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CURRENT ISSUES SURROUNDING THE QUALITY OF CONSTRUCTION DOCUMENTS

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by

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ABSTRACT

The quality of construction documents is perceived to have decreased over the last few years according to professionals in the construction industry. Many feel that this decrease is due to the use of computer technology. This thesis strove to answer the question "Have construction documents improved with the introduction of computers or have they simply added to an already existing problem?" Through literature research, a survey, and follow-up interviews, the study concluded that communication was the main problem surrounding the quality of construction documents. Computers were also implicated as part of the problem yet also a way to solve it in the future.

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CHAPTER 1 - INTRODUCTION

Problem Statement

The construction process has always intertwined different skills in order to produce drawings and then construct the actual building. The major players in a construction project are the owners, architects, engineers, and general contractors. In order for these groups to work together, they must possess skills varying from communication and coordination to knowledge of design and construction. A project is typically deemed successful only if it is completed on time as well as within budget. In recent years, this seems to becoming more and more difficult.

Drawings and specifications are used as the means to communicate design to all the parties involved in the construction process. Within the past 20 years, the construction industry has seen an incredible surge of new information technology, including CAD, begin to replace the manual design techniques companies previously utilized in order to complete these drawings. Computer programs are becoming so advanced that in many cases an engineer need only enter the appropriate inputs, and the program will return an answer. In many ways this technology is beneficial at first glance because construction drawings are being produced at a faster rate than in previous years. Also these are easier to read than hand produced drawings. As drawings are completed at a faster rate, companies become more productive, in turn increasing profits. However, have construction documents really improved because of technology or has it simply added to an already existing problem? This thesis

strove to answer that question as well as identify the others problems that may have already been present.

An executive of the Minneapolis-based building contractor M.A. Mortenson Company Inc. addressed the issue of computer dependence the best when he said, "The more sophisticated the programs get and the more dependent we become, the more likely an error will occur and the more difficult double-checking becomes" (ENR February 26, 2001). Is this becoming a trend in the construction industry?

The purpose of this thesis is to investigate the problems that are apparent when creating construction documents. Are there underlying problems that have been present for years or has this problem been introduced with the computer? Basis for this thesis will be an investigation focusing on problems in the office and the field, problems architects, drafters, and contractors see with the process in general along with the influx of technology, and what steps, if any, are being taken to fix this problem.

Objectives and Scope

In order for the construction industry to be able to complete a project without major difficulties everyone involved needs to concentrate on how to accomplish this. It may not happen over night or within the next ten to fifteen years, but if people do not start to consider the issues surrounding the quality of construction documents that goal could be postponed indefinitely. The main objective of this thesis is to allow the professionals involved in the construction industry to identify the issues surrounding the quality of construction documents, what might be causing these problems, and how these problems could be solved. In order to accomplish this, an in-depth

methodology was created including background research, a survey, and follow-up interviews.

Methodology

To effectively complete the objectives and scope of this thesis, background research was done as well as conducting an online survey that was followed up by phone interviews, a discussion board, and a luncheon discussion held on the WPI Campus. These methods are discussed in the following sections.

Background Research

Many articles and texts were read in order to initially determine what the problems surrounding the issue of the quality of construction documents were. A majority of these articles were found in *Engineering News Record* (ENR), *Journal of Computing in Civil Engineering*, *Journal of Architectural Engineering*, *Concrete International*, and from the Construction Industry Institute (CII). Background topics include the increase of computer technology, project management tools utilizing the internet and what affect they may have on construction documents, methods used to measure the quality of construction documents, and other sources that may have caused the decrease in quality of construction documents.

Once different issues surrounding the quality of construction documents were identified, a matrix was created to organize them. They were separated into three categories: the problem, what is causing the problem, and how the problem could be solved. An example of part of this matrix is shown in Figure 1 below:

Diminishing accuracy and detail of construction drawings	Lack of dimensions	Provide information that is needed instead of information not needed
	Arch and Eng fail to communicate and they think the other is responsible for dimensions	
	Causes speculative and inflated bids	More engineering information on drawings (scaling up is not precise enough)
	Economic pressures and shortage of inexperienced design professionals	
	In today's market, major pressure on A/E's to produce plans that may be less detailed than desired	Utilize method such as the objectives matrix to make sure drawings meet the required standards
	Nature of the process is changing, affecting what construction documents need to be	Implement a design and review system for drawings like DrChecks

Figure 1: Organization Matrix

The categories discussed previous are shown from left to right in the above matrix. The entire matrix can be found in Appendix A – Organization Matrix. This matrix was then used to help create the survey questions so they would represent the problems already identified, yet inquire as to other issues that may not have been found yet.

Survey

Having enough participants in order to make the results reliable was a key factor for the survey. The length of the survey was also an important aspect because if it were too long, the participants may not have the time to fill it out. This survey was posted on the Internet or sent through email for the convenience of all the parties

involved. CHAPTER 2 - THE SURVEY goes into more detail about the components of the survey.

Follow-up Interviews

Information was collected through follow-up interviews with approximately 5 to 10 representatives of the different groups that responded to the survey. The purpose of these interviews was to validate the results of the survey and to also extend the questions of the survey to include the use of computers. When the follow-up interviews were complete, the question as to whether or not computers are a major problem in the decreasing quality of construction documents was addressed. To see a list of the questions that were asked in all three formats, please refer to Appendix B – Follow-up Interview Questions. These follow-up interviews were conducted using three different methods: phone interviews, an online discussion board, and a luncheon discussion that took place at WPI.

The phone interviews were done at the participant's convenience. The interviews lasted approximately 30 minutes and the interviewees were asked a variety of questions regarding the results of the survey, solutions to the problems, and the usefulness of computers. There were five participants involved in the phone interviews – 3 engineers and 2 contractors. Other people responded to the invitation to participate in the follow-up interviews but never responded to confirm a time despite various email reminders.

The online discussion board ran from February 24, 2003 to March 17, 2003. This method was conducted on a WPI internal site (http://my.wpi.edu). External users were given usernames and passwords so they could log in. From there they

could answer the posted questions as well as post their own threads of discussions. Two contractors and two architects participated in this format. Again, others had volunteered and then failed to respond to the messages reminding them about the discussion board.

