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INTEGRATING DELIVERY OF A LARGE HOSPITAL COMPLEX

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Abstract: Building a high performing building requires project teams to integrate their knowledge, their organization and their information, leveraging metrics, models (energy, BIM, cost and schedule), co-location and collaboration, and production management. This model, the "Simple Framework for Integrating Project Delivery" was validated in action on the UCSF Mission Bay Hospitals project. The senior project leaders created an integrated community that employed Lean and Virtual Design and Construction methods to create solutions in the best interest of the project.

Keywords: Simple Framework, integration, leadership, collaboration, capabilities.

1 INTRODUCTION

This paper describes the integration of a large Healthcare project relative to a theoretical model for integrating project delivery explained in a previous IGLC paper (Fischer et al., 2014) and a recently published academic text (Fischer et al., 2017) by four of this paper's authors. The emphasis is on how leaders and team members, without explicit knowledge of the Simple Framework, developed a working system that closely approximated the Simple Framework. The paper reports reflections by senior leaders on the work they did to integrate their project. It also describes Lean and Virtual Design and Construction as essential capabilities for effective integration. Figure 1 shows elements and enabler of the Simple Framework.

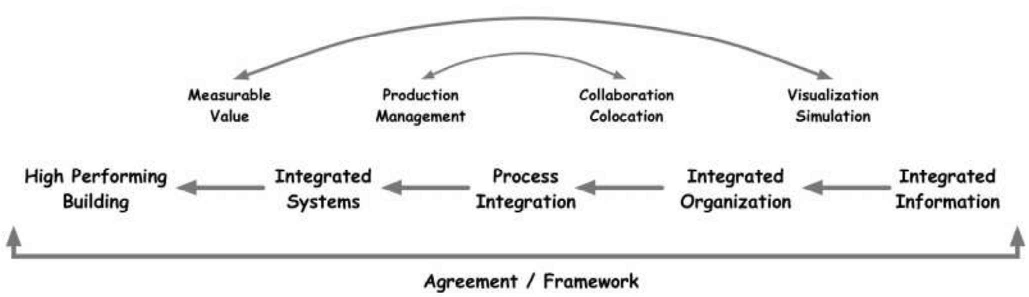

Figure 1: The Simple Framework for Integrating Project Delivery.

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2 THE IMPERATIVE OF INTEGRATION

The authors of Integrating Project Delivery define the "high-performing building" as one that is usable, operable, sustainable and buildable. This means that it should be useful for the people who engage with and rely upon the building. This certainly includes function, form and aesthetics. The building should be economical to operate, and, if our planet is to remain habitable, the building should be constructed and run without depleting or harming the environment. The building most also contribute to the success of its sponsors, using the metrics the sponsoring organization uses to define success.

The process of creating the building must be similarly high performing. Project cost and duration must stay within constraints. Workers should not be exposed to avoidable risks. Project quality must meet the sponsor's needs. Unless the project process can be efficient and effective, the building will not be successful and may not even be built. Seeing the goal of delivering a high performing building allows stakeholders and deliver team members to understand their challenge.

A high-performing building can only be achieved through a building with integrated building systems, which can only be produced through an integrated process, which depends on an integrated team with the right people, which needs integrated information, i.e., BIM+ to function effectively and efficiently. Simulation and visualization are the primary ways in which BIM+ informs the integrated team. Collaboration and co-location are the primary ways that allow the integrated team to integrate processes. Production management methods enable the productive design, fabrication, and construction of the integrated building system. Outcome metrics define the performance of the building and validate the integrated building system. All of this is supported by the appropriate agreement or framework.

