

CAN DESIGN-BUILD PROJECT DELIVERY FACILITATE GREEN CONSTRUCTION  
PRACTICES?

By

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I thank my parents and grandparents, who have been extremely supportive throughout my college career. I am also greatly appreciative of all of my professors, from both architecture and building construction, throughout my time at the University of Florida.

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Abstract of Thesis Presented to the Graduate School  
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Requirements for the Degree of Master of Science in Building Construction

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Major: Building Construction

Our planet and its population are in a serious dilemma concerning natural resources, energy consumption, and pollution. The construction industry is responsible for a very large portion of the negative effect on our environment in recent centuries. It is the responsibility of current and future construction professionals to convert the trade to a more sustainable industry. The objective of this research was to determine if design-build is a superior project delivery method to facilitate this transition.

The first step was to create a list of perceived advantages of design-build project delivery over conventional project delivery methods. A survey was then developed and distributed to fifty construction professionals who have experience in building sustainable projects.

Their insight, opinions, suggestions, and experiences were used to determine if design-build is indeed a superior project delivery method. The low response percentage made the results inconclusive. However, most of the responses were very supportive of design-build facilitating the transition to a greener construction practice.

## CHAPTER 1 INTRODUCTION

There is a major predicament in the world today and it is a direct result of our uncontrolled and thoughtless expansion, construction, resource depletion, and pollution. Our Earth can not support our current trends of resource consumption, contamination, or population growth. The construction industry and our buildings are responsible for forty percent of our landfill mass and energy consumption. The situation is already beyond repair, but we need to act quickly and effectively to minimize the negative permanent effects of our previous actions. Because the construction industry is such a major contributor to the problem, it needs to be at the forefront of the solution.

To be a part of the solution, designers and builders need to be producing structures that do not deplete resources, do not produce large amounts of carbon dioxide or other dangerous gases and do not consume large amounts of energy. This evolution of building design and technique is known as green or environmentally-friendly and is an absolutely necessary progression. It needs to happen and it needs to happen very quickly. Many groups, design firms, and owners are making green buildings a priority. However, there are still a great majority of buildings that are being constructed in a traditional manner with no extra concern for environmental factors or effects. Some are evolving and some are reluctant to make the change.

Expediting the change to green construction is the major concern of this research. Design-build firms may be a portion of the answer. Under the traditional design-bid-build project delivery method, an owner hires an architect to design the building. The owner then puts the project drawings out for bid. It is usually the lowest bidding contractor who is hired to construct the building according to the plans. There is little or no collaboration between the

designer and builder before the construction begins. This traditional method is not very conducive to communication or progress toward a new building language.

An architect can design a very green and efficient building but he/she may not fully understand the effects of his design in the field. The feedback from the contractor is limited and usually limited to major problems or conflicts in the design documents. The architect's learning curve is extended as a result of this limited communication. Design-build firms bring the design and construction entities under one roof. This greatly opens the line of communication. Design details and construction methods are discussed in great length before anything leaves the drawing board. This should effectively make progress toward a new building method much quicker and simpler. A designer can learn from successes and failures more directly. Some mistakes or bad designs may be caught and corrected before construction ever begins. They can also see what parts of the design are truly successful and should be considered in future projects. The library of successful green building practices should grow more quickly at design-build firms than traditional companies.

Green construction is generally categorized as those projects which attain a LEED certification rating. It is certainly possible to build sustainable without going through LEED certification, but this is currently the most popular means of being recognized as having a green building. There is an involved process of paperwork and documentation of building process details that is involved in attaining a LEED rating. Firms that have previous experience with the process will have an advantage over others, no matter what type of firm.

There are designers and construction managers of traditional firms that have great relationships and communicate extremely well. Especially after working together on a number of successful projects, a great sense of team and desire to work together is established. Great

teams who communicate efficiently can result from any project delivery method. However, a design-build method is more likely to build this team chemistry in a consistent manner. There are fewer variables involved in the relationships of design-build team members.

An owner who uses a design-build firm will have the advantage of using a single point-of contact and simplify the process for himself in that manner. Having a qualified team, whether it is design-build or another type, will always weigh more heavily than the general project delivery method. There are such things as poor design-build firms, and in that scenario, the owner may not have a good experience. However, when comparing equally qualified teams, the design-build firm still has the advantage of a single point of contact for the owner and having all involved team members under one roof.

This study looks at if and how design-build firms are facilitating the transition to green building practices. Are they actually evolving more quickly? How much collaboration actually takes place between the designers and builders? What are the specific differences that lend to an easier changeover? How can they be adapted to help traditional firms build green quickly? Are there any drawbacks to design-build firms regarding green buildings?

A survey of design firms, construction firms, design-build firms, and owners was conducted in order to investigate whether or not design-build project delivery facilitates green building. The findings may give some answers as to what practices can be adapted to help other firms move into green building quickly and efficiently.

## CHAPTER 2 LITERATURE REVIEW

“Since there has been no fundamental reinvention of design practice in order to play an active roll in the culture of sustainability, clear paths to new forms of practice do not exist” (Margolin 1998). This statement, made in regards to the relatively recent shift toward sustainable design, expresses the general uncertainty on exactly how to build “green.” Everyone agrees that there is a dire need to consider our planet’s condition and resource supply while designing and constructing buildings today and into the future. However, there is not such agreement on the best or most efficient method of accomplishing this goal.

“The practice of architecture is not a static endeavor that can be easily defined by fixed and precise characteristics; it evolves with the demands and developments of society” (Brady 1996). It is true that the practice of building design is a constantly changing one. The problem is that in our current environmental state, we need a transition from traditional building design to a much more eco-friendly era of construction, and we need it fast. We can not afford to wait around and let these changes happen at a leisurely pace. We need to be very active in making this metamorphosis of the design and construction industry happen.

There has been much research done in the arena of our changing environment and the negative effects humans have had. From resource depletion to water and air pollution to loss of natural habitat and wildlife, humans have been abusing the Earth since their earliest days. There are differing views as to how much damage we have caused and exactly what the effects will be. The truth is that the damage is extensive and that we must act quickly and efficiently to give our grandchildren and our planet a fair chance. The construction of buildings and the energy used in building operations is a major contributor to environmental degradation. We must act to lessen and eventually eliminate the negative effects of our structures. “Though the concept of

sustainability may seem relatively new, the substance of its principles is already embedded in our national character. What is respect for life but our appreciation for the integrity, stability, and beauty of the biotic community upon which we all depend? Living within limits embodies the traditional values of frugality and thrift” (Potera 2005).

It is commonly understood that designing and creating environmentally friendly buildings is a necessity. There is, however, not a common belief as to how to make the change happen. The most common method of construction project delivery is currently the “design-bid-build” approach. This process involves an owner hiring an architect to design the building. The owner then puts the project drawings out for bids from contractors. The project is usually awarded to the lowest bidding contractor with little or no regard to the relationship between the architect and contractor. There is also generally a minimal amount of design collaboration between the two parties.

This common practice is not very conducive to change or progress. The designer continues to design how they are used to designing and the contractor continues to build how they are used to building. “Building more effective knowledge systems for sustainability takes time and patience. Strategies to promote such systems require a sufficiently long-term perspective that takes account of the generally slow impact of ideas on practice, the need to learn from field experience, and the time scales involved in enhancing human and institutional capital necessary for doing all these things” (Cash 1998). We need to find a means of quicker change. The slow progression of the traditional design-bid-build approach will allow many more buildings to be constructed without the due concern for environmental effect.

The concept of feedback is very important in the world of design. A designer needs to know if his concepts have worked perfectly, have failed, need improvements, or whatever the

case may be. The discipline of Green Construction is on the forefront of design, materials, and construction technique developments. Green buildings are constantly incorporating new ideas and new materials. The designers of these green buildings need as much real world feedback about them as is possible in order to make informed future decisions.

Design-build firms offer a direct line of feedback between the construction personnel and the building's designers. The field administrators can give direct feedback on such details as ease of construction, materials durability and usability, and the effectiveness of design concepts. The progression of green construction hinges on the ability of designers to learn from mistakes and perpetuate effective design concepts. The ability to receive feedback on these subjects is heightened in the design-build project delivery format.

