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# What makes the delivery of a project integrated? a case study of Children's Hospital, Bellevue, WA

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## Abstract

**Question:** What makes the delivery of a project integrated?

**Purpose**: To investigate the components that make the delivery of a project integrated

**Method**: Participant observation and structured interviews

**Findings**: Five elements contribute to the integration of the project delivery: (1) contract type, IFOA (integrated form of agreement), (2) culture, (3) organization, (4) lean principles, and (5) building information modeling (BIM). These five elements are interrelated and enhance one another's effectiveness.

**Limitations**: Findings are based on a single project

**Implications**: (1) The antecedents of effective integration were the development of the team's orientation and culture as well as the processes of working together. The tools, such as lean and BIM, supported the integrated teamwork, but did not create the integrated team; (2) however, the contract, lean and BIM tools did reinforce the project team's integration and facilitated better results in terms of design and construction products.

**Value for practitioners**: The research tells practitioners how each components work with each other to make project integrated

**Keywords**: Integrated project delivery, lean construction, building information modeling, IFOA (integrated form of agreement), culture, organization

**Paper type**: Case study

## Introduction

The fragmented approach of construction procurement and the delivery of construction projects has affected project effectiveness in that they do not encourage integration, coordination and communication between project parties (Love et al 1998). Many suggest that to overcome the problems arising from this fragmentation the construction industry needs to move toward coordination of participants and more collaborative and integrated approaches

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to deliver more predictable results to clients (Egan 1998; 2002; Mitropoulos and Tatum 2000; Fairclough 2002; CMAA 2009).

Existing literature describes an integrated project team as "where different disciplines or organizations with different goals, needs and cultures merge into a single cohesive and mutually supporting unit with collaborative alignment of processes and cultures"(Baiden et al 2006, pp 14). The degree of achieved integration for delivering a construction project is subject to Contractual, Organizational, and Technological mechanisms (Mitropoulos and Tatum 2000). In previous research, we found that organizational cultures and the norms of organization on construction projects play important roles in how practices contribute to successful projects and that conflicting obligations of scope, company and project often impede successful inter-organizational collaboration (Dossick, Neff et al. 2009; Dossick and Neff 2010).

In this paper, we investigate further the components that make the delivery of a project integrated given the application of contractual, organizational and technological tools designed to foster team integration. In the case study analyzed here, three industry-driving forces, Integrated project delivery, lean construction and building information modeling (BIM), were adopted and used as tools for project integration. BIM is often discussed as a collaboration process as well as a set of software tools; however, since we explore the collaboration process more broadly and in terms of the IPD and lean practices, we focus the BIM discussion primarily on BIM tools and the use of these tools in the context of putting IPD and lean construction principles into practice.

## Case Description

Children's Hospital and Regional Medical Center (Children's Hospital), the owner of the project, initiated the first integrated project delivery in the northwestern area. The Children's Hospital project used a form of the integrated form of agreement (IFOA) to align risks and rewards to optimize project success ensuring implementing lean principles at the project level. Though the project was not a mega project in its size, all interviewees concurred that the project was complex, uncertain, and fast tracked: the physical site and building type were complex, the delivery method was new to stakeholders, and schedule and budget was tight. Initiated by the owner, there was a strong focus on implementing lean construction practices throughout the project, and particularly in the design phase. To that end, a lean specialist was hired to facilitate lean activities. Given the affordances of the IFOA contract, the project participants also tried to take advantage of Building Information Modeling technologies.

## Research Method

"In general, case studies are the preferred strategy when "how" or "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context." (Yin 1984, 1). A case study was selected as a research strategy in this study to investigate how the project team was integrated. Data collection included participant-observation and interviews of a single unique case where IPD, BIM and lean construction were all incorporated into the project process for the first time in Washington State.