Finally, a luncheon discussion took place from 12:00-2:00 on March 6, 2003 in the Chairman's Room of the WPI Campus Center. Representatives from all three groups were present for the discussion and they discussed the results of the survey and all the problems it revealed as well as the use of computers in the construction industry. Each participant was given the topics of discussion beforehand in order for them to prepare their thoughts and to assist the discussion in flowing smoothly. They could also view the result charts online so they could form their opinions. Once they arrived at WPI they were given a handout of the results to be discussed in the form of tables and comments. This handout is provided in Appendix C – Luncheon Handout. The distribution of participants was as follows: 1 contractor, 1 architect, 2 engineers, 1 owner, 2 professors, 1 undergraduate, and 1 PhD student. To view a transcript of this discussion, please refer to Appendix D – Luncheon Discussion Transcript.

CHAPTER 2 - THE SURVEY

There were three separate surveys conducted, one each for architects, engineers, and general contractors. This helped separate the opinions of all parties. Professional contacts were selected based on background, availability, experience, and the type of work that they do. This narrowed the scope of the project enough to provide useful results. Contacts included members of the Boston Society of Architects (BSA), the Associated General Contractors of America (AGC), the American Council of Engineering Companies (ACEC), The LaiserinLetter™ and personal contacts throughout the region.

In order to get the most information possible from each side of this topic, architects, engineers, and general contractors throughout the United States were contacted to participate in this survey. Fifty-six percent of 136 people that responded to the survey were located in Massachusetts. Other states reached were Colorado, California, Rhode Island, Georgia, Connecticut, Michigan, Pennsylvania, Idaho, Arkansas, Iowa, Vermont, Illinois, Florida, New Jersey, Texas, New York, and Louisiana. In addition to the United States, one person from Alberta, Canada, one from Barcelona, Spain, and one from India responded to the survey. Architects and engineers were asked to provide information on topics such as the inter-workings of their offices, involving the computer operators and review processes, while general contractors provided information regarding how they perceive the quality of the construction documents they receive.

The questions that were asked in the survey are provided in Appendix E – Survey Questions. Even though the involvement of computers was a main objective

of this research, computers were not specifically inquired to in the survey to allow the participants to discuss various problems within the construction industry without limiting their answers. This helped to determine whether computers were an additional problem or a problem all unto itself. The participants were also asked to leave their contact information indicating that they would not mind being contacted for follow-up interviews.

Reminder emails were sent out at different periods in order to solicit additional responses from those that may have simply forgotten to respond to the survey. The distribution of these reminder emails as well as the number of responses received each day is shown in Appendix F – Survey Responses by Day.

Each survey could then be analyzed separately and charts and tables could be constructed for each group. The most significant charts from the survey are discussed in the following sections. Appendix G – Survey Result Charts contains all of the charts created from the survey.

Cross-reference charts were also created in order to see if there were any differences among the correlations in the results with specific characteristics of the sample. Data was cross-tabulated by year's experience, volume of work, and type of work. Tables were constructed to see if any group influenced the results more than others. An example of one of the general contractor questions is shown in Figure 2 below:

Experience		
0-5	9	27.27%
5-15	6	18.18%
15+	18	54.55%

Question 5: On average, how would you rate the quality of construction documents your company receives?

Totals:	
Poor	6.06%
Below Average	27.27%
Average	60.61%
Above Average	6.06%
Excellent	

Poor		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	3.70%	6.42%
15+	6.06%	11.11%	100.00%		

Figure 2: Example of Profile Analysis

The total percentage of each group (in this case year's experience) was determined to see the make-up of the entire group. The question was then broken down into what percentage of the group selected each response. From there the information was broken down further into which group(s) made up that response. For example, for the response of Poor seen in Figure 2, it can be seen that the 15+ group was the only one that responded with that answer. The Percentage/Experience column shows what percentage of each group responded with Poor; in this case 11.11% out of the 54.55% responded with Poor. The Percentage/Total group is the percentage of each group that responded with Poor divided by the entire population that responded with Poor. As can be seen in this example, 100% of the Poor respondents were from the 15+ group. Anything above 80% in this column was considered an influential response to that question. Finally, the mean shows how close the responses from each group

were to the actual percentage that responded with that answer. The standard deviation shows the range of the responses. In this case, the mean was below the actual response, 3.70% and 6.06% respectively. This is due to the one group representing the entire response. Overall, the major groups that influenced the results were as follows: Architects – 15+, Public/Private work, $0-10 million in volume; Engineers – 15+, Public/Private work, $0-10 million in volume; Contractors – 15+, Public/Private work, $100+ million in volume. None of these results were considered significant due to the fact that they represented the majority of the respondents for each survey with the exception of volume of work for Engineers. In this case, $0-10 million represented 30.51% of the responses while $10-100 million was 37.29%. However, this too was deemed insignificant because the number of 80%+ responses was 9 and 7 respectively. The remaining tables can be found in Appendix H – Profile Analysis.

Due to the fact that a majority of the questions were paragraph responses, categories had to be made in order to analyze the data effectively. A majority of these categories turned out to be significant responses and are discussed at length in following chapters. The minor categories that were formed that are not discussed or were not accompanied with explanations can be found in Appendix I – Survey Responses not Specifically Discussed. The actual responses from all of the surveys can also be seen in Appendix J – Survey Responses. Please keep in mind that their responses were not edited in any way.

CHAPTER 3 – PROBLEMS WITH THE CURRENT STATE OF CONSTRUCTION DOCUMENTS

The reviews of recent publications seem to be pointing to the fact that the quality of construction documents is decreasing. There are also many reasons provided as to why the quality seems to be decreasing. This chapter will discuss some of the problems found and responses from the survey and follow-up interviews that either verify the views collected through the review of the literature or disagree with it. Figure 3 below is an influence diagram created to summarize the relationships found more clearly. It shows how all of the different factors found in this research influence the design process which then, in turn, influences the quality of construction documents. The "real" issues that are shown below are those that were found in the publications that were read. As discussed in the beginning of this report, the problems with computers were being investigated and the implications were unclear. So these issues represent the "theory" that was being investigated.

