project Delivery Performance

Bryan Franz, Ph.D., A.M.ASC, Robert Leicht, Ph.D., A.M.ASC, Keith Molenar, Ph.D., and John Messner, Ph.D.

Abstract: The architecture, engineering, and construction (AEC) industry is often criticized for its fragmented approach to project delivery. Traditional procurement and contracting intentionally serve to isolate designers from contractors to provide checks and balances, but limits opportunities for collaboration. This research presents a structural modeling approach to studying the role of integration in the performance of building construction projects. A sample data set of 234 completed projects was collected to compare, schedule, and quality performance under different delivery methods. Integrations of project teams was proposed and tested in the form of two latent constructs—team integration and group cohesion—that mediate the link between delivery methods and performance. More integrated teams interacted with more participants from all levels of the building construction process, from designers to specialty trade contractors. These interactions included design charrettes, joint goal setting, and multidisciplinary building information modeling (BIM) uses. The selected project delivery method had a significant effect on team integration. Delivery methods that involved the builder and specialty trade contractors before schematic design achieved higher levels of integration and were more equipped to control project schedule growth. Cohesive teams were characterized by better chemistry, goal commitment, and timelessness of communication. Project delivery methods that included cost transparency with open book contracts and qualification-based selection of the builder resulted in more cohesive teams and a lower average project cost growth. Additionally, the owner’s perception of their turnover experience and building system quality was rank higher for cohesive teams. Understanding how delivery decisions influence the integration and development of their project teams will aid building owners more aware of how these decisions ultimately affect the project’s performance. DOI: 10.1061/ASCECO.1943-7862.0000219

Author keywords: Contracting; Integrated project delivery (IPD); Structural equation modeling (SEM); Collaboration.

Introduction

There is a growing consensus in the architecture, engineering, and construction (AEC) industry that integration of people and processes is an effective means of improving project performance. (Budker and Hampson 2003; Smyth and Pyke 2008). Authors also suggest that some project delivery methods are more integrated than others. Building on Knechel and Sadowski’s (1996) seminal work, follow-on studies found that design-build (DB) and construction manager at risk (CMR) yield higher levels of integration than a traditional design-build (DBB) approach (Zhang and Kerkvliet et al. 2005). As a result, some owners are considering alternative delivery options, including integrated project delivery (IPD), that promote the integration of design and construction disciplines.

1Associate Professor, M.E. Baker, Senior School of Construction Management, Univ. of Florida, 333 Newell Dr., Gainesville, FL 32611 (corresponding author). Email: mbaker@ufl.edu.
2Professor, Dept. of Architectural Engineering, Pennsylvania State Univ., 314 Engineering Unit A, University Park, PA 16802. Email: mlc6@psu.edu.
3Professor, Construction Engineering and Management, Univ. of Colorado Boulder, 8940 W. 72nd Ave., Boulder, CO 80305. Email: leslie@colorado.edu.

Fig. 1. Conceptual model

Fig. 2. Confirmatory factor analysis with standardized estimates
The evolution of project delivery models, 1970–2020

- **70s**: Tracing Paper
- **80s**: Layered Production
- **90s**: Computer-Aided Drafting
- **00s**: Object
- **10s**: Building Information Modeling
- **20s**: Objects
  - Digital Design Data + Interconnectivity
  - Digital Fabrication + Big Data
  - Integrated Design + Construction / Building Lifecycle
  - Measured Performance + Outcomes

**Figure 20: Basic design services dominate as the top source of firm revenue**

Source: AIA Firm Survey 2018 The Business of Architecture, K. Baker
Technology
**Techies**
I have to try it!

