THESIS

INVOLVEMENT OF ELECTRICAL CONTRACTORS IN INTEGRATED PROJECT DELIVERY (IPD)

Submitted by

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ABSTRACT

INVOLVEMENT OF ELECTRICAL CONTRACTORS IN INTEGRATED PROJECT DELIVERY (IPD)

IPD is believed to be one of the most prominent movements in addressing the inefficiencies inherent in the Architecture Engineering and Construction Industry. However, there is some reluctance in pursing this system, especially by specialized contractors such as electrical contractors. Therefore, the primary goals of this research were to identify issues and risks for ECs to pursue IPD, and provide recommendations to address those issues and risks. The researcher first sought to gain a better understanding of the ECs point of view, and how it could affect their ability to pursue, and ultimately complete IPD projects successfully. This was largely accomplished by conducting interviews with thirteen ECs—six who had experience with IPD and seven who did not have experience with IPD.

Overall, the majority of issues/risks expressed by both sets of interviewees were limited to characteristics of the IPD process itself, or the performance of the other team members. Most of the non-experienced ECs wanted prior favorable knowledge of the other IPD team members as a condition for them to participate in an IPD project. However, these same ECs did not possess the favorable qualities they set as a prerequisite for other team members. Therefore, the recommendations to address their issues/risks involve methods to "prepare" the ECs to be successful with IPD. The experienced ECs also expressed issues with BIM and IPD Agreements, which have been addressed in Chapter 5. This report concludes by offering suggestions for future research. These consist of issues/risks the ECs expressed which were outside the scope of this study.

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Chapter 1: Introduction

Historically, the Architecture, Engineering, and Construction (AEC) industry has been the most inefficient "non-farm" industry in the U.S. Between 1964 and 2003, the industry's productivity decreased by 20%, while the productivity of all other "non-farm" industries increased by 125%. In more recent years, the economic downturn has exacerbated this situation by forcing AEC companies to cut costs by 35%, as shown in Figure 1(LePatner, 2007). This reduction in productivity and overall spending takes away from the AEC industry's profits, forcing them to pursue higher yielding, riskier investments. In this environment, only the strongest companies survive, while those that cannot absorb a risky investment gone wrong are forced out of business. To recover quickly, the AEC industry will need to be open to change and new opportunities.

The AEC industry has recognized this need for innovation in macro-level project management techniques and processes. In 2009, the Financial Management Institute (FMI) and the Construction Management Association of America (CMAA) surveyed nearly 200 of the world's owners from all industry sectors. When asked to define the greatest improvement potential for the AEC industry, the most popular response was "Greater team coordination through process, accelerated with technology" (18%), followed by "Cost control and management" (6%), and "Sustainability in design, construction and operations" (5%) (CMAA, 2010). Integrated Project Delivery (IPD), as will be explained in the next section, has the potential to achieve all three of these identified improvement opportunities, overcoming the inefficiencies inherent in today's construction industry.

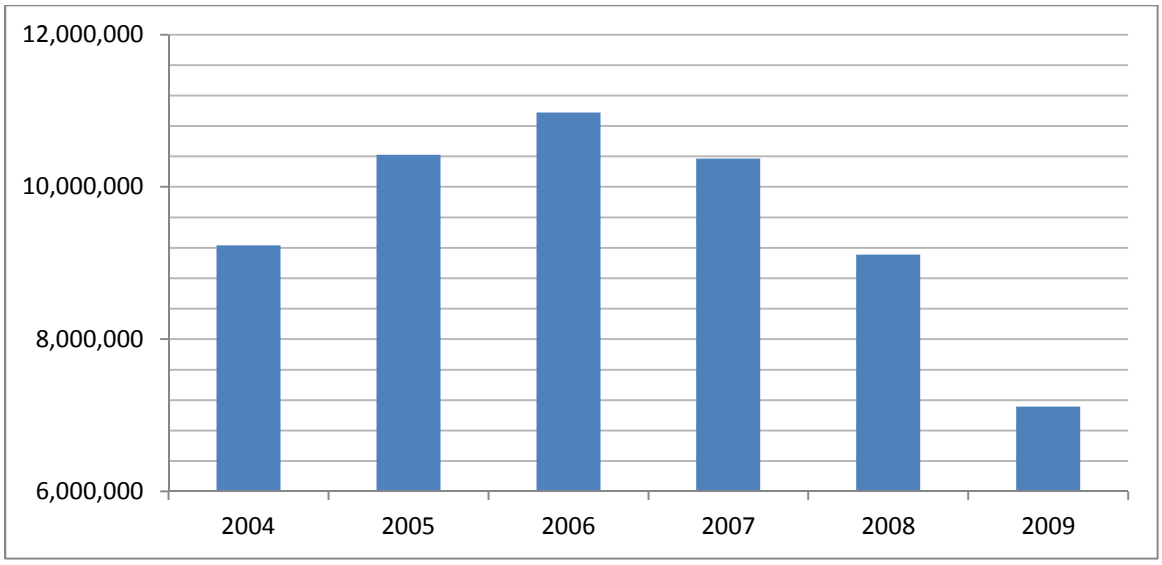

Figure 1: Private Construction Spending-Seasonally Adjusted in Millions of Dollars (Census, 2011)

1.1: Brief Background on IPD

A project delivery system (PDS) characterizes construction processes based on the position, and responsibilities of project team members and/or stakeholders. Since the beginning in the 20th century, design-bid-build has been considered the standard benchmark. However, collaboration between project stakeholders eventually began to decrease, resulting in ineffective designs, inflated costs, and an overall adversarial relationship (Sanvido & Konchar, 1998).

Starting in the 1970s, the construction manager emerged, whose role was to streamline the construction process by advising the design team on constructability, project scheduling, etc. In the 1980s, alternative project delivery methods were developed to further increase project efficiency such as construction management at risk and design-build which is more prominent in the AEC industry (Sanvido & Konchar, 1998).

Today, 55% of owners describe their primary delivery system as "Most like design-bid-build." However, in recent years, design-build has been gaining momentum in the AEC industry. For large projects, 18% of owners described their approach to construction delivery as "Most like design-build" while 24% said they have a "blended approach" (FMI & CMAA, 2010).

IPD is the "next generation" of project delivery systems, building off of design-bid-build and design-build by seeking to improve upon their core concepts. For this reason, the discussion presented herein will only include design-bid-build, IPD and design-build, although other project delivery systems do exist. IPD emphasizes increased stakeholder collaboration, increased project efficiency, and improved design quality. However, IPD places the highest importance on complete and comprehensive collaboration with all stakeholders, especially in the design phase. IPD's other characteristics take a more aggressive approach than other delivery methods in order to achieve these goals more effectively, as will be discussed in Chapter 2.

Increased collaboration requires a higher upfront cost from stakeholders who would normally not be involved until later in the process. IPD offers incentives for this early involvement in the form of reward payments based on the extra value a company brings to the project; these incentives are to be paid at the time of project closeout. IPD stakeholders are also bound together contractually through a multi-party agreement and/or single purpose entity. This creates a situation where the financial success of an individual stakeholder is dependent on the financial success of the project as a whole—a fundamental difference from any other project delivery method (AIA, 2007b). In practice, "pure" IPD projects have been limited to large/complex projects (e.g. medical & higher education facilities) but have proven to be largely successful in terms of cost, time and quality(AIA, 2010).

1.1.1: IPD Concerns

IPD is a new project delivery system, which has only been utilized in a relatively small number of projects (Maisel, Porter, Zoccola, & Glavinich, 2010). In comparison to traditional project delivery systems, the legalities of IPD's principles and processes such as multi-party contractual arrangements, shared risk/reward incentives, and buyout processes have not been adequately researched (Ozbek & Youssef, 2010). The industry has also identified issues involving the increased risk of multi-party contracts and/or limited liability corporations (Glavinich, 2010).

1.1.2: IPD & Building Information Modeling

The AEC industry lacks technological innovation because it spends less on information technology and employs fewer engineers and scientists than any other sector (LePatner, 2007). Due to its collaborative nature, IPD is aptly suited to utilize cutting-edge technology such as BIM. Various software programs utilize BIM technology to create dynamic 3-D models which contain all the information necessary to take a project from conceptualization to construction, and eventually operation and maintenance. It also enables complete collaboration among project stakeholders, because they can add new information to the model and share it in real time. Overall, it is estimated that BIM has the potential to save the AEC industry over $200 billion per year in costs (Holness, 2008).

Owners and AEC professionals that are interested in sustainable design also have the potential to benefit from BIM. For example, project information can be linked to Leadership in Energy and Environmental Design (LEED) specifications. The financial return for projects that utilize LEED have the potential to be seven to ten times the initial investment (Gleeson, 2005).

1.2: The Electrical Contracting Industry

Electrical Contractors (ECs) specialize in the design, installation, and maintenance of electrical and communication systems. They can also be categorized by the type of work they perform (outside, inside, etc.), the type of employees they hire (union or nonunion), and whether they assume the role of a general contractor or sub-contractor (NECA, 2010).

1.2.1: Economics

72% of ECs have less than 10 employees and earn less than $1 million per year, controlling a relatively small portion of the market. As shown in Table 2, about 8% of companies have more than 100 employees, most of which have annual revenues exceeding $25 million (Kelly, 2010).

For new construction, ECs earn more of their revenue from commercial, industrial and institutional (CII) projects than from residential or nonbuilding projects. Companies with fewer

than 10 employees perform much more residential work, whereas larger companies perform more CII and nonbuilding projects. However, this market share can fluctuate depending on the size of the company. On average, maintenance, service and repair activities account for a slightly larger percentage of revenue (38%) than new construction (34%). As shown in Table 1 Modernization/retrofit work accounts for an average of 28% of ECs revenue (Kelly, 2010).

Table 1: Average Work Revenue from Types of Work Performed (Kelly, 2010)

	Total		1-9 Employees		10+ Employees	
	2010	2008	2010	2008	2010	2008
New Construction	34	<42%	29%	<38%	47%	52%
Modernization/Retrofit	28	27%	29%	27%	25%	27%
Maintenance/Service/Repair	38>	31%	42%>	35%	28%	22%

Similar to the rest of the AEC industry, ECs have felt the impact of the recent economic downturn. A 2010 study by Electrical Contractor Magazine estimated that 40% of companies had to lay off employees in the prior 18 month period. The report went on to say that compared to 2008, a significantly higher percentage of ECs reported that their annual revenues were less than $250,000. Fewer ECs also reported having annual revenues between $1 million and $10 million (Kelly, 2010).

1.3: ECs and IPD

Electrical contractors may also experience significant losses in productivity, which may be the result of shortcomings in traditional project delivery systems. Some of the causes include jobsite congestion, out-of-sequence work, lack of information, change orders, and performing work while a facility is in operation. Productivity losses ranging from 25-40% are common for ECs to incur on a typical project, and can be difficult to recover from owners and/or contractors (Thomas & Oloufa, 2001).

ECs have the potential to address these issues by taking advantage of IPD's collaborative processes. Currently, over 80% of ECs report that they already have a "medium" or "high" ability

to influence the overall design created by owners and/or the design team. Furthermore, research has shown that within the last 5 years, ECs have made an effort to be involved earlier in design collaboration (Kelly, 2010).

1.4: Problem Statement

For traditional project delivery systems (design/bid/build, design/build, and CM at risk), there is a large amount of research that has studied risk allocation, advantages and disadvantages of each system for a given situation, and areas of conflict and concern. Being a new project delivery system, IPD has not been researched in this manner to determine these factors (Ozbek & Youssef, 2010). Furthermore, very little of the existing research on IPD focuses on specialty contractors such as ECs.

However, the preliminary findings of this study have shown that ECs could be more likely to resist participation in IPD projects, since they are normally involved with a project for a short period of time and have a limited scope of work (Ozbek & Youssef, 2010). This reluctance can cause major deficiencies in the IPD system, as integrating all project participants is one of the key attributes that will make IPD successful for a given project.

ECs who are not willing to pursue IPD would also be ignoring the trend that is inherent within the rest of the construction industry, e.g. the transition towards using IPD, and obtaining the potential benefits from the efficiencies attained from utilizing this delivery system. The delivery method can also allow companies to expand their services to the pre-construction phase of a project.

Lastly, smaller ECs may not have the ability to pursue the large/complex projects characteristic of IPD, given their limited resources, manpower, and bonding capacity. (AIA, 2010). Therefore, these small ECs may be at a disadvantage due to their limited resources, manpower, bonding capacity, etc. when considering participation in IPD projects (Kelly, 2010).

1.5: Research Objectives

This research seeks to achieve the following objectives:

1. Gain a better understanding of the point of view retained by ECs, and how it will affect their willingness to participate, and ability to be successful in IPD projects.

This understanding was generated from literature reviews, IPD case studies, interviews, and interacting with ECs during networking events such as the National Electrical Contractors Association (NECA) Annual Conference.

2. Identify issues and risks for electrical contractors to participate in projects using IPD.

These possible issues/risks include IPD's legal aspects, issues with BIM implementation, and exact parts or phases of the IPD process thought to be risky.

3. Provide recommendations to the EC industry to address the identified issues and risks.

Once these issues and risks are identified and addressed, the EC industry is likely to be more willing to pursue IPD. ECs will be more willing to expand their services to the pre-construction stage of the project, and therefore be able to participate in projects that utilize IPD. In this manner, they will be able to follow the trend that is inherent within the rest of the AEC industry.

1.6: Scope of Research

The scope of this research is limited with respect to the following two aspects:

1) While this research provides recommendations to address IPD related issues/risks for ECs, those recommendations will not propose changes to the IPD process itself, as will be defined in the Literature Review chapter.

2) Detailed statistics such as a financial cost/benefit analysis with respect to IPD is beyond the scope of this research.

1.7: Limitation

While every effort was made to recruit as many management level professionals in the EC industry as possible for the interviews as discussed in Chapter 3, a large sample representing a

wide cross-section of the EC industry was not attained. While this is acknowledged as a limitation of this study, it is believed that the findings of this study can still be useful for the EC industry and can serve as a basis for future research.

1.8: Thesis Organization

Chapter 1: Introduction: The purpose of this chapter is to first explain why this research is relevant at this point in time. A brief background of the topics in this study, as well as a problem statement, specific research objectives, and scope and the limitation of this research have also been provided.

Chapter 2: Literature Review: This chapter gives a thorough overview of all relevant information the researcher has reviewed in the course of this study. This includes a general overview of traditional project delivery systems (including advantages and disadvantages), a synopsis of the principles and processes of IPD (including advantages and disadvantages), a discussion of the electrical contracting industry, and relevant IPD case studies.

Chapter 3: Methodology

The purpose of the previous sections was to introduce the relevance, purpose, and objectives of the research, as well as a background of topics discussed. Chapter 3 marks the starting point for new information exclusive to this study. This includes the means and methods used to complete the research, in order to ensure the validity of the results and conclusions.

Chapter 4: Results and Analysis

Chapter four will first give a demographic overview of the interviewees, and then report the results of their responses.

Chapter 5: Conclusions

This chapter will conclude the research process by drawing inferences related to the issues and risks of IPD expressed by ECs, the researcher's recommendations to address these issues/ risks, and future research recommendations.

Chapter 2: Literature Review

2.1: Introduction

Organizations such as the American Institute of Architects (AIA) and Design Build Institute of America (DBIA) are supporting the use of integrated project delivery systems. IPD has been identified as one of the most prominent movements in addressing the inefficiencies inherent in the construction industry (Evey, 2009).

Although only a relatively small number of projects have been constructed using an IPD model, owners, architects, and general contractors have reported success in terms of cost, time, and quality (Yoders, 2008). However, specialized contractors seem to be reluctant to utilize this system (Ozbek & Youssef, 2010). The purpose of this literature review is to build a detailed understanding of IPD and how ECs fit into this new project delivery model.

2.2: Overview of Traditional Project Delivery Systems

Project delivery systems (PDS) characterize construction processes based on the position, and responsibilities of project team members and/or stakeholders (Konchar, 1997). In essence, a PDS defines how stakeholders collaborate with one another in order to move a project from the concept phase, to a completed facility (Jergeas & Fahmy, 2006).

The first PDS consisted of one individual who would design, engineer, and construct a project, known as a master builder. In the U.S, master builders first began to organize early in the 18th century, forming organizations such as the Carpenters Company in Philadelphia (Yates & Battersby, 2003). Due to the growing complexity of projects, master builders were replaced by professionals who specialized in specific building systems around the turn of the 20th century. This scenario formed the traditional design-bid-build (DBB) project delivery system (Sanvido & Konchar, 1998).

Eventually, collaboration between these project stakeholders began to decrease, resulting in ineffective designs, inflated costs, and increasing adversarial relationships. Starting in the

1970s, the construction manager emerged, whose role was to streamline the construction process by advising the design team on constructability, scheduling, etc. In the 1980s, alternative delivery methods such as construction management at risk and design-build were developed, as will be discussed in the following two sections (Sanvido & Konchar, 1998).

2.2.1: Design-Bid-Build

With this traditional method, the owner first forms a contractual relationship with the design team, who is responsible for producing all of the design documents. Next, the owner solicits bids from contractors to construct the facility according to the plans and specifications. Normally, the owner will choose the "lowest responsible bidder" and then issues a notice to proceed to begin the project (Konchar, 1997).

By sheer numbers, DBB is the most widely used project delivery system in the U.S. today. 55% of owners describe their primary delivery system as "most like design-bid-build," whereas 24 % said they took a "blended approach" between DBB and design-build (FMI & CMAA, 2010).

2.2.2: CM Agency and CM at Risk

Around 1950, the construction industry welcomed professionals who specialized in managing increasingly complex projects, otherwise known as General Contractors (GCs). In the private sector, owners largely selected GCs based on management skills and negotiated cost-reimbursable contracts with a guaranteed maximum price (GMP). However, most state laws required the public sector to award projects based on competitive bidding. To obtain benefits comparable to those in the private sector, public owners hired construction managers as professionals (CM as agent), and took competitive bids for multiple trade contracts held by the owner. However, many owners were uncomfortable with multiple contracts and no price guarantee for an entire project. They examined the private sector's use of negotiated GMP contracts and convinced lawmakers to allow alternative project delivery systems that would give them equal opportunities (Chuck Thomsen & Sanders, 2011).

The result was CM-at-Risk, similar to the private sector approach to a negotiated contract. It permits an owner to choose a CM based on qualifications, make the CM a member of a collaborative project team, and obtain a bonded guaranteed maximum price. CM-at-Risk is currently gaining momentum in the public-sector, replacing projects traditionally built under design-bid-build (Chuck Thomsen & Sanders, 2011).

2.2.3: Design-Build

Design-build is the closest form of project delivery system to IPD. With this model, the owner has a single contract with the design build team who is responsible for both the design and construction of the project. Team selection can be based on a number of factors such as qualifications, best value, or low price. The team may then subcontract portions of the work to other trades; however those trades will have no contractual relationship with the owner. Some owners see this as an advantage because there is a single point of responsibility if the project is not built according to the contract documents. They also have the flexibility to contribute as much or as little as they see fit during the construction phase (Jergeas & Fahmy, 2006).

Design-build has also gained popularity in recent years. In 2009, a comprehensive survey of owners found that 18 % of owners describe their project delivery approach as "most like design-build." For "large" projects, this number increased to 21 % (FMI & CMAA, 2010).

2.2.4: Project Alliancing

Project Alliancing was first developed by British Petroleum (BP) in the early 1990s, in hopes of developing a more cost-efficient way to tap oil reserves in the North Sea. Given the success of this endeavor, BP decided to implement the delivery system in many subsequent projects. Similar to IPD, Project Alliancing has core principles which are essential to the success of its projects (Sakal, 2005):

- Financial risks are shared between project stakeholders, as an alternative to the risk allocation methods of traditional contracts.

- Stakeholders receive payments through a "3-limb compensation model" where Limb 1 fees are guaranteed and Limb 2 fees are the maximum amount that the participant can lose for project cost overruns:
    - Limb 1: direct project costs/overhead
    - Limb 2: organizations' overhead and profit
    - Limb 3: prearranged shared risk/reward agreement, dependent final cost.
- Project is overseen by a "Project Alliance Board" where decision making must be unanimous.
- Project management team comprised of individuals who are able to make decisions that are in the best interest of the project.
- All disagreements and conflict are handled within the "Alliance Organization". Litigation is only used as a last resort.

Despite the success of BP's projects, the energy industry did not embrace the new Project Alliancing method. Companies seemed to want more manageable lump-sum contracts with more profit potential, and didn't need the top management attention required by Alliancing. Owners also questioned the benefits of collaborative delivery, and felt it increased their financial risk. Furthermore, investors looked more highly upon fixed-priced projects. (Chuck Thomsen & Sanders, 2011).

However, Alliancing did transition to public infrastructure projects in Australia. One of the most notable projects was the National Museum of Australia, where the team delivered a high-quality project ahead of schedule and within budget (Chuck Thomsen & Sanders, 2011).