3 UCSF MISSION BAY HOSPITALS

The University of California San Francisco Mission Bay Hospitals opened in 2014 after a 45-months of design and construction. It currently serves pediatric specialties, the adult surgical oncology program, and a women's birthing program. There are 16 imaging rooms, 20 operating rooms, and 289 patient rooms. Heating, cooling, and power for the hospital and connected outpatient clinic are supplied by an energy center. Altogether, the facility is 878,000 gross square feet and has 60,000 square feet of roof gardens. The total construction budget was $765 million, pared down from an original $965 million cost estimate; the project budget was $1.52 billion. It earned LEED Gold and was opened eight days early. (Fischer et al., 2017, pp.176-177)

4 LEADERSHIP

While the Simple Framework model was not available during the project, senior leaders and many Mission Bay Hospitals team members knew more than most about collaboration and integration, Lean, and BIM. Stuart Eckblad, came to UCSF Medical Center as director of Design and Construction in 2006 as a long-time advocate and practitioner of collaboration. Long before IPD came into being, Stuart joined with other industry leaders to cofound and serve as president of the Collaborative Process Institute (CPI) in the mid 1990s. CPI's mission was to educate owners and industry leaders about building collaborative cultures to enable project teams to deliver extraordinary results. In

2007, he chaired the AIA California Council committee, which drafted and published the "Working Definition of Integrated Project Delivery." Laurel Harrison, a highly-regarded Healthcare planner and design architect and Principal at Stantec Architecture was a key leader of the architectural team. Ray Trebino, with years of experience building advanced technology facilities, was at the center of a team managing the project for the General Contractor, DPR Construction.

In conversation reflecting on their experience leading the project, Eckblad, Harrison and Trebino described countless conversations amongst themselves and with other leaders to design and redesign the project organization, information flows, and decision-making through the course of the project. (Fischer et al., 2017, pp.183-184) The three leaders described sharing leadership and how important it was for them to go into the project convinced that it could only succeed if they could create a "best-for-project" culture and community of people building for Healthcare. They spoke of the need to be confident that most people would respond positively. They spoke of creating and inventing delivery rather than applying methods and processes. (Eckblad, Harrison and Trebino, personal communication, December 19, 2016)

5 Performance Prerequisites

5.1 Removing Obstacles to Collaboration

Stuart Eckblad convinced university officials that he could produce better results by engaging the general contractor and key trades early and adopting major IPD concepts. The University had little prior experience with any of these concepts and was reluctant to deviate from their traditional standards. Eckblad was convinced, however, that real change required real change and he challenged university and outside counsel to transform traditional contractual and business models into a reasonable approximation of IPD principles. Although the resulting documents were complex, they did improve integration by interlocking the parties through shared incentives and collaborative management.

DPR Construction was selected in a competitive process as the GC and joined the project in August of 2008, followed in December of 2008 by eight design-assist MEP, concrete, steel, drywall, and doors-frames-hardware subcontractors chosen via a competitive process. All were contracted to work under Cost-Plus Guaranteed Maximum Price (CPGMP) contracts with target costs and target incentives to reduce overall construction cost by $200 Million and to meet schedule and other constraints. (Fischer et al., 2017, p.177)

5.2 Trust for Collaboration

Larry Prusak, founder and Executive Director of the Institute for Knowledge Management (IKM) has stated, "Without trust, it's spectacularly difficult for collaboration to flourish, even between peers and within practices." (Prusak, 2011)

In anticipation of construction contract awards, Stuart Eckblad invested in establishing a co-location center on the building site, the "Integrated Center for Design and Construction" (ICDC). Then he insisted that the design team move-in with the general contractor's staff. The architects did relocate which greatly increased knowledge among the project team and significantly reduced time required to have questions answered (Fischer et al., 2017, p.178). Trust increased as people came through with the useful information as they had promised. "Basic Action Workflow," developed by Fernando

Flores, shown in Figure 2, illustrates how people working in the ICDC built trust. (Flores, 2012)

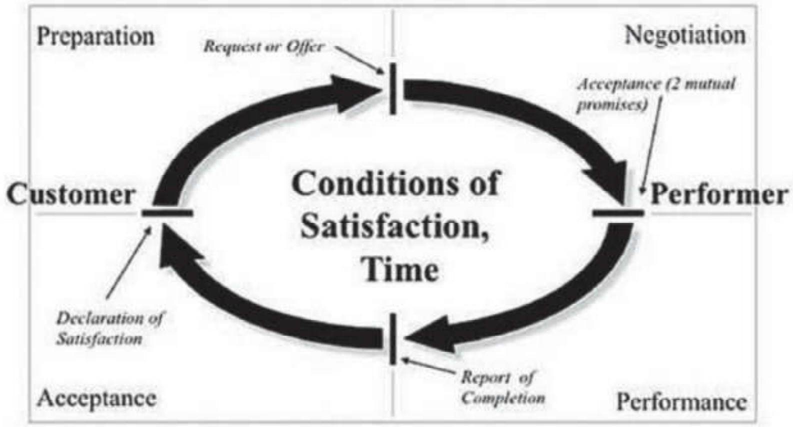

Figure 2: The Basic Action Worflow of Fernando Flores.