**Conservatives**
Is it a standard yet?

**Skeptics**
Is there no way to avoid it?

**Visionaries**
We can drive huge competitive advantage

**Pragmatists**
Have my peers implemented?
Innovation Adoption in the U.S. (2012)
**FIGURE 23:** Share of firms using BIM for billable projects continues to expand over time, even for smaller firms

<table>
<thead>
<tr>
<th>Year</th>
<th>Small firms (under 10 employees)</th>
<th>Midsize firms (10 to 49 employees)</th>
<th>Large firms (50 or more employees)</th>
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<tbody>
<tr>
<td>2005</td>
<td>7%</td>
<td>10%</td>
<td>16%</td>
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<td>2008</td>
<td>43%</td>
<td>35%</td>
<td>21%</td>
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<td>2011</td>
<td>74%</td>
<td>60%</td>
<td>28%</td>
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<tr>
<td>2013</td>
<td>65%</td>
<td>65%</td>
<td>28%</td>
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<tr>
<td>2015</td>
<td>96%</td>
<td>72%</td>
<td>28%</td>
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</table>

**FIGURE 24:** Most firms use BIM for design visualization, presentations, and renderings

- **Design visualization:** 88%
- **Presentations and renderings:** 85%
- **Coordinated construction documents:** 74%
- **Sharing models with consultants:** 69%
- **Sharing models with clients/owners:** 61%
- **Resolving conflicts with other disciplines (class detection):** 49%
- **Sharing models with constructors/clients:** 47%
- **Quantity takeoffs/estimating:** 28%
- **Energy/performance analysis:** 24%
- **Managing model data during construction:** 23%
- **Fabrication and prototyping:** 11%

Source: AIA Firm Survey 2018 The Business of Architecture, K. Baker
The Building Supply Chain

How does an innovation affect the entire project network?

Source: “Identifying the Role of Supply Chain Integration Practices in the Adoption of Systemic Innovations” (Hall, Levitt, Algiers)
Future
Implications for the architect's **process**

Increasing project value

**Improvement:**
- Aspirational
- Operational
- Executional
- Transactional

**Process:**
- Profit
- Credibility
- Influence

**Implications for the architect’s **results****

= improved social conditions and advancing culture
= improved performance of the final asset
= improved construction means and methods
= improved efficiency

Risk: Low

Value: High

Mitigate

- Anticipate, mitigate owner changes of scope

Manage

- Predict and manage costs
- Accelerate schedule

Embrace

- Predict project outcomes

Integrate trade coordination

Zone of competent practice = standard of care

Reduce design and coordination errors

Value: Low

Risk: High

Zone of competent practice = standard of care
Clients and Users

Builders

Designers

Execution optimization

Technical performance

Operating performance

Social Performance

Discipline optimization to smooth delivery

Inter-disciplinary delivery optimization

Project operational optimization

Project performativity optimization

Program conformance

Design schedule

Design quality (Cost)

Budget conformance

Schedule

Built quality

Systems to spec

Durability

Systems performance

Energy savings

Carbon

Staffing optimization

Maintenance

Project value

Economic performance

Employee satisfaction

Higher test scores

Healthier patients

Lower infection rates

Discipline optimization to smooth delivery

Inter-disciplinary delivery optimization

Project operational optimization

Project performativity optimization

Program conformance

Design schedule

Design quality (Cost)

Budget conformance

Schedule

Built quality

Systems to spec

Durability

Systems performance

Energy savings

Carbon

Staffing optimization

Maintenance

Project value

Economic performance

Employee satisfaction

Higher test scores

Healthier patients

Lower infection rates
Innovation

Business judgment rule

Shareholders challenging the wisdom of a business decision taken by management must overcome the business judgment rule. . . . . For efficiency reasons, corporate decision makers should be permitted to act decisively and with relative freedom from a judge's or jury's subsequent second questioning. It is desirable to encourage directors and officers to enter new markets, develop new products, innovate, and take other business risks.” 1 A.L.I., Principles of Corporate Governance (1994) § 4.01(c) comment, p. 174

Source: Leslie King, Esq.
Yale School of Architecture
ARCH 22308: Exploring New Value for Design Practice
(Viewed 1.1)
Spring Term, 2019