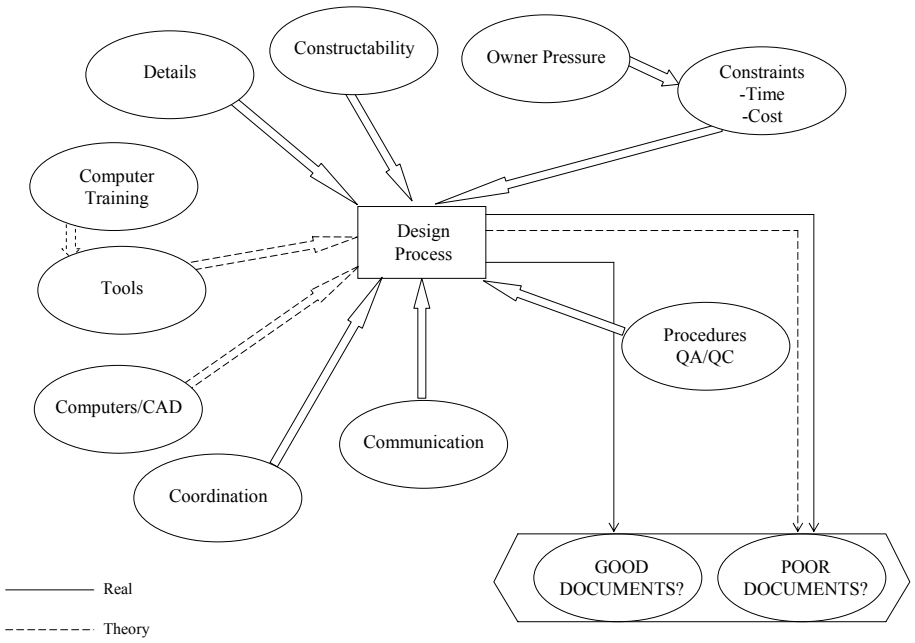

Figure 3: Influence Diagram

Currently, it is perceived that many professionals in the construction industry feel that the quality of construction documents is decreasing. Grady M. Rodney of G.M. Rodney Plumbing Company in Norco, California said, "'Unfortunately, drawing accuracy and detail have diminished over the years'" (Post 34). Contractors are always saying that "architects' drawings . . . don't 'close,' which means the parts don't add up to the sum" (Post 34). As with any controversy however, there are people on the other side of the coin. Some professionals think there is no problem with the current quality of construction documents. Charles Thomsen, chairman of architect-engineer-constructor 3D/International in Houston, Texas says, "I'm not sure I agree that drawing quality is declining. It seems we are producing the best drawings in our history" (Post 34-35). Robert L. Lundgren, an employee at A-E Hammel, Green and Abrahamson Inc. in Minneapolis agreed. He "maintains drawing quality

has not eroded in recent years. But he concedes 'the nature of the process is changing, which affects what the documents need to be'" (Post 42). However, there are more professionals that feel construction document quality is decreasing.

One issue that was brought up was usability. ". . . general areas that indicate design usability are: the availability of necessary cross-referencing between the documents; drawing size; and the amount of unanticipated field engineering (or design engineering time spent during construction) necessary to interpret or complete the design documents" (CII 8-1 6). The construction documents are essential in completing a successful project and when they cannot be used, there are major problems.

According to the survey, 60.61% of the general contractors reported that the construction documents they received on their jobsites were average and 27.27% said the drawings were below average. These results help support the claim that the quality of construction documents is not as high as it should be. The graph below shows the overall distribution of how general contractors view the quality of construction documents.

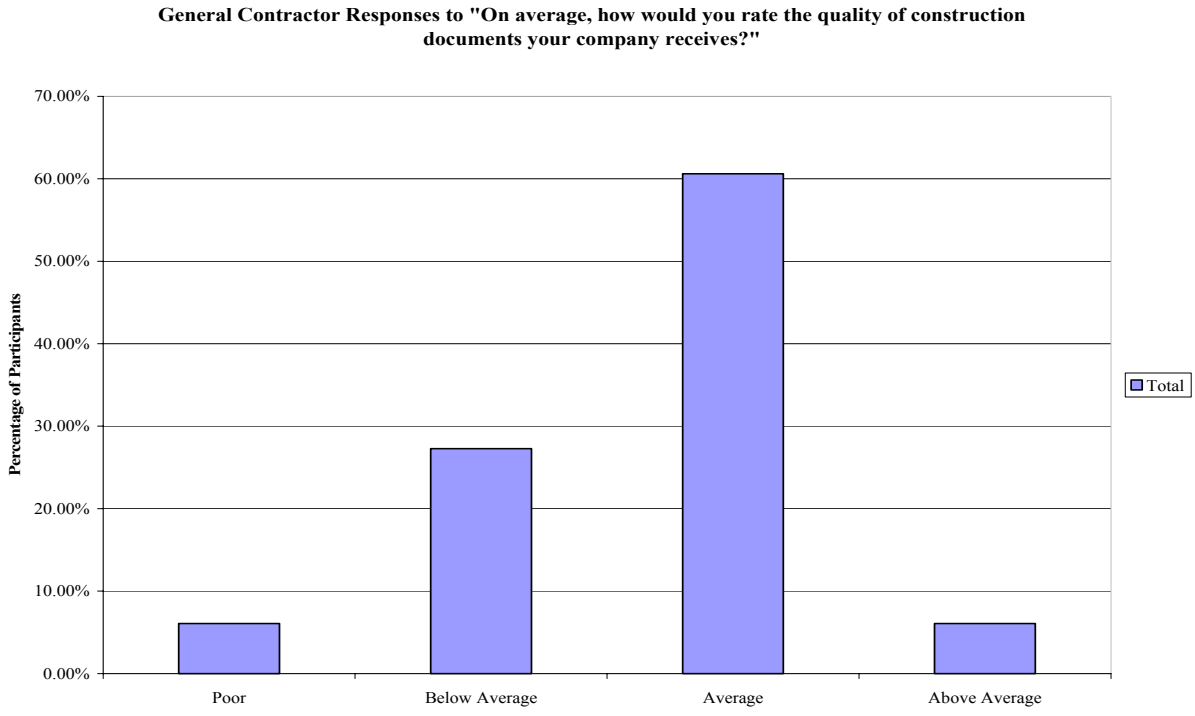

Figure 4: Contractors View of the Quality of Construction Documents

Document Reviews

A vital procedure in the production of construction documents is document reviews. The quality of the documents depends on these reviews. There seems to be many conflicting views on the topic of document reviews. According to the survey, only 3.03% of the general contractors feel that the construction documents they receive are not going through proper reviews as shown in Figure 7. One contractor responded that the construction documents were going unchecked. He goes on to explain that the architects do not spend enough time "ensuring complete documents" (Survey). The contractor results were not supported by the architect and engineer responses however; 91.52% and 79.55% said that their companies did have a method of reviewing documents, respectively. Figure 5 below shows these results.