2.2.5: Design Assist

Design-Assist is similar to design-build in that trade contractors (such as ECs) are involved early in the design process to provide value engineering and field detailing expertise. Generally, the in-house engineering group will then review the design to ensure it adheres to good

design practice, applicable codes, and any special requirements. The in-house engineering group would also ensure all load calculations are correct prior to final review by other stakeholders. This process allows for a smother communication of design alternatives and gives the owner the benefit of multiple engineering viewpoints (Lane, 2006).

2.3: Inefficiencies in Today's Construction Industry

As stated in Chapter 1, AEC companies are the most inefficient of any other non-farm industry. For example, research has shown that the construction industry is 10 % value-added and 57 %, compared to the manufacturing industry which is 66 % value-added and 26 % waste (Holness, 2008). In other words, 57 % of the activities the AEC industry performs use resources (labor, time, construction materials, etc.), but add no value to the final project (Gustafsson & Marzec, 2007).

This industry has also underperformed in terms of productivity. Between 1964 and 2003, the AEC industry's productivity decreased by 20 %, when all other non-farm productivity increased by 125 % (LePatner, 2007). This decreasing productivity takes away from profits, forcing companies to pursue higher yielding investments which are riskier. Many companies simply cannot absorb the loss in a risky investment gone wrong, and are forced out of business. The declining economy in recent years has also amplified this situation. As discussed in Chapter 1, from 2006-2009, private construction spending decreased by 35 %, and is expected to experience a similar decline in 2010 (Census, 2011).

This may be attributed to the fact that current project delivery methods utilize the "lowest responsible bidder" method. The result is a situation where contractors and sub-contractors are more likely to submit a bid which will produce a low profit margin, hoping they can make up for it during the construction process, otherwise known as underbidding. In order to meet their minimum return on investment (ROI), they may resort to using lower quality materials, paying lower wages, filing claims to the owner, or suggesting change orders (Simpson & Polich, 2010).

This scenario can cause time delays, reduced quality, cost-overruns, and an adversarial relationship between project stakeholders. Owners try to avoid this problem by "short listing" preferable companies and then picking the lowest bidder from that pool, hoping to foster better relationships and increase project quality. However, these short listed companies are still competing against each other for the job, and are therefore still likely to underbid.

2.4: Defining IPD

Currently the subject of much research and debate, IPD is the next generation of progressive project delivery system, and is fundamentally different from traditional methods such as design-bid-build. In many ways, IPD takes concepts such as partnering and design-build to the next level by creating an environment where trust and teamwork prevent disputes and foster a cooperative bond for the benefit of the project (Fisk & Reynolds, 2010).

Like design-build and CM at Risk, IPD seeks to improve project efficiency through increased collaboration, but places more importance on complete and comprehensive collaboration with all stakeholders, especially in the design phase. Its contractual principles also take a more aggressive approach than other delivery methods, in order to enhance efficiency, and create a higher quality project (AIA, 2007a).

IPD is not the first collaborative delivery model utilized in the AEC industry; however it modifies the relationship amongst project stakeholders in areas such as profit sharing, liability, and dispute resolution. The definition of IPD is also somewhat unclear to many individuals in the AEC industry, given that the means and methods for drafting agreements, and the roles and responsibilities of project stakeholders are still being established (Hatem, Jr., & Frownfelter, 2011).

Since its concepts are new, project stakeholders are prone to modify an IPD approach on a project-by-project basis (Chuck Thomsen & Sanders, 2011). As stakeholders adapt IPD principles to address project-specific issues and concerns, the definition of IPD will continue to evolve. The American Institute of Architects (AIA) is on the forefront of this research, and has

developed two distinct categories of principles that define an IPD project; contractual and behavioral. These principles are listed in Table 2 and will be discussed in the subsequent two sections.

Table 2: Principles of IPD (AIA, 2011).

Behavioral Principles: IPD and CD	**Contractual Principles: IPD**
• Mutual Respect and Trust • Willingness to Collaborate • Open Communication	• Key Participants Bound Together as Equals • Shared Financial Risk/Reward Based on Project Outcome • Liability Waivers between Key Participants • Fiscal Transparency between Key Participants • Early Involvement of Key Participants • Jointly Developed Project Target Criteria • Collaborative Decision Making

Currently, there are very few "pure" IPD projects which utilize all of the contractual and behavioral principles identified in Table 2. Research has shown that the majority of stakeholders pursuing IPD have modified contracts to eliminate certain aspects of liability and/or shared risk/reward incentives (AIA, 2011).

In addition to a stand-alone delivery model, the term IPD has also been used to describe a set of techniques used to enhance an existing delivery model (Maisel, et al., 2010). To simplify this discussion, the former will be referred to as "IPD," and the latter will be referred to as Collaborative Delivery (CD) (AIA, 2011). However, to be effective, CD principles must be used with a compatible delivery model such as CM at risk or design-build (Maisel, et al., 2010). This is because these delivery models have the greatest potential to be enhanced by CD principles, since they rely on increased stakeholder collaboration (AIA, 2007a).

2.4.1: Behavioral Principles

Mutual Respect and Trust

With IPD, all stakeholders must understand the value of collaboration, and be committed to working as a team in the best interest of the project. The roles of team members are defined based on who is best suited to complete the job.(AIA, 2007b).

Willingness to Collaborate

The project stakeholders rely on increased collaboration throughout a project's full delivery cycle, especially in the design phase. This allows the knowledge and expertise of all participants to be reflected in the design, construction and fabrication process. (AIA, 2007b).

Open Communication

Project stakeholders must focus on team performance, and the overarching goal of creating the best project possible in order to benefit from the rewards and incentives of IPD. This is fundamentally different from traditional delivery methods where rewards and incentives are largely based on the performance of each individual organization. To transition to IPD, organizational communication skills such as conflict prevention are necessary in order to satisfy the conditions necessary for organizational change (Richmond & McCroskey, 2009).

2.4.2: Contractual Principles

Key Participants Bound Together as Equals

At the start of an IPD project, the owner and primary stakeholders must agree on a legal structure. The team must decide what form of legal entity maximizes collaboration, and will work for the specifics of the project and the constraints of the owner (Charles Thomsen, 2008). The four most common types of legal relationships are as follows:

1. Multiple Independent Contracts

In this arrangement, the owner holds separate contracts with project stakeholders. Unless limitations or transfers of liability are included in the agreement, each company is liable for their own portion of the work as well as related contractual risks. Stakeholders may also be bound to clauses which require dispute resolution measures, limiting their ability to pursue legal action against each other (Charles Thomsen, 2008).

2. Single Multi-Party Contract

Multi-party contracts define the duties of each party to one another; and require the owner to pay each party individually. This is unlike traditional contracts, which only define responsibilities to the owner. Payment terms can be lump-sum or cost-plus-fee, with a target price or GMP. With a multi-party contract, it is possible to define and stipulate the responsibilities and liabilities of each party within the context of an integrated team (Thomsen, 2008). Legal research has also shown that a multiparty agreement is the ideal legal relationship for IPD, due to the fact that it is simple, consistent, and is utilized more than any other agreement. Furthermore, negotiating a multiparty agreement allows stakeholders to have a more comprehensive understanding of each other's needs and interests (Ashcraft, 2011).

3. Joint Venture

With a joint venture, companies can combine their resources for a specific project. This arrangement produces two contracts: The joint venture has a contract with the owner that spells out its duties and responsibilities, and the members of the joint venture have an agreement among themselves that spells out their individual duties and responsibilities to the joint venture (Charles Thomsen, 2008).

"Joint and several" clauses are also common in joint ventures, which hold each stakeholder responsible to the owner for the entire project. If one stakeholder defaults, the remaining stakeholders must cover their responsibilities. For this reason, joint ventures are seldom used for IPD or design-build (Charles Thomsen, 2008).

4. Limited Liability Companies

Stakeholders can also form a Limited Liability Company (LLC) to complete a project. Ownership of the LLC could then be distributed based on criteria such as level of effort or cost of services provided. The team would agree to divide the work and subcontract it amongst themselves (Charles Thomsen, 2008).

Shared Risk/Reward Incentives Based on Project Outcome

Early collaboration of key stakeholders will produce a higher quality project, but also requires a higher upfront cost from all stakeholders. Therefore, IPD offers incentives for this early involvement in the form payments awarded at final build-out based on the extra value a company brings to the project (AIA, 2007b). Usually, a technique called "shared risk/reward" is used where project stakeholders put up a predetermined contingency prior to the project start date. If there are cost under runs, the stakeholder will be reimbursed the contingency, and receive a bonus based on a percentage of profit predetermined by the original contract (See Figure 2). However, if there are cost overruns, the stakeholder will only be liable for their original contingency (Darrington, Dunne, Lichtig, & al, 2008). Shared risk/reward incentives also align the interests of all project stakeholders, providing a monetary incentive for collaboration (Jackson, 2011).

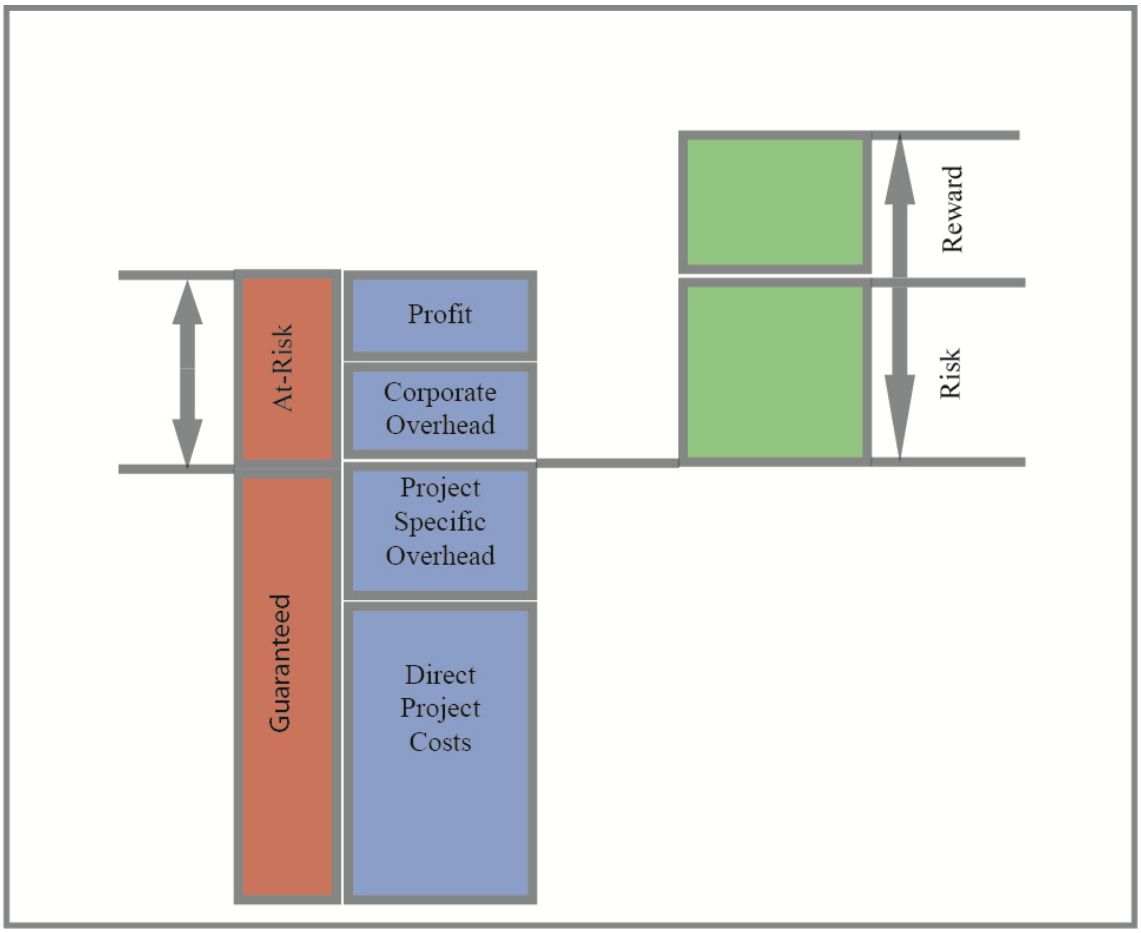

Figure 2: Graphical Representation of Shared Risk/Reward Incentives (Jackson, 2011)

Liability Waivers between Key Participants

Liability waivers in IPD agreements reinforce the principle of free information exchange without fear of liability to other team members. Stakeholders typically agree to waive claims against one another that are the result of performance issues, with the exception of willful default. Furthermore, IPD agreements typically dictate that all stakeholders are jointly liable to third parties (Ciotti & Pasakarnis, 2011).

Fiscal Transparency between key Participants

This contractual principle requires stakeholders to have an "open book environment" where financial information is shared. With fiscal transparency, stakeholders have knowledge of the other parties' contingency payments, particularly shared risk/reward contingencies. This

creates greater trust amongst the IPD team, leading to more effective collaboration (AIA, NASFA, COAA, & AGC, 2010).

Early Involvement of Key Participants

Starting from project conception, the owner collaborates with key stakeholders to create goals. Input from each participant is valued on a team that promotes and drives innovation and outstanding performance; however the overarching goal is always to create the best project possible (AIA, 2007a).

IPD has the potential to attain a higher quality final product for a significantly lower price, due to increased effort in the planning phase. All project stakeholders (owners, architects, engineers, contractors, fabricators, etc.) are able to work design issues and inconsistencies out on paper, rather than in the field where changes are much more costly (AIA, 2007a).

Jointly Developed Project Target Criteria

Project stakeholders must collaborate to develop and agree upon the goals of the project. An AIA document outlining IPD case studies has shown that teams who fail to do this at the beginning of a project experience many difficulties later on. For example, the MERCY Master Plan Facility Remodel Team developed the following six goals early in project development (AIA, 2011):

1. Cost
2. Schedule
3. Quality
4. Workforce Diversity
5. Sustainability
6. Team Responsiveness to Implementation

From this list, a scorecard was created to quantify the level of achievement, which was given to all project stakeholders to reiterate the goals and metrics for which they would be held accountable (AIA, 2011).

Collaborative Decision Making

Similar to the behavioral principal of "willingness to collaborate," collaborative decision making emphasizes early involvement of stakeholders, particularly in the design phase. To reap the full benefits of this collaboration, the language of IPD agreements should reflect relational and behavioral expectations. For example, San Francisco's Cathedral Hill Hospital project in San Francisco required stakeholders to "work together in the spirit of cooperation, collaboration, and mutual respect for the benefit of the project" (AIA, 2011).

Collaboration usually comes in the form of weekly meetings where the entire IPD team is present. If an issue is too urgent to wait for this meeting, stakeholders may also hold conference calls or submit formal written inquiries to integrated team members, allowing quick decisions to be made. In either case, the goal of collaborative decision making is for the project to benefit from the knowledge and expertise of all IPD stakeholders (AIA, 2011).

2.4.3: Project Stakeholders

An IPD project normally begins when the owner selects a group of potential key stakeholders including the AE, CM, key subcontractors, and any other applicable organizations. The owner will then invite companies to present their qualifications, and then short-list a smaller group who will be invited to a "final selection" interview. During this final interview process, the candidates present their thoughts on the best way to go about completing the project. For example, the candidates might be asked to evaluate certain aspects of the program and preliminary plans. The owner uses this discussion as a tool to evaluate a firm's ability to collaborate in innovative processes. Frequently, once a core member is selected, they also become involved in selecting subsequent members (Chuck Thomsen & Sanders, 2011). For a summary of

the various stakeholders on an IPD project, and their roles under traditional delivery systems, see Table 3.

2.4.4: IPD Phases

The American Institute of Architect's "Guide to Integrated Project Delivery" provides a detailed synopsis of IPD phases. The following is a summary of these project phases, emphasizing the potential role of the EC in each phase. It should also be noted that these phases are only meant to be utilized in conjunction with the AIA C191 or AIA C195 Agreements (Bridgett, 2010):

1. Conceptualization

The project begins when the owner decides what is going to get built and who is going to build it. He/she also decides how project proposals will be evaluated with respect to current and future operations. Design consultants select major building systems and identify unique conditions that need to be addressed in the next phase as the systems are being detailed (AIA, 2007a).

2. Criteria Design

Designs for major building systems such as basic structural components and HVAC systems are developed. Agreements are also made between trades regarding tolerances and prefabrication (prefab) items. The various participants in the project team are also continuously updating their deliverables as the design becomes more detailed and more information becomes available (AIA, 2007a).

Table 3: IPD Stakeholders and their Traditional Roles (AIA, 2007a)

IPD Role	Traditional Project Delivery Role
Owner	Same as traditional project delivery method
Integrated Project Coordinator	Not part of traditional project delivery method. Responsible for overall facilitation, coordination, organization and direction of integrated team.
Prime Designer	Architect
Design Consultants	Mechanical engineers, electrical engineers, etc.
Prime constructor	General contractor and fabricators
Trade contractors	Sub-contractors such as mechanical and electrical
Agencies	Same as traditional delivery method. Includes various local, county, and state government agencies

3. Detailed Design

The detailed design phase finishes answering the question of "what" the project is going to be. By the end of this phase, all of the engineering, designs, drawings, and specifications will be complete, and the team will be ready to move toward implementation (AIA, 2007a).

4. Implementation Documents

Now the team transitions from what is being created, to documenting how it will be implemented. In this phase, the prime constructor finalizes the construction means and methods and produces the cost and schedule for the teams review. Project specifications are finalized and shop drawings are produced so that the team can move toward production. With IPD, this phase is considerably shorter than traditional project delivery methods because of the increased effort in previous phases (AIA, 2007a).

5. Agency Review

This phase is almost identical to traditional project delivery methods. Depending on the scope of the project, many government agencies could be involved in reviewing a project for code compliance, and to insure all government regulations are being met. Ideally, these organizations would utilize BIM to review and analyze the project (AIA, 2007a).

6. Buyout

Buyout is the process of obtaining price commitments for all work packages in a project; however IPD is unique in that most of these commitments are developed through a continuous team effort, starting from project inception. Therefore, this phase should be limited to obtaining price commitments from sub-contractors and suppliers who were not involved in this process (AIA, 2007a).

7. Construction

The construction phase is the same as in any other project delivery system, except it is shorter and more streamlined. Construction administration efforts are reduced because submittals for key scopes of work have already been integrated into the BIM model and conflicts have been resolved virtually. There is also more prefab, resulting in a project which is built faster and requires less onsite labor (AIA, 2007a).

8. Closeout

Owner verifies that the project has been completed according to the contract documents, and then issues a certificate of completion. Outstanding shared risk/reward payments and warranty issues are also handled at this time (AIA, 2007a).

2.5: Negotiating IPD Agreements

Negotiating an IPD agreement is one of the most important events on an IPD project, because it is the team's first collaborative endeavor. The results of this experience will also have a profound effect on the project as it unfolds. To succeed in this process, stakeholders need to

focus on identifying the intersections of stakeholder interests, rather than every detail of the contract language (Ashcraft, 2011).

Ideally, this process begins by defining the outcomes that stakeholders want to achieve, by focusing on the processes and behaviors required to achieve those outcomes. Next, structures needed to support the desired processes and behaviors are developed. These can include tools such as BIM and lean construction techniques as will be discussed in Sections 2.9-2.10. By addressing the outcomes desired by all stakeholders prior to drafting the agreement, the contract structure will be closely aligned with the project objectives (Ashcraft, 2011).

2.6: Potentially Optimum Insurance Arrangements for IPD

The collaborative "team" approach of IPD suggests that disputes are not forced into litigation. Even still, the AEC industry still has questions regarding contract terms, risk allocation, and insurance to cover these items (Ferreira, 2011).

Wrap-Up Liability Insurance has the potential to work well with an IPD model, given that a single package covers all stakeholders on a given project. If the owner purchases the policy, it is referred to as an Owner Controlled Insurance Program (OCIP). In turn, if the contractor purchases the policy, it is known as a Contractor Controlled Insurance Program (CCIP) (Abdulaziz, 2009).

OCIPs utilize a "bid deduct" process, where contractors and subcontractors are asked to submit bid proposals that include insurance costs. Once the contracts are awarded, the insurance costs are simply deducted out of the bid prices. This process is facilitated by an agent of the owner known as the "OCIP Administrator." This individual provides a document known as the "OCIP Manual," which provides all the terms and conditions of the insurance package, and the bid deduct process (Hallinan, 2009).

For CCIPs, the construction manager procures the wrap-up insurance program. This may present an advantage over OCIPs since the construction manager is in a better position than the owner to control the contracting process and potentially obtain greater savings (Hallinan, 2009)

2.6.1: Advantages

One of the most significant advantages of OCIPs and CCIPs is the potential for cost savings. It has been estimated that this method can save anywhere between 0.5%-2% of the total project cost. This type of insurance also offers higher limits for "umbrella" coverage and allows stakeholders to be contracted through a single carrier, which simplifies the claims resolution process. These insurance arrangements may also give contractors the opportunity to participate in a wider variety of projects (Hallinan, 2009).