Over a six-week period, the first author worked as an embedded participant in the preconstruction group of the general contractor on the Children's Hospital project. As a participant-observer, the first author worked closely with the integrated team as they developed the lean production plan. Through a participant-observation method, the authors were able to observe the observable details such as the attitude of the stakeholders (Dewalt et al 1998).The first author observed most of meetings including MEP coordination, management, target costing and meetings with potential subcontractors. Field notes and meeting minutes were recorded and used for this study. Consequently, he had access to both formal and informal discussions with project managers as well as architects, consultants and subcontractors.

To triangulate and verify the observational findings (Taylor et. al. 2011), the authors conducted a series of structured interviews with key stakeholders in the project including an owner representative (Seneca Group), an architect (NBBJ), a general contractor (Sellen), and a structural engineer (PCS Structural Solutions) in July and August 2010. The structured interview tool included questions regarding

- the attributes of the project,
- their role on the project,
- collaboration with others,
- how they used lean and BIM, and
- their characterization of the IPD processes.

Most questions were open-ended, and encouraged interviewees to provide their own perspectives. The findings reported in this report are a culmination of the first hand participant observation and the structured interviews with key stakeholders.

## Findings

Through participant observation that was verified with structured interviews, we found that five elements contribute to the integration of the project delivery:

- contract type, IFOA (integrated form of agreement),
- culture,
- organization,
- lean construction, and
- building information modeling (BIM).

Based on a comparison with other IPD projects (Cohen 2010[3]), it appears that integrated projects have some characteristics that address each of these five elements. In this case study, we have found that in addition to the presence of the five elements, these enhance one another's effectiveness such that the whole is greater than the sum of the parts.

In the following analysis, we first introduce each element, as it is understood from the literature, and then present how this element was articulated in the case study.

[3] The joint research led by American Institute of Architects reported that six (6) features define the integrated project delivery (IPD). They are early involvement of key participants, shared risk and reward, multi-party contract, collaborative decision-making and control, liability waivers among key participants, jointly developed project goals through case studies on six (6) completed IPD projects.

## Contract Type: The IFOA

Traditional project deliveries have contractual structure that sets up a conflict where project participants must look out for their own interests as well as those of the project. Moreover, they organize different project parties separately in a way that their diverse interests sometimes converge and sometimes oppose (CMAA 2009, Dossick & Neff 2010b). To avoid conflicts of interests in construction projects, project participants' interests and objectives need to be reconciled in the early stages of a project (Olander & Landin 2005). In other words, sub-goals of project participants should be aligned with the goals of the project in a way that all involved in the project have a sense of wining (Love et al 1998).

Historically, the construction industry has responded to these conflicts with a variety of project delivery systems, including design-build, construction manager at risk and agency-construction manager. Among them, design-build has some IPD principles in that constructors expertise can be leveraged in the design phase and project costs can be decreased and the quality can be improved compared to design-bid-build because of involvement of contractor in the design stage and close coordination of contractor and designer. However, there is a difference in design-build and IPD in that

- IPD uses a relational contract and
- specialty trades (subcontractors and suppliers) are contractually involved as a stakeholder in the design phase (as opposed to just "be invited" as a design-reviewer).

In the Children's Hospital project they used an IFOA (integrated form of agreement) to establish the framework for the IPD that included a shared pool of contingency. The IFOA with shared contingency has been known to change the mindset of project participants (Matthews & Howell 2005; Lichtig 2005; CMAA 2009, 2010), and in this case it did, as illustrated by the builder's reflection

*"… in my 30 years of history, I've seen lots of different ways to do this but, you know, this is the best way, I can do it for less money and you'll get better results, and maybe what you might spec and it will look the same. so it's all about trying to achieve the design intent that the architect has or design kind of vision that he has for the best value."*