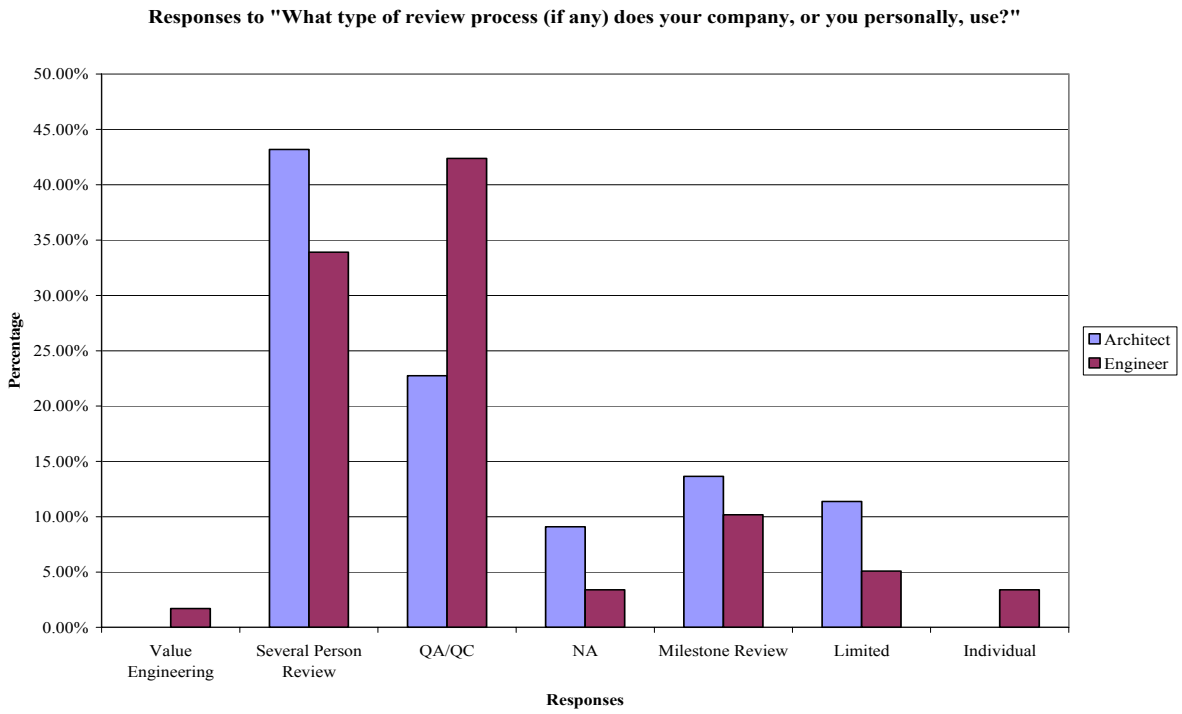

Figure 5: Architect and Engineer Review Methods

In a phone interview, another contractor, Adria Rizzo, stated that despite the architects and engineer claims, they should review their drawings better. One architect, Russ Karlstad, was also on the side of the contractors. He did not agree with the fact that 40% of architects performed several person reviews. "I don't know where the other architects are coming from, but I don't see 40% on that several person review. From the firm I just came from, there were probably one or two reviews, the second one was probably the day before it was going to be printed. In between those two points there is . . . very little coordination" (Luncheon).

As stated at the beginning of this section, the responses to the issue of document reviews were highly diversified. Overall it comes down to what side of the construction process you are on. Karlstad's comment was a key point that possibly

does signify that architects and engineers do not check the documents as well as they should. This issue also goes hand-in-hand with items being omitted from the documents. This topic is discussed in the following section.

Details

The details on the drawings cause major problems with the quality of construction documents. The reasons for this problem range from fear of litigation to time and money constraints. Henry H. Deutch, president of HHD Consultants Inc. in Kissimmee, Florida "says the primary problem with present-day design professionals is 'a fear of future litigation and a lack of fee to properly design a project. Fear results in the designer leaving pertinent data off the drawing, effectively delegating design to contractors. When there is a problem, the design team absolves itself of responsibility and blames the general contractor or construction manager for not building what was designed but not shown'" (Post 38). As can be seen from Figure 6, both architects and engineers feel that details are among the items that are difficult to communicate through the construction documents.

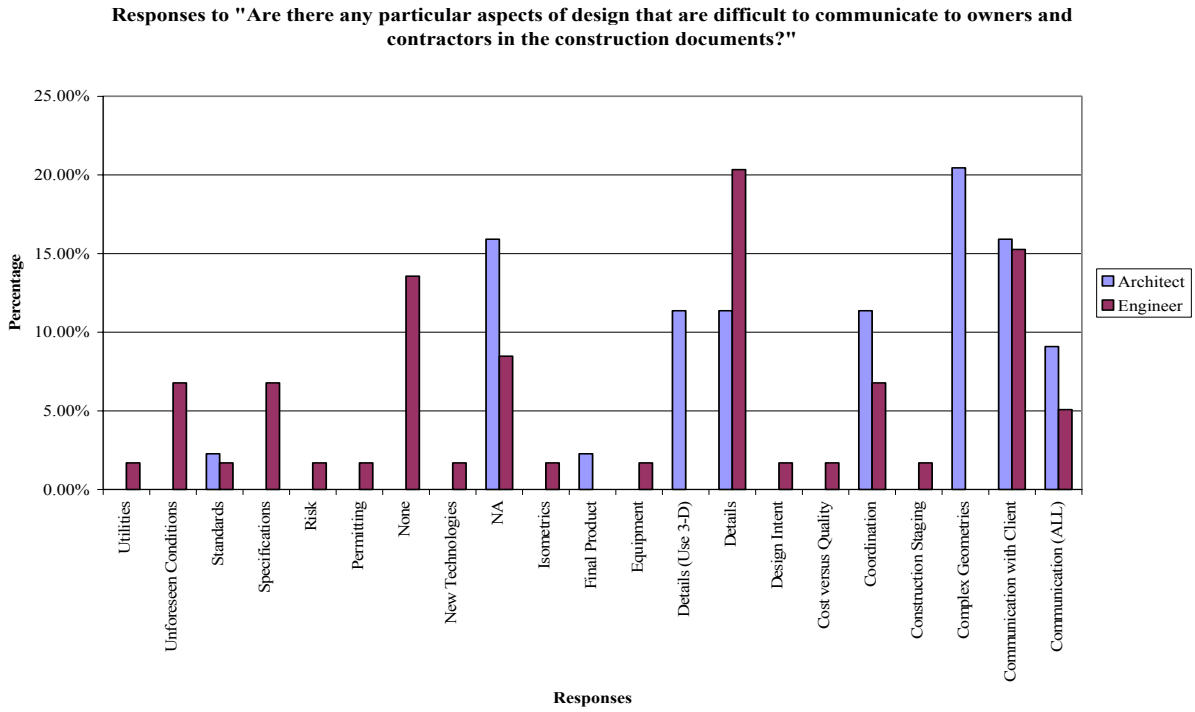

Figure 6: Architect and Engineers Responses to Items Difficult to Communicate

Leaving details out of a drawing causes various problems throughout the entire project. This causes the money and time involved to increase. Emile Troup agrees with Deutch. He states, "Dimensions are a major problem. Incomplete drawings breed speculative and inflated bids. This leads to change orders, construction delays, finger-pointing, disputes and, ultimately, litigation" (Post 35). Contractors also agree that a lack of details is a major problem with construction documents and is causing the quality of construction documents to decrease as shown in Figure 7.