Of course, a major design failure will make its way back to the designer as mistakes cost someone money. Whoever is out money due to a design mistake will come looking for the designer to recoup losses or place responsibility. It is the smaller design failures, successes, and details that may go overlooked in a traditional project delivery. Often times, after a set of drawings leaves the desk of a designer, communication with the construction firm is limited to clarifications and problems with the design. The architect may not get feedback on every aspect of the job and minor flaws can be perpetuated through the design of later buildings. When dealing with new materials and methods associated with green construction, this can slow the process and keep sustainable construction practices from progressing at their maximum potential.

“Design-build” is a relatively new approach to building construction that allows for much greater cooperation between the building designer and contractor. Design-build puts both parties under one entity and one roof, where communication is greatly simplified. In some smaller scale scenarios, the designer and contractor is even the same person. “I find a fundamentally different

image in innovative organizations that is centered on hands-on practice. People understand value creation as a long-term working relationship with customers, in which they apply the firm's skills to anticipate and solve customer problems" (Dougherty 2001). The design-build approach gives designers hands-on experience with the construction process and frequent direct communication with the field management. This lets the designers become familiar with the construction practices and lets them understand what design practices are successful and efficient in the field.

A 2007 Article by Melissa Bilec and Robert Ries suggests that, "Project team collaboration early in the design and construction process is an important aspect of green projects." Several of their interviewees strongly suggested that a key to project success for green projects was collaboration. "Collaboration is cooperation among the owner, contractor, designer, or design-builder" (Bilec 2007). Their study showed a strong relationship between successful green construction projects and an integrated team approach and collaboration. These qualities are inherently present in the design-build project delivery method.

Design-build construction administration streamlines the design and construction practice. It eliminates conflicts between the designing and contracting parties. How does it affect the ability to build green? There has been little, if any, research into this question. It seems feasible that if design-build simplifies traditional construction practices, it should do the same for green construction. Designers should be able to see the effects of their green designs more directly and have more feedback regarding the construction procedures.

There is a common conception that building green costs more money for the owner. In many cases, green construction is not more expensive than traditional practices. Planning and forethought are key ingredients to bringing a green construction project to fruition within a

reasonable budget. The life-cycle costs are also greatly reduced in an efficient building and result in an overall net savings.

There is significant research to show that sustainable design and construction is a necessity for our society. There are also plenty of examples as to why design-build construction practices are more efficient in making changes and progress in construction practice. However, little research has been done to establish a correlation between design-build firms and sustainable construction. Some of the overall advantages of design-build project delivery have been identified through this literature review. These strong points will become areas of focus in the survey of construction professionals. The goal will be to see if the identified advantages are a factor in the practice of green construction.

## CHAPTER 3 METHODOLOGY

### **Introduction**

This thesis seeks to determine the characteristics of design-build firms that contribute to their ability to more effectively transition to green building practices. Research will be conducted by contacting people from many areas of the construction industry and process. Project owners, design-build firm managers, traditional construction firm owners, architects, and other parties involved in the industry will be surveyed to see what the opinions are on the subject. Views from all areas of the subject will be gathered in an attempt to arrive at an unbiased conclusion. The methodology followed in this research was determined by the objective of the study and the hypotheses statements listed in Chapter 1. The steps were as follows:

1. A literature search was performed on material related to the design-build industry and its relationship with the sustainable construction industry.
2. The data needed for the analysis was identified.
3. The sources of data were identified.
4. Survey questionnaires were designed to collect the necessary data and opinions from industry and project owners.
5. The questionnaires were administered to obtain the data.
6. The questionnaires were analyzed to determine the important features of design-build project delivery that help or hurt the ability to efficiently build green

### **Survey Questionnaires**

The survey was designed to obtain qualitative information on the subject of design-build firms and building green. There are some characteristics that may seem to be obvious advantages, and these will be explored through the questions. The questions were also designed

to uncover other factors that may not be so clear as well as factors that act against the design-build firm's ability to adapt quickly.

### **Sample Selection**

The attendees of the UF Building Construction Career Fair were targeted for the survey. Project Managers, Operations Managers, and Directors of Pre-Construction were contacted among others. Some respondents wished to remain anonymous. Construction professionals who have had experience with sustainable construction projects, through both design-build and traditional project delivery methods were targeted.

### **Surveys Conducted**

The surveys were conducted by mail between the dates of January 2008 and February 2008. The survey was approved by the University of Florida IRB02 committee. The survey was exempt from approval based on 45 CFR 46.101 (b)(2) that states "Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior." After receiving that information, the survey was mailed to fifty individuals with extensive construction experience. Self addressed stamped envelopes were included to make responding easier for the survey subjects. Fourteen responses were received with widely varying degrees of insight.

### **Expected Results**

The hypothesis is that design-build project delivery is effective in making green construction simpler for the owner. This is ultimately what will advance the green construction practice. Making it easier and cheaper for the owners will create more opportunities. A secondary hypothesis is that the ease of communication between the designers and construction administrators allows both parties to learn from the process more quickly. Building a library of effective green construction practices is another key aspect to increasing the use of sustainable

design and construction. Advantages of design-build project delivery are expected to be found in these areas.

### **Limitations**

Contacts for the surveys were limited to construction companies who attended the 2009 University of Florida Building Construction Career Fair. A broader group of construction professionals would have given more insight into the question. The major limitation to the study, however, was receiving only fourteen responses from fifty surveys for a response rate of 28%. The written responses were analyzed to gain some ideas about the correlation between design-build project delivery and green construction practices. However there are no definite conclusions that can be formulated.

CHAPTER 4  
ANALYSIS OF RESULTS

**Introduction**

Analysis of the survey responses was done by grouping the respondents into two categories. Survey item number two asked the respondents about their green building experience. The responses to this question were used to create the two groups. Those with four or more green projects experience were put into the group of high experience. Those respondents with three or fewer green projects experience were put into the group of low experience. These two groups were statistically analyzed, using t-tests, to find if a significant difference exists between their mean responses. Some of the respondents also gave more detailed written responses, but all were helpful in gathering information for the project.

**Item 1**

**(Optional) What is your name and position and what company do you work with?**

- A) N/A
- B) Director of Business Development
- C) Sustainable Construction Manager
- D) Vice President – A/E Project Principal
- E) Project Manager, LEED AP
- F) Chair of National Green Task Team
- G) Assistant Project Manager
- H) Operations Manager
- I) V.P. of Design-Build
- J) Project Manager
- K) Director of Pre-Construction Services
- L) N/A
- M) N/A
- N) N/A

**Item 2**

**How many green projects have you been involved in?**

Table 4-1. Survey respondents' green construction experience (number of projects)

Respondent	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Answer	4	1	9	20	2	6	1	3	3	0	6	3	1	2

- A. Four. I have been involved in the construction of two LEED Certified Projects in the LEED for Retail pilot program. I have been involved in the budgeting / preconstruction process for two others.
- B. One.
- C. Nine green projects, seven with LEED certification.
- D. More than twenty projects, including ten which have been LEED certified.
- E. Two, both LEED silver.
- F. Six, prior to joining Balfour Beatty, I was Design Production Manager on the largest Design-Build, LEED project in the country – McCormick Plaza West Expansion, 2003-2005.
- G. One.
- H. Three.
- I. Three. One LEED certified, one LEED silver, and one LEED silver (pending).
- J. None.
- K. I have been involved in six green projects in various delivery methods (one certified, one silver, and one gold).
- L. Three.
- M. One.
- N. Two LEED projects are in the preconstruction phase.