The IFOA bound three parties — client/owner, designers, and constructor — into a single agreement that required them to share risks and rewards, and the project team had a statement of intent and guide to standard work on which all parties agreed. This encouraged everyone on the team to think of the project first as their commercial interests were contingent upon the overall success of the project. As one of the owner's representatives stated "Everyone's role changed… it wasn't really Seneca leading it, it was a team effort." Those we interviewed agreed about the team orientation. For example, the design architect described their approach to the project as not only as a designer, but as a stakeholder in the final product. A builder explained the impact this mindset had for Children's Hospital project:

*… on other jobs they [the designers] might listen and give you, you know, a smile and then they'd go off and they'd, you know, the structural engineer might work with the architect, so they'd go off and 'do you really want me to do what he says' – 'no, I want you to'… because of the hierarchy, because of who they work for, everything we say gets filtered down to them [the design consultants] to really*

*what gets accomplished … if the architect says well, 'I don't really, yeah, I listen and I heard but, you know, this is the way I want it done.' Versus having the team approach where everything is voiced and everybody kind of listened and the opinions are put on the table and the team makes the decision… we were all equals, and there was a level of trust that was established amongst everybody, and so we listened to all the players in this arrangement.*

Although the IFOA did not include the subcontractors on the project, the mechanical and electrical subcontractors were involved throughout the design phase and as one designer put it "good Ideas came from everywhere." Consequently, the integrated team incorporated the builder's expertise into the design and rallied around the design intent and program. This was illustrated by a late change in the budget. Right before the start of construction, due to the economic downturn, the owner had to reduce the budget by 10%. The integrated team had already been working hard to meet the existing budget, and now was being asked to make a big cut. All the interviewees remarked that this is when the teamwork really paid off. They were able to sit down with the integrated team and pull off the seemingly impossible: provide the owner's original program, keep intact the architect's design intent with a 10% reduction in construction costs. The builder commented that this would not have happened on a regular project.

It is interesting to note that in this case study, the architect shared the IFOA rewards and risks with their sub-consultants while the general contractor did not share the rewards and risks with the trade subcontractors. The architect used the IFOA agreement in its subcontracts with its sub-consultants in which risks and gains are shared. On the other hand, the general contractor used the traditional subcontract with its subcontractors. The general contractor, however, states now that if they were to do another IPD project with the IFOA agreement, they would definitely include their subcontractors in the arrangement to make them equal partners in the shared contingency and team effort. The owner representative pointed out that trade contractors tended to protect their bottom line without shared risks and reward pool:

*"what breaks down the process is regressing back to your traditional ways, right, and that's disruptful to the whole process and so as you have the electrical who is insistently asking for changes as the drawings shift, you know you're getting away from the key element of target value design… it's just disruptful to them, it's two different cultures going on, and so that the farther you can take that down through the subs, the better I think it would be for the overall process, the project."*

Consequently, organizational strategies, such as leadership, were needed to reinforce authentic collaboration on the project, particularly at the second and third tiers of project participants who were not in the IFOA.

They used a GMP (guaranteed maximum price) contract in the IFOA in which they had pools of contingency controlled collectively. By leveraging collectively controlled contingency pools and incentives, all members agreed that the risks and gains were properly shared with their interests aligned through the agreement. However, "once it got really close to dipping in to any part of the incentive, then it became like a normal change order discussion, you know, 'hey, you know, this is an unrealistic expectation and interpretation by the City; this shouldn't be in the [shared contingency]'." A shared contingency appears to have helped align the project participants and create a team-oriented culture, but there were still work to be done in terms of continual realignment and negotiation throughout the project.

## Culture: Orientation to the Project and the Team

Construction Industry Institute (1997) defines alignment as the process of incorporating all of distinct priorities and requirements of project participants into a uniform set of project objectives that meet the business needs of the facility. In the interviews, we found that the cultural alignment significantly contributed to the effectiveness of the integrated team in this case study. They achieved strategic alignment (goals, objectives and activities) as one interviewee states the "contractor and the architect are the, you know, had their eyes on the carrot, and it changed their, you know, the way that they were reacting." They also achieved cultural alignment (values, practices and behaviors): "the drawings might not be done but I talked with the architect, we came around to the same page, this is the kind of quality, this is the business enterprise we're going to deliver to you for this much money." Organizational alignment, as this model suggests, occurs when strategic goals and cultural values are mutually supportive (Construction Industry Institute 1997).