5.3 Feedback for Continuous Improvement

W. Edwards Deming taught Japanese industrialists and engineers the Shewhart Learning Cycle, which Toyota and other Japanese companies made famous as the Plan-Do-Study-Act cycle. The idea was to predict results, check on whether they were achieved, and find ways to improve and then implement them in a continuous learning / improvement cycle. (Latzko, 1995)

UCSF Mission Bay Hospitals senior leaders followed this approach. They worked with the sub-teams responsible for different aspects of work to set targets for cost reduction, responding to contractor's questions about design, approving materials submittals, and completing work as promised. Leaders met 4-days each week with their teams and then with other teams leaders and a "Captain" for the design or construction of one of the buildings who would then meet with the top leaders. Results, problems and solutions were always on the meeting agendas. Figure 3 illustrates the practice of daily tiered meetings described by David Mann (2014) in his book, *Creating a Lean Culture: Tools to Sustain Lean Conversations*.

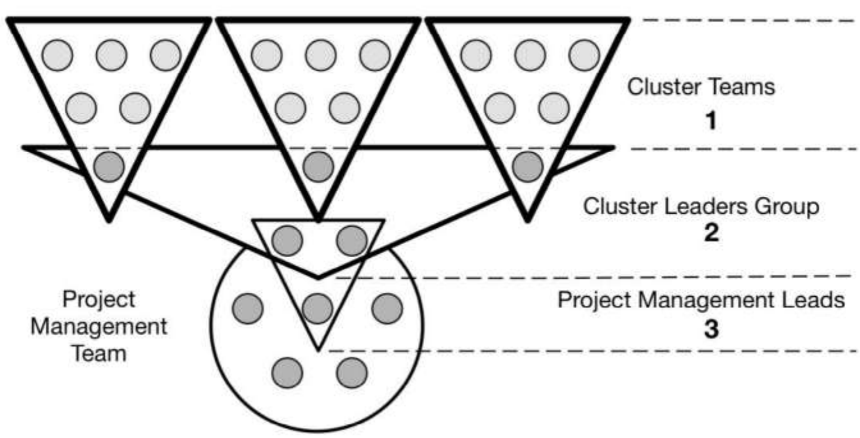

Figure 3: Daily Tiered Meetings.

6 INTEGRATING & DELIVERING

6.1 Capabilities

Forming and maintaining a collaborative community required Lean thinking and practices. The first step was to get everyone to commit to using best-for-project as the paramount decision criteria. Team performance depended on people making clear requests and promises and delivering on them. Top leaders granted decision-making authority down through the organization based on cost.

Shortly after the GC and key trade contracts (mechanical, electrical and plumbing) were awarded, project leaders, and BIM specialists spent four days attending a Virtual Design & Construction (VDC) workshop at Stanford University, presented by Martin Fischer and others in the Center for Integrated Facility Engineering. The workshop doubled as a team formation retreat and an introduction to VDC. They learned that BIM was part of VDC and that it is a powerful methodology for delivering the Lean goal of greater customer value. On the third day, people began to understand the definition of Virtual Design and Construction as "the use of multi-disciplinary performance models of building projects, including their products (facilities), organizations, and work processes for business objectives." Figure 4 illustrates how different models of the product (facility), the organization, and work processes can be brought together to increase understanding the ability to predict outcomes (Fischer et al., 2017, pp.178-180).