2.6.2: Disadvantages

The two greatest disadvantages of OCIPs and CCIPs are possible gaps in coverage, and deductions that exceed the actual insurance cost savings. Additionally, uncompensated administrative costs also have the potential to outweigh cost savings inherent in OCIPs and CCIPs (Hallinan, 2009).

2.7: Potential Risks & Rewards of IPD

2.7.1: Potential Issues/Risks

IPD can potentially increase risks for all project stakeholders. Under traditional project delivery methods, stakeholders such as GCs and their subcontractors have a limited scope of work and may only be working on a project for a short period of time. IPD requires a higher upfront cost for these stakeholders in the form of engineering input in the design phase and shared risk/reward contingencies. Ideally, these upfront costs will be recovered in the closeout phase, along with an additional bonus for a project that exceeds the predefined criteria. However, if the project underperforms in terms of these criteria, the upfront costs would not be recouped, and no bonus would be awarded. Furthermore, the success of individual stakeholders is dependent on the

success of the entire IPD team, so there is the potential for one underperforming stakeholder to decrease gainsharing bonuses.

Although IPD has only been utilized on a relatively small number of specialized projects, they have largely proven to be successful for all stakeholders. However, its legalities have not been tested in court under "worst case scenario" conditions. If one party underperforms or does not fulfill their contract obligations, there is a potential for claims and disputes to arise. (Post & Jr., 2010).

Because of the multi-party arrangements and increased collaboration between stakeholders, transitioning to IPD will also require companies to make structural changes to their chain of command, work functions, and spans of control (Shockley-Zalabak, 2009). This will be significant for smaller contractors who are not accustomed to collaborating with multiple entities.

2.7.2: Potential Rewards

IPD allows all project stakeholders to contribute their expertise early in the design process. Increased planning with the constructor in the pre-construction phase also results in a better understanding of constructability issues, sequencing, and pricing estimates (AIA, 2007a).

If fully implemented, IPD can also significantly increase project efficiency. It is estimated that an experienced integrated team can reduce project costs by 30 % (AIA, 2007a). The ability for the team to communicate early in the design process is of great value to the owner because they can more easily choose project options based on their goals. In turn, the project team can have a better understanding of these goals and desired outcomes, increasing the chances that they are implemented (AIA, 2007a).

2.8: BIM and Project Management Information Systems

As previously mentioned, approximately 57 % of construction industry spending is considered non value-added waste, equivalent to approximately $600 billion in 2008 dollars. This adversely affects the cost, schedule, quality and productivity of construction projects. This

situation could be the result of the industry's lack of technological innovation, causing inoperability and inefficient information exchange (Zuppa, et al., 2009).

BIM has the potential to overcome this lack of technological innovation and increase project efficiency. A survey of over 200 AEC professionals in the U.S found that the majority of respondents believe BIM can improve productivity, scheduling, cost, and quality of construction projects (Zuppa, et al., 2009) (see Figure 3). This has the potential to save the AEC industry over $200 billion per year in excess costs (Holness, 2008).

BIM utilizes cutting-edge modeling software to create dynamic 3-D models which contain all the information necessary to carry a project from conceptualization all the way to operation and maintenance. In addition to a 3D building model, this technology integrates with scheduling software (4D) and estimating/ budget programs (5D) (Holness, 2008). BIM also provides data to owners which can be useful for space planning, energy performance, and remodeling (AIA, 2007a).

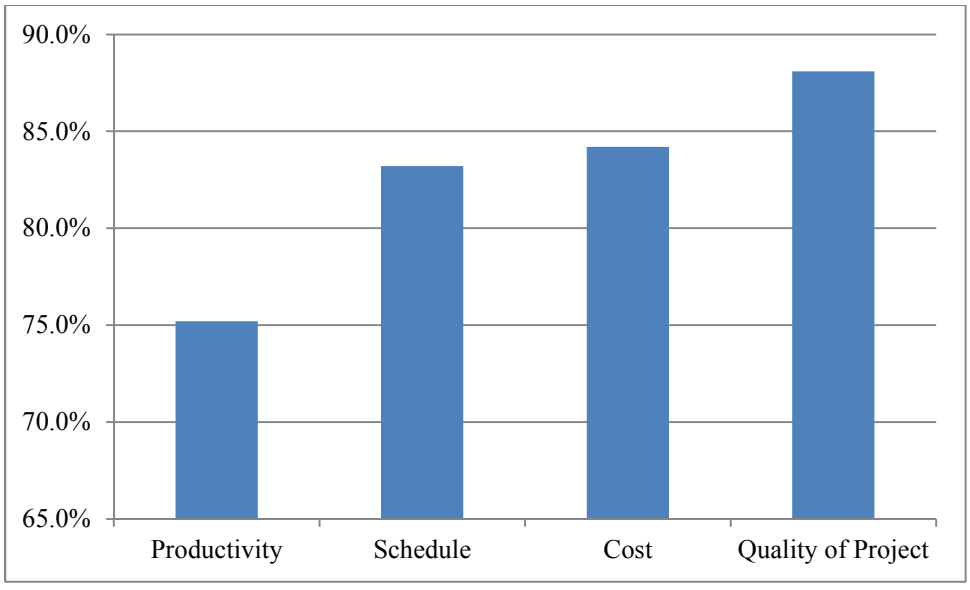

Figure 3: Percentage of Respondents that believe BIM has the Potential to Improve Productivity (Zuppa, et al., 2009).

A project management information system (PMIS) is similar to BIM in that it is an internet-based centralized database developed and utilized by the project team. However, rather than

contributing to the product (the final 3-D model), a PMIS assists the project team in the process of completing a collaborative project. The specific components of a PMIS are as follows (Chuck Thomsen & Sanders, 2011):

- Defines the Project in Terms of:
    - Cost
    - Time
    - Quality
- Defines the team
    - People
    - Organizations
    - Their roles
- Agreement Management
    - Contracts
    - Permits
    - Approvals/commitments
- Document Management
    - Capable of producing standard and custom reports

IPD places an emphasis on cutting-edge technology such as BIM and PMIS with the goal of achieving maximum collaboration. A PMIS helps to achieve this goal by allowing the entire project team to have a common understanding of all project data. Errors are also more likely to be found and corrected, since a large number of stakeholders have the ability to examine the data and make corrections as necessary (Chuck Thomsen & Sanders, 2011).

BIM is also ideally suited for IPD because it allows building information to flow much more easily between project stakeholders. In turn, this increase in information flow allows the team to make more knowledgeable decision throughout the project development process. Also, by

creating the BIM model prior to construction in the field, decisions can be made without delays during construction, where they can be much more costly (Chuck Thomsen & Sanders, 2011). Furthermore, the use of BIM is already on the rise, even when used in conjunction with traditional project delivery systems. A 2007 study found that BIM was utilized by 20 % of designers in the AEC industry, and projected 80 % use within five years and 100 % within 10 years (Holness, 2008).

2.9: Lean Construction

Companies that pursue IPD also seem to focus on facilitating continuous process improvement with techniques such as lean construction. The goals of lean construction can best be characterized as reducing or eliminating waste, adding value, and streamlining workflow. The next three sections will discuss techniques that seek to implement these goals (Chuck Thomsen & Sanders, 2011):

2.9.1: Continuous Improvement

Continuous improvement is based on the concept of "program management." In this process, stakeholders examine multiple projects to find common characteristics. Ideally, this information is then used to improve the cost, schedule, and quality of future projects in the program. The idea is to look at a "program" of projects on a macro level instead of individual projects on the micro level whenever possible (Chuck Thomsen & Sanders, 2011).

The continuous improvement comes from rotating these similarities from the project workflow to the program. In this manner, the organization does not have to "Reinvent the wheel" on every new project (Chuck Thomsen & Sanders, 2011).

2.9.2: The Last Planner System

Created by the Lean Construction Institute, the Last Planner System seeks to address the construction industry's need to reduce delays as much as possible, so a project can be completed on time. Specifically, the technique seeks to reduce these delays by increasing the predictability

of construction processes. To increase predictability, The Last Planner System gives more responsibility and control to workers that are more directly involved with on-site construction. Ideally, these workers will aid in the process of continuous improvement, having direct lines of communication to management to provide valuable feedback. The concept is also based on the fact that the Last Planner can keep the most dependable short-term obligations (Chuck Thomsen & Sanders, 2011).

2.9.3: Target Value Design

With this method, key stakeholders create a cost model using a predetermined system specifically designed for the project, which is beyond the scope of this discussion. Prior to design, the various systems of the project are analyzed with the in the context of bringing the best value to the owner through constructability and value engineering. This results in the team devising an "expected cost," and then a, more aggressive target cost as a "stretch" to facilitate innovation. Similar to IPDs shared risk/reward, the project team can be awarded incentives for achieving the "stretch" target (Chuck Thomsen & Sanders, 2011).

2.10: The Electrical Contracting Industry

ECs specialize in the design, installation, and maintenance of electrical and communication systems. They can also be categorized by the type of work they perform, the type of employees they hire (union or nonunion), and whether they assume the role of a general contractor or sub-contractor (NECA, 2010).

"Outside" or line contractors are responsible for high-voltage power transmission distribution lines. They ensure that electricity generated at power plants is safely carried through high-voltage lines and substations before it is used to power a building (NECA, 2010). "Inside" contractors are involved with providing electricity to residential, commercial, or industrial buildings. They can also serve as prime contractors for all electrical and cabling design, installation, and maintenance (NECA, 2010).

"Integrated building systems" or "voice/data/video" electrical contractors are involved with low-voltage applications, such as back-up power, climate controls, wireless networks, energy efficient lighting, telecommunications, fiber optics and security systems. Their primary responsibility is to integrate these systems to achieve optimal energy efficiency and performance (NECA, 2010).

However, it should be noted that ECs may not necessarily be limited to these distinctions. Contractors may specialize in all aspects of electrical work for commercial projects. In recent years, these large ECs have also begun to take advantage of stimulus funding for alternative energy projects. These projects largely consist of small scale rooftop photovoltaic installations, or utility-scale installations.

2.10.1: Market Share

ECs earn more of their revenue from commercial, industrial and institutional projects, rather than residential or nonbuilding projects. However, this market share can fluctuate depending on the size of the company (Kelly, 2010).

2.10.2: Labor Inefficiencies

Significant losses in productivity may also be experienced by ECs, which may be the result of shortcomings in traditional project delivery systems. Some of the causes include jobsite congestion, out-of-sequence work, lack of information, change orders, and performing work while a facility is in operation. For a typical project, it is not unusual for electrical contractors to experience productivity losses in the range of 25-40 %. The monetary losses resulting from this decreased productivity are often difficult to recover from owners or contractors (Thomas & Oloufa, 2001).

2.10.3: Involvement in Design-Build

ECs have participated in the growth of design-build in the AEC industry. About half of ECs total revenue comes from design-build, and for firms with over 100 employees, it is well over 80 % (Maisel, et al., 2010). Past research has also shown that 75 % of ECs believe design-

build provides a greater chance of success compared to the traditional design-bid-build system (Sanvido, Mace, & Konchar, 2000).

In 2000, the Electrical Contracting Foundation published a two-part research report involving design-build in the electrical contracting industry. "Success Factors for Electrical Contractors on Design-Build Projects" analyzed the impacts of the design-build project delivery system on electrical contractors. The goal was to gain a better understanding of the benefits and risks involved in design-build, which was a more progressive delivery system at the time of publication (Sanvido, et al., 2000). The second report entitled "Design-Build Methods for the Electrical Contracting Industry" explored the factors ECs would have to consider before pursuing a design-build project. These included selecting the owner, specific skills and knowledge, internal organizational structure, and contractual and risk management issues (Rowings, et al., 2000).

The abovementioned study surveyed electrical contracting companies of varying sizes and specializations who had experience working on design-build projects. Overall, the respondents reported financial success with the delivery system. 77 % of the respondents acknowledged a higher profit margin for design-build work compared to traditional methods, with 5 % seeing a lower margin, and 18 % seeing no difference (Rowings, et al., 2000). The ECs also identified specific benefits of utilizing design-build (Sanvido, et al., 2000):

- Option to utilize local materials
- More consistency in product development
- Shared team knowledge created more value for client
- Less change orders
- Better communication with all members of the project team
- Ability to provide the owner with more effective solutions in terms of cost

2.10.3.1 Characteristics of Successful Design-Build Contractors and Projects

The ECs designated a large number of potential contacts for new job opportunities. Construction companies and owners/users/developers seemed to be the best source for potential job opportunities, as show in Figure 4. However, many considerations must be made before a contractor considers entering into design-build contractual arrangement. ECs must look for a firm with good quality workmanship, but they also need to look at the type of arrangement, prior experience, company compatibility, as well as other factors. Respondents rated a number of statements relative to their importance on a scale from one to five. The scale breakdown and response average are listed in Table 4 (Rowings, et al., 2000).

The responding contractors also described company characteristics that were successful at drawing clients. There was no isolated characteristic the ECs felt the owners sought out, however several attributes were found to be favorable, as shown in Figure 5 (Rowings, et al., 2000).

Past experience with a given project type was also identified as a critical factor for success on a design-build project. All of the respondents who reported successful projects had extensive experience with the given project type. ECs who were brought onto the team with less than 10 % of the design complete also reported a great deal of success (Sanvido, et al., 2000).

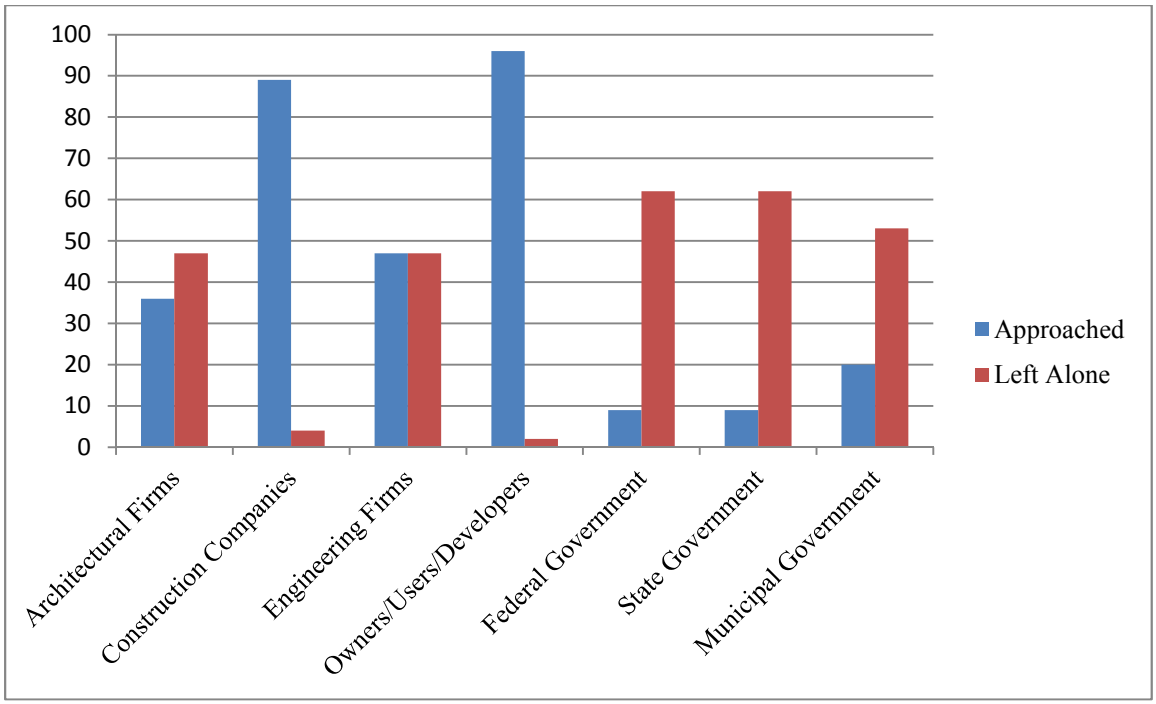

Figure 4: Targeted Markets for New Design-Build Job Opportunities (Rowings, et al., 2000)

The report revealed common aspects of "excellent" performing design build projects, based on the respondents' experience with the delivery system. ECs reported being selected to the project team via prequalified bidding and negotiated contracts on the reported successful projects, which created a "better overall project team environment" (Sanvido, et al., 2000).

Collaboration by all members of the design-build team was also imperative. If stakeholders preserved the same mindset they used in design-bid-build work, it could have been detrimental to the project. Another key attribute was having a team that was honest and could trust each other (Sanvido, et al., 2000).

Table 4: Design-Build Team Selection Determinants (Rowings, et al., 2000)

Considerations	Average*
Previous experience with the design firm on a design-bid-build project	3.5
Previous experience with the design firm on a design-build project	3.6
Industry reputation of design firm	3.5
Recommendation from another EC	2.4
Personal relationship with design firm principal	3
Use of information technology (IT) by design firm	3.1
Compatibility of design firm's IT with your firm's IT	3.1
Attitude toward ECs	3.5
Their understanding of the electrical contracting business	3.2
Technical expertise that matches the requirements of the project	3.9
Professional registrations held by design firm	3.2
Professional liability insurance held by design firm	3.2
Previous relationship with owner	3.2
Sensitivity to construction schedule and budget concerns	3.9
Fee structure	3.4
Terms and conditions of the contract	3.8
Ability to communicate and work constructively with your home office and field staff	3.9
Willingness to consider value analysis and constructability suggestions of your firm	4.1

***Scale Breakdown**

1= "not all that important"

2= "slightly important"

3= "somewhat important"

4= "very important"

5= "considered a must"

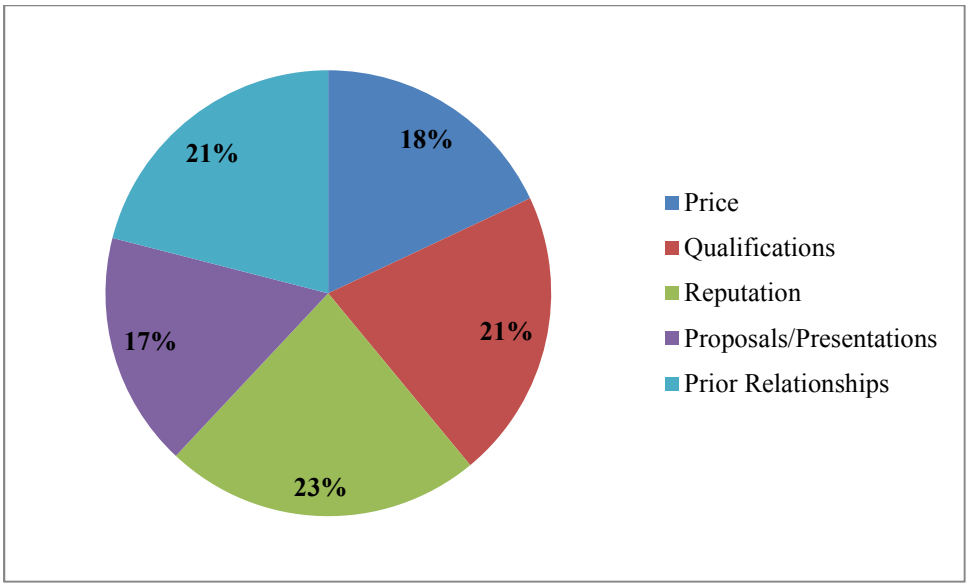

Figure 5: Company Factors Effective at Drawing Design-Build Clients (Rowings, et al., 2000)

The responding ECs also described several other miscellaneous characteristics of successful design-build projects (Sanvido, et al., 2000):

- Reasonable schedule/budget
- Experience with the type of work to be completed
- A team that is involved early on in project development
- Good "chemistry" with owner and project team, including a high-level of communication
- Having team members who are honest and trustworthy
- Having an owner who identifies needs correctly and openly

2.10.3.2 Barriers to Design-Build

The primary barrier for ECs to enter the design-build market identified by the study was the requirement to invest more time and overhead in order to be awarded a project successfully. Teams that were unable to communicate effectively also reported unsuccessful projects. Effective communication is critical on a collaborative project, in order to understand the team's needs, resulting in better coordination and minimal claims. Laws which require multiple primes and

lowest bid awards, and the favoritism and politics in the selection process also hindered the respondents from pursing design-build.

2.11: Conclusion

IPD seeks to break the adversarial relationship between project team members (such as the GC and architect), which is inherent in traditional project delivery systems. This system also takes a more aggressive approach, in order to increase stakeholder collaboration and project efficiency, compared to other progressive project delivery methods and techniques, such as design-build and partnering. Potentially, the most effective attribute of IPD is its ability to tie the success of a completed project to the success of individual stakeholders though legal relationships and shared risk/reward incentives.