A large part of the alignment strategy on the Children's Hospital project was in the selection of project participants. The architect indicated that the culture of the owner, the general contractor, and the architecture was already aligned in that the three organizations have adopted innovative practices in their own fields. For example, the owner has implemented its own version of lean or Toyota Production System on their operations side for some time. Prior to the Children's Hospital project, and the architect had adopted the lean principles in their design processes with experiences in integrated project delivery on a variety of projects in California. In this case study, they were all looking to be transformative and innovative in the way the project was delivered. This innovation required planning in it's own right. Early on in the project, the owner, lean consultant, and architect convened a special meeting to discuss what 'lean" meant for this particular project, as they all were approaching the project with various flavors of lean and IPD. Once a shared understanding between owner, lean consultant and architect was created, they created a snowball selection process. As additional project participants were selected, these new participants then helped in the selection of others on the project. This had a dual effect of creating a strong team through collaborative selection, as well as brought companies and individuals on who were aligned with each other as well as with the project's goals and culture.

This was a unique project delivery process where many of the project participants were not familiar with IPD and the cultural goals it implies, the leadership of the teams needed to reinforce the orientation to the project and the culture of participation over and over throughout the process. The team leadership needed to resist and continually counter "regressing to old ways". Team leaders encouraged the project participants to participate even when it was outside of their scope by saying "you need to get out of your silo." One project participant reported that the integrated team's mantra "are we making the project better?" helped to refocus the team around the project. Our interviewees confirmed that once the team achieved this culture, it was maintainable throughout the design phase and into the early phases of construction where design decisions were still being made.

## Organization of the Integrated Team

The organization of the integrated team pivots on two issues. First, more pragmatically, who is in the room? The second issue is one of culture, as introduced in the previous section, and deals with the process of minimizing the at times conflicting obligations of project, scope and company; promoting individual participation; and mutual collaboration. As with any organizational change, the legacy of work processes, traditions, and cultures frame both the initial adoption and subsequent adaptation of technology and work practice.

One of the most powerful organizational strategies is collocation. Other IPD case studies have become known for their Big Room collocation (Mikati, 2007; Ballard and Rybkowski 2009; Ballard et al. 2009), where project participants conducted their day-to-day work in the same space. Collocation allows for informal communication that crosses the formal divisions of project organizational hierarchies and builds a sense of teamwork, where owners, designers, detailers and builders are working side by side for a specific duration. Brainstorming for problem solving and design solution generation can support organizational memory, provide skill variety for designers, create an inquisitive, knowledge-based environment, and reward technical skill (Sutton and Hargadon 1996). However, collaboration is inherently inefficient and messy and the team leaders have to work hard to create a collaborative space, culture and team that achieves the benefits of collaboration while maintaining forward progress(Dossick and Neff 2010).

In the Children's Hospital case, the team used a hybrid approach where individual team members did a bulk of their scope-specific work in their owner offices but attended weekly day-long group working sessions. This hybrid suited the project for a couple of reasons. This was a relatively small project that for many consultants and contractors was not a full time commitment. Additionally, the project participant's offices were all in a 2-mile area, and it was easy for them to meet on an as-needed basis. The design was an interactive and iterative process – starting with user's needs and requirements, then designers collecting, reflecting and proposing design alternatives, builders working through means, methods and costs and finally iterating back again to user's needs. The owners, users, designers and builders conducted a complex dialog throughout the design and construction process. To facilitate meaningful dialog, a common vocabulary and project-specific culture had to be cultivated. As a general contractor stated