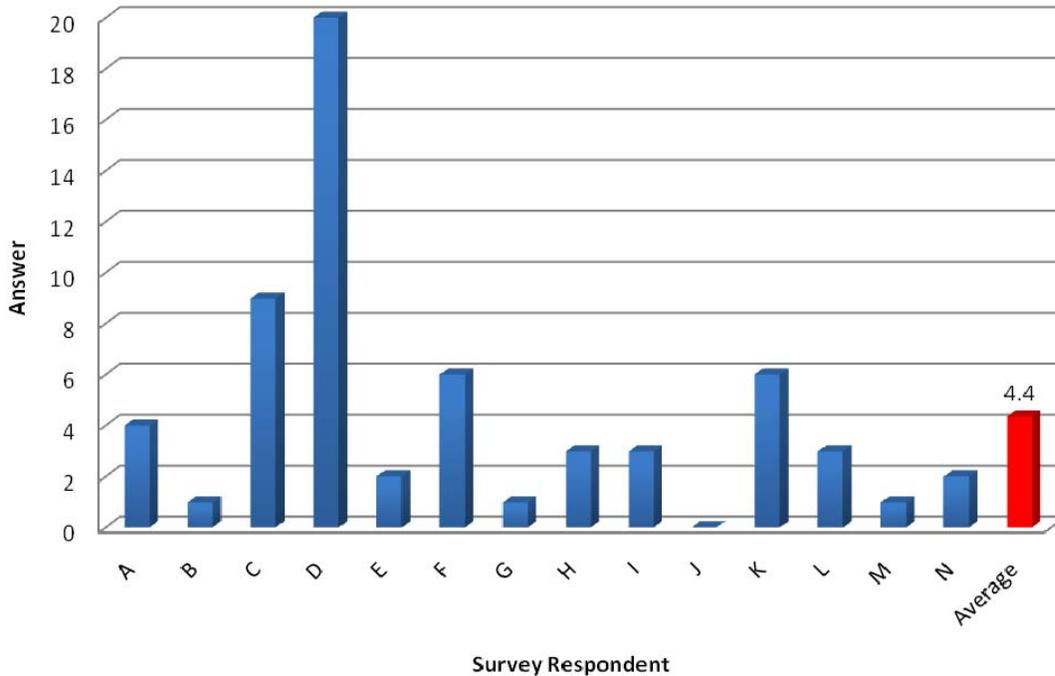


Figure 4-1. Survey respondents' green construction experience (number of projects)

The responses to item 2 are shown in Table 4-1 and Figure 4-1. The range of responses for green construction experience is from zero to twenty projects. It would be surprising to find many people who have been involved with more than twenty green projects at this point because it is a relatively new field. The answers to this question were used to group the respondents for analysis of the following survey questions based on their level of experience.

### Item 3

**Please respond to the following statement with a number 1-10 (1 = strongly disagree, 10 = strongly agree):**

**Expanding green construction practices is a major concern.**

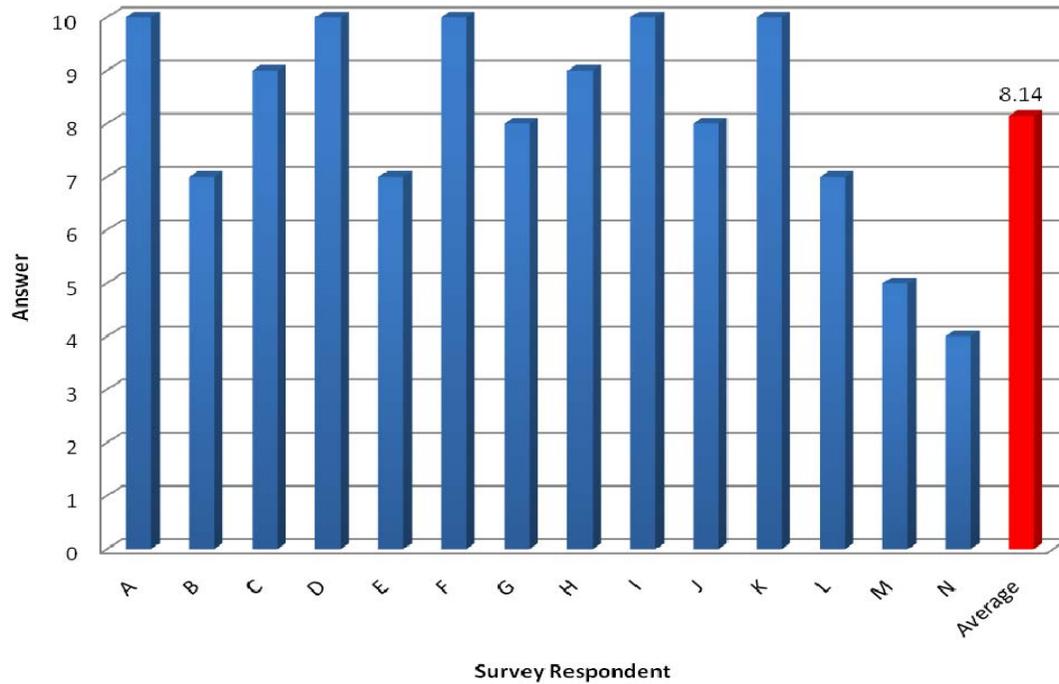


Figure 4-2. Respondents' answers to survey item 3.

Table 4-2. Survey item 3 statistical analysis.

Respondent	Answer	High Experience	Low Experience
A	10	10	
B	7		7
C	9	9	
D	10	10	
E	7		7
F	10	10	
G	8		8
H	9		9
I	10		10
J	8		8
K	10	10	
L	7	7	
M	5		5
N	4		4
Avg	8.14	9.33	7.25
T-Value Probability			0.032

For survey item 3, the null hypothesis ( $H_0$ ) is that the mean response of the high experienced group = the mean response of the low experienced group. The alternative hypothesis ( $H_a$ ) is that the mean response of the high experienced group  $\neq$  the mean response of the low experienced group. Test of the null hypothesis finds that it is rejected with 95% confidence. Therefore, it can be concluded that in general, expanding green construction practices is a greater concern for individuals who have more experience with green projects compared to those that have less experience. The responses to this survey question show a generally high interest in expanding green construction practices, as indicated by the mean response of 8.

Shown in Table 4-2, those respondents who have had more experience with building green gave a mean response of 9.3 compared to a mean of 7.3 for those who have been involved in 3 or fewer green projects. However, both groups agree with the statement, and it is hard to say why there is a difference. Possibly the greater experience in the field leads to a greater understanding of the problem.

The following written responses were also received:

Our population growth and its subsequent impact on dwindling natural resources and our environmental footprint can only be managed responsibly by the use of 'green' construction practices.

With the economy the way it is, a 4, from a 10 two years ago.

One respondent stated that two years ago, his response would be a 10, or that he strongly agreed that expanding green construction was a major concern. Now, in the current economic situation, his response is only a 4. This shows that in some cases, building green is tied strongly to the economic conditions.

#### Item 4

**Please respond to the following statement with a number 1-10  
(1 = strongly disagree, 10 = strongly agree):**

**The use design-build project delivery makes green construction less complicated for the owner and team involved in the project.**

For survey item 4, the null hypothesis ( $H_0$ ) is that the mean response of the high experienced group = the mean response of the low experienced group. The alternative hypothesis ( $H_a$ ) is that the mean response of the high experienced group  $\neq$  the mean response of the low experienced group. Test of the null hypothesis finds that it is accepted with 95% confidence, and there is no significant difference between the groups with high or low levels of experience, shown in Table 4-3.

Figure 4-3 illustrates a mean response of 6.71 out of 10. There is a fair level of agreement with the statement that “The use of design-build project delivery makes green construction less complicated for the owner and team involved in the project.” Although most of the respondents agree here, there is some difference between those professionals with more experience and those with less. However, the difference in the means is not statistically significant.

The following written response was also received:

I believe that the right construction team makes green construction less complicated for the ownership entity. I believe that the ‘one-stop shopping’ angle offered by design-build firms does not necessarily make the green construction process less complicated for the owner.