ECs have the opportunity to benefit from participating in IPD. As discussed earlier, productivity losses ranging from 25-40 % are a possibility for ECs to incur on a typical project. By participating in IPD, ECs can overcome such productivity losses which may be the result of shortcomings in traditional project delivery systems. Furthermore, ECs have had success with similar project delivery systems in the past, such as design-build. A study by the Electrical Contracting Foundation found that 77 % of the EC survey respondents acknowledged a higher profit margin for design-build work compared to traditional methods (Rowings, et al., 2000).

Chapter 3: Research Methodology

This chapter describes the framework for accomplishing the following research objectives, as described in Section 1.5:

1. Gain a better understanding of the point of view retained by ECs, and how it will affect their willingness to participate, and ability to be successful in IPD projects.
2. Identify issues and risks for ECs to participate in projects using IPD.
3. Provide recommendations to address the identified issues and risks.

3.1: Research Design

The first step in the research process was to start gaining a better understanding of ECs, IPD, and the interactions between the two. Therefore, an extensive literature review of ECs, traditional project delivery systems, IPD, and project delivery systems similar to IPD was conducted. In order to formulate interview questions that would help identify issues and risks for ECs to participate in projects using IPD, the researcher examined various documents published by both ECs and the AEC industry, which expressed their issues and concerns. Next, a plan and procedure for data collection and analysis (research design method) was selected. A qualitative method was chosen because it allows the researcher to better understand an identified group of people, and how they view a specific topic (Creswell, 2009).

To assist the researcher in formulating defined measures for research design, a strategy of inquiry was also chosen. A phenomenological strategy was identified as most appropriate, because of its ability to develop common themes and relationships of meaning. With this method, it is also essential for the researcher to overlook their own experiences, in order to effectively evaluate the participants (Creswell, 2009). To implement the research design method and strategy of inquiry, questionnaires and semi-structured interviews were utilized, as will be discussed in detail in the next section.

3.1.1: Data Collection Procedures

In order to obtain input from management-level professionals of electrical contracting companies throughout the U.S., two distinct phases of data collection were conducted. The goal of phase one was to recruit these individuals, invite them to participate in an electronic survey, and obtain their commitment to participate in the phase two interviews. Phase two consisted of one-on-one semi-structured interviews.

To recruit respondents, and gain more insight into the EC industry, the researcher became involved in the student NECA club at Colorado State University. This involvement included coordinating student club meetings and meeting with the regional NECA Chapter President in Denver. From this involvement, the opportunity was presented to attend the annual 2010 NECA National Conference in Boston, MA. Thousands of ECs attended the conference for the purposes of networking, technical/management workshops, vendor exhibits, and a "Student Green Energy Challenge Competition." Several respondents were recruited at these events, as well as at regional NECA meetings, CSU Construction Management club events, and through referred contacts.

Prior to these events, an informational flyer (Appendix I) and poster (Appendix II) were prepared for the purpose of educating potential EC participants in the following areas while trying to recruit them:

- General information about IPD
- Uncertainties
- Benefits
- The goals of the research
- How the research could benefit the student NECA club at CSU

Once contact information was obtained for potential recruits, the ECs were sent a recruitment email (see Appendix III) requesting their participation in an electronic "Google Documents" survey. The purpose of the survey was to obtain company demographic information,

in hopes of ensuring an even distribution in selecting the phase two interview respondents. The survey consisted of twenty five questions, with fixed response choices determined by the researcher (See Appendix IV) (Fellows & Liu, 2008).

For the second phase of data collection, two sets of interview questions were developed, as shown in Appendix V & VI. The "No Experience Questions" were geared towards ECs with no experience working with IPD or a similar method. Participants who had experience working on IPD projects (or a similar project delivery method utilizing the "CD" principles discussed in Chapter 2), were given the "With Experience Questions."

The majority of interview appointments were arranged via telephone recruiting. After the appointment data/time was confirmed, the participants were sent a confirmation email containing the consent form, formal recruitment letter, a digital version of the informational poster, and the questions that they were to be asked during the interview (See Appendix VII, VIII for recruitment emails).

The majority of interviews were conducted via telephone, and the conversations were captured with a digital recording device. The interviews were semi-structured in format, where predefined topics were introduced and the respondent expressed their thoughts. Depending on the response, the respondent may have been prompted to expand on an idea, or was asked a follow-up question (Fellows & Liu, 2008).

To accomplish the objectives of the research through interviews, the respondents in both categories were first given an opportunity to speak freely about their perceived issues/risks of participating in IPD. Subsequent questions asked the respondents to answer questions involving specific issues/risks of IPD which were previously identified by the researcher in the literature review process.

This process also gave participants the opportunity to discuss projects where they had experience dealing with similar issues/risks, and how they addressed them. For ECs with IPD

experience, these comments are particularly noteworthy because they are directly addressing one of the research goals—provide recommendations to address the identified issues/risks of IPD.

3.2: Categories of "No Experience Questions"

Described below are the categories of questions used for companies with no IPD experience. Since many of these respondents had little or no existing knowledge of the new delivery model, the principles and processes of IPD were explained within the questions themselves as needed. For the complete list of questions asked to the interviewees with no IPD experience, refer to Appendix V.

3.2.1: Open-Ended Questions to Identify Positive & Negative Perceptions of IPD

These questions were asked first, and were designed to allow the respondents to express their opinions freely, without being influenced by the nature of the question itself. The two questions in this category essentially asked the respondents if there was any aspect of IPD that would encourage/discourage them from participating. Based on these responses, follow-up questions were asked as necessary.

3.2.2: Is IPD the Future of the Construction Industry?

This category was included in the "no experience questions" because many of the ECs expressed that they had very little knowledge of IPD and its role in the AEC industry. Therefore, the goal of the researcher was to gain insight as to whether ECs felt that IPD was just a short-term "fad," or if it was going to be a staple project delivery system.

3.2.3: Are ECs Willing and Able to Pursue IPD?

The goal of the two questions in this category was to gauge the respondent's dedication to pursuing IPD. The first question presented information regarding "IPD internship programs." The second question emphasized the fact that IPD requires ECs with limited scopes of work to be involved with a project for a longer period of time, compared to traditional project delivery

methods. After being presented with the information in these questions, the respondents were asked whether they would still be interested in pursuing IPD.

3.2.4: Financial Risks

Respondents were asked to discuss whether or not they believe they would be willing to expand their services to include IPD projects, given its increased financial risks stemming from increased collaboration in the design phase.

3.2.5: Issues with Shared Risk/Reward

The AIA "IPD Case Studies" document briefly discussed in Chapter 2 showcased six projects which utilized IPD in "The purest form possible." However, this document also identified the fact that the "Fairfield Sutter Health Medical Facility" and the "Arizona State University Walter Cronkite School of Journalism" projects did not utilize shared risk/reward. The former expressed that the concept of shared risk/reward was too new and they were "still in the mindset of business as usual," while the latter claimed that the local government utilized a design build contract, which did not allow the shared risk/reward arrangement.

These issues also coincide with the expressed issues/risks the AEC industry identified with IPD, as discussed in Section 2.7.1. Therefore, respondents were asked to give their opinions regarding the processes involved with shared risk/reward, and the fact that stakeholders on various IPD projects have decided to opt out of this option.

3.2.6: Issues with BIM

Since BIM is an essential aspect of IPD, participants were asked to express their overall views of the software, areas of improvement, and how their organization could better utilize it.

3.2.7: Legal/Liability Risks

In this question set, the interviewees were first asked to discuss their general thoughts on the legal issues/risks inherent in IPD. Subsequent questions specifically asked about their

thoughts on insurance coverage, and participating on an IPD team with stakeholders who had no previous experience with the delivery model.

3.2.8: Unions and IPD

In the phase one survey, the majority of ECs identified an affiliation with electrical unions. The goal of the questions under this category was to find out the effects of IPD on union employees, and if union organizations would have any effect on the ECs ability to pursue IPD.

3.3: Categories of "With Experience Questions"

Listed and discussed below are the categories of questions used for companies with IPD/CD experience. The overarching goal of these questions was to first identify if/how the respondents were successful in overcoming potentially problematic aspects of IPD. Subsequent questions sought to identify any issues/concerns the respondents encountered on an IPD project, and how they were dealt with.

ECs with no IPD experience may be more interested in pursuing IPD if they can learn from competitors who have gone through the trials and tribulations of dealing with the issues/concerns of IPD projects. For the complete list of questions asked to interviewees with IPD/CD experience, refer to Appendix VI.

3.3.1: How the Company Decided to Pursue IPD

The purpose of the questions in this category was to identify how these companies were able to initially pursue IPD. Therefore, the researcher emphasized that the respondent discuss their first IPD project.

3.3.2: Performance of Latest IPD Project as a Whole

This question set contained two sets of questions to gauge the success of the ECs latest IPD project by identifying any issues/risks, and how they were handled during the project. The responses to these questions were particularly significant to the goals of this research, as the ECs

essentially described issues experienced on actual IPD projects, and techniques to address those issues.

3.3.3: General Information for Involvement in Latest IPD Project

These questions identified the types of work the ECs performed, and the timeline for contractual arrangements.

3.3.4: Contractual Information for Latest IPD Project

This question set identified the type of contractual arrangement (if known), how the decision was made to pursue this arrangement, as well as any issues/risks experienced by the project.

3.3.5: Shared Risk/Reward Information for Latest IPD Project

Respondents were asked to identify whether their project utilized shared risk/reward, how the related contingencies were calculated, and how the ECs contingencies compared to the rest of the IPD team.

3.3.6: Electrical Contractor's Opinions of IPD

The ECs were then asked the same open-ended questions as the "non-experienced" respondents, in order to determine their opinions involving the benefits and risks of IPD. Three subsequent questions asked the respondents if they could identify any issues with multiparty agreements, IPD insurance, and the fact that IPD is a new project delivery system that hasn't been tested in court. The respondents then discussed their thoughts on union vs. non-union labor, and whether they were able to collaborate effectively with all IPD stakeholders. The remaining questions asked the ECs which stakeholder(s) had the most to risk or gain from participating in IPD, and the size and type of project that they thought to be the most appropriate for the delivery system.

3.3.7: BIM Specific Questions

As discussed in Section 1.1.2, IPD is aptly suited to take full advantage of BIM. Therefore, these questions identified the respondent's involvement with BIM, and how the ECs managed any related issues/ risks.

Chapter 4: Results

The purpose of the phase one electronic survey was to collect demographic information for ECs who would potentially participate in the phase two interviews. However, given that only 24 ECs responded to the survey (only nine of which agreed to participate in the phase two interviews), the sample size was too small to make selections for interviews based on demographic information as originally planned. As shown in Figure 6, the majority of respondents represented companies with annual revenue greater than $25 million. The majority of the respondents' (14) company size was 100+, while six had 20-99 employees, and four ECs refused to disclose the information.

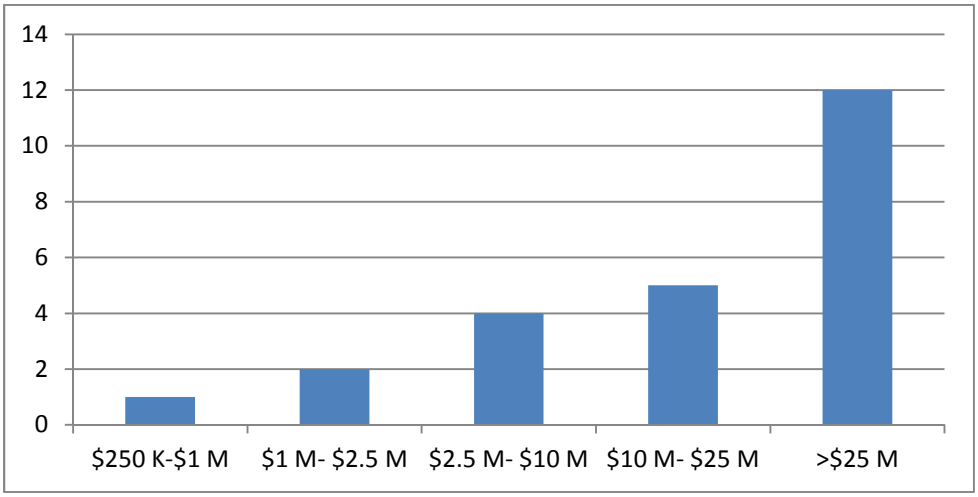

Figure 6: Annual Revenue of Phase 1 Survey Respondents

The second phase of data collection involved interviewing management-level staff of ECs. Overall, thirteen participants (nine who participated in the phase one survey and four recruited from industry conferences) were interviewed. Four of these respondents had IPD experience, two had CD experience, and seven had no IPD/CD experience. The respondents identified as having CD experience were given the same interview questions as those with IPD experience, since they all had experience with IPD-like delivery systems.

4.1: Interview Response Analysis for Respondents with No IPD Experience

The same question categorization described in Section 3.2 was used to analyze the interview responses for ECs with no IPD experience. Each category seeks to gain insight into the ECs viewpoint, in hopes of identifying issues/risks for them to participate in projects that utilize IPD. A total of seven ECs with no IPD experience participated in the interview process. All but one of these participants had experience with design-build, alternative energy projects, and had experience working as a GC. However, only two respondents reported experience in the "experience with prefabrication" and "provided preconstruction services" categories. Furthermore, the majority of the respondents performed the same types of work, but reported varying levels of annual revenue, as shown in Figures 7-8.

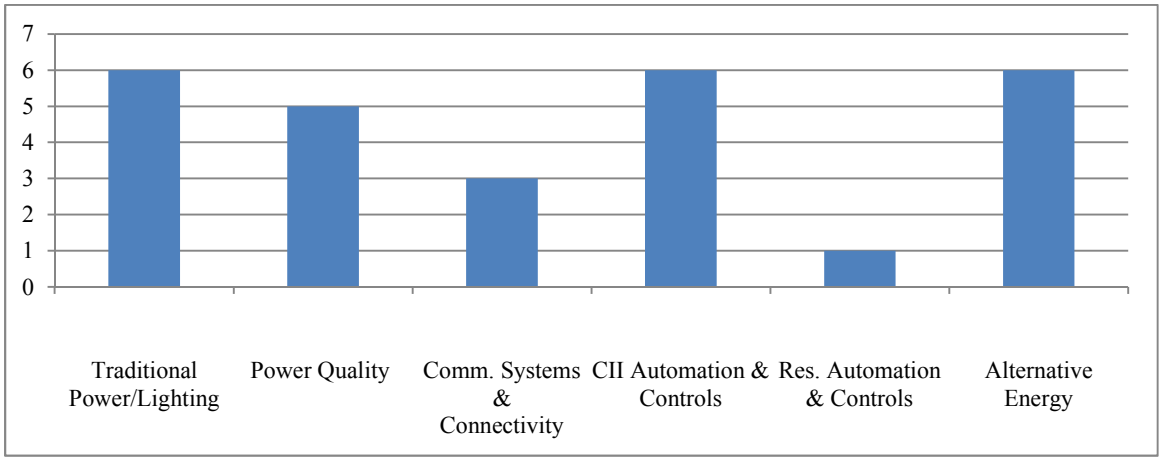

Figure 7: Number of "Non-Experienced Respondents by Type of Work Performed

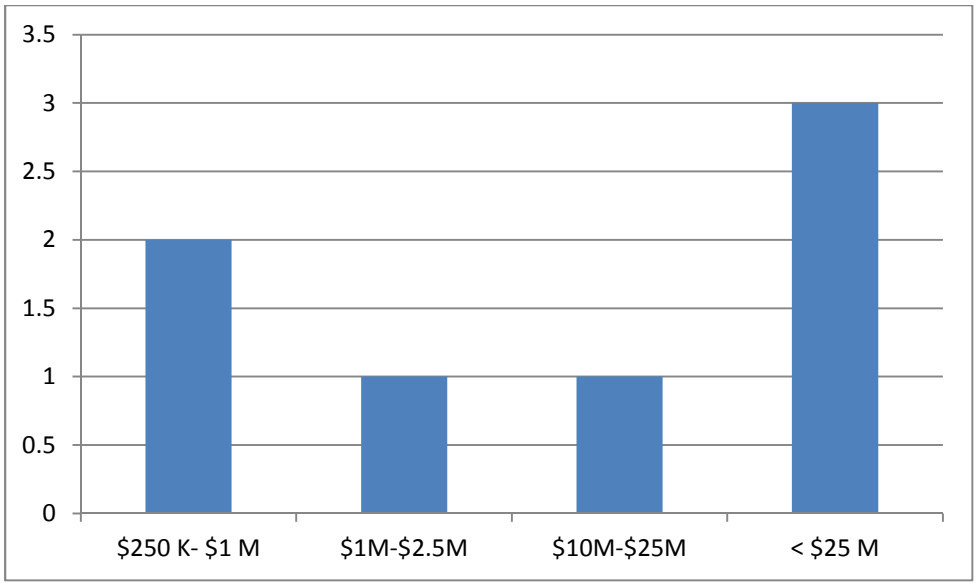

Figure 8: "Non-Experienced" Respondents Annual Revenue

4.1.1: Open-Ended Questions to Identify Positive & Negative Perceptions of IPD

These questions were asked first and were designed to allow the respondents to express their opinions freely, so they would not be influenced by the nature of the question itself.

In discussing experiences with traditional project delivery systems, three ECs expressed issues with not being able to be involved early in the project development phase. This was an encouraging factor for them to pursue IPD, due to its requirement of early stakeholder collaboration. For example, two respondents stated that their company routinely struggles to obtain detailed design information early in the project development process. This affected their ability to identify value engineering opportunities, and to provide "final design" input to other team members. To remedy this situation, the respondents recommended working with a sophisticated owner who has extensive experience with collaborative techniques.

One of the most significant findings amongst the non-experienced ECs was the fact that their experience with collaborative delivery was an encouraging factor for them to consider pursuing IPD in the future. For example, one respondent described how they successfully completed projects utilizing design-build. Their experience was similar to IPD where

stakeholders make decisions with the best overall project value in mind, and not just the lowest price for the ECs scope of work. The ECs company also participated in an employee incentive program, which is much like IPD's shared risk/reward incentives (e.g. if a project is completed under budget, individual members of the team are awarded a share of the profits).

The ECs went on to say that the increased collaboration would improve clash detection between trades, reducing the amount of change orders, and thereby increasing the EC's profit margin. Overall, the respondents expressed how IPD has the potential to allow the respondents to have a more definitive picture of what the project was going to look like, and improve workflow.

However, the respondents also discussed potential issues/risks of participating in IPD, due to the fact that it's a new delivery method that has only been utilized in a relatively small number of projects. The increased upfront investments inherent in IPD also increased the risk from their perspective. For example, one respondent was concerned that their profit margins would be dictated by the rest of the IPD team.

4.1.2: Is IPD the Future of the Construction Industry?

These questions sought to find out whether the interviewees thought IPD would stand the test of time as a project delivery system, or if it was just a short-term "fad." As a whole, the willingness of the respondents to pursue IPD was dependent on their knowledge and experience with other members of the project team. For example, several ECs expressed that that they would not need to see any more successful IPD projects completed before they decided to pursue the delivery system, as long as they were part of a project team that was committed and trustworthy.

Three respondents felt that early collaboration efforts inherent in IPD would eventually allow it to achieve the success of design-build. They went on to say that IPD allows stakeholders to produce a higher quality facility in less time, thereby increasing ECs profit margins. The ECs then discussed how the delivery method enhances design-build's ability to give them more control of construction processes, which would increase its popularity.

4.1.3: Are ECs Willing and Able to Pursue IPD?

This question set presented information on IPDs requirement of increased time commitments for ECs, in an attempt to gauge their level of interest in pursuing the delivery system. Furthermore, the respondents were asked whether or not they would be willing to participate in an "IPD internship" program.

The majority of respondents expressed that they would not be willing to pursue an IPD training program for a number of reasons. Two ECs were not open to this type of training, because they were not sure if their organization had the potential to become successful at IPD. These respondents did not like the fact that ECs have to give up a high-level of control to stakeholders who have traditionally been adversaries, which would cause the EC industry to be unwilling to pursue the delivery model. They went on to say that there is not enough historical data from successful projects that show the potential to increase the profit potential of ECs.

Another respondent pointed out that it would be difficult to offer IPD training, since they didn't have any employees who possessed the required knowledge. However, this respondent went on to say that if they were to hire an IPD intern, they would look for someone with an engineering background. The respondent explained that this type of student would have the thought process to be successful in a collaborative environment, and wouldn't be "burdened" with traditional construction practices.

However, it should be noted that three respondents stated that they were open to IPD training, under certain conditions. One EC did not want to bear any direct costs for the training, but was willing to put in the necessary time. Another EC expressed interest in the training, but wanted to know more information about the associated costs. The final respondent stated that their company would be willing to implement any type of training that would produce a better employee.