> *"what we've found is that part of the IPD is to bring subs in early, and bring them onboard when they can impact the design. And I think we all like to have people ask us for their help and how can you bring your expertise to the table, so they, once they go the gist of it and understood their role and not all, I mean it was an education process, just like for us it was an education for them because some of, and we had to remind a couple of people that hey, this is different, … we hired you for your systems and your expertise on what's best for this job, so come prepared and show us, and we can talk about whether it meets design intent or how we can tweak stuff but be proactive."*

As the industry explores collaboration strategies, questions remain as to when to bring different project participants together? What are the roles of designers and builders? How do we foster buy in from second and third tier sub-consultants and subcontractors? Some have observed that if a culture of mutual respect is cultivated on a project, where the project participant's expertise is used in the decision-making, individuals feel compelled to act in the best interest of the project. However, if they become disenfranchised from the decision-making and confined to their scope of work, they become increasingly protective of their own scope and their own time — the things over which they have control (Dossick, Neff et al. 2009).

The goal of the IFOA members (owner, architect and general contractor) on this case was to cultivate a culture of participation. To do that, they challenged the team to work in a different way—closely and iteratively with project stakeholders:

> *Well, everyone's role was different because Children's took the initiative of establishing a design core team, so this included doctors, nurses, some of their strategic planning people, they had someone from Supply Management there, IT, we had a medical equipment planner there, the architect, the contractor and then we had the clinical engineering there. So we tried to get a good sampling of who would be using the building or who would be developing the building or who would be designing the building… the sessions would last for a week, and they started from really abstract, really down to micro… so we'd really try to get as much information as we could out of them for the week, so [the operations consultant], the architect, the contractor, Seneca, we'd all sit in a room and we'd just set kind of the agenda for the week, and it would be a really intense agenda. … We talked about adjacencies, key adjacencies, and then we went into macro design, where we'd actually set up false walls and stuff like that and actually develop the whole building out of false walls or big chunks of the building to validate key adjacencies, room sizes, operations procedures…*

This team was seeking to establish Mutual Collaboration (Maher, Cicognan et al. 1998), where users, designers and builders alike participated in the design discussions. This has been found to be a powerful organizational strategy for AEC projects; in a study of 26 teams by Taylor (2007) he found that when relationships bridge the intersection of design and construction companies the teams found more novel solutions to project problems from which both parties benefit. This was the experience of the project participants on the Children's Hospital project as well. As one consultant put it "I think we made a better building because of the collaboration with builders."

## Lean Construction: The Operating System

As indicated, the contractual agreement enforces the project team to implement lean construction. In this project, some of lean construction principles were applied with all stakeholders. The project team used

- target costing,
- set-based design, and
- the last planer system (LPS):

### Target Costing

Target costing in the construction industry is a practice of constraining design and construction of a capital facility to a maximum cost. It is an appropriate practice for all clients with financial constraints (maximum available funds or minimum ROI requirements) that a capital facility project must meet in order to be considered successful by that client.

On the Children's Hospital project, the owner required the practice of target costing, which was designated as "target value design" in the IFOA, which was developed specifically to facilitate lean project delivery. When the project requirements and design philosophy had been developed, the general contractor and trade contractors prepared for review by the owner's staff, a preliminary cost model utilizing area, volume or similar conceptual estimating techniques. This preliminary cost model included all of the major building systems with the quantity and unit cost of each component presented. This cost model became the basis of the target value design initiatives.

The general contractor worked with trade contractors to show real-time target cost models. In regular target costing meetings, each subcontractor presented how the numbers were derived including all of the assumptions. Assumptions and inquiries were discussed and resolved on spot. Since target costing requires collective efforts of stakeholders, collaborative organization and culture helped target costing successfully implemented throughout the design phase.