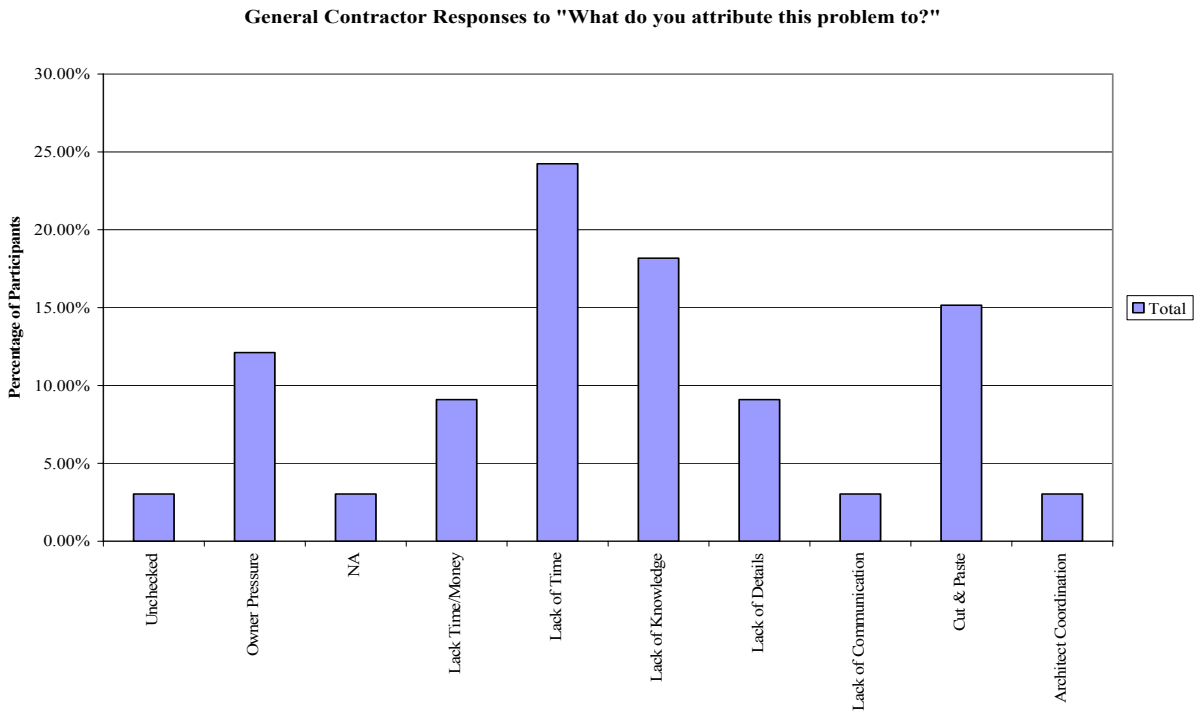

Figure 7: Contractors Reasons for the Decrease in the Quality of Construction Documents

During a phone interview with Cynthia Blondin, she commented that she felt that items were definitely omitted from the drawings. She attributed this to people trying to rush everything out of the door. At the luncheon discussion, William Barry stated, "I think drawings go out with items missing because you don't always have the luxury of getting every one done at once. Not to mention, as we did say, changes occur and sometimes you don't want to get everything designed right at the beginning." David Cronin said, "I think on the architectural side more things are omitted and on the engineering side things aren't omitted, but they're omitted through the process that the architect didn't tell them" (Luncheon). As can been seen from this comment, lack of details could also be attributed to communication problems.

Figure 8 shows the architect and engineer responses to whether or not they felt items were being omitted.

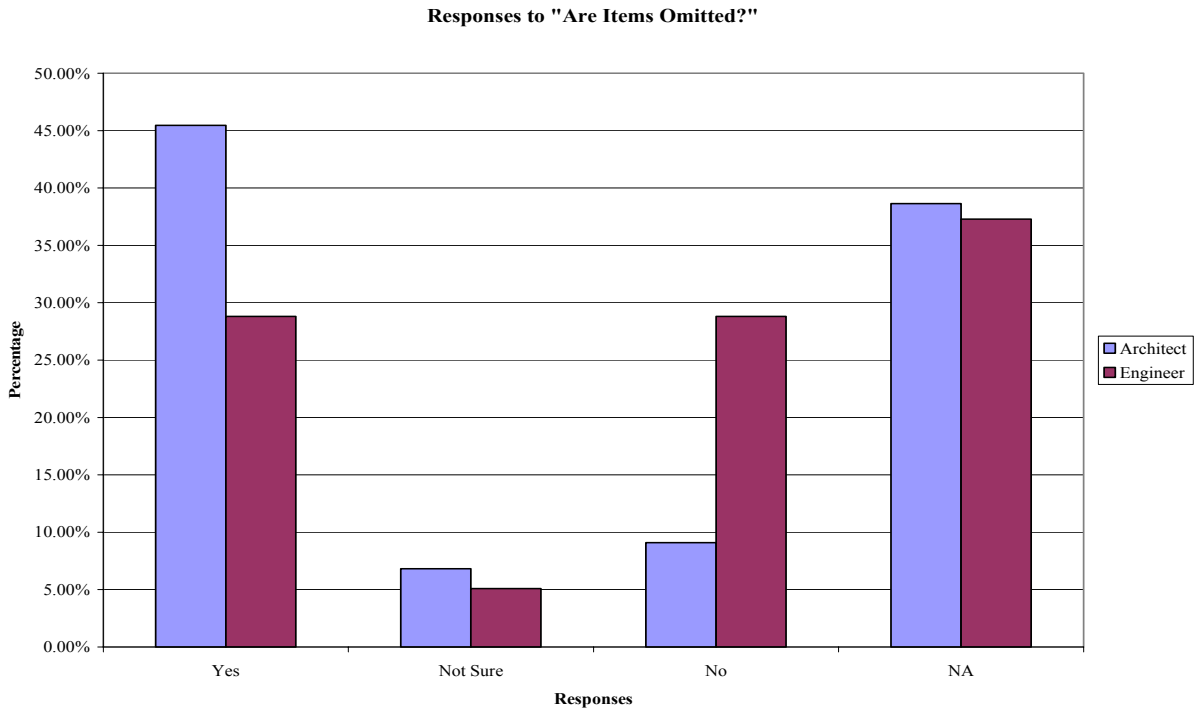

Figure 8: Architect/Engineer Responses to "Are Items Omitted?"