Respondents also provided comments regarding the fact that IPD is mostly utilized on large/complex projects. Most of them felt that ECs who lack experience with large/complex

projects would not be as willing to pursue IPD. In discussing this, one interviewee described how they would have to change their organization's overall mentality and business model in order to be successful with IPD. Another respondent could not justify the requirement for increased time commitments inherent in IPD due to the size and limited scope of work of the projects they complete.

4.1.4: Financial Risks

The respondents were informed of the fact that IPD requires an increased upfront investment, with the potential of earning more profit at the end of the project. Overall, the interviewees were fairly split as to whether they would still want to pursue the delivery system.

The respondents who had experience with project delivery systems and/or processes similar to IPD were more open to increased upfront investments. However, they acknowledged that this would require a mindset change amongst ECs who currently use traditional project delivery approaches.

One EC discussed their involvement with design-build and design-assist projects, expressing no issues with increased investment in terms of increased time commitments (indirect costs). They went on to describe how the indirect labor costs can be anywhere from 25% of man hours or higher, depending on the complexity of the project. This EC also discussed a transit system upgrade which had to be in continuous operation, and therefore had high indirect labor costs. Another respondent was open to the idea because of their previous experience involving the increased upfront costs of value engineering. This EC described how they try to assist early to get the required information necessary to provide the best value to the customer, while reducing risk in the process. The respondent went on to say that they would welcome the opportunity to do this process more formally, in order to incorporate it into their compensation model, and create a method for completing the job, rather than trying to do it as an added value approach from an EC stakeholder perspective.

One respondent discussed the process of "job cost history" and "phase codes" utilized on design-bid-build projects. This is where the time and labor associated with a specific task is documented and then analyzed for a specific situation. The respondent went on to say that the upfront costs for design input could either produce a more profitable project, or raise the price of a bid so high that they would not be awarded the job.

The interviewees who didn't have experience with project delivery methods similar to IPD were not as open to an increase in upfront investments. Some of the respondents feared that the unsatisfactory performance of one stakeholder could eliminate any potential increase in ROI for the entire IPD team. Another EC declared that the potential for a higher ROI with an increased upfront investment is only in theory, and may not apply to every construction project. They went on to express that under lien law, legal recourse to recover money invested in a project only applies to the actual product installed. Therefore the upfront investment for design input and creation of a BIM model would be lost if a project went under.

A respondent emphasized the fact that pursuing IPD would require additional overhead for research and development (R&D). This overhead would offset the slim profit margins from the low volume of work being completed. This EC went on to say that in order to make a profit, the total project cost would have to be at least $20 million. Another respondent stated that, in order to justify this overhead, ECs would have to know in advance that they would be able to participate in future IPD projects.

One respondent also discussed how smaller ECs could take on too much risk with an IPD model, because of the upfront funds required for shared risk/reward contingencies. This was due to the fact that the small volume of work these ECs complete is only enough to cover overhead and a small profit. As a result, there is no money available for the extra upfront costs required for shared risk/reward contingencies.

In the context of the economic downturn in recent years, the majority of respondents were open to the idea of pursing IPD in order to expand their services and become more

profitable. Interestingly, one EC mentioned that a guarantee that they would be able to participate in future IPD projects would encourage them to participate in an IPD project. However, these same respondents felt this would be much more difficult for ECs who do not have experience with large/complex projects. As a whole, all of the respondents were open to the increased upfront investments inherent in IPD, as long as they had adequate knowledge of the other stakeholders.

4.1.5: Issues with Shared Risk/Reward

As a whole, the respondents expressed how they would be open to participate in shared/risk reward on their first IPD project. One EC even discussed a successful project that included an incentive/penalty clause similar to IPD's shared risk/reward. It involved the construction of seven bridges, each with a predetermined deadline to meet. If one of the deadlines was missed, they were penalized, but if none were missed, they received a reward upon project completion.

However, the respondents did place various conditions they wanted to be met in order to participate in shared risk/reward. The majority wanted to have a prior business relationship with members of the project team, or at least have knowledge that the stakeholders (particularly the owner) were trustworthy companies who regularly complete quality work on time and under budget.

Another respondent expanded this thought by stating how the terms and conditions of the contract are significant because they can have different limits of liability, insurance, bond coverage, and project controls. Another respondent added that they would like to be part of the team deciding the initial contingency price, and the timeline for receiving the potential bonuses. Two other respondents stated that they would like to have prior knowledge of how much profit they stand to lose in the case of cost overruns. They went on to say that their organization has parameters in place to overcome cost overruns, which may not be the case with other ECs.

Respondents also had issues with the fact that the owner is generally in charge of determining the criteria, amount, and distribution date of incentives on IPD projects. For example, one respondent stated that if the owner decides on the payment schedule, it is a conflict of interest because they will attempt to hold the money as long as they can. They also discussed a project where they had to put up a 10% retention, which was essentially the same amount of their profit. If they did not know when they were going to be reimbursed for that retention, the EC could go out of business. In discussing a third party, the respondent stated that it could be a better option, depending on how it was applied. The respondent recommended an escrow company or a project management firm, but concluded by stating that it would be best to just come up with the shared risk/reward criteria equally as a team.

Two other respondents felt that a third party decision-maker would be more appropriate, as she/he could act as an impartial mediator in the process. They went on to point out that an owner-controlled shared risk/reward arrangement could possibly force the smaller trades to take on excessive risk.

4.1.6: Issues with BIM

ECs with no BIM experience were asked if they could anticipate any issues with utilizing the technology, given that it is a requirement for IPD projects. These respondents acknowledged the benefits of BIM, but felt it was better suited for contractors who work on large, complex projects. They went on to say that there is simply too much time and money involved in order to update files, integrate the systems, and input data.

The respondents with BIM experience were asked if they ever had any issues with the technology. One EC stated that there could be a potential issue with incorporating the 4-D layers, due to the fact that there could be other contractors using an older version of the software.

4.1.7: Legal/Liability Risks

The respondents were asked to comment on the inherent legal/liability risks of IPD, such as being on a team of stakeholders who lack experience with the new delivery method. Three ECs

openly stated that IPD's potential legal issues were significant enough to prevent them from participating. The remaining four respondents were concerned about potential legal issues caused by other members of the project team. However, if they were comfortable with other stakeholders' qualifications, much of the legal risk was eliminated in their eyes. These qualifications include reputation, financial stability, and prior working relationships. It should also be noted that one respondent stated that pursuing an IPD project which was smaller in scale and complexity could compensate for a stakeholder lacking these qualifications.

The respondents were also asked to discuss any perceived issues with obtaining insurance for IPD projects. One EC stated that there are many legal issues on construction projects that can only be solved through a costly litigation process. They went on to say that the language of the contract and the amount of potential liability would be significant factors for insurance.

Two ECs emphasized the importance of professional liability insurance for construction projects, particularly those which utilize an IPD model. One respondent discussed their involvement in design-build projects where they complete value engineering. For these types of projects, the EC will hire a design/engineering firm which provides professional liability insurance, protecting the EC from errors and omissions caused by the design team. In order to participate in an IPD project, the EC stated that they would like to have similar insurance coverage.

One of these respondents stated that anytime an EC has design engineers on staff, they are expected to have professional liability insurance, particularly on public projects. This respondent went on to say that there are many organizations completing design-build work that operate without this insurance coverage, which is a liability to the owner.

4.1.8: Unions and IPD

The interviewees felt that unions would support an IPD model, as one respondent discussed how their local union is open to any opportunities that would make ECs more

successful, due to the current economic downturn. Another respondent concurred, discussing how their local union offers "market recovery money" which goes towards employee wages and benefits, allowing the EC to stay competitive with open-shop companies.

One of the respondents also discussed the tradeoff between the lower labor cost of open-shops, and the higher level of quality and productivity seen in closed-shops. Open-shops may have lower labor costs, but the decreased quality and productivity may cost the EC more money in the end.

However, it should also be mentioned that two respondents felt that open-shops are better suited to complete prefab work, due to their lower labor rates. These ECs also stated how open-shop companies consequently would have the potential to be more successful in IPD projects.

4.2: Interview Response Analysis for Respondents with IPD & CD Experience

4.2.1: How the Company Decided to Pursue IPD

The respondents with IPD experience had very similar demographic characteristics. All these ECs had more than 100 employees, an annual revenue exceeding $25 million, and experience with prefab, design build and preconstruction services. The ECs also had experience with the following categories of work:

- Traditional Power/Lighting: All
- Power Quality: All but 1
- Communication systems/connectivity: All but 1
- CII Automation & Controls: All
- Residential automation & Controls: All but 2
- Alternative energy: All but 2

During the interviews, the respondents first discussed how their company originally became involved with IPD. The majority expressed that they had prior relationships with stakeholders who approached them to participate in their first IPD project. They went on to

describe GCs and the role they play in deciding which other stakeholders will be on the IPD. They also mentioned their company's experience working on collaborative projects, and that this was necessary in order to establish credibility as a qualified stakeholder. This allowed their organization to have many of IPD's processes and procedures already in place prior to being accepted onto a team. Many of the respondents also had experience with projects that are ideal for IPD, such as large medical facilities. One respondent mentioned that pursing IPD would help them to expand their services and become "Industry Leaders."

The participants were then asked to discuss how their company had to change in order to be successful with IPD. The majority expressed that they had to be much more involved with all project stakeholders. This could include increased communication and incorporating the feedback obtained from other team members into their decision making.

They also noted that it was a challenge to remove the adversarial relationship with other stakeholders, which was common under traditional delivery systems. IPD requires increased effort by ECs, in order to put differences aside and work through problems when they arise (e.g. clash detection). They also need an understanding of what all stakeholders are trying to accomplish, essentially working from the role of the engineer, project manager, and budgeter. For example, one respondent described how it was not practical to bring every specialized contractor into every meeting. It was also expressed that it is essential to have a well-qualified GC who is also a strong leader to head the project team.

4.2.2: Performance of the Latest IPD Project

The respondents, then, described the performance of their latest IPD project in terms of schedule, budget, completion of project goals, etc. However, their responses were largely limited to issues involving schedule delays. As one EC described "We are losing time because if we want to move one object, thirty people have to agree on it. Everyone on the entire IPD team should not

have to review every single change. The best people should be in charge of their specialty area and there has to be some level of trust."

In discussing a large health care project, another respondent described a scheduling delay resulting from too many stakeholders involved with project changes, as the doctors and hospital staff were even allowed to recommend a large number of changes to the facility. When discussing a foundation delay, one respondent also described how they were able to use prefab to keep production going and stay on schedule.

Issues involving the GC, and other secondary stakeholders also caused delays to contract negotiations and finalizing a budget. For instance, the respondent described how the GC did not have adequate experience with collaborative delivery systems, and was unable to collaborate with the team to produce an appropriate budget. There were also similar issues with other secondary stakeholders, resulting in schedule and contractual delays. Eventually, the GC and all secondary stakeholders were replaced, with the exception of the EC on that project.

4.2.3: General Information for Involvement in the Latest IPD Project

In this category of questions, the respondents continued to discuss their involvement with prefab, as well as the type of work they performed on their latest IPD project. All the ECs described how they only completed work as an electrical subcontractor for their latest IPD project. One EC also took the opportunity to discuss contractual issues due to poor performance by another key stakeholder. Specifically, they had difficulty with a GC who was not experienced with important IPD techniques such as facilitating a high level of collaboration, coordination, and BIM expertise.

Prefabrication work gave the respondents a competitive advantage amongst other ECs. One respondent described how their goal was to prefabricate an amount of work equal to 15% of their total man hours. This coincides with their culture of being problem solvers—instead of writing RFIs and waiting for answers, they seek to work collaboratively and provide the

necessary input to eliminate the need for RFIs. With this ease of information flow, it is easier to make decisions that are in the best interest of the owner, and the constructability of the project.

The ECs also believed that simply utilizing IPD gave them more opportunities to complete prefab work, for a wide-variety of reasons. One respondent described how IPD enabled them to know the exact type and location of all the electrical equipment. Next, the detailers and electricians would perform quality control and constructability reviews on engineered drawings, and then every available prefab option was examined.

The respondent also mentioned that they take prefab into consideration when considering any project changes. Overall, it was emphasized that IPD allows all stakeholders to have a better understanding of everyone's needs. To meet final completion dates, the ECs were able to make up for delays in the schedule simply by completing extra prefab work.

When asked to describe their involvement with prefab work on their latest IPD project, all respondents emphasized the importance of the technique. One respondent described how they didn't realize IPD would give them so many new prefab options, until they completed their first IPD job. Another EC admitted that prefab work gave them a much needed competitive advantage in a down economy. Overall, the respondents seemed to believe that it was in their best interest to prefab as much work as possible.

4.2.4: Contractual Information for the Latest IPD Project

All of the respondents stated that they have never filed a claim on an IPD project, given that the contract review process was similar to traditional delivery models. One EC mentioned that their organization made an effort to avoid "claim situations," due to its negative impact on their reputation throughout the AEC industry.

Another EC described how every contract goes through legal review, where erroneous items are negotiated out, and future needs are assessed. Another respondent stated that there was

no legal review because of their prior experience with the CM. The interviewees also described the types of contractual arrangements utilized on their latest IPD project:

- Corporation was formed which utilized a GMP contract, eventually converting to a lump-sum contract.
- Cost-plus-fee contract where the EC was bound to a certain budget, but had the flexibility to set rates for manpower, and submit invoices for work performed.
- Two distinct contracts using an Integrated Form of Agreement (IFOA). One was for preconstruction, and another for when construction actually began.
- Only contractually bound to complete BIM modeling which became as-built drawings.

One respondent discussed a particularly fast contract negotiation period, where a contract was signed two weeks after the interview process. This was due to a number of factors including industry reputation, the schedule of the project, and the willingness of the IPD stakeholders to get the project moving forward without getting caught up in the contract negotiation process.

4.2.5: Shared Risk/Reward Information for the Latest IPD Project

When asked to disclose the contingency percentages for shared risk/reward incentives on their latest IPD project, the ECs expressed a wide-variety of responses. When discussing logistics, one respondent described how the budget was established first, and then the shared risk/reward contingency percentages were negotiated. Another respondent was not involved in this type of program, while another stated that he was not aware of the percentages. The remaining four respondents revealed the following details involving the percentage of their bid price required to participate in a shared risk/reward program:

Respondent 1: The MEP as well as the drywall contractors contributed 13.5% of their contract price.

Respondent 2: The EC contributed 5% of their contract price.

Respondent 3: The architect contributed 15% of their contract price, while the MEP contractors contributed 5% of their contract price.

Respondent 4: This respondent was involved in a slightly unusual shared risk/reward incentive program. Although the EC did not have to put up an extra contingency, they were still rewarded for a participating in a project that was completed ahead of schedule, or under budget. Rather than a cash bonus, the owner promised to contract with the EC when additional work became available.

4.2.6: ECs' Opinions of IPD

The participants were first asked to freely express any factors of IPD that would encourage/discourage them to participate. Subsequent questions presented aspects of IPD that were identified as potentially problematic by the researcher prior to the interviews. This section will first present the discouraging factors ECs expressed, and then discuss the encouraging factors.

4.2.6.1: Discouraging Factors for Experienced ECs to Participate in IPD

One of the main discouraging factors was the increased financial risk for the ECs to pursue IPD projects. Several respondents mentioned that IPD presented a significant financial risk, for a wide variety of reasons. Like the non-experienced respondents, the experienced ECs mentioned that working with an IPD team who they did not have experience completing successful projects with in the past was a significant risk. However, they also mentioned that a strong GC with good knowledge of IPD and BIM would eliminate some of this risk.

A few respondents also mentioned the fact that there is a lack of hard financial data for existing IPD projects, which increased the risk from their perspective. This lacking financial data also makes it more difficult for owners to consider IPD in the project conceptualization phase. Another respondent mentioned that many ECs have enough profit to maintain their revenue stream, so there is no reason to pursue a negotiated IPD project with more risk.

Several ECs mentioned that being successful at IPD will require their organization to shift to an "IPD paradigm." They described how this could be a difficult talk because many people are accustomed to operating under traditional project delivery systems which did not require them to understand the viewpoints of all project stakeholders. They went on to say that understanding the principles and processes of IPD and embracing this new paradigm needs to happen prior to the EC's first IPD project. Educating stakeholders after the project has begun would be much more difficult and costly.

One respondent also suggested that the lack of "pure" IPD projects throughout the AEC industry was another discouraging factor. Two ECs also stated difficulty with establishing a target price as the IPD project is progressing. Pressure to push their prices down in order to reach a target number seemed to affect their ability to work in the best interest of the project.

With respect to the size/type of project that would be the most appropriate for IPD, one EC responded by recalling the history of the construction industry. When trade contractors first became popular, they were not very integrated to the rest of the construction team. In recent years, these contractors have become a lot more integrated, particularly in recent years where techniques such as design-build and partnering have become more common. IPD is simply the next iteration of this process. However, this respondent went on to say that the management and process requirements would not justify IPD on smaller projects stating "The contracting methods are foreign to so many people, so it would have to be a significant project. By the time you got all the team members to understand how IPD works, half the project would be completed."

However, this EC felt that IPD will eventually catch on, which means everyone will eventually need to understand how to make it work on smaller projects. Two other respondents strongly believed IPD could be appropriate for smaller projects. One stated that their participation in the creation of a BIM model on smaller projects was the driving force for IPD principles. The other respondent stated that they use a "Partnering approach" on smaller projects, and that it

enhanced their ability to keep up with the schedule. They went on to say that partnering would be utilized on all jobs in a "perfect world."

The participants were also asked to respond to the fact that opponents of IPD argue that a multiparty agreement is not necessary to achieve the goals of the delivery method. Two respondents agreed with the statement, recalling how they completed lump-sum, hard-bid projects which functioned similar to IPD. Another EC felt that the appropriateness of a multiparty contract was dependent on the team. For example, if a contractor has multiple contracts that are somewhat disconnected, then you could end up with teammates who find ways to attain individual opportunity, and work against each other.

4.2.6.2: Encouraging Factors for Experienced ECs to Participate in IPD

Increased productivity was the major encouraging factor for the respondents to participate in IPD projects. When discussing RFIs, one EC described how they could easily interact with the chief electrical engineer to ask questions or provide input. This interaction gave the EC a better understanding of the work being performed, and eliminated potential RFIs.

The respondents also felt that IPD's "team focused mentality" had the potential to increase the productivity and overall quality of the project. They noted that with IPD, problems are approached as a team, rather than attempting to shift them to another stakeholder. However, they acknowledged that this requires sacrifices from individual stakeholders in order to provide the best value to the owner.

Many of the interviewees also liked the fact that IPD focuses on positive business relationships. The ECs also saw the benefit of this in the form of new partnerships with project stakeholders. They went on to say that these types of relationships create a more productive work environment for the entire team. One respondent also mentioned that when owners interview potential ECs for a new project, they are beginning to inquire about their ability to participate in a collaborative IPD model, even if the particular project does not happen to use IPD.

When asked to discuss their thoughts on multiparty contracts, three ECs felt that it was an important aspect of IPD. They went on to say that the arrangement has the ability to shift the mindset of stakeholders away from traditional methods, where adversarial relationships are common and disagreements are often settled in court. For example, multiparty contracts allow stakeholders to make decisions that will cost them money, as long as it saves another stakeholder more money. Another EC cited the process of clash detection as an example of the importance of sacrificing for the good of the project team. "With clash detection, if there is not a committed team, nobody will want to compromise on equipment location. We all make sacrifices at some point" this respondent stated.

None of the ECs identified issues with respect to insurance on IPD projects. However, one respondent noted that the best approach to insurance would be to join together as a project team and purchase a single insurance package.

The majority of respondents felt that closed-shops could be just as effective on an IPD project as open-shops. For example, one EC stated that the high level of education, training, and compensation offered to the union workers contribute to a more efficient and higher quality project outcome. In the respondent's mind, this made up for any cost savings a non-union contractor would see in the form of reduced labor rates.

4.2.7: BIM Specific Questions

The interviews were concluded by discussing building information modeling (BIM) with the participants. All of the ECs stated that they had extensive experience with the technology, and were capable of producing the models in-house. One EC stated that their company has a BIM manager who oversees two individuals who aid in the modeling effort. Another respondent described how each stakeholder employed between one and four BIM detailers on the project. They went on to discuss how all of the various stakeholders who participated in the building information modeling were also able to work in the same area to collaborate, perform clash detection, and troubleshoot.

Organizational goals pertaining to BIM and IPD were also discussed in the interviews. One respondent described how their overall goals were to eliminate clashes out in the field, utilize the available space in the most efficient way possible, and provide the owner with a working model that will allow them to better maintain the facility. In discussing how detailed BIM should be, the respondent went on to say that it is dependent on what the owner sees value in, and which components will facilitate the construction process once they are digitized in the virtual model. The primary software types the ECs discussed were NavisWorks and Revit.