## Set-Based Design

It is not a tool but a principle that governs the process of cross-functional collaborative design process. The principle of 'set-based engineering' connotes Toyota's application of a least commitment strategy in its product development projects (Ward et al. 1995, Sobek et al. 1999). That strategy could not be more at odds with current architectural design practice, which seeks to rapidly narrow alternatives to a single point solution, but at the risk of enormous rework and wasted effort. Whether or not one has the time to carry alternatives forward, would seem to be a function of understanding when decisions must be made lest we lose the opportunity to select a given alternative. Choosing to carry forward multiple alternatives gives more time for analysis and thus can contribute to better design decisions. On the Children's Hospital project, the team used a "decision matrix" that described the set of alternative systems. In each decision matrix, many different aspects including life cycle costs and sustainability issues of each alternative were addressed. Many aspects in a design matrix require an expertise and knowledge in processes and products where specialty contractors (i.e., subcontractors) usually got. In this regard, the set-based design leveraged the early involvement of downstream stakeholders (i.e., specialty contractors and suppliers)

While set-based design practice reduced the "wasted" cycle of "redesign" and engineering, the practice showed the challenges as well. The architect mentioned that there was a challenge in choosing the last responsible moments. The structural engineer expressed concern about working multiple solutions; "Someone needs to make a decision at some point." Usually, the construction team needs to specify the last responsible moments taking into account reasonable lead time and installation date. Sometimes, it was observed that some design uncertainties still remained at the last responsible moment. For a consultant who is accustomed to working through a single design, set-design requires a doubling or tripling of design effort and this extra effort needs to be balanced with the risk of "redesign".

## The Last Planner System (LPS)

The project team held two workshops on the Last Planner System where front-line managers and project managers of all stakeholders including subcontractors participated. In workshops, they learned the method of the Last Planner System including pull-phase scheduling and constraint analysis. The LPS was applied not only in construction but also in design phase. The focus in design phase was placed on identifying the constraints, communication, and updating the schedule instead of identifying the reasons for failure and calculating the PPC (percent plan completion) (Ballard 2000).

In construction phase, the project team developed pull-driven phase schedule, from which the detailed look-ahead planning and constraints were driven. In a pull-driven schedule meeting, every trade contractor as well as a general contractor participated in developing schedule activities discussing the constraints thereof. Throughout those collaborative planning process, the work-flow is shaped. In everyday LPS meeting, the daily work plans including the updated status of constraints are developed. Additionally, they identified the reasons for failures and PPC every week as a learning process in construction phase.

We observed that the LPS contributed to the project team integrated in two ways. First, the LPS intends to improve workflow reliability (Ballard 2000). Improving reliability leads to nurturing relationships with project participants. Building relationships comes from trusting each other. Trust comes from reliability, from being trustworthy, not from commitment or contract. In line with that, the LPS contributed to developing "trust" between stakeholders. Second, every stakeholder is participated in the LPS and the LPS let each stakeholder plan its own work through negotiating with other stakeholders. It is different from the way the general contractor stipulates what should be done.

## Building Information Modeling Technologies

In industry and academia alike, discussions about Building Information Modeling (BIM) often include arguments for collaboration across organizational boundaries (CURT 2004; American Institute of Architects 2006; Eastman, Teicholz et al. 2008; Smith and Tardif 2009). For this discussion, we separate the concepts of BIM as a collaboration process and BIM as a set of software tools. Above we have explored the collaboration process in terms of the IPD and Lean practices. Consequently, as we discuss BIM in this context we focus primarily on BIM tools and the use of these tools in the context of putting IPD and Lean principles into practice.

Internationally, architects, engineers, fabricators and builders are using BIM tools to document, identify, exchange, calculate, analyze, and see. These new computer tools ease the process of communicating and exchanging technical specifics such as geometry, reference points, material type, and quantities between different project participants (Ku, Pollalis et al. 2008). The predominant discussion in the professional as well as academic literatures is the technical collaboration—the creation, exchange, and management of data (Ku, Pollalis et al. 2008; Smith and Tardif 2009); the creation of naming conventions; shared geometries and scales; and software interoperability (Taylor 2007). This focus is understandable because BIM tools excel at "documentation" and the exchange of this documentation. BIM is often used for problem solving or understanding and defining the problem space and BIM is currently most widely adopted for MEP coordination for precisely this reason.