The Non-Applicable responses here represent the respondents who answered "Yes" to the question of "Is Enough Time Allowed to Complete Accurate Documents?" The responses to that question can be found in Figure 9.

Communication

Communication between all of the parties on a construction project, including the owner, was a main problem that was brought up by all parties involved in the construction process. This could be in terms of the architect or engineer communicating the intent of the documents to the general contractor or the general contractor communicating constructability issues to the architect or engineer.

Communication also includes working together as a team and "minimizing adversarial relations" (Survey). Figure 6 showed the architect and engineers responses showing communication as one of the main problems.

Many of the survey participants mentioned that the clients/owners did not understand the design intent of the project and that sometimes it was difficult to communicate that to them. This was also shown in Figure 6. Some clients do not even know how to read architectural drawings and sometimes that is considered frustrating.

Some architects said that it is hard to communicate the need for time without distraction from the clients. This means that changes to the documents while they are still being designed is very disruptive and the architects would appreciate it if the owners would let them design and discuss it with them when they are finished. In the luncheon discussion, Karstad confirmed this point. "I like to get the owner and talk to them, get their check, send them away for about 8 weeks, bring them some drawings, send them away for another 8 weeks and everything is fine."

Also during the discussion, Cronin discussed the lack of communication between people in the same office. "I know the company that I work with has in-house design. The fact that they have [communication] problems and the person is actually sitting in their office somewhere and they could've just held a meeting or discussed it directly is definitely a problem that I see." If people that work in the same building are having a problem communicating with each other it may not be a big surprise that people working at different companies are not communicating.

Items Difficult to Communicate

There have already been many references to items that may be difficult to communicate in the construction documents. All of these responses are provided in Figure 6. The question of what items were difficult to communicate to others in the drawings was asked in order to identify additional areas that might cause problems with the construction documents and between all the parties involved. There were many different issues discussed and different categories were formed in order to analyze all areas. These are presented in the following sections.

Complex Geometries

The complex geometries are representative of design items such as "highly complex, non-orthogonal, or curvilinear geometries" (Survey). Other items that are included in this category are "spatial relationships, stairs, [and] fireplaces" (Survey). Unusual frames and roofs are also mentioned and referenced by this category.

Design Intent

One engineer said that design intent is not communicated effectively. "This often leads to misconceptions by the construction contractor and subsequently requires the expenditure of excessive effort by the engineer to help the contractor understand this intent. There is usually an adverse cost/schedule impact that the contractor may be forced to assume since it may differ from his implementation plan that he mentally understood during bidding" (Survey). Design intent is also closely related to communication because if the architect is not able to communicate his or her intent problems will arise in the documents as well as in the construction process.

Construction Site Variables

There are many different aspects of construction sites that people may not understand. For example, construction staging was brought up as an item difficult to communicate. Another respondent mentioned equipment. His response was "The intended operation for the equipment that was specified and installed" (Survey). One participant discussed the impact of utilities. He said it was difficult to communicate "the complexity of the potential utility impacts due to insufficient or unreliable record plan information provided by utility companies" (Survey).

Unforeseen Conditions is another issue difficult to communicate. They felt that it was hard to communicate the fact that the unforeseen conditions were just that, unforeseen. Sometimes the cost can increase dramatically because the site conditions were much different than found in the test borings. Sometimes these unforeseen conditions have a major impact on the design as well.

If all of the participants in construction projects could understand the different aspects of everyone's job, the projects could be run more smoothly. However, communication of these aspects needs to be improved in order for this to be accomplished.

Attention to Codes, Permitting, and Specifications

Attention paid to the initial items on a construction project such as codes, specifications, and permitting is another problem area. Again, these items go along with communication because in essence these topics need to be communicated to all participants of a project. One contractor said these items are like the backbone of a project and if they are not addressed correctly at first there could be major problems

later. “Pay attention to code requirements for the project, don't over or under design” (Survey).

One engineer from Boston said that permitting is not done in a timely manner. He said that this requires the site design to be 95-100% complete and that the city reviews can take days or months “depending on agencies backlog and political pressure or non-pressure the project has” (Survey).

Engineers feel specifications are a main problem. One participant said, “Specifications are probably the most difficult. The tendency is to use standard models that may not fit the particular project in total, and thus are not fully coordinated with the drawings. Traditionally, designers tend to spend more time on calculations, drawings and less on specifications” (Survey). Another engineer said that it is not only hard to prepare appropriate specifications but to get the contractors to read them carefully (Survey).

The issues involving specifications were verified through the discussion board. Cronin wrote, “I have noticed more and more discrepancies, more responsibility put on the contractor through vague or ambiguous wording, and downright unfair clauses.” Steve Templet responded to Cronin’s comment by saying, “With shorter and shorter time allowed for CD’s, I believe that in most cases the effort and time is allocated for the drawings and the [specifications] are just ‘make-do,’ cobbled together from older projects and quickly modified for the current project.” The topic of specifications and computers is also addressed in the section entitled Cut & Paste in CHAPTER 5 – COMPUTER IMPACTS ON CONSTRUCTION DOCUMENTS.

Coordination

Coordination was mentioned in the survey numerous times and includes many different variations. Coordination is closely related to communication because in order to coordinate with the other parties involved, you must have a good line of communication established. Mostly it represents the coordination between the different parties on the projects such as architects with engineers and general contractors. Figure 6 also showed the responses given for coordination for the architects and engineers. The general contractors' responses for coordination were shown previously in Figure 7.

Kerri S. Olsen made a comment about architects and engineers coordinating with each other. "'In most cases, the architect and engineer fail to coordinate with each other. Each side takes the attitude that it's up to the other to provide dimensions – if not, the trade concerned will work it out. In the meantime, the fabricator and detailer are going nuts trying to maintain an unrealistic schedule'" (Post 34). It is obvious the types of problems that can be caused with the construction documents if the architects and engineers do not coordinate in the very beginning of a project. By simply communicating and coordinating perhaps many of the problems with the documents could be avoided.

During the luncheon discussion Cronin discussed the coordination between the architects and engineers, agreeing with Olsen's statement. "I know this issue came up with the project I work on: coordination between architects and engineers before the project even starts. There are several pieces of plumbing fixtures that appear on the wall in the architectural drawings but if you look on the mechanical

drawings they aren't piped. From a contractor's side, the contractor says, 'Well they aren't drawn, I don't own it.' The architecture side says, 'It's on one of the drawings, you should've known to pipe it.' To me, that's a red flag that says they don't do coordination early enough and that they didn't spend enough time on coordination to give me a complete set of drawings."