However, the ECs did express several issues involving BIM. Four of the six respondents felt that there is a general lack of BIM education and training for IPD stakeholders. BIM specialists and design engineers traditionally complete this modeling work, but have no experience installing electrical equipment out in the field. Two respondents recognized the need to bridge this gap by providing BIM education and training to key stakeholders from every trade. One category of key stakeholders includes the skilled technicians and craftsman who coordinate and install work out in the field. One EC explained that these are the people that can better understand how the benefits of BIM translate into productivity savings. Currently, BIM modelers do not have an understanding of how the equipment is installed, so they are unaware if their efforts save any time during construction. These modelers need to have an understanding of codes, constructability, materials, and the means and methods of construction for electrical work.

Another respondent discussed how vendors and manufactures involved in IPD projects should be considered key stakeholders. Providing BIM education and training for these stakeholders will allow better pricing information to be transferred to the 5-D layer in the model. This EC explained that, on an IPD project, pricing information needs to be consistent with the schedule. However, vendors and manufactures would rather just quote one price to every EC, regardless of the schedule or type of delivery system. BIM education and training will help these stakeholders retain the correct pricing parameters.

One respondent suggested that a clear definition of BIM should also be included in stakeholder education. This EC stated that when stakeholders discuss BIM, they rarely talk about what everyone's expectations are. His definition of BIM was a 3-D model which is alive and growing as the design progresses. The model would also have manufactured 3-D shapes of equipment such as generators, switchgear, and light fixtures. When items were clicked on, it would have a hyperlink of an O&M manual, submittals, and other items in real time. The respondent went on to say that there are a lot of people who say they have BIM experience, but most likely have not worked on these types of jobs.

When discussing logistics, the respondents suggested that a centralized BIM training area would be the most appropriate way to accomplish this BIM education. They went on to say that if everyone is in the same room together at the same time, the training process would go much more smoothly. Bridging the gap between key stakeholders and the BIM team will allow a wealth of knowledge and experience to transfer to the BIM model and eventually the owner's completed project (see Figure 9). It will also allow BIM to be utilized in a more efficient manner.

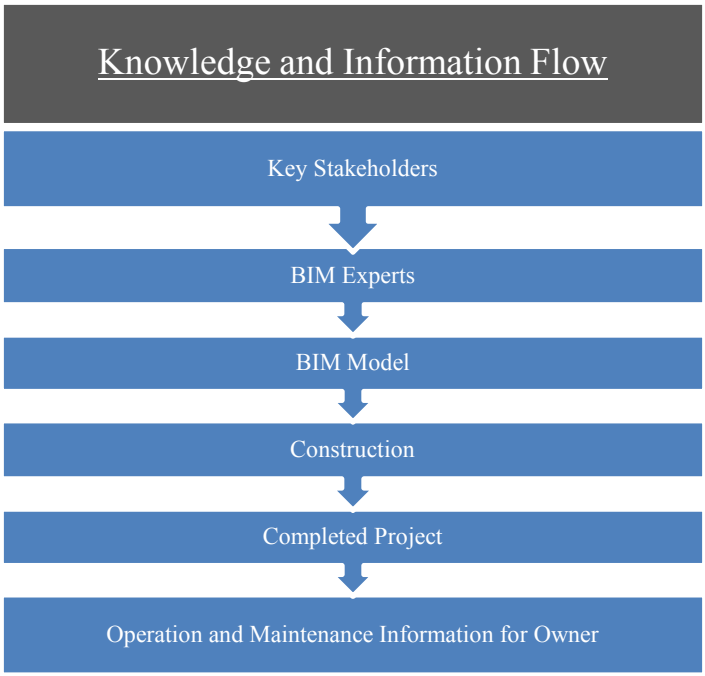

Figure 9: Effect of BIM Training and Education for "Key Stakeholders"

The respondents acknowledged BIM's potential to improve project efficiency and reduce installation costs. However, they also mentioned BIM's potential to be wasteful if used inefficiently. As a general note, one EC suggested that the size of the project is the most significant factor—unless a project is large and complex, using BIM is not necessary.

One interviewee was involved in a project where a GC did not have adequate BIM knowledge, and could not take the lead on the modeling. As a result, the mechanical contractor took over and included more information in the model than was necessary. In discussing the BIM work performed on their latest project, another EC stated that there was a high volume of man hours billed for modeling that was not examined on a best value basis. Another respondent also mentioned that it is difficult to perform a best value analysis; because they don't know what the effects on project cost would be if BIM was not utilized. They went on to say that it would be useful if research was conducted to provide a way to determine the cost payback of utilizing BIM for a given scenario.

To allow BIM to reach its full potential, one respondent suggested that it would be useful if all IPD stakeholders could work in the same software platform. Currently, the various trades utilize different software platforms which optimize their own work, creating compatibility issues. Utilizing BIM more efficiently should include coordinating with the appropriate stakeholders on a weekly basis to examine which BIM options have the best value, and to perform clash detection.

One EC stated that BIM suffered more with traditional delivery methods such as design-build, because the BIM effort did not start until the engineering and procurement work was to a certain point. However, they still believed it was worth the cost in the end because it saves money on prints for various documents such as operation and maintenance manuals, and provides greater value to the owner.

Chapter 5: Conclusions

This study explored the involvement of Electrical Contractors in Integrated Project Delivery by seeking to accomplish the following research objectives:

1. Gain a better understanding of the point of view retained by ECs, and how it will affect their willingness to participate, and ability to be successful in IPD projects.
2. Identify issues and risks for electrical contractors to participate in projects using IPD.
3. Provide recommendations to the EC industry to address the identified issues and risks.

To reach these objectives, the researcher conducted an extensive literature review of the EC industry, IPD, and other related topics. In order to formulate interview questions that would help identify issues and risks for ECs to participate in projects using IPD, the researcher also examined various publications published by both ECs and the AEC industry. Then, two distinct phases of data collection were utilized to obtain input from management-level professionals of ECs throughout the U.S. The goal of phase one was to recruit these individuals, invite them to participate in an electronic survey, and obtain their commitment to participate in the phase two interviews. For phase two, two sets of interview question sets were created, one for ECs with no IPD experience, and another for ECs with IPD experience.

Within each set, the questions were divided into distinct categories, each of which seeks to identify various issues/risks for ECs to pursue IPD. However, the respondents were first given the opportunity to freely express if there were any aspects of IPD that would discourage or encourage them to participate. This allowed them to discuss their existing thoughts of IPD, without being swayed by the nature of the question itself.

This chapter will begin by providing a summary of the main results for ECs with no IPD experience. Next, recommendations to address issues/concerns these ECs had with IPD will be discussed. Both of these sections will be presented for ECs with IPD/CD experience as well. The last section entitled “Future Research” will introduce research problems and unanswered questions that could be addressed in future studies. The findings presented in this chapter are

primarily based on the results from the interview process; and supported by the literature review and first-hand experience of the researcher with the EC industry that was accumulated during the researcher's involvement as a student officer at CSU NECA Chapter, as well as his 3-month internship with an electrical contractor.

5.1: Summary of Responses for ECs with no IPD Experience

5.1.1: Open-Ended Questions to Identify Positive & Negative Perceptions of IPD

All ECs with no IPD experience mentioned that a major flaw of traditional delivery systems was their lack of early involvement, which was an encouraging factor for them to pursue an IPD model. ECs that had experience with similar collaborative delivery systems such as design-build were also more open to consider pursuing IPD. Overall, this group of ECs believed that IPD's increased early collaboration would help them have a better picture of what a project is going to look like. This in turn improved workflow, clash detection between trades, and reduced the number of change orders.

However, the ECs also took the opportunity to discuss potential issues/concerns that they had with the delivery system. The fact that IPD is a new delivery system that has only been utilized in a relatively small number of projects was a discouraging factor for some ECs. They also expressed issues with the increased upfront investments inherent in IPD, which increased the risk from their perspective. One EC was also concerned that their profit margins would be dictated by the rest of the IPD team, through processes such as value engineering.

5.1.2: Is IPD the Future of the Construction Industry?

As a whole, the willingness of the respondents to pursue IPD was dependent on their knowledge and experience with other members of the project team. Three respondents felt that IPDs early collaboration efforts would eventually allow it to achieve wider adoption as in the case of design-build. IPD also allows stakeholders to produce a higher quality facility in less time, thereby increasing ECs' profit margins.

5.1.3: Are ECs Willing and Able to Pursue IPD?

The majority of respondents expressed that they would not be willing to pursue an IPD training program, because they were not sure if their organization had the potential to achieve success with IPD. Another respondent pointed out that it would be difficult to offer IPD training, since they do not have any employee who has the knowledge to offer IPD training and/or internships. This respondent went on to say that there is not enough historical data from successful projects that show the potential to increase the profit potential of ECs. The respondents also emphasized the fact that IPD is mainly utilized on large/complex projects. They went on to say that ECs who lack experience with large/complex projects would not be as willing to pursue IPD.

5.1.4: Financial Risks

The respondents were split as to whether IPDs increased upfront investments represented an increased financial risk. They described how these upfront investments would allow other stakeholders to dictate their markup percentages. Respondents who had experience with project delivery systems similar to IPD were more open to increased upfront investments. Another respondent mentioned that a guarantee that they would be able to participate in future IPD projects would be an encouraging factor for them to participate in an IPD project. One respondent also discussed how smaller ECs could take on too much risk with an IPD model, because of the upfront funds required for shared risk/reward contingencies. This was due to the fact that the small volume of work these ECs complete is only enough to cover overhead and a small profit. As a result, there is no money available for the extra upfront costs required for shared risk/reward contingencies.

As will be discussed later in this chapter, the ECs acknowledged that the concept of higher upfront investments would require a mindset change.

5.1.5: Issues with Shared Risk/Reward

The expressed issues with insurance and shared risk/reward incentives were largely dependent on the terms and conditions of the contract. Other issues with shared risk/reward included not being part of the team that set the initial contingency percentages, and not being aware of how much profit is at stake in the event of cost overruns. In the context of the economic downturn in recent years, the majority of respondents were open to the idea of pursuing IPD in order to expand their services and become more profitable. However, these same respondents also felt this would be much more difficult for ECs with no experience on large/complex projects.

5.1.6: Issues with BIM

ECs with no BIM experience were asked if they could anticipate any issues with utilizing the technology, given that it is a requirement for IPD projects. They acknowledged the benefits of BIM, but felt it was better suited for contractors who work on large, complex projects. They went on to say that there is simply too much time and money required to update files, integrate the systems, and input data. The ECs with prior BIM experience stated that there could be potential issues with incorporating 4-D layers, due to the fact that there could be other contractors using older versions of software.

5.1.7: Legal/Liability Risks

Three ECs openly stated that IPD's potential legal issues were significant enough to prevent them from participating. The remaining four respondents had concerns, but generally felt that any potential legal issues were dependent on the other members of the project team—if they are comfortable with the stakeholders' qualifications, much of the legal risk is eliminated. These qualifications include reputation, financial stability, and prior working relationships.

5.1.8: Unions and IPD

In the last set of questions, the ECs stated that local unions would support an IPD model. In fact, they felt unions would be open to any opportunities that would make ECs more

successful. One of the respondents also discussed the tradeoff between the lower labor cost of open-shops, and the higher level of quality and productivity seen in closed-shops. Open-shops may have lower labor costs, but the decreased quality and productivity may cost the EC more money in the end. However, it should also be mentioned that two respondents felt that open-shops are better suited to complete prefab work, due to their lower labor rates.

5.2: Recommendations to Address the Issues and Risks for Non-Experienced ECs

This section will introduce the two main issues/risks that surfaced as a result of the interviews with non-experienced ECs, and then provide specific recommendations to address these issues/risks. Please note that these recommendations will not propose changes to the IPD process itself, as stated in Section 1.6.

5.2.1: Issue 1: Lack of Collaborative Reputation and Skill Set

The interviewees were not willing to pursue IPD unless the other stakeholders had a favorable reputation throughout the AEC industry. These favorable aspects included experience with IPD or similar collaborative delivery methods, experience with BIM, prior successful business relationships with the EC, ability to avoid "claim situations," etc.

It should be noted that the ECs made the favorable aspects of the other potential stakeholders a condition to participate in IPD. From their perspective, if this condition was met, many of the perceived risks of IPD were eliminated. Even the ECs who did not currently have these favorable aspects implemented within their own organization still wanted the other potential stakeholders to have them. ECs cannot control the reputation of other stakeholders, but they can enhance their own collaborative skills, and improve their reputation throughout the AEC industry.

5.2.2: Recommendations to Address Issue 1

5.2.2.1: IPD Mindset

The principles and processes of IPD are fundamentally different from any other project delivery system. Rather than being motivated by self-interest, the project team must be united by,

and work towards achieving the goals of the owner (Chuck Thomsen & Sanders, 2011). The respondents with IPD experience also recalled the challenges of switching to an "IPD mindset" when discussing how they originally became involved with the delivery method.

ECs interested in pursuing IPD must be aware of these differences, and approach the project with a different mindset from what they are used to with traditional delivery methods. IPD requires increased effort by ECs in order to put differences aside and work through problems when they arise. They also need an understanding of what all stakeholders are trying to accomplish, essentially working from the role of the engineer, project manager, and budgeter.

Therefore, ECs who are willing and able to pursue IPD should first gain experience with large/complex projects and collaborative delivery methods commonly used in conjunction with IPD. Although this will not change the reputation of other stakeholders, it will give them experience with many of IPDs established processes and procedures— factors that enabled the experienced ECs to pursue their first IPD project. This experience will also give the ECs more opportunities to form new business relationships with organizations that could potentially be future IPD partners. Specific recommendations for ECs to gain more experience with large/complex projects and collaborative delivery methods, will be discussed below.

5.2.2.2: Behavioral Principles

IPD relies on specialized stakeholders who must unite and work as a team in the best interest of the project. In addition to understanding the means and methods of their trade, ECs must also recognize the behavior of these stakeholders, in order to utilize IPD to its full potential. (Chuck Thomsen & Sanders, 2011).

Leaders in collaborative organizations first need to understand how to set goals that will allow the team to be successful. Teamwork can suffer when unattainable goals are set or stakeholders are subject to excessive criticism. Managers must find the correct balance of work for the team. Performance can suffer if there is not enough people assigned to a certain task or if

there are too many people on a job competing for similar tasks. They also need to be open to all stakeholders' ideas, regardless of their expertise (Chuck Thomsen & Sanders, 2011).

For example, take the relationship between architects and construction managers. Construction professionals are expected to turn the creative "vision" of architects into reality, but also must consider many other variables including constructability, price restrictions, schedule, etc. In contrast to the architects creative expertise, construction managers often rely upon traditional construction means and methods to deal with all these variables and still present a finished product that is acceptable to the owner (Chuck Thomsen & Sanders, 2011).

In order to manage this conflict of interest in a collaborative environment, architects need to acknowledge that construction managers rely on this consistency, and are less concerned with creativity and innovation. In turn, construction managers need to respect the designer's vision, and implement their ideas whenever possible (Chuck Thomsen & Sanders, 2011).

5.2.2.3: Process Improvement /Collaboration Techniques

Companies that are successful with IPD also focus on continuous process improvement, cutting edge technology, and innovative collaboration techniques (Chuck Thomsen & Sanders, 2011). This can include BIM, prefabrication, project management information systems, and lean construction principles such as continuous improvement, The Last Planner System, and target value design. IPD also shares many of these same concepts. For example, IPD's shared risk/reward incentives are very similar to Lean Construction's "stretch targets award incentives," as described in Section 2.10. ECs interested in pursuing IPD should first implement as many of these techniques as feasible.

This was also reiterated by the interviewees with IPD experience, when discussing how they originally became involved with IPD. Their organizations had many of IPDs processes and procedures in place prior to being accepted onto the IPD team, due to their experience with collaborative techniques. They went on to say that this was necessary in order to establish credibility as a qualified stakeholder. For example, they discussed how prefabrication gave the

respondents a competitive advantage amongst other ECs. They went on to say that IPD also gave them more opportunities to complete prefab work, due to the high level of collaboration.

5.2.2.4: Experience with Project Types Ideal for IPD

ECs should also gain experience with the types of projects that commonly utilize IPD before they pursue their first "true" IPD project. In theory, IPD could be utilized on any construction project, as long as the team is committed to the cause. However, the interviews and outside research conducted in the course of this study revealed that all "true" IPD projects have been large/complex in nature, demanding the highest level of collaboration. The ECs also expressed that BIM was better suited for large/complex projects, so pursuing these project types will also allow the EC to gain experience with the technology.

5.2.3: Issue 2: Insurance

When asked about IPD's legal liability risks, the respondents discussed issues with obtaining insurance for IPD projects. One EC stated that there are many legal issues on construction projects that can only be solved through a costly litigation process. This respondent went on to say that the language of the contract and the amount of potential liability would be significant factors for insurance.

5.2.4: Recommendations to Address Issue 2

5.2.4.1: Optimum Insurance Arrangements for IPD

Professional liability insurance would essentially protect ECs from errors and omissions caused by the design team. Its importance on collaborative projects has been recognized by the EC Industry since the year 2000. As discussed in Section 2.11.3, a study by the Electrical Foundation sought to aid ECs interested in pursuing design-build (a relatively new delivery system at the time). This was achieved by determining their educational needs and developing a curriculum to help them be successful with design-build. The respondents rated the importance of professional liability insurance for stakeholders on a design-build project. On average, the

respondents gave it a rating of 3.2 which is between "Somewhat important" and "Very important" (Rowings, et al., 2000).

The interviewees in this study also emphasized the importance of professional liability insurance for all construction projects. They discussed how organizations who participate in design-build work that lack this insurance coverage shift a good amount of liability to the owner; and how this situation is exacerbated with an IPD model. One EC with IPD experience mentioned that the best approach to insurance would be to join together as a project team and purchase a single insurance package. For example, "Wrap Up" insurance has the potential to work well with an IPD model, given that a single package covers all stakeholders on a given project (see Section 2.7 for more details).

5.3: Summary of Responses for ECs with IPD Experience

5.3.1: How the Company Decided to Pursue IPD

The respondents with IPD experience first discussed how they originally became involved with the delivery system, and the performance of their latest IPD project. They expressed that prior relationships with key stakeholders (especially the GC) was a major factor that allowed them to participate in their first IPD project. They went on to say that the GC was the best stakeholder to have a prior relationship with, because of their important role during the construction process. The ECs also mentioned that previous experience with collaborative delivery, and project types that are ideal for IPD (such as large medical facilities) allowed them to pursue their first IPD project.

The interviewees were then asked how their organization had to change in order to be successful with IPD. In general, the ECs had to be much more involved with all project stakeholders. This includes increased communication, incorporating feedback into their decision making, and removing adversarial relationships with other stakeholders. For example, in "Clash detection," they needed to put differences aside and work through problems when they came up.

5.3.2: Performance of the Latest IPD Project

All of the respondents expressed issues with the project schedule on IPD projects, although this question set also asked the interviewees to discuss any issues with the budge. As one EC described: "We are losing time because if we want to move one object, thirty people have to agree on it. Everyone on the entire IPD team should not have to review every single change. The best people should be in charge of their specialty area and there has to be some level of trust."

The ECs also reiterated the importance of an excellent GC for IPD projects. On one project, issues involving the GC (along with other secondary stakeholders), caused delays to contract negotiations and finalizing a budget. For instance, the respondent described how the GC did not have adequate experience with collaborative delivery systems, and was unable to collaborate with the team to produce an appropriate budget.

5.3.3: General Information for Involvement in the Latest IPD Project

In this category of questions, the respondents continued to discuss their involvement with prefab, as well as the type of work they performed on their latest IPD project. All the ECs described how they only completed work as an electrical subcontractor for their latest IPD project. However, one EC took the opportunity to discuss contractual issues due to poor performance by another key stakeholder. Specifically, they had difficulty with a GC who was not experienced with important IPD techniques such as facilitating a high level of collaboration, coordination, and BIM expertise.

When asked to describe their involvement with prefab work on their latest IPD project, all respondents emphasized the importance of the technique. One respondent noted that after they completed their first IPD project, they realized that IPD gave them new opportunities for prefab that they never had before. This was due to the fact that IPD allowed ECs to have a better understanding of all project stakeholders' needs.

The respondents also mentioned that it was in their best interest to prefab as much work as possible. This was due to the fact that the technique coincides with their culture of being

problem solvers—instead of writing RFIs and waiting for answers, their goal is to help people make decisions that are in the best interest of the owner and constructability of the project. The flexibility of prefabrication also seemed to help the respondents stay on track with the project's schedule when problems arose. Lastly, the ECs with IPD experience agreed that prefab gave them a much needed competitive advantage in tough economic times.