1. Abstract: Are architects undervalued in the systems of delivery and if so, how do we make design a more profitable practice? Design practice has traditionally positioned building as a commodity in the delivery supply chain, valued by clients like other products and services purchased at lowest first cost. Intense market competition, sole focus on differentiation by design quality, and lack of innovations in project delivery and business models have resulted in a profession that is greatly underpaid and marginally profitable, despite the fact the building sector in its entirety operates in large capital pools where significant value is created and profits taken. Innovation in practice is largely deployed in the service of traditional design objectives rather than value generation opportunities. The profession must explore new techniques for overlapping the real value of an architect’s services to clients and thereby break the downward pressure on design compensation.

This course will reimagine and re-design the value proposition of architecture practice, explore strategies used by better compensated adjacent professions and markets, and investigate methods and models by which architects can deliver—and be paid for—the value they bring to the building industry. Using the platform of business plans—where value generation is defined through specific business parameters—we will compare and contrast value generation strategies. Students will form firms and propose new practice paradigms as a final project.

The course is designed to achieve the following outcomes:

a. Understand the relationship of the architect to the economic systems of building.

b. Understand the role of the architect in various models of building delivery.

c. Define value creation challenges inherent in the current architect’s role and speculate on future options.

d. Understand and be able to deploy essential principles of strategic and business planning in defining value propositions and how they are instantiated, including financial analysis and business planning.

e. Understand and be able to manipulate operating models of practice and the relationship of those models to money, risk and value.

f. Create a viable business plan for an alternative value practice.

2. Students/Prerequisites: The course is designed for students with either substantial office experience or nearing graduation who want to understand more specifically how architects practice might change in the future. The course is open to M.Arch students with either three or more years of office experience or those who successfully completed 2031A/Architectural Practice. The course is open to all M.Arch II students, but please note that an appropriate background in professional practice will be necessary in order to understand and execute the class requirements.

3. Class design: Schedule: Class will meet twice weekly: Tuesday lectures from 3:00PM—4:00 PM in Loria B51, and Wednesday sections/discussions from 11:00-12:30 also in Loria B51. Most Tuesday lectures will be accompanied the following day by an interactive discussion with a guest who will join the class for a relevant discussion about the weekly topic. Topics will cover one or more of the three course components:

1. Context: what is the environment in which architects currently work, and what are the structural challenges? Why are new value propositions necessary?

2. Tools: what are the technical characteristics of business planning and generation? What is a business plan, a strategy, a firm financial model, a compensation method?
The Distractions of Disruptions

In the spring of 2013, a new course was offered at the Yale School of Architecture, one of only two in its professional practice curriculum. Exploring New Vistas Propositions for Design Practice was a small seminar designed to interrogate current business models, examine other models both within and outside of the building industry, and propose new strategies for the practice of architecture. Its first students had vivid memories of the recent-world financial crisis, and despite the relative isolation caused by studio-based design education they were very much aware of the general "start-up" zeitgeist among their peers on college campuses elsewhere. Since that first year, the course has grown in popularity and size as one of few opportunities for architects in training to experience beyond the boundaries of building design in the innovation era.

Architect and Associate Dean at the Yale School of Architecture, Phil Bernstein sees a tsunami of change brewing for the architectural profession, conditioned by artificial intelligence, big data, the ubiquitous cloud and robotics. Yet the delivery and procurement of buildings is often inhibited by pre-digital structures of the construction industry. He argues that architects need to rethink their processes from first principles.
Verticalization

Integrated Design / Build / Operator

Owner / Operator

Architect as Developer

Prefabricator

Architect as Construction Manager

Delivery Relationships

O – Owner
A – Architect
C - Contractor
Spanning

Delivery Relationships

O – Owner
A – Architect
C - Contractor

Post-occupancy evaluation (data loop)
Sustainable building optimisation
Fiduciary intermediary
AI-driven pre-design services
Prefab system designer
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