As seen in Cronin's comment, coordination also has to do with the coordination between all of the drawings whether they are produced by the same company or not. It is important to make sure that the different aspects of the different drawings do not overlap each other. "Contractors tell horror stories of uncoordinated drawing sets that allow ductwork to crash into beams, and of ceiling plenums 'filled' to overcapacity" (Post 34). The coordination between the drawings also includes communicating these problems to the appropriate parties as soon as possible.

Money

One of the most important aspects of a large project, construction or any other, is money. This is obviously what motivates the owner. Olsen was quoted saying, "The root issue is money. To save money, they use inexperienced personnel. When the budget is spent, work is stopped. Nothing is done until the request-for-information process begins" (Post 34). All of the others involved in the project are essentially driven by money so it is not a big surprise that one of the issues involved with the production of construction documents is money.

When the general contractors were asked in the survey what was causing the problem with the quality of construction documents, many of them responded with a lack of time, money, and knowledge. The chart representing these responses was

already provided in Figure 7. They feel that there is not enough money in the budget to pay for the time it takes to create quality documents. Details are then left out due to this lack of time and money.

One survey participant agreed that a driving factor in the production of construction documents was money. "It is not lack of time that influences lower quality but the competitive nature of the business environment between owners and consultants that influences quality the most. Selection of designers is in many public cases based on quality and not price. However, this practice is mainly a theoretical one where the large majority of owners strive to select by quality but in reality end up deferring to price. This automatically leads without fail to pressure on the successful firm (in this argument, the low bidder) to perform all the work that the client requested for the smallest possible fee. In many cases, the competitive nature of business forces some firms to take on projects for prices where they compromise their ability to break even on the job. This of course does eventually reflect itself in time. However, in this discussion, the detraction is not originating in time but is originating in money" (Survey).

Money was briefly touched on during the luncheon discussion. The focus was more on the owner understanding the cost and putting more money in up front to produce better construction documents. This topic is discussed in depth within this chapter in the section entitled Owners Understanding Cost.

Time

Second behind money is the issue of time. Money can only buy a certain amount of time and most owners will not spend extra money to get extra time. In the

survey, one participant responded, “I think, for the most part, quality left out of construction documents is a function of limited time allotted to complete them. I see this as falling under the responsibility umbrella of the owners. Owners who want seamless, high quality workmanship have to budget time for it” (Survey). A number of other architects and engineers said they need to be given enough time by the owner to complete quality documents. Figure 9 and Figure 10 represent these responses.