5.3.4: Contractual Information for the Latest IPD Project

In order to be successful with IPDs contractual arrangements, the ECs expressed how their organization's made an effort to avoid a "Claim situation," because they are aware that if a company is eager to submit claims, they may develop a negative reputation throughout the AEC industry. Furthermore, five of the six ECs stated that they had no more issues with IPD contracts than with traditional contracts. In fact, one respondent discussed a particularly fast contract negotiation period, where the contract was signed two weeks after the interview process. This was due to a number of factors including industry reputation, the schedule of the project, and the willingness of the IPD stakeholders to get the project moving forward without getting caught up in the contract negotiation process.

5.3.5: Shared Risk/Reward Information for the Latest IPD Project

When asked to disclose the contingency percentages for the shared risk/reward program on their latest IPD project, the ECs expressed a wide-variety of responses. When discussing logistics, one respondent described how the budget was established first, and then the shared risk/reward contingency percentages were negotiated with all IPD stakeholders. Another respondent was not involved in this type of program, while another stated that they were not aware of the percentages. The remaining four respondents revealed the following details involving the percentage of bid price required to participate in a shared risk/reward program:

Respondent 1: The MEP and drywall contractors contributed 13.5% of their contract price.

Respondent 2: The EC contributed 5% of their contract price.

Respondent 3: The architect contributed 15% of their contract price, while the MEP contractors contributed 5% of their contract price.

Respondent 4: This respondent was involved in a slightly unusual shared risk/reward incentive program. Although the EC did not have to put up an extra contingency, they were still rewarded for a participating in a project that was completed ahead of schedule, or under budget. Rather than a cash bonus, the owner promised to contract with the EC when additional work became available.

5.3.6: Discouraging Factors for Experienced ECs to Participate in IPD

The respondents then expressed discouraging aspects of IPD, and how they were overcome. Two ECs stated difficulty with establishing a target price as the project is progressing. Pressure to push their prices down in order to reach a target number seemed to affect their ability to work in the best interest of the project. Two of the participants also expressed that a multiparty agreement is not necessary to achieve the goals of IPD. They supported this statement by recalling how they completed lump-sum, hard-bid projects which functioned similar to IPD.

Several respondents mentioned that IPD presented a significant financial risk, for a wide variety of reasons. Like the non-experienced respondents, the experienced ECs stated that working with an IPD team who they did not have experience completing successful projects with in the past was a major risk. However, they also mentioned that a strong GC with good knowledge of IPD and BIM would eliminate some of this risk. A few respondents also mentioned the fact that there is a lack of "pure" IPD projects," and lacking financial data for these projects, which increased the risk from their perspective.

Several ECs mentioned that being successful at IPD will require their organization to shift to an "IPD paradigm." They described how this could be a difficult talk because many people are accustomed to operating under traditional project delivery systems which did not require them to understand the viewpoints of all project stakeholders.

Lastly, the participants were asked to respond to the fact that opponents of IPD argue that a multiparty agreement is not necessary to achieve the goals of the delivery method. Two respondents agreed with the statement, recalling how they completed lump-sum, hard-bid projects which functioned similar to IPD.

5.3.7: Encouraging Factors for Experienced ECs to Participate in IPD

Increased productivity and reduced costs were major encouraging factors for the respondents to participate in IPD projects. The ECs also felt that IPD's "Team focused mentality" has the potential to increase the productivity and overall quality of the project. They noted that with IPD, problems are approached as a team, rather than attempting to shift them to another stakeholder. Many of the interviewees also liked the fact that IPD focuses on positive business relationships. The ECs saw the benefit of this in the form of new business continuity and partnerships with project stakeholders.

When asked to discuss their thoughts on multiparty contracts, three ECs felt that it was an important aspect of IPD. They went on to say that the arrangement has the ability to shift the mindset of stakeholders away from traditional methods, where adversarial relationships are common, and disagreements are often resolved in the legal system.

Finally, the respondents were asked to discuss their thoughts on IPD insurance arrangements and union vs. non-union labor. None of the respondents identified issues with insurance on IPD projects. However, one respondent noted that the best approach to insurance would be to join together as a project team and purchase a single insurance package. The majority of respondents felt that closed-shops could be just as effective on an IPD project as open-shops. For example, one EC stated that the high level of education, training, and compensation offered to the union workers contribute to a more efficient and higher quality project outcome. In the respondent's mind, this made up for any cost savings a non-union contractor would see in the form of reduced labor rates.

5.3.8: BIM Specific Questions

The interviews were concluded by discussing building information modeling (BIM) with the participants. Four of the six respondents felt that there is a general lack of BIM education and training for IPD stakeholders. BIM specialists and design engineers traditionally complete this modeling work, however they have no experience installing electrical equipment. Two respondents recognized the need to bridge this gap by providing BIM education and training to key stakeholders from every trade.

The respondents acknowledged BIM's potential to improve project efficiency and reduce installation costs. However, they also mentioned BIM's potential to be wasteful if used inefficiently. As a general note, one EC suggested that the size of the project is the most significant factor—unless a project is large and complex, creating a BIM model is not necessary.

To allow BIM to be used to its full potential, one respondent suggested that it would be useful if all IPD stakeholders could work in the same software platform. Currently, the various trades utilize different software platforms which optimize their work, creating compatibility issues. Utilizing BIM more efficiently should include coordinating with the appropriate stakeholders on a weekly basis to examine which BIM options have the best value, and to perform clash detection.

5.4: Recommendations to Address the Issues and Risks for Experienced ECs

Sections 5.1 and 5.2 discussed issues/risks of IPD that the non-experienced ECs expressed, as well as several recommendations to address those issues/risks. Despite the expressed issues/risks, the ECs largely agreed that they would be willing to pursue IPD, as long as they had previous experience and/or favorable knowledge of the other team members. However, many of these same ECs did not possess the favorable qualities they set as a prerequisite for the other team members. Given this, the goal of the recommendations for non-experienced ECs was to "prepare" them to be successful with IPD. In other words, the recommendations were in line with the favorable characteristics of the experienced ECs which the non-experienced ECs did not possess.

This section will address recommendations to address the issues/risks the experienced ECs expressed. However, it should be noted that the majority of the expressed issues/risks involved the IPD process itself and/or the performance of other IPD stakeholders—issues that are beyond the scope of this research, and that will be discussed in Section 5.5 (Future Research) where applicable. Therefore, the recommendations in this section will be limited to issues with BIM and negotiating IPD agreements (contracts), which are the only issues that are within the control of the ECs and thus can be potentially addressed following the recommendations below.

5.4.1: Issue 1- Lack of BIM Education & Training for IPD Stakeholders

The experienced ECs discussed how there is a general lack of BIM education and training for IPD stakeholders (e.g., BIM specialists and design engineers traditionally complete modeling work; however they have no experience installing electrical equipment). BIM has the ability to assist project stakeholders in performing pre-planning and pre-fabrication, as well as improving overall productivity. As a result, ECs have the potential to save up to 15% of their total bid price, simply by having a comprehensive understanding of BIM (Simonian & Korman, 2011). Research has also shown that ECs are at a disadvantage during the MEP coordination process because of their lack of BIM knowledge (Simonian & Korman, 2011).

5.4.1.1: Recommendation to Address Issue 1- BIM Education &Training for Key Stakeholders

Based on the input obtained during the interviews, ECs interested in pursuing IPD need to "bridge the gap" by providing BIM education and training to key stakeholders from every trade. In addition to MEP contractors being considered key stakeholders, skilled technicians/craftsman coordinating and installing work out in the field, vendors, and manufactures should also have the key stakeholder designation (See Section 4.2.7).

Ideally, this training would specifically be aimed towards the Revit Structure, and would be facilitated by Autodesk. A 2010 report by the American Society of Civil Engineers (ASCE) described such a training scenario in a report entitled "Implementing BIM at the Firm Level." It

described how one company held Revit Structure Training (RST) about once every 2-3 months, depending on the team's level of knowledge (Harrington, 2010).

5.4.2: Issue 2-Negotiating IPD Agreements

As mentioned in Section 2.5, negotiating an IPD agreement is one of the most important events on an IPD project, due to the fact that it is the team's first collaborative endeavor. The results of this experience will also have a profound effect on the project as it unfolds. Although the majority of the respondents with IPD experience stated that they had few issues with negotiating IPD agreements, they acknowledged the potential for issues to arise in the future. Furthermore, some of the issues they had with other project stakeholders in some projects can be attributed to how IPD agreements were negotiated and formed in those projects. It should also be noted that not all of these respondents had utilized a multiparty agreement. For this reason, a four step "Best practices" process has been recommended, based on research conducted by legal experts specializing in IPD agreements.

5.4.2.1: Recommendation to Address Issue 2: Four Step Process for IPD Negotiations

The first step in the process is holding an IPD workshop prior to the actual IPD contract negotiations. This allows project stakeholders to focus on the most important issues, resulting in a much easier and streamlined contract procurement process. First, the workshop will identify what IPD is, why it has been successful, and how it is fundamentally different from traditional project delivery systems. By having this common level of knowledge, stakeholders can focus on issues that will make the IPD agreement successful, speeding up the overall process. It is also useful to have a skilled facilitator with IPD experience during the contract negotiation process (Ashcraft, 2011).

During step two, stakeholders should hold a discussion of their genuine interests and concerns, and document it for successive negotiations. The overarching goal of the agreement should be to develop a project where all stakeholders benefit by its success, and are equally

determined to avoid its failure. To accomplish this, the interests of any stakeholder cannot be hidden or ignored (Ashcraft, 2011).

Next, a key terms summary is created by defining the key elements of the commercial terms. This summary should concisely describe the central points in the parties' agreement, as these important elements could get lost in the details of the final contract (Ashcraft, 2011).

The last step is to carefully examine the key terms summary, and create a contract that fully expresses the agreement it documented. Ideally, the result of this process will produce a contract that aligns the parties' interests, as well as a tool to help manage the project (Ashcraft, 2011).

5.5: Future Research

This section discusses potential areas of future research that were identified during the course of this study. They are based on interview responses and the literature review conducted by the researcher.

5.5.1: Lack of Data for Existing IPD Projects

As the Problem Statement discussed in Chapter 1, for traditional project delivery systems (design/bid/build, design/build, and CM at risk), research has studied risk allocation, advantages and disadvantages of each system for a given situation, and areas of concerns and conflicts. Being a new project delivery system, IPD has not been adequately researched in order to determine these (Ozbek & Youssef, 2010).

Several of the respondents with IPD experience also mentioned that fact that there is a lack of hard financial data for existing IPD projects. In their eyes, this represented an increased financial risk that discouraged them from participating in IPD. They went on to say that this lack of data also makes it more difficult for owners to consider IPD in the project conceptualization phase.

In 1998, a study entitled "Comparison of U.S. Project Delivery Systems" analyzed the three main project delivery systems used at that time: CM at risk, design-build, and design-bid-

build. The study empirically compared cost, schedule, and quality performance using project-specific data collected from a large number of projects in the U.S. (Sanvido & Konchar, 1998). The result was a useful benchmark for project delivery research thereafter. Ideally, a similar study should be conducted which includes IPD, so potential IPD stakeholders can better understand which circumstances are ideal for the delivery system. However, a sufficient number of IPD projects need to be completed prior to this research, in order to have enough reliable data.

5.5.2: Can IPD be Implemented by Smaller ECs and/or on Smaller Projects?

The respondents with no IPD experience felt that smaller ECs would not become more profitable, simply by including IPD in their business model. As one respondent explained "They are going to have to add additional overhead that's going to offset their margins from their low volumes. So you definitely get into a larger contractor before it's [IPD] going to be more profitable." Overall, they felt smaller ECs simply don't have the resources, and that the complexities of IPD projects are beyond what the smaller contractors are used to. Surprisingly, the ECs with IPD experience felt that IPD could work on smaller projects. One EC even went so far as to say "This is the approach we want to use on all our jobs in a perfect world." Another EC discussed how they were starting to utilize BIM on smaller projects, due to contractual obligations.

"True" IPD projects are normally large/complex in nature, and are completed by larger ECs. For example, all of the respondents in this study had annual revenue exceeding $25 million. Therefore, the possibility of smaller ECs utilizing IPD to complete smaller projects should be explored in future research.

5.5.3: Defining IPD

Based on the interviews conducted in this study, ECs will be more likely to pursue the delivery system if the definition of IPD is better understood throughout the AEC industry. Both

categories of respondents stated that the lack of "pure" IPD projects discouraged them from participating in the delivery system.

As discussed earlier in this chapter, the AIA has published two reports which highlight eleven "pure" IPD projects which were built successfully. However, these reports were somewhat unknown amongst the ECs interviewed. The electrical contracting industry could conduct similar IPD case studies from their point of view. This would answer many of the outstanding questions ECs have with IPD processes.

5.5.4: Too Many Stakeholders Involved with Changes

Research should be done to discern how to effectively manage the input of the large number of stakeholders normally involved on an IPD project. The interviewees expressed schedule issues due to the large number of stakeholders involved on project changes. This made it difficult for everyone to agree on each change, causing a significant delay to the schedule. For example, one respondent who completed a large medical facility described how even the doctors and hospital staff were involved with many project changes.

5.5.5: Establishing Target Price

Research should be conducted in order to address difficulties in establishing a target price as an IPD project is progressing. The ECs expressed difficulty with this issue, as pressure to push their prices down in order to reach a target number seemed to affect their ability to work in the best interest of the project.

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Appendix I: Recruitment Flyer

Help Us Make Integrated Project Delivery (IPD) Work For You!

IPD Uncertainties

With your help, we would like to answer many of the questions electrical contractors might have about IPD such as:

- Is IPD the best choice for project delivery?
- How do I get paid?
- Is my company compromising its proprietary information?
- Has IPD worked well in the past?
- Are there any legal ramifications?
- Is the contract language suitable for electrical contractors?
- How will IPD benefit my company?
- Do owners want to use IPD?

Not only does our research have the potential to benefit your company, it will also benefit Colorado State University's brand new student chapter of NECA. Currently we are in the process of new student member recruitment and would love to have more industry involvement. Thanks for your input!

For more information and to participate please contact:

Freddy Lewis: flewis@lamar.colostate.edu

or

Dr. Mehmet Ozbek: meozbek@cahs.colostate.edu

Colorado State University

Department of Construction Management

With a Grant From:

NECA

ELECTRI INTERNATIONAL

THE FOUNDATION FOR ELECTRICAL CONSTRUCTION INC.

IPD Quick Facts

Mutual Reward

IPD allows all stakeholders involved have mutual rewards. This means when a project finishes under budget or ahead of schedule, everyone would receive a portion of the cost savings. This creates an environment where all parties have an incentive to do what is best for the project.

Time and Cost Savings

Because of the advanced planning in preconstruction and collaboration during project design, IPD projects can have more prefabricated materials, and less onsite troubleshooting. The end result is a higher quality project built in a shorter period of time with reduced costs.

Building Information Modeling (BIM)

BIM is a critical tool for IPD. This technology can drastically improve collaboration among a wide range of expertise needed to design and construct a building and to increase efficiency. Once construction is complete, BIM is also a valuable asset to the owner.

Appendix I: Recruitment Flyer (Cont.)

Ever wonder what it would be like to work on a project with no RFIs? No change orders? No time lost, money lost? IPD has the potential to make that possible.

These flow charts show the core differences between traditional project delivery and IPD. In essence IPD brings the owner, contractors, and subcontractors together in the design phase. This allows conflicts and inconsistencies to be worked out before construction begins, resulting in fewer RFI's and change orders.

Students and faculty in the Construction Management Department at Colorado State University are currently conducting research in an effort to acclimate electrical contractors to the IPD process. Input from industry professionals such as yourself (in the form of a future survey and interview) will be an extremely important part of our research.

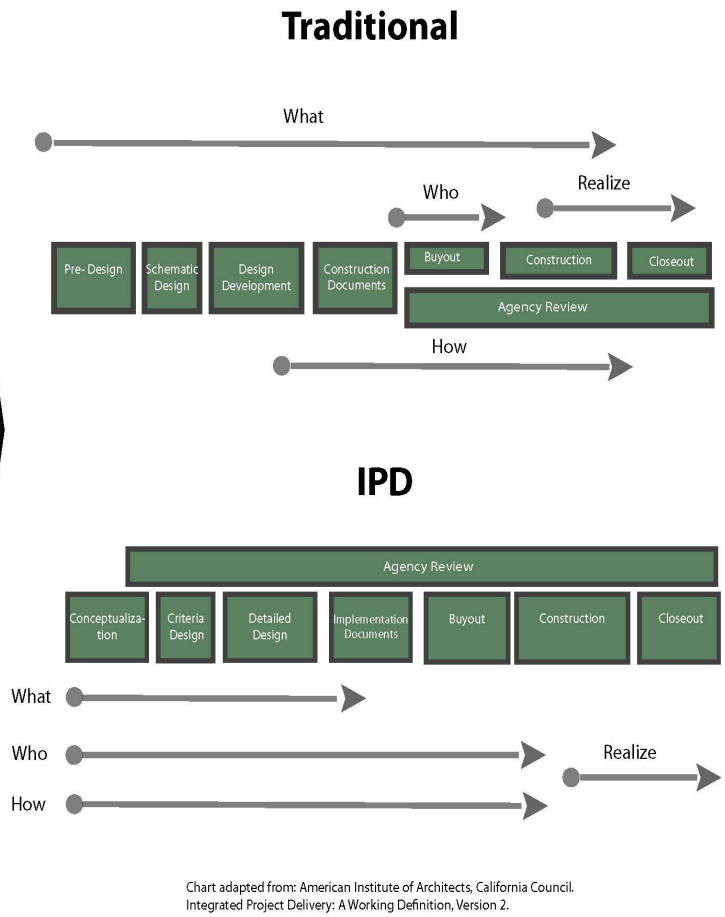
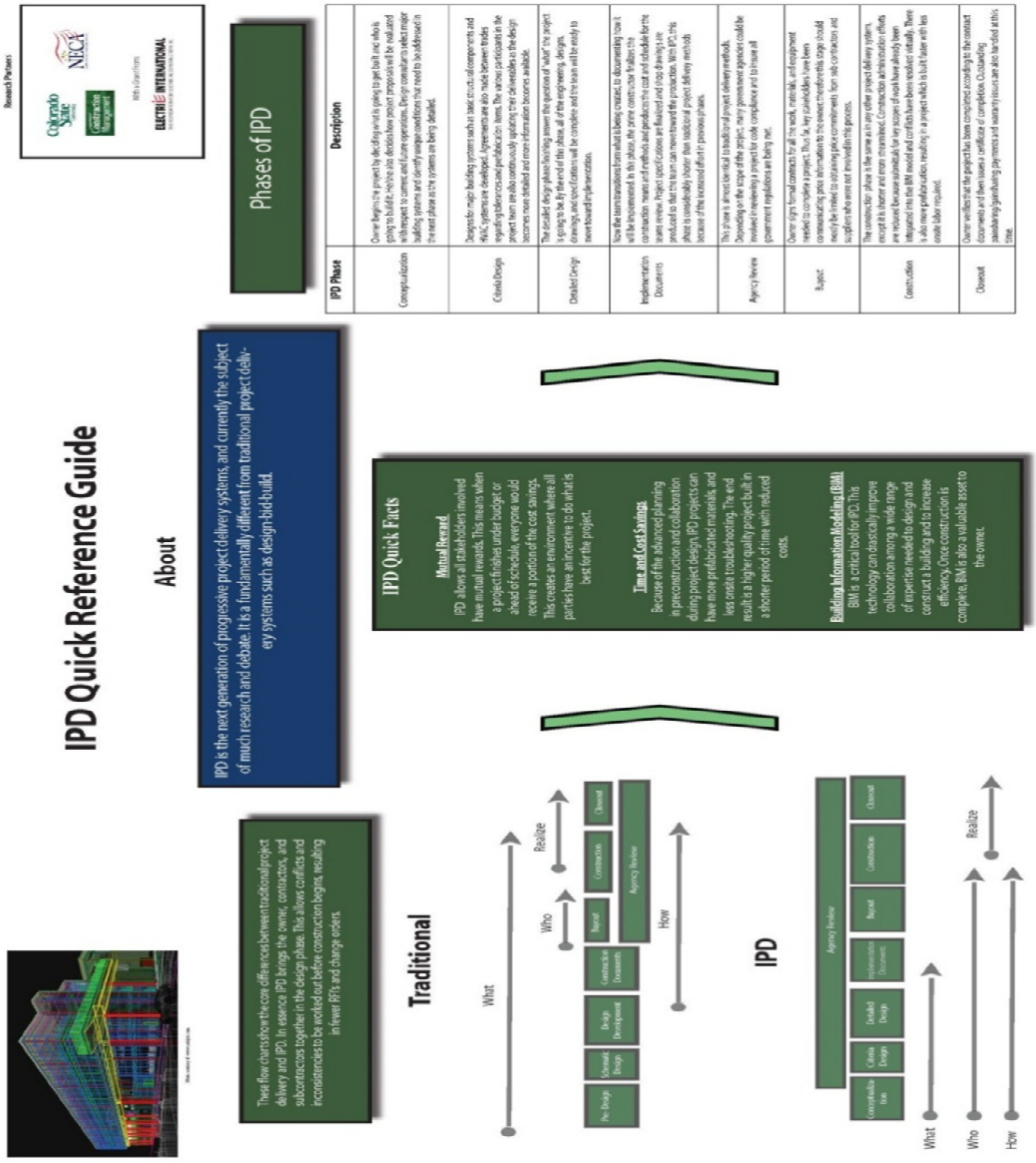


Chart adapted from: American Institute of Architects, California Council. Integrated Project Delivery: A Working Definition, Version 2.