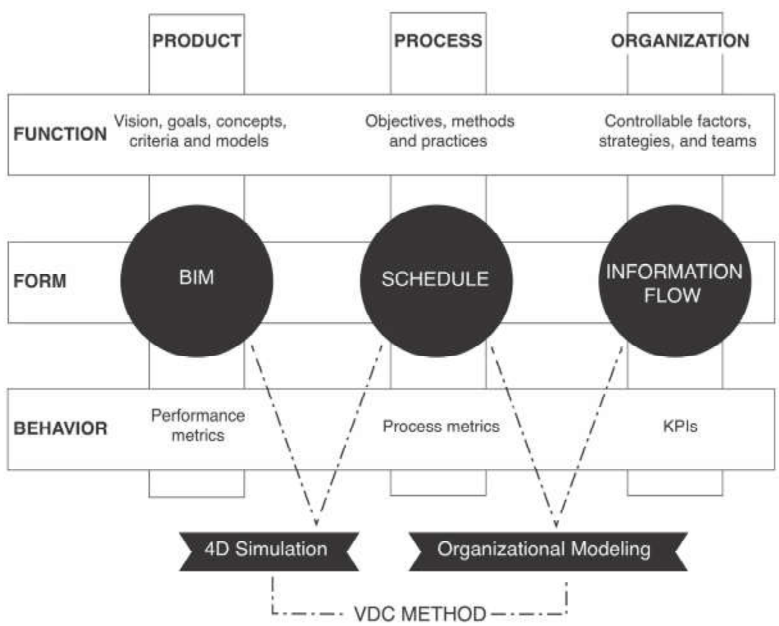

Figure 4: Modeling the Product, Organization and Process using Virtual Design & Construction.

Building the design virtually, piece by piece using BIM, was critical to meet the turn-over ("Staff and Stock") date. Design packages had to be delivered on a schedule negotiated with California's Office Statewide of Health Planning and Development

(OSHPD). This work coincided with an intense Target Value Design effort mostly focused on true Value Engineering to lower cost while maintaining functionality and durability. Teams and sub-teams for the three major buildings pull-planned their work from target dates they believed were achievable. They coordinated daily with project managers, architects and engineers working on the buildings to stay in sync.

6.2 Integrating Knowledge, Organization and Information

Leaders developed and drove the adoption of the process for documenting, analysing and deciding on value engineering proposals. Larger decisions, which impacted cost, schedule, or sustainability goals, were passed up to the cluster and senior leadership levels for approval using a process and template developed by UCSF Mission Bay Hospitals project leaders called Project Modifications and Innovations© (PMI).

First, the building team would discuss and vet the idea, gathering as much input as possible from all clusters that could be impacted, along with the facility operators, architects, and so forth. If a building or cluster lead signed on as a "Sponsor, "the PMI would then be passed up to the senior leadership level, where the change would be accepted or rejected. Figure x shows an overview of the PMI process.

One successful PMI centered on the tray system, which carries cables throughout the hospital. Standard cable trays were expensive, but one common alternative, J-hooks, seemed too unattractive and potentially disorganized to the UCSF Mission Bay Hospitals facilities representatives. A low-voltage designer working on the team suggested using common brackets, which would reduce cost and be easier to install, yet keep the cables and wiring organized. After requesting samples from the manufacturer, vetting the system with the facilities staff, and successfully completing the PMI©, the team determined that the cable tray substitute would be a perfect solution. The cable tray solution was implemented using an information-rich analysis created in an Integrated Concurrent Engineering ("ICE") session that included the responsible team members and representatives of affected stakeholders. Integrated Concurrent Engineering (ICE) is an element of VDC and these sessions were used on several other items to bring rapid closure to issues and opportunities. Figure 5 illustrates the accordion model of ICE depicting integrated sessions followed by breakout meetings over some period.