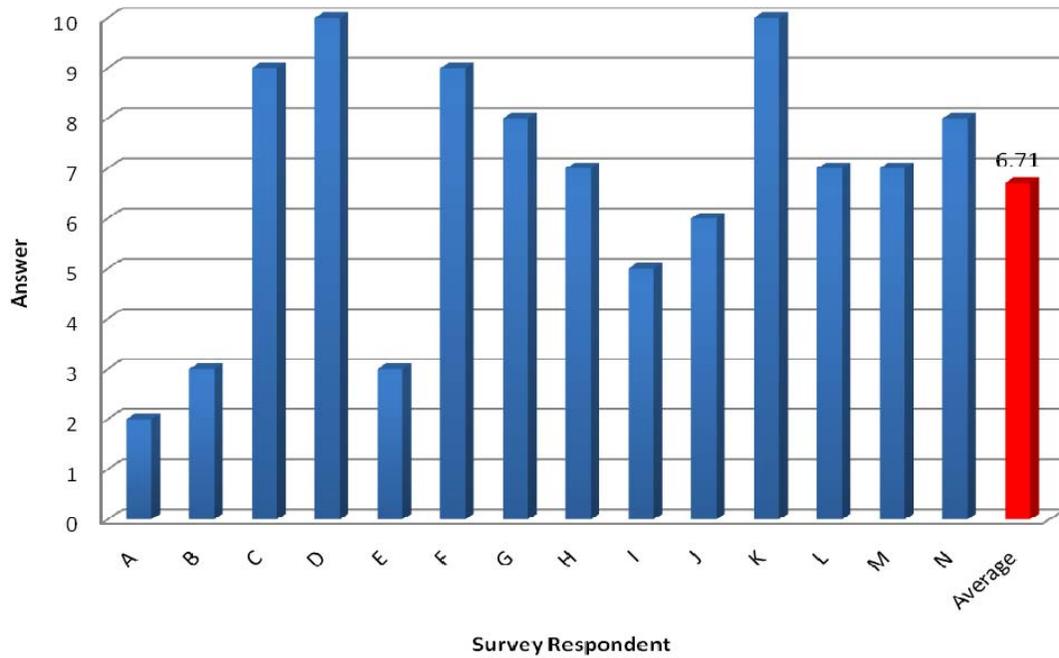


Figure 4-3. Respondents' answers to survey item 4.

Table 4-3. Survey item 4 statistical analysis.

Respondent	Answer	High Experience	Low Experience
A	2	2	
B	3		3
C	9	9	
D	10	10	
E	3		3
F	9	9	
G	8		8
H	7		7
I	5		5
J	6		6
K	10	10	
L	7	7	
M	7		7
N	8		8
Avg	6.71	7.83	5.88
T-Value Probability			0.210

### Item 5

Please respond to the following statement with a number 1-10  
(1 = strongly disagree, 10 = strongly agree):

**Traditional project delivery methods work just as efficiently and are no more complicated than design-build for green projects.**

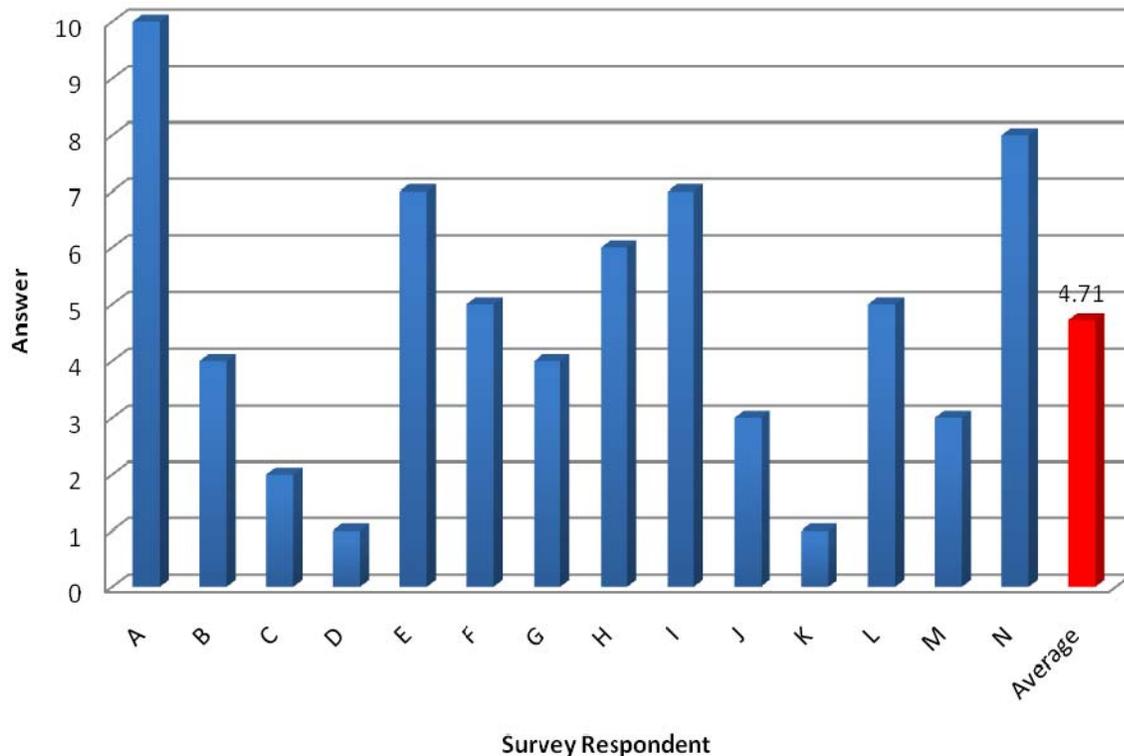


Figure 4-4. Respondents' answers to survey item 5.

The mean response of 4.71, shown in Figure 4-4, is just below the “agree” level of 5. This shows that the respondents do not feel that traditional project delivery methods work as efficiently as design-build for green projects. Those responders with more green building experience agree even less with the statement (a mean of 4). This shows that the more experienced green builders somewhat prefer design-build over traditional methods for building successful green projects. However, this difference is not statistically significant.

For survey item 5, the null hypothesis ( $H_0$ ) is that the mean response of the high experienced group = the mean response of the low experienced group. The alternative

hypothesis ( $H_a$ ) is that the mean response of the high experienced group  $\neq$  the mean response of the low experienced group. Test of the null hypothesis finds that it is accepted with 95% confidence, and there is no significant difference between the groups with high or low levels of experience. This is illustrated in Table 4-4.

Although other project delivery methods may have the ability to achieve the same exceptional green building results as design-build, they are not necessarily as simplified. The low mean response of 4.71 indicates that the surveyed professionals agree. However, the low number of responses does not allow any definite conclusions.

Table 4-4. Survey item 5 statistical analysis.

Respondent	Answer	High Experience	Low Experience
A	10	10	
B	4		4
C	2	2	
D	1	1	
E	7		7
F	5	5	
G	4		4
H	6		6
I	7		7
J	3		3
K	1	1	
L	5	5	
M	3		3
N	8		8
Avg	4.71	4.00	5.25
T-Value Probability			0.453

The following written responses were also received:

I especially agree if the Contractor has a LEED Accredited Professional involved with the project in some capacity.

It becomes the risk management responsibility of the D/B, not the owner.

If a true “green” project is the desired end result, as defined by the USGBC and the LEED rating system, then you must have all project team members involved at the onset of planning and design. Even when you attend a USGBC LEED training seminar, the training test projects (which are real, built example projects) are DB projects where all parties were involved from the onset. With that said, let me go on to counter that if budget and schedule truly are of no consequence, which is rarely if never the case in the real world, then the DB/CM Contractor may not need to be involved during design to monitor cost and constructability issues during the process. In that sense, my answer to this statement may be different.