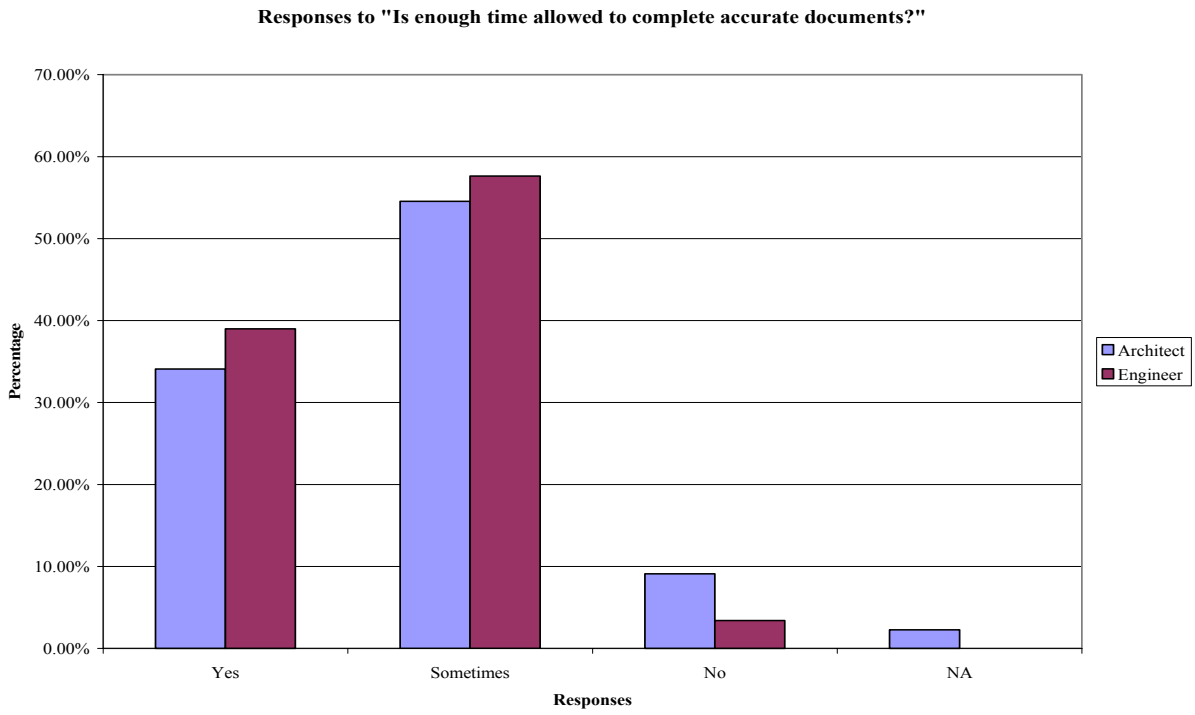

Figure 9: Architect/Engineer Responses to Enough Time Being Allowed

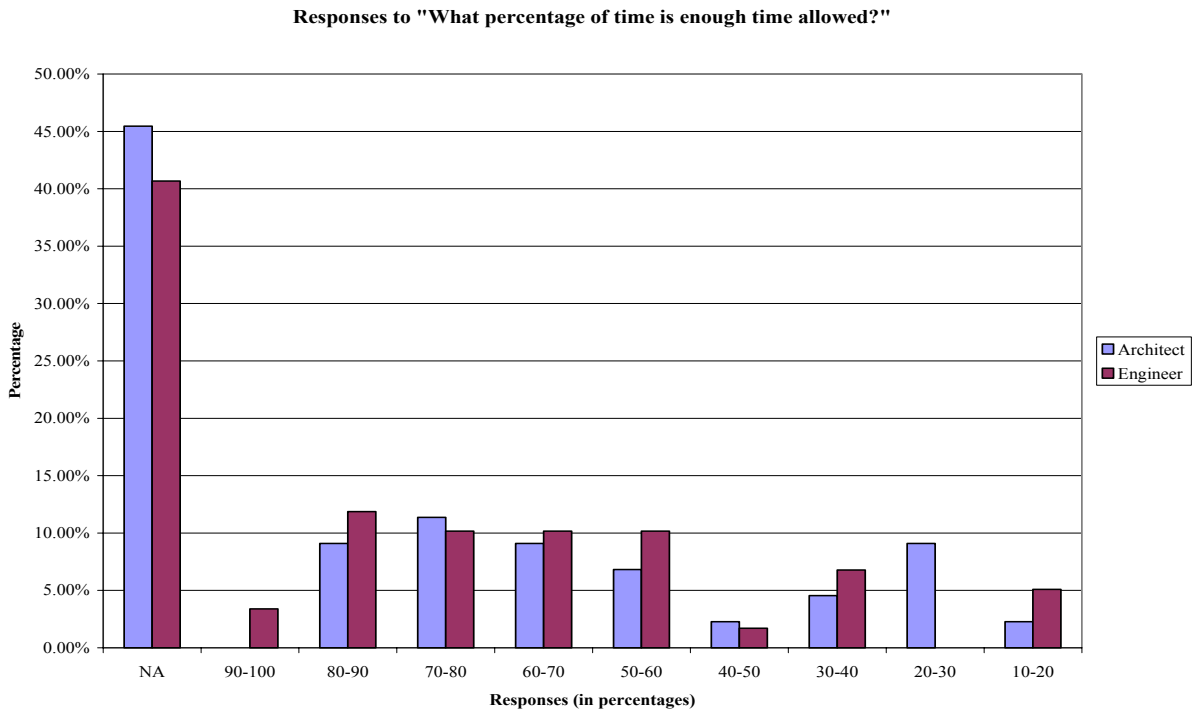

Figure 10: Architect/Engineer Responses to the Amount of Time Enough Time is Allowed

Contractors agree with the architects on this point and responded that they felt the architects were not given enough time to complete accurate drawings as shown in Figure 11.

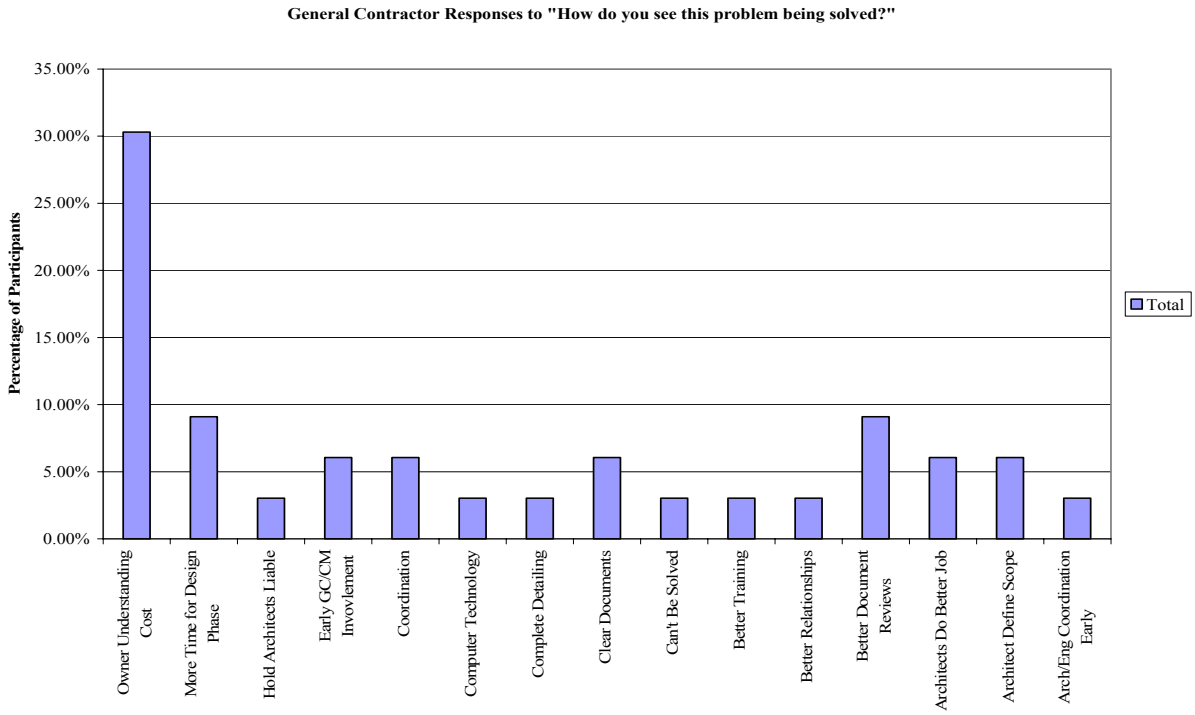

Figure 11: Contractors Responses for How This Problem Should be Solved

From the engineer point of view, Jim Sippel stated that there are unrealistic expectations in terms of time and cost (Interview). Cynthia Chabot agreed by saying that there are schedules set up front that sometimes are not realistic (Interview). Mike Winters, a general contractor, said that projects that used to be done in 2 years are now being completed in 18 months. He also said that the architects are getting slammed in time constraints (Interview).

Karlstad agreed that architects are placed under time constraints. "We are working under time constraints and timeliness issues so a lot of time [a drawing] goes out and it is missing information or [the] scope is not well defined or intent isn't across the board on all traits so there are some problems." That being said however, he also stated, "There is always enough time because we set the time limit. There's

always enough time, but do we make the best use out of that time? Most of the time, no" (Luncheon). So possibly the issue is not that enough time is not allowed for the different parties involved to complete quality work, but is that they do not manage their time effectively.

Finally, the fast-track method of construction is one that definitely involves time. Some people in the industry feel that the fast-track method should not be used because of the accelerated time schedule. Lawrence Griffis, senior vice president and director of structural engineering at Walter P. Moore in Houston, Texas "attributes incomplete drawings to fast-track construction: 'When you produce documents out of sequence to facilitate construction there are going to be changes" (Post 36). John Harris agrees and thinks the fast-track method is the "'dumbest, silliest thing ever perpetuated'" (Post 36). Finally, Douglas Folk, a construction lawyer in Phoenix, Arizona, says, "I would recommend no project be fast-tracked because it only results in claims and disputes" (Post 37). The other side to these opinions is that owners want their projects completed as fast as possible because they feel this will save them money in the end. Once again, this issue is discussed in the section entitled Owners Understanding Cost.

Constructability

Constructability is a large problem seen from the contractor's side of the process. Architects design buildings as they see them regardless of thinking about whether or not it can be built. Rizzo commented