By their own admission, the Children's Hospital team did not push the envelope in terms of BIM usage, but they did "leverage BIM a great deal". In general the project participants felt that one "could do IPD without BIM, but it would be difficult, BIM helps a lot." IPD did seem to impact the ways the team exchanged models. As one consultant put it "IPD allowed us to trade models with more confidence. "

The use of BIM on the Children's Hospital project echo's the authors' observations that BIM adoption is trending towards a loose coupling of scope-specific models throughout the design and construction phase of a project. As it was implemented on Children's hospital, individual scope models were shared across company boundaries. These individual scope models were consolidated together in various combinations to develop other project information (e.g. the structural engineer referenced the architects model during design development), or to review how the different scopes intersect with one another (e.g. MEP coordination work). In other instances, the individual scope model was used alone. For example, the structural engineer shared his concrete model with the general contractor, where the concrete foreman used the model to visualize the complex formwork in areas of curved and sloping slabs, curbs and edge details. However, because of the integrated team approach, when it came time to commit to construction costs, using the model data, there were less risks in the budget going into construction. Here the general contractor: "So at the end of the CD's, we had basically an 80% complete, we coordinated mechanical model, fabrication model, and … a couple of benefits for that was that when the subcontractor had to finalize his GMP pricing, he said he's never been in a better position. So he knew how many pounds of sheet metal, he knew the routings, he knew the complexity."

When asked about working with BIM, the team members of talk about visualization. The team would project models on a large screen during the meeting. As one designer put it, "you can quickly see what others are doing." This aligns with the findings of Taylor (2008), who found that through the co-creation of BIM models "disparate" design and construction firms "more clearly articulate their knowledge of constructability issues." One of the Children's Hospital project participants described the process of using the models in the working meetings as facilitating more iteration between "design" and "means and methods" during design development. The environment was characterized as a learning environment. The collaboration and iteration resulted in an expansion of all project participants' awareness of other disciplines.

## Discussion

Researchers found that five interrelated elements contributed to the integration of the Children's Hospital project delivery:

- the relational contract,
- the culture of participation,
- the organization around group working sessions,
- the application of key lean principles, and
- building information modeling (BIM).

These elements are commonly found in other IDP projects as well (Cohen 2010). Additionally, we have found that these five elements support and reinforce one another. For example, IFOA coupled with cultural alignment resulted in an effective integrated team organization. With cultural alignment the integrated team then leveraged lean and BIM more effectively compared with other projects the interviewees have worked on. We found that BIM facilitated and improved the lean implementation including set-based design in which stakeholders shared and communicated with models. Consequently, we can make two claims based on this case study.

*The antecedents of effective integration were the development of the team's orientation and culture as well as the processes of working together. The tools, such as BIM, supported the integrated teamwork, but did not create the integrated team*

Researchers have found that when digital tools are introduced to help coordination, teams may be more satisfied with results, but "considerable mutual adjustment" is often required to make technology adoption successful in inter-organizational collaborations (Orlikowski 2000; Liston, Fischer et al. 2007; Taylor 2007). In the Children's Hospital project, much effort was put into the design and management of the "considerable mutual adjustment as the continual efforts to create a project focus and an integrated team.

*the IFOA, Lean and BIM tools did reinforce the project team's integration and facilitated better results in terms of design and construction products.*

Lean and BIM were proven tools in the industry to improve project performances, and in this case study they worked in harmony with culture and organization toward the integrated project delivery. All of the interviewees mentioned that the use of the tools were often more effective in the integrated approach. They also felt that the use of these tools in an integrated team resulted in a better final product in that the expertise and perspectives of various team members were voiced and incorporated into the design and construction. The team was able to focus on making the best decisions for the project's goals.

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