**Item 6**

**Please respond to the following statement with a number 1-10  
(1 = strongly disagree, 10 = strongly agree):**

**Communication between Designers and Construction Managers is improved and more effective in design-build firms than in traditional project delivery.**

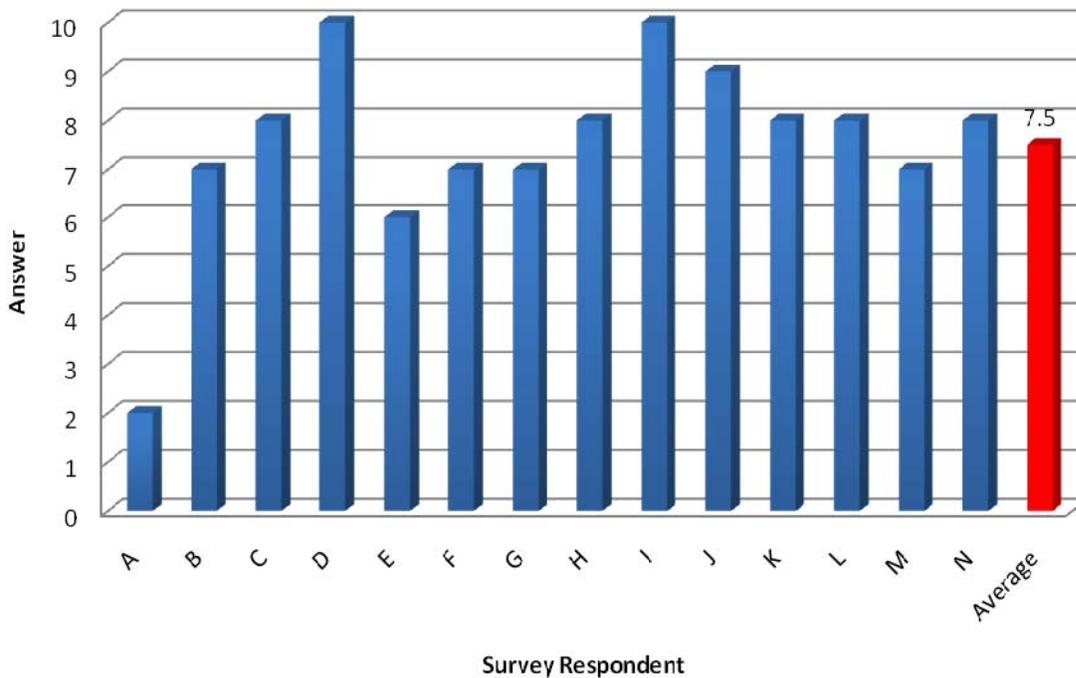


Figure 4-5. Respondents’ answers to survey item 6.

The mean response of 7.5, shown in Figure 4-5, indicates that surveyed professionals agree. Communication is improved in design-build firms over traditional designer and contractor relationships. The general nature of a design-build firm lends it to promote better

communication between the designers and construction managers. Having both parties working under one name, under one roof, and for the same entity naturally creates a team scenario.

Table 4-5. Survey item 6 statistical analysis.

Respondent	Answer	High Experience	Low Experience
A	2	2	
B	7		7
C	8	8	
D	10	10	
E	6		6
F	7	7	
G	7		7
H	8		8
I	10		10
J	9		9
K	8	8	
L	8	8	
M	7		7
N	8		8
Avg	7.50	7.17	7.75
T-Value Probability			0.642

For survey item 6, the null hypothesis ( $H_0$ ) is that the mean response of the high experienced group = the mean response of the low experienced group. The alternative hypothesis ( $H_a$ ) is that the mean response of the high experienced group  $\neq$  the mean response of the low experienced group. Test of the null hypothesis finds that it is accepted with 95% confidence, and there is no statistically significant difference between the groups with high or low levels of experience.

One of the respondents, a Director of Pre-Construction Services goes so far as to say, “It has been my experience that the design-build delivery, no matter the relationship between the designers and the CM, always finishes with a better end product in all measurable parameters

(quality construction, budget, and schedule).” This is certainly an indication of improved communication. Although, most of the respondents agree, the response level is too low to make any conclusions.

The following written responses were also received:

My experience has shown me that the same disconnects between Design and Construction can exist whether the project is Traditional or Design-Build.

I agree. I’m not sure that communication between designers and CMs in the design-build process is always “improved and more effective,” but it certainly is the desired end result for a better project delivery. It has been my experience that the design-build delivery, no matter the relationship between the designers and the CM, always finishes with a better end product in all measurable parameters (quality construction, budget, and schedule).

**Item 7**

**Please respond to the following statement with a number 1-10  
(1 = strongly disagree, 10 = strongly agree):**

**Designers more frequently and constructively get feedback on successful/failed design ideas in a design-build firm than a conventional design firm.**

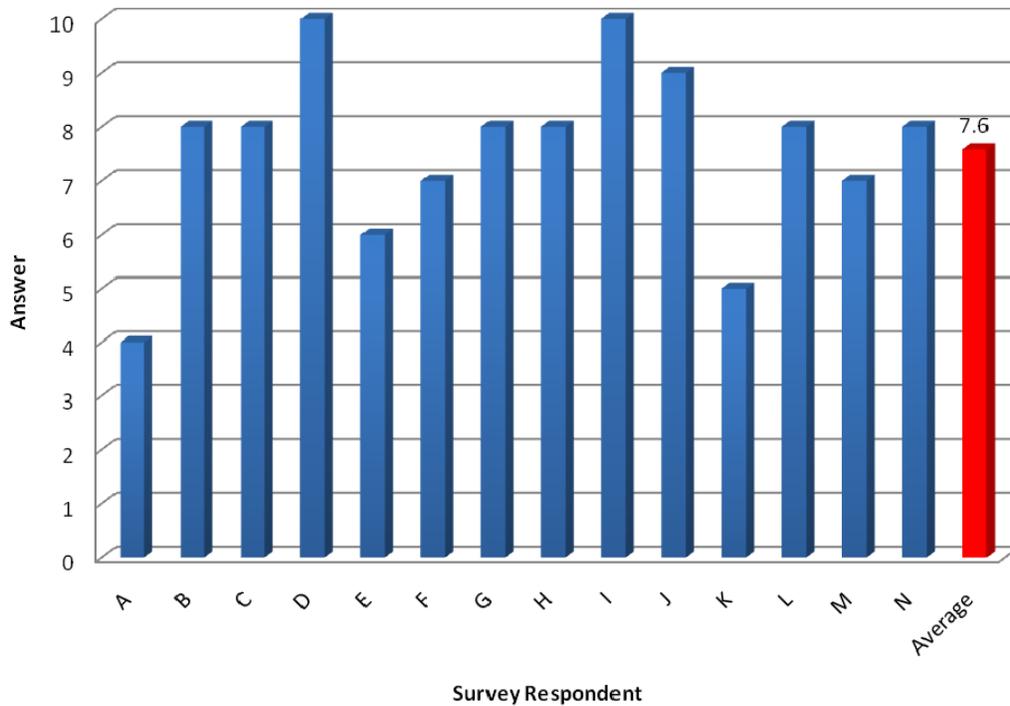


Figure 4-6. Respondents’ answers to survey item 7.

Table 4-6. Survey item 7 statistical analysis.

Respondent	Answer	High Experience	Low Experience
A	4	4	
B	8		8
C	8	8	
D	10	10	
E	6		6
F	7	7	
G	8		8
H	8		8
I	10		10
J	9		9
K	5	5	
L	8	8	
M	7		7
N	8		8
Avg	7.57	7.00	8.00
T-Value Probability			0.345

Figure 4-6 shows a mean response of 7.6. This indicates that the surveyed construction professionals agree. Receiving more feedback on building design can do nothing but improve future designs. In a design-build firm, the ability to receive input from the construction team is greatly improved over a conventional construction project delivery method.

For survey item 7, the null hypothesis ( $H_0$ ) is that the mean response of the high experienced group = the mean response of the low experienced group. The alternative hypothesis ( $H_a$ ) is that the mean response of the high experienced group  $\neq$  the mean response of the low experienced group. Test of the null hypothesis finds that it is accepted with 95% confidence, and there is no statistically significant difference between the groups with high or low levels of experience. This is indicated in Table 4-6.

The more experienced green builders had a slightly lower mean response to this statement. This may be more of a reflection on their design-build experience than their green construction experience as the statement does not directly include green construction. However, both groups more than agree that designers are more able to receive feedback on design ideas in a design-build firm than a conventional design firm. There are not enough responses to reach a valid conclusion.