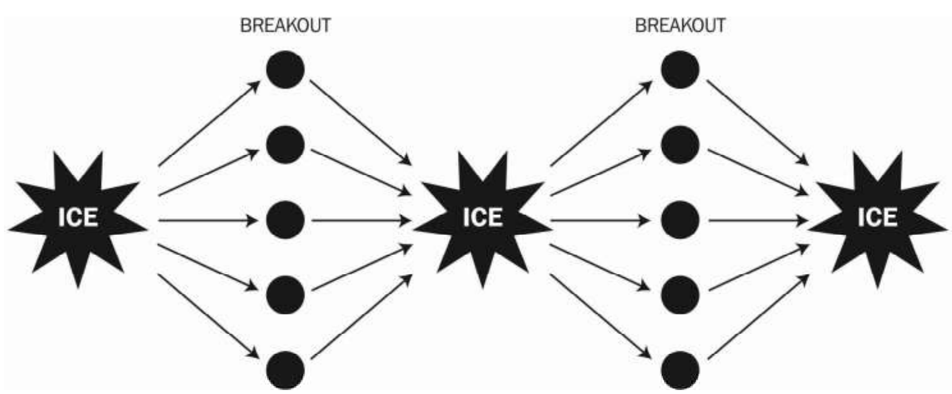

Figure 5: ICE Accordion Model.

ICE sessions were held to deal with other problems, such as inadequate ceiling space above caesarean section operating rooms and intensive care units. Three 4-hour sessions were held with leaders from every entity involved with the design and construction of the hospitals buildings. They found a solution, which as the roof garden would stay and the ceiling height would be maintained by resizing steel beams, rerouting above-ceiling HVAC and power, and shifting the location of the operating rooms (ORs) to a different area without sacrificing the clinical program. Every participant realized that they had saved months and significant dollars through their intense collaboration within the span of three weeks.

Team members reported each week on how they were performing relative to their latency metric: 80 percent of issues resolved in 30 minutes or less within teams, and 80 percent of all others resolved in four hours or less in the Big Room. Design cluster teams consistently tracked and reported progress towards reducing costs. These teams also tracked numbers of requests for information (RFIs), material submittals, and change requests and compared these against key performance indicators (KPIs) they had set. Performance relative to metrics was reported each week in the project executive meeting and charts posted on the Big Room wall for everyone to see, including the many visitors to the project.

A third-party estimator forecast a $200 million USD cost overrun. But using a Lean, integrated methodology, the team achieved the cost reductions required to proceed with building and achieved the full program without scope reductions. Fully modelled and coordinated design packages were submitted and permitted on schedule. And, the team met all but one of its performance targets for incentive compensation.

There were thousands of issues and questions on a project this large. Most of those were resolved by the parties working collaboratively in the Big Room and documented in a confirming RFI. However, if an issue had a schedule, cost, or design impact, or required additional outside consulting, the team would bring the issue into the Project Solutions Group© (PSG), an organizational mechanism developed by Stuart Eckblad together with UCSF Mission Bay Hospitals team leaders. Project leaders for the UCSF Medical Center, the construction manager, and the design and construction firms met daily except for Fridays in the PSG to address issues as quickly as possible. The goal was always to solve the problem.

Leaders wore several hats throughout the project. The GC and design team project managers led clusters and the three buildings' teams. Some of these people participated with others in the project captains and senior leadership team. Each building team leader stayed on during construction to manage that subproject and surface issues for the PSG. Construction teams, organized by floor, took over from the area BIM teams for each building.

During construction, the ICDC open office space doubled in size to accommodate the general contractor's staff, the architectural team for construction and Inspectors of Record. Slides showing quantities of work installed were added to the weekly progress update to the project owner, architect, contractor (OAC) meeting, printed as posters and displayed along a wall in the new area of the ICDC.

Senior leaders worked with the UCSF Medical Center counsel to redraft the UC standard contract, including general and special conditions and the scheduling specification, to incorporate Lean construction planning and scheduling practices. The new specification allowed for a high-level contract schedule supported by the Last Planner™ System methodology of phase schedules, short interval work plans, pull scheduling, and weekly commitments updated daily. This extended the integrated organization to work crews through daily huddles to coordinate work. (Fischer et al., 2017, pp.181-184)

7 Conclusions

The experience, work and outcomes of the UCSF Mission Bay Hospitals provide useful insights integrating project delivery, as follows.

1. Senior leaders face an imperative to integrate the building components and systems to achieve high performance.
2. In the face of this imperative, senior leaders of the project committed themselves to building a community and committed to create integration, as opposed to implement a set of methods and process.
3. Project leaders and team members learned and applied Virtual Design and Construction to produce deliverables using Lean methods.
4. Independent of the Simple Framework model, team members used all the enabler described in the model to create the essential building blocks required to deliver what they had promised.

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