Appendix II: Recruitment Poster



Appendix III: Phase I Recruitment Email

Dear NECA Contractor:

You may have met one of our Colorado State University NECA Student Chapter officers at the Boston Convention. They were seeking your interest in participating in the ELECTRI International funded study entitled "Involvement of Electrical Contractors in Integrated Project Delivery."

On behalf of the NECA Student Chapter at Colorado State University, we would like to thank you for stating your interest to participate. We just wanted to inform you that you will receive a short electronic survey through which we will be able to categorize your company based on its size, region, work areas, etc. This will enable us to sample a representative population of contractors within NECA to interview subsequently.

Please feel free to contact us if you have any questions at this point.

Regards,

Mehmet E. Ozbek, Ph.D. (Faculty at Colorado State University and Principal Investigator for this study) <mehmet.ozbek@colostate.edu>
Freddy Lewis (Graduate Student at Colorado State University and NECA Student Chapter Officer) <flewis@lamar.colostate.edu>
Michael Burrows (Undergraduate Student at Colorado State University and NECA Student Chapter Officer). <mburrows@rams.colostate.edu>
Drew McLeod (Undergraduate Student at Colorado State University and NECA Student Chapter Officer) drewmcleod@gmail.com

Appendix IV: Phase 1 Survey Questions

1A. Which Company are you representing?

1B.What is the location of your company?

2. What is your name?

3. What is your email address?

4. What is your company's current number of employees?

5. What was your company's revenue in 2009?

6. Is your field staff union or non-union?

For questions 7 and 8, please indicate the percentage of work your company performs in the given category:

7. As a general contractor

8. As a sub-contractor

For questions 9-15, please indicate the percentage of work your company performs in the given category.

9. Traditional power/lighting

10. Power Quality

11. Communication systems/ connectivity

12. commercial, industrial, institutional automation and controls

13. Residential Automation and Controls

14. Alternative Energy/Green/Sustainable

15. Preassembly/Prefab of Electrical Components or Radiant/Electrical Heat

For Questions 16 and 17, please indicate the percentage of work your company performs in the given category (please make total= 100%).

16. Public/ government projects

17. Private projects

18. Have you heard of the new project delivery method called Integrated Project Delivery (IPD)?

For questions 19-22, please state what percentage of projects your company utilizes for the specified project delivery method.

19. Traditional design-bid-build

20. design-build

21. IPD

22. Other (if applicable)

23. In what percentage of projects does your company utilizes Building Information Modeling (BIM)?
24. Is your company involved in providing preconstruction services to the owners?

25. Which of the following categories of software programs does your company utilize?

- Takeoff/estimating, scheduling
- Computer Aided Design (CAD)
- electronic document management
- none of the above

Appendix V: "No Experience" Interview Questions

Please answer these questions based on your knowledge of IPD. Our goal is to identify any potential issues or risks you as an electrical contractor could experience while participating as a stakeholder in an IPD project. If there is a question you don't understand, feel free to stop me at any point for clarification, or contact me prior to the interview. I have access to various documents which clearly explain the principles and processes of IPD in more detail, so please let me know if you would like me to send them to you:

Open-Ended Questions to Identify Positive & Negative Perceptions of IPD

1. Is there any aspect of IPD which would discourage you, as an electrical contractor from participating?
2. Is there any aspect of IPD that would encourage you as an electrical contractor to participate?

Is IPD the Future of the Construction Industry?

3. Research by ELECTRI International found that the percentage of electrical contractors' revenue generated by design build projects has increased in recent years. Based on this information, do you feel the electrical contracting industry will experience similar results for IPD projects in the future?
4. Research suggests that although less than 20 IPD projects have been completed in the United States, they have been largely successful (Maisel, et al., 2010). With this in mind, how many more successful IPD projects would you like to see before you would commit to work on an IPD project? Options= 0, 10, 50, 100, over 100

Are ECs Willing and Able to Pursue IPD?

5. There are several engineering, architectural, and construction firms that have "IPD Internship" programs which seek to acclimate young professionals with the IPD process. Furthermore, NECA offers design-build training courses such as "Design-Build Contract and Risk Management." Creating internship programs and training courses in the EC industry could help acclimate everyone to this new project delivery system. At this point in time, do you think the EC industry is willing and able to put forth the time and expense for these techniques?
6. IPD requires electrical contractors to collaborate with project stakeholders throughout the entire project life-cycle. As a result, electrical contractors with limited scopes of work are involved with a project for a longer period of time, compared to traditional project delivery methods. Simply looking at this aspect, would you as an electrical contractor, be willing to put in this extra time on projects that utilize IPD?

Financial Risks

7. For electrical contractors (ECs), IPD requires a higher upfront labor cost for engineering input in the design phase, creation of a BIM model, etc. However, the benefits of IPD such as more accurate quantity estimates and vendor price quotes, better trade coordination leading to reduced errors in the field, and increased prefab abilities can cover, and potentially exceed these upfront costs by the end of the project. Based on this information, do you believe your company would be willing and able to incur these higher upfront costs with a potential of a greater overall return on investment (Maisel, et al., 2010)?
8. Since the downturn of the economy in recent years, many ECs have downsized simply to stay in business. However, companies that are willing and able to participate in IPD projects and expand their services to include this project delivery system could become more profitable. Do you agree with this statement?

Issues with Shared Risk/Reward

9. IPD contracts are structured so that all stakeholders risk a certain percentage of their profits based on the success of the project, which gives everyone an incentive to act in the best interest of the project. Usually, a technique called "shared risk/reward" is used where project stakeholders put up a contingency prior to the project start date. If there are cost under runs, the contingency will be reimbursed to the stakeholder, and they will also be given a bonus based on a percentage of profit predetermined by the original contract (gainsharing). This gainsharing benefit to cover, and potentially exceed the upfront contingency cost may not be fully realized until a project is completed.
However, project stakeholders may opt out of shared risk/reward, in which case the owner would receive any bonuses or be responsible for any cost overruns. Based on this information, would you, as an EC be willing to participate in shared risk/reward?
10. Generally, the owner would be in charge of determining the criteria, amount, and distribution date of incentives. Does this present a conflict of interest to you? Would a third party be more appropriate?

Issues with Building Information Modeling (BIM)

11. If no BIM experience…would the fact that BIM must be used on IPD projects affect your decision to participate?
Yes to BIM experience: Has your company experienced any problems or issues with BIM on any project (compatibility with existing software, lack of knowledge, etc.)? If so, how could BIM be a better fit for ECs?
Legal/Liability Risks

12. The legalities and risks of some IPD aspects have not fully been tested in court. Some of these include boilerplate multi-party contracts, insurance coverage, and Limited Liability Companies. Strictly from a legal perspective, would you be willing to participate in an IPD project?
13. Based on your knowledge, can you identify any problems with obtaining insurance to cover the risks inherent in IPD projects?
14. Would you like to have the project team having previous IPD experience as a required condition to work on an IPD project?

Unions and IPD

15. IPD projects are better suited for prefab work because of the increased collaboration in the design phase. Research by ELECTRI International has shown that open-shop companies could be more able to do prefab work because they have the flexibility to have non-union employees work on prefab work while the union employees are out on the jobsite. (Although, it should be noted that not all unions allow union employees to work in an open shop).
With this in mind, do you think a closed shop, open shop, or a mixture of both would be better suited for IPD? Why?
16. Do you think unions in your area would support IPD? Why or why not?

Appendix VI: "With Experience" Interview Questions

How the Company Decided to Pursue IPD

1. Can you talk a little about how your company got started with IPD:
-How did your company arrive at the decision to pursue this new project delivery system?
-How did your company get involved with its first IPD project? How were you selected? Are you aware of the selection criteria used for the EC?
-How did your company have to change in order to be successful with IPD projects? What was the hardest part about this transition from utilizing traditional project delivery methods to IPD? If you could do it all over again, what would you do differently?

Performance of the Latest IPD Project as a Whole

For the latest IPD project your company **completed…**

2. Did the project perform well in terms of timeline for completion, budget, completion of project goals, etc.?
3. At any point was your portion of the project behind schedule or over budget? If so, how was it dealt with?

General Information for your Involvement in the Latest IPD Project

For the latest IPD project your company **completed…**

4. Was your company only involved in completing electrical work as a subcontractor?
-role in the project (work that you performed)
- After you were selected as part of the IPD team, how long did it take for you to sign the contract and start receiving payments for work completed?
5. Did you complete prefab work? If so, how much and what type? Is this amount/type typical, or unique to IPD projects?

Contractual Information for your Latest IPD Project

6. Was there a lengthy period of contract negotiations prior to the start of the project?
7. What type of contractual agreement was used on the project?
-Project alliance
-Single purpose entity (corporation, limited liability company, limited liability partnership, etc.)
-Relational contract. Which one was used (AIA, ConsensusDoc, etc.)? Did you see any shortcomings in the contract?
8. Was there a guaranteed maximum price?
9. Who reviewed the contract documents prior to the start of the project (attorneys, insurance carriers, surety, other risk management professionals)? Do you know if they had any objections, additions or recommendations?
10. Has your company filed any claims on **any** IPD project?

Shared Risk/Reward Information for your Latest IPD Project

11. With IPD, an incentive called "shared risk/reward" is used where project stakeholders put up a contingency prior to the project start date. If there are cost underruns, the contingency will be reimbursed to the stakeholder, and they will also be given a bonus based on a percentage of profit predetermined by the original contract.
Were you involved with "shared risk/reward?" How much was the initial contingency (in $ or % of bid price).
12. Assuming your company's bonus was based on completion of your goals and the project's as a whole, what bonus were you awarded (in the form of % of bid price for all electrical work-initial shared risk/reward contingency)? [if not ask how the bonus was calculated].
13. Do you know how your bonus compared to other stakeholders on the IPD team?

14. Were any other incentives used on the project for achieving non-cost goals?

Electrical Contractor's Opinions of IPD

From your knowledge and experience of IPD…

15. Is there any aspect of IPD which would discourage you, as an electrical contractor, from participating in this particular project delivery system?
16. Can you identify any aspects of IPD that would benefit you (either financially or non-financially), as an electrical contractor?
17. Opponents of IPD argue that a multiparty agreement is not necessary to achieve the goals of IPD. Do you agree with this? Why or why not?
18. Research by ELECTRI International suggests that open shops could be more successful at completing prefab work because of the flexibility to have non-union workers doing prefab work back in the shop while the union workers are out on the jobsite. Do you agree with this statement?
19. In general, have you been able to collaborate effectively with IPD stakeholders in all project phases?
20. Were your electricians able to complete installations more smoothly with an IPD project?
21. Have you experienced any issues with insurance for IPD projects? (This can include obtaining insurance, coverage, filing claims, liability, etc.)
22. Opponents of IPD argue that IPD is too risky because it is a new project delivery which hasn't been tested in court. Do you believe this to be a significant risk? If so, how did your company justify this increased risk?
23. Which party do you think benefits the most from IPD?
24. Which party do you think has the most risk in IPD?
25. What size and type of project do you think is most appropriate for IPD? Why?

BIM Specific Questions

26. Did your company utilize BIM before it was involved with this latest IPD project?
27. Please describe how your company was involved with creation of the BIM model for your latest IPD project:
-Work completed by an outside consultant or completed in house?
-What type of software was used (Archicad, Revit, etc.)
28. If an outside consultant was hired, would you be interested in training in-house staff members on BIM for use on future projects?
29. What percentage of your project budget was spent on the BIM model? Do you think it was worth the cost in the end?
30. Has your company experienced any problems or issues with BIM on any project (compatibility with existing software, lack of knowledge, etc.)? If so, how could BIM be a better fit for ECs?

Appendix VII: Phase 2 "No Experience" Recruitment Email

Dear ____,

Thank you once again for taking the time to assist the Colorado State University research team (Dr. Ozbek, Michael Burrows and myself), and ELECTRI International in the study entitled: "Involvement of Electrical Contractors in Integrated Project Delivery (IPD)." We have identified you as a prime candidate for our research, and believe your input will benefit both your company and the electrical contracting industry as a whole.

Per our conversation, our interview is scheduled for ____.

I have also attached the following information, which is necessary for your participation:

- Interview questions: These will be the same questions asked during the interview. Feel free to begin coming up with answers beforehand, and collaborating with other electrical contractors if necessary.
- IPD Quick reference guide: This is a single page document which gives a brief overview of IPD to offer assistance in answering the questions if needed. I also have a variety of documents which clearly explain the principles and processes of IPD in more detail, so please let me know if you would like me to send them to you for further reference.
- Formal recruitment letter: The University requires us to send you this informational letter which gives a little more information on our research and the interview process.
- Consent form: The University requires that you provide consent to participate in this study. I have highlighted a specific portion of this form which asks if you consent to me audio recording the interview. I strongly encourage that you provide this consent, in order to complete the interview as quickly as possible and to provide the most accurate information possible. The audio files will be deleted after the research is completed. Please complete this consent form and fax to:

  (970) 491-2473 Attn: Mehmet Ozbek; Or scan and email to flewis85@gmail.com

Please let me know if you have any questions and I look forward to speaking with you.

Sincerely,

--
Freddy Lewis
Graduate Research Assistant
Colorado State University
Department of Construction Management
flewis85@gmail.com
(925) 640-1214

Appendix VIII: Phase 2 "With Experience" Recruitment Email

Dear ____,

Thank you once again for taking the time to assist the Colorado State University research team (Dr. Ozbek, Michael Burrows and myself), and ELECTRI International in the study entitled: "Involvement of Electrical Contractors in Integrated Project Delivery (IPD)." We have identified you as a prime candidate for our research, and believe your input will benefit both your company and the electrical contracting industry as a whole.

Per our conversation, our interview is scheduled for ____.

I have also attached the following information, which is necessary for your participation:

- IPD Background Questions: These ask basic information about your latest IPD project. In the interest of time, please answer as many of these questions as possible prior to the interview.
- Interview questions: These will be the same questions asked during the interview. Feel free to begin coming up with answers beforehand, and collaborating with other electrical contractors if necessary.
- IPD Quick reference guide: This is a single page document which gives a brief overview of IPD to offer assistance in answering the questions if needed. I also have a variety of documents which clearly explain the principles and processes of IPD in more detail, so please let me know if you would like me to send them to you for further reference.
- Formal recruitment letter: The University requires us to send you this informational letter which gives a little more information on our research and the interview process.
- Consent form: The University requires that you provide consent to participate in this study. I have highlighted a specific portion of this form which asks if you consent to me audio recording the interview. I strongly encourage that you provide this consent, in order to complete the interview as quickly as possible and to provide the most accurate information possible. The audio files will be deleted after the research is completed. Please complete this consent form and fax to: (970) 491-2473 Attn: Mehmet Ozbek; Or scan and email to flewis85@gmail.com

Please let me know if you have any questions and I look forward to speaking with you.

Sincerely,
--
Freddy Lewis
Graduate Research Assistant
Colorado State University
Department of Construction Management
flewis85@gmail.com
(925) 640-1214

Appendix IX: Glossary

Building Information Modeling (BIM): BIM utilizes cutting-edge modeling software to create dynamic 3-D models which contain all the information necessary to carry a project from conceptualization all the way to operation and maintenance. In addition to a 3D building model, this technology integrates with scheduling software (4D) and estimating/ budget programs (5D) (Holness, 2008). BIM also provides data to owners which can be useful for space planning, energy performance, and remodeling (AIA, 2007a).

Change Order: A written order to the contractor signed by the owner and the architect, issued after the execution of the contract, authorizing a change in the work or adjustment in the contract sum or the contract time as originally defined by the contract documents, may add to, subtract from, or vary the scope of work (Harris, 2006).

Collaborative Delivery (CD): A set of techniques used to enhance an existing delivery model. Specifically, they include the behavioral principles of mutual respect/trust, willingness to collaborate, and open communication, as shown in Table 2 (AIA, 2011).

Contractor Controlled Insurance Program (CCIP): For CCIPs, the construction manager procures the wrap-up insurance program. This may present an advantage over OCIPs since the construction manager is in a better position than the owner to control the contracting process and potentially obtain greater savings (Hallinan, 2009).

Design Assist: Design-Assist is similar to design-build in that trade contractors (such as ECs) are involved early in the design process to provide value engineering and field detailing expertise. Generally, the in-house engineering group will then review the design to ensure it adheres to good design practice, applicable codes, and any special requirements. The in-house engineering group would also ensure all load calculations are correct prior to final review by other stakeholders. This process allows for a smother communication of design alternatives and gives the owner the benefit of multiple engineering viewpoints (Lane, 2006).

Design-Bid-Build: By sheer numbers, DBB is the most widely used project delivery system in the U.S. today. With this traditional method, the owner first forms a contractual relationship with the design team, who is responsible for producing all of the design documents. Next, the owner solicits bids from contractors to construct the facility according to the plans and specifications. Normally, the owner will choose the "lowest responsible bidder" and then issues a notice to proceed to begin the project (Konchar, 1997).

Design-Build: With this model, the owner has a single contract with the design build team who is responsible for both the design and construction of the project. Team selection can be based on a number of factors such as qualifications, best value, or low price. The team may then subcontract portions of the work to other trades; however those trades will have no contractual relationship with the owner (Jergeas & Fahmy, 2006).

Electrical Contractors (ECs): ECs specialize in the design, installation, and maintenance of electrical and communication systems. They can also be categorized by the type of work they perform, the type of employees they hire (union or nonunion), and whether they assume the role of a general contractor or sub-contractor (NECA, 2010).

Integrated Project Delivery (IPD): IPD seeks to improve project efficiency through increased collaboration, but places more importance on complete and comprehensive collaboration with all

stakeholders, especially in the design phase. Its two defining principles—shared risk/reward incentives and multiparty contracts take a more aggressive approach than other delivery methods, in order to enhance efficiency, and create a higher quality project (AIA, 2007a).

Last Planner System (LPS): The collaborative, commitment-based planning system that integrates should-can-will-did planning (pull planning, make-ready look-ahead planning with constraint analysis, weekly work planning based upon reliable promises, etc. (LCI, 2012).

Lean Construction: Reducing or eliminating waste, adding value, and streamlining workflow. Specific techniques to achieve these goals include continuous improvement, The Last Planner System, and Target Value Design (Thomsen & Sanders, 2011).

Owner Controlled Insurance Program (OCIP): Form of Wrap-Up Liability Insurance program where the owner purchases the policy. OCIPs utilize a "bid deduct" process, where contractors and subcontractors are asked to submit bid proposals that include insurance costs. Once the contracts are awarded, the insurance costs are simply deducted out of the bid prices. This process is facilitated by an agent of the owner known as the "OCIP Administrator" (Hallinan, 2009).

Project Delivery System (PDS): A PDS characterizes construction processes based on the position, and responsibilities of project team members and/or stakeholders. Since the beginning in the 20th century, design-bid-build has been considered the standard benchmark. However, collaboration between project stakeholders eventually began to decrease, resulting in ineffective designs, inflated costs, and an overall adversarial relationship (Sanvido & Konchar, 1998).

Project Management Information System (PMIS): A project management information system (PMIS) is similar to BIM in that it is an internet-based centralized database developed and utilized by the project team. However, rather than contributing to the product (the final 3-D model), a PMIS assists the project team in the process of completing a collaborative project. The specific components of a PMIS are as follows (Thomsen & Sanders 2011).

Shop Drawings: Drawings, diagrams, illustrations, schedules, performance charts, brochures, and other data prepared by the contractor or any subcontractor, manufacturer, supplier, or distributor, which illustrate how specific portions of the work shall be fabricated and/or installed (Harris, 2006).

Target Value Design: A disciplined management practice to be used from definition through construction to assure that the facility is designed within budget and meets the operational needs and values of the users. The process goal is to increase value and eliminate waste (time, money, human effort) (AIA, 2012).

Waste: The opposite of value. There are seven basic types of waste including: defects, waiting, transportation of goods, motion, inventory, overproduction, and unnecessary process steps (LCI, 2012).

Wrap-Up Liability Insurance: Insurance packaged where a single package covers all stakeholders on a given project. If the owner purchases the policy, it is referred to as an Owner Controlled Insurance Program (OCIP). In turn, if the contractor purchases the policy, it is known as a Contractor Controlled Insurance Program (CCIP) (Abdulaziz, 2009).