The following written responses were also received:

Design failures most certainly are communicated equally frequently in both Design-Build and Traditional construction due to the fact that failures cost someone money. Design successes I suspect are probably conveyed better in a Design-Build project than in a Traditional project.

They are more acutely aware of their performance because of the contractual relationship with the contractor.

I have to land in the middle on this one. In true design-build, the CM is afforded the time to properly and effectively perform valuable constructability studies thus providing the designers time to provide corrective measures to the documents before bidding and construction. Problems in the field are thus avoided, averting any possible opportunity for any failed-design feedback. Conversely, in the conventional design-bid-build scenario, most design flaws are discovered along the way providing more opportunity for so-called “feedback,” good or bad.

### **Item 8**

**Please respond to the following statement with a number 1-10  
(1 = strongly disagree, 10 = strongly agree):**

**A contractor who isn't involved in the building's design through the design-build project delivery method may get frustrated by specified construction techniques used in green construction projects.**

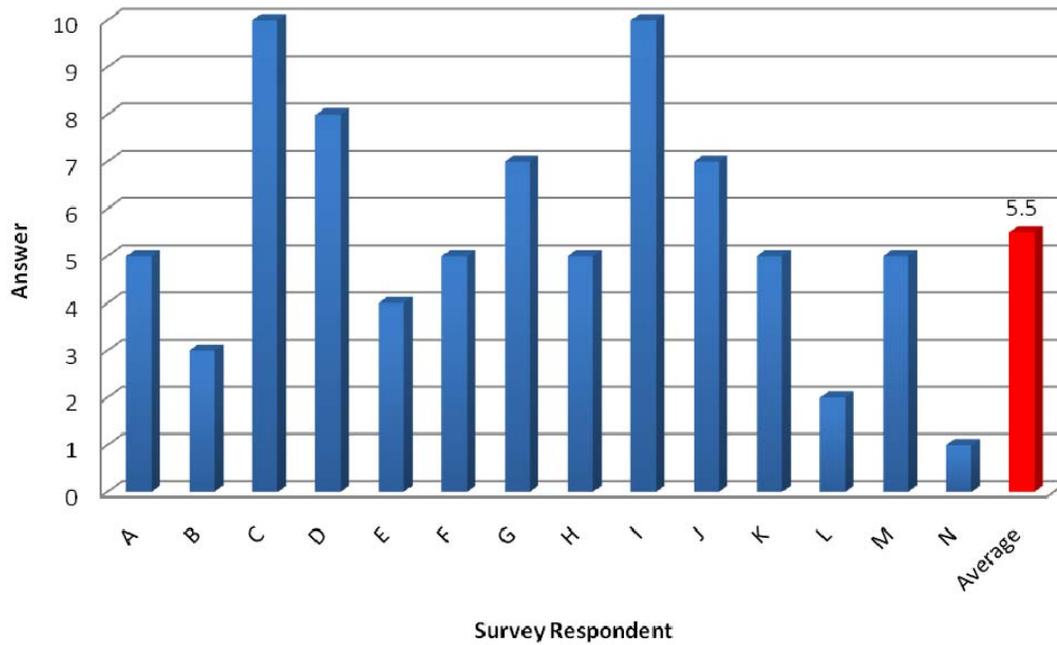


Figure 4-7. Respondents' answers to survey item 8.

Table 4-7. Survey item 8 statistical analysis.

Respondent	Answer	High Experience	Low Experience
A	5	5	
B	3		3
C	10	10	
D	8	8	
E	4		4
F	5	5	
G	7		7
H	5		5
I	10		10
J	7		7
K	5	5	
L	2	2	
M	5		5
N	1		1
Avg	5.50	5.83	5.25
T-Value Probability			0.705

Figure 4-7 shows a mean response of 5.5. This indicates that the respondents agree that contractor involvement from the building's conception may reduce frustration with green building construction techniques. There is a polarization of the responses to this survey item. The respondents tended to agree or disagree relatively strongly. This could be a result of differing personal experiences in dealing with inexperienced green contractors. The written responses indicate a stronger relationship between a contractor's level of frustration and his/her experience with green construction or his acceptance of the concept of sustainable design.

For survey item 8, the null hypothesis ( $H_0$ ) is that the mean response of the high experienced group = the mean response of the low experienced group. The alternative hypothesis ( $H_a$ ) is that the mean response of the high experienced group  $\neq$  the mean response of the low experienced group. Test of the null hypothesis finds that it is accepted with 95% confidence, and there is no statistically significant difference between the groups with high or low levels of experience. This is shown in Table 4-7.

The following written responses were also received:

If the Contractor has no prior experience with 'green' construction methods then yes, he could become frustrated. I don't believe this is an advantage of Design-Build over Traditional construction but rather a function of familiarity with 'green' construction methods.

This depends solely on the contractor's experience to date with green projects, his willingness to participate in the green building process, and ultimately in his level of commitment to the cause of environmentally conscious construction.

Many of the green building practices create more work for the contractor or deviate from the traditional practices to which they are accustomed. A contractor who has experienced these differences already or who is willing to accept them based on our need to lessen the environmental impact will likely be less frustrated.

Any contractor who is involved early in the design process is going to be more successful and experience fewer problems than one who joins the project at the construction phase. In most green projects, the contractor is involved early in the design phase. This lends to a higher rate of success. Design-build firms incorporate the construction personnel early on every project and are less likely to experience the problems that come from having an uninformed contractor.

When a green project uses a traditional project delivery method, there is a chance that the contractor will not have been a part of the design process. Under these conditions, the contractor is more likely to run into problems that he is not familiar with and did not have any input with the design. This could lead to a frustrated contractor and a compromised final product. Using a contractor or a design-build firm who is familiar with green construction is the best method to avoid problems involving a contractor who is aggravated by new techniques used in sustainable building construction. This idea is supported by the survey respondents, however the sample size is too insignificant to come to a definite conclusion.

## CHAPTER 5 CONCLUSIONS

The responses from the surveyed construction professionals gave some insight into whether design-build project delivery can facilitate green construction. However, the low number of responses renders the study inconclusive. The hypothesis was that design-build project delivery was the method best suited to advance construction into a greener industry. The responses support this hypothesis, but there are not enough responses to make a legitimate conclusion. Survey responders agree that design-build project delivery simplifies the process for the owner and allows for greater communication between the designer and project manager. Future successes in sustainable construction are built upon past and present successes. There are a number of basic qualities that are important to producing successful green projects today.

Based on both the literature review and written survey responses, the most important part of a successful green construction project is the very early development of a committed team format. The designer, contractor, owner, and all parties involved must begin their relationship at the earliest stages of the project. In most design-build firms, this team has been formed, tested, and perfected before the project has even been conceived. Design-build architects also have a better line of communication with the construction managers and generally get more feedback on their design efforts.

The survey found that a very important aspect of advancing sustainable construction is making the process easier for the owner. Since the owner is the one who provides funding for projects, they ultimately make the decision on whether or not the project will be green. Design-build delivery gives owners a single point of contact for their venture as well as streamlines many aspects of the procedure, simplifies mid-project changes, and potentially reduces the construction time and completes the building sooner. All of these details give design-build a

distinct advantage over conventional project delivery and make green construction a more feasible option for the owner.

Some of these inherent advantages of the design-build structure can be adapted over to conventional construction project delivery methods to make green projects more successful. The early development of a committed team was a recurring answer in the research. If the building designer, contractor, owner, and other parties can work efficiently together, the project will be successful. Having LEED experienced professionals on the project team is very advantageous in dealing with the extensive documentation that is required for certification.

The respondents gave some insightful feedback, however the low number of survey responses renders the study inconclusive. A much larger sample size is needed to make any valid conclusions. The fact remains that all of us need to make every effort to reduce our footprint. Converting the construction industry into a less environmentally-destructive practice is a necessity, and it must be done quickly.

**Recommendations for future research:** The major obstacle of this research was receiving survey responses. In order to reach a valid conclusion, additional survey responses are needed. Future researchers need to develop a survey and distribute it to as many and diverse a group of construction professionals as possible. Owners would also be a great survey target. Especially those who have experience building green with both design-build and traditional project delivery methods.

## APPENDIX

### SURVEY MATERIALS

#### **Survey Introduction Letter**

January 21, 2009

Dear Mouji Linarez:

My name is Andy Surprenant and I am a Graduate Student in the Building Construction program at the University of Florida. I am working on a thesis project about how design-build project delivery can potentially facilitate a transition to a “greener” construction industry.

It would be greatly appreciated if you could take the time to fill out the included short survey and informed consent form. If you feel someone else within the company may be more qualified to answer the questions, please feel free to pass it along. I have included a self-addressed and stamped envelope to make responding easier.

Thanks a lot for your time,

Andy Surprenant  
1236 SW 4<sup>th</sup> Ave, #12  
Gainesville FL 32601  
941-468-0398  
Andrewjames440@comcast.net

## **Informed Consent Form**

**Protocol Title:** How Can Design-Build Project Delivery Facilitate Green Construction?

**Please read this consent document carefully before you decide to participate in this study.**

**Purpose of the research study:**

The purpose of this study is to find what characteristics of design-build project delivery lend to a faster transition to green construction and ultimately how the transition can be made easier.

**What you will be asked to do in the study:**

Answer a short questionnaire about your construction project experiences and thoughts.

**Time required:**

10-25 minutes, depending on the level of detail in your answers.

**Risk and benefits:**

You will have to give up 10 to 25 minutes of your day. I do not anticipate that you will gain any direct benefit from participation.

**Confidentiality:**

Your identity can be kept confidential if you so wish.

**Voluntary Participation:**

Your participation in this study is completely voluntary. There is no penalty for not participating.

**Right to withdraw from the study:**

You have the right to withdraw from the study at anytime without consequence.

**Whom to contact if you have questions about the study:**

Andy Surprenant, Graduate Student, School of Building Construction, phone: 468-0398

Dr. Ries, University of Florida School of Building Construction, 352-273-1150

Dr. Issa, University of Florida School of Building Construction, 352-273-1150

**Whom to contact about your rights as a research participant in the study:**

IRB02 Office, Box 112250, University of Florida, Gainesville, FL 32611-2250; phone 392-0433.

**Agreement:**

I have read the procedure described above. I voluntarily agree to participate in the procedure and I have received a copy of this description.

Participant: \_\_\_\_\_ Date:

Principal Investigator: \_\_\_\_\_ Date:

## Survey

### How Can Design-Build Project Delivery Facilitate Green Construction? A Master Thesis Project by Andrew Surprenant

#### Definitions:

- Design-build:** A project delivery method wherein the design and construction of a project are handled by a single company.
- Design-bid-build:** A traditional project delivery method wherein an architect is hired by the owner to design the project. The plans are then put out for bid and a contractor is hired based on qualifications and bid price.
- Green construction:** A growing form of construction practice where extra care is taken to preserve the environment. Typical areas of concern are: reducing construction waste, using natural lighting, improving indoor environmental quality, and reducing energy and water consumption. LEED certification is often a priority in these projects. However, for this questionnaire, any project with significant design efforts to reduce environmental impact will be considered green construction.

## Questionnaire

1. (Optional) What is your name and position and what company do you work with?

Please respond to the following statements with a number 1-10  
(1 = strongly disagree, 10 = strongly agree):

2. Expanding green construction practices is a major concern.
3. The use design-build project delivery makes green construction less complicated for the owner and team involved in the project.
4. Traditional project delivery methods work just as efficiently and are no more complicated than design-build for green projects.
5. Communication between Designers and Construction Managers is improved and more effective in design-build firms than in traditional project delivery.
6. Designers more frequently and constructively get feedback on successful/failed design ideas in a design-build firm than a conventional design firm.
7. A contractor who isn't involved in the building's design through the design-build project delivery method may get frustrated by specified construction techniques used in green construction projects.

Please answer the following questions as thoroughly as possible: (use more paper if necessary)

8. How many green projects have you been involved in?
9. What are some ways that the project delivery methods helped or hurt the projects? Please provide any specific examples.
10. What are your opinions on design-build overall (when compared to traditional methods)?
11. In your opinion, can or cannot design-build project delivery help transition construction into a greener industry?
12. Please add anything that you think may be useful to my study:

### **Survey Item 9**

**What are some ways that the project delivery methods helped or hurt the projects? Please provide any specific examples.**

- A) Both of the LEED Certified Projects that we were involved in were constructed traditionally. Our familiarity with LEED Construction practices as well as the documentation management helped us
- B) The project was a GC, but we were very involved in preconstruction.
- C) The earlier the construction manager is involved in the project, the better the outcome. Past experience in use of untried, so-called green materials has enabled the company to provide insight into material selection to make the project more sustainable.
- D) The Design-build project delivery approach gave the construction/project management team early insight and buy-in of the green construction strategies, requirements, and materials, which made the procurement, sub-contracting, and construction phases of the project run more smoothly. It also simplified the documentation phase required for LEED certification since all involved worked toward a common goal.
- E) In both cases, we (the general contractor) were on board during the design phase for budgeting and gathering LEED submittals. It was important to maintain close contact with the architect, as they were driving the LEED process.
- F) Design-build on the McCormick project was helpful as the contractor was the majority JV partner and thus could manage the design process and green attributes.
- G) Bringing the GC in early allows for cost effective design changes which will improve schedule and budget

- H) I have worked on a design-build LEED project (UF Powell Structures Lab) and am now working on a LEED project as a CM (UF Hough Hall). As long as the project team (Architect, Owner, Builder) works together and fulfills their rolls, there should not be a big difference. The CM project we are currently doing has just as much cooperation as the design-build project.
- I) The use of design-build allowed us to complete a state funded project for the Little White House Museum in a 12 month period, which would have been impossible with traditional methods.
- J) N/A
- K) I'll answer this question with a specific example. One LEED project I was involved in was actually a design-bid-build project where the owner spelled out all the green parameters and LEED specs and points to be adhered to for the project to reach LEED Certified rating. At the time, this was to be our first LEED project. We were so into the project and excited about the fact that it was our first LEED project, we actually identified and made a reality more LEED credits at no added cost to the owner so that the project could become LEED Silver instead of LEED Certified. We didn't have to do that. We were not contractually obligated to act in any capacity other than the GC that bid the job to build it per plans and specs, but we acted as a member of the team, acted responsibly, and made the team results all the better.
- L) In a design-build project, the contractor has control over the design and specifications. In the traditional design-bid-build method, the contractor is left the decisions of the architect or owner who are many times at odds with each other. On a recent job, the architect and owner could not agree on the intent of the door finish, leaving the contractor in the middle having to eat some cost.
- M) Increased communication
- N) The project delivery methods are design-bid-build. On one project, the LEED rating went up through the field team's proactive approach after award. On the other project, the LEED rating is being maintained by a team and owner who are more passive. Neither project is complete.

Analysis of the responses indicates that traditional project delivery methods certainly have the ability to deliver a successful green project. Having team members who are knowledgeable of LEED documentation will make any LEED certified project that much easier. Early involvement of the construction team in the design phase will improve results. A good

construction team will join the team early and make use of their materials and methods knowledge and potentially shorten the schedule and reduce costs.

Eric Hickox feels that, “As long as the project team (Architect, Owner, Builder) works together and fulfills their roles, there should not be a big difference (between design-build and traditional methods)”. Successful traditional construction projects and successful design-build projects have many of the same characteristics. They both involve people who work well together toward a common goal. The difference is that the odds of a deficient relationship affecting the project are greatly reduced when a single entity is used for both phases of a construction project.

### **Survey Item 10**

**What are your opinions on design-build overall (when compared to traditional methods)?**

- A) I believe that Design-Build is capable of helping an owner avoid many of the design errors that occur in Traditional construction. In my experience however, the same failures occur in either method.
- B) It can be a very successful delivery method. The owner must understand the process, the risks and the benefits.
- C) Just as any delivery method, there are pluses and minuses. Hedrick Brothers primarily provides pre-construction services, acting as the construction manager on the project. The earlier the C.M. is on the project, the better the green project is.
- D) The Design-build approach to project delivery provides the customer with a single point of contact, which simplifies the project contracting for them. It also contributes to a shorter overall schedule (Design-permitting-construction), by allowing full team involvement and collaboration on the early decisions that will ultimately affect the project cost and schedule. Thereby, avoiding costly rework and also allowing for an overlap of project phases.
- E) I am always for having a contractor on board before drawings are finalized – this is quazi design-build. I think pure design-build has its benefits, but is best utilized with very tight schedules. It is probably too project specific to make general assumptions.
- F) I prefer design-build
- G) It is effective with the proper team.

- H) I like them. The communication is very good and the Construction Managers can provide input early on cost, schedule, and constructability.
- I) I prefer this delivery method. A great deal of preparation is required for a successful execution, namely the culture compatibility of all the firms involved and their willingness and capability to function as a “TEAM.”
- J) Design-build provides a streamlined construction process for all parties involved and allows for one point of contact for clients.
- K) Once again, because of my position, my opinion here is a biased one, but I think all projects generally benefit from a delivery method that involves having all parties involved as a team from the beginning.
- L) Design-build is the preferred method of construction when you can get the owner to buy into the contract and relinquish control. Design-build brings a team atmosphere to the project and creates a working relationship between the parties because the goals are aligned.
- M) Effective
- N) My opinion is a positive one. General Contractors can speak the architect’s language better than the owners. General Contractors can also speak the owner’s language better than the architect. This allows the design-build GC to steer the design in the direction of the budget, minimizing costs while maintaining style and quality.

An analysis of the responses indicates that design-build is a very capable delivery method. All responders had very positive things to say about the design-build project delivery method and most prefer it over traditional methods. In ideal conditions, any project delivery method can produce a successful project. The primary benefit of design-build project delivery is a simple reduction in the number of variables.

Many other benefits that apply to green projects and everyday construction projects were mentioned by the survey subjects. These include early detection of design errors, a single point of contact for the owner, the potential for a shorter schedule and quicker overall project completion, a full team concept from project inception, good communication, and alignment of goals for all parties involved.

All of these advantages can be applied to both green and traditional construction projects. Successful green projects today lead to a wider acceptance and desire to build green in the future. Ultimately the owner decides what project delivery method is used. When things can be simplified for him, he/she is more likely to take the step from conventional construction practices to more sustainable building designs.

### **Survey Item 11**

**In your opinion, can or cannot design-build project delivery help transition construction into a greener industry?**

- A) Yes, but no more than Traditional Construction methods where the Design and Construction teams both have LEED education, LEED experience and a clear line of communication between one another.
- B) I'm not yet convinced it will help or hurt. The most important decisions still lie with the government standards and owner requirements.
- C) Yes, Design-build can help transition construction into a greener industry, but there are also constraints that need to be resolved, i.e. subcontractor and engineer work early in the project to resolve conflicts. But cost of construction can increase based on the fact that typically an engineer's design fee is based on the size of the system and a subcontractor's fee is based on cost of materials and scope of work.
- D) The USGBC recognizes the importance of an integrated team approach to green design and construction and to the LEED certification process. The design-build delivery system, including early consensus decision making, full team buy-in, and coordination and collaborative design and construction is perfectly suited to delivering cost effective and efficient green projects.
- E) This is dependent on the individual firm. Tradition design-bid-build scenarios are just as effective in terms of transition if both the architect and contractor embrace green practices.
- F) Yes, but design-bid-build is working also.
- G) Yes.
- H) I don't think there is a direct correlation. The "team approach" is the key. That can be accomplished with design-build or construction management. Design-bid-build makes it a bit tougher.

- I) I don't see a direct correlation here. The real difficulty is the finite documentation and credible audit trail of materials and manufactured products that comprise the completed structure. Very few subcontractors and suppliers are experienced in the level of documentation required and are either unable or unwilling to respond in a timely manner.
- J) If a project were to be designed with sustainability in mind from the beginning in a traditional delivery method, I do not feel there would be a great difference between traditional and design-build as relates to a greener project. Design-build would however allow for greener initiatives to be more easily implemented "on the fly."
- K) Yes, I think the design-build delivery can help transition construction into a greener industry but only from the standpoint that it is a tool. The responsibility of taking care of our built environment lies with the individual and the decisions we make as a team.
- L) Design-build can help transition into a greener industry as long as that is a stated goal of the design-build arrangement.
- M) Yes, however it is most affected by direction of client.
- N) IT CANNOT! The owners must accept the life cycle cost savings of the green process before we will have a "greener industry." With the economy as tight as it is, owners are just trying to get things built without the up-front cost impacts of "greening" their buildings.

Most of the responders agreed that design-build project delivery can help progress the green building movement. Some had different reasoning than others and a few felt that the transition is entirely up to the owners. Many of the answers included traits of any type of firm that would lend to good green construction projects. These included: LEED certified architects and contractors, an early commitment and team approach, and a full buy-in to the sustainable construction ideals. Although these characteristics could be found in conventional firms, design-build firms have a leg up with the inherent team structure.

Some of the responses focused on the commitment of owners and this is completely valid. The owners are responsible for the funding of any project. It is primarily up to them to make a commitment to this environmentally-friendly construction. In order for the owners to turn this corner, they need to be confident in the abilities of their designers and contractors as

well as the building performance and life-cycle savings. Building this confidence in the owners is done through successful green projects and successful green construction firms. The idea was summed up well by one of the anonymous survey responses, “The design-build delivery system, including early consensus decision making, full team buy-in, and coordination and collaborative design and construction is perfectly suited to delivering cost effective and efficient green projects.”

### **Survey Item 12**

**Please add anything that you think may be useful to my study:**

- A) N/A
- B) N/A
- C) N/A
- D) A successful transition toward green construction requires a commitment from owners, architects, engineers, contractors, subcontractors, vendors and material suppliers. Truly integrated design-build firms include in-house architects, engineers, and contractors and have well developed relationships with subcontractors, vendors, and material suppliers. Design-build firms therefore have the best opportunity to facilitate an effective green project solution for an owner committed to green construction.
- E) N/A
- F) Look into the IPD delivery method as this is the future way. Also, IPD, D/B, D/B/B can all benefit from BIM and the integration of green attributes.
- G) Bringing a GC into a project during the design phase is an all around good idea. It helps keep costs down and productivity up.
- H) N/A
- I) Review the LEED criteria to understand the value of a consultant or at least team members who are LEED accredited and the level of effort required for successful submittals to achieve desired certification.
- J) N/A
- K) N/A

L) N/A

M) N/A

N) I think a survey of owners' interest in "greening" their projects in 2009 and 2010 vs. in 2005 and 2006 would be valuable.

The survey responses consistently highlight an early team approach and LEED certified team members as well as a full team buy-in to green construction. "Truly integrated design-build firms include in-house architects, engineers, and contractors and have well developed relationships with subcontractors, vendors, and material suppliers. Design-build firms therefore have the best opportunity to facilitate an effective green project solution for an owner committed to green construction." This statement by one of the surveyed construction professionals sums up the advantage of design-build firms well. The fact that the team and the relationships are established before the project even begins is a huge advantage over other project delivery methods.

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## BIOGRAPHICAL SKETCH

Andrew Surprenant is a student of the University of Florida Rinker School of Building Construction.. He was born in Jacksonville, FL and has lived in Florida his whole life. He moved to the west coast of the state at a young age and has lived in Englewood, FL most of his life. He graduated from Lemon Bay High School and spent some time at Florida Gulf Coast University before entering the architecture program at UF in 2004. He received a Bachelor of Design in 2007 and entered the building construction master's program at the University of Florida the following fall semester. He received his M.S.B.C. from the University of Florida in the spring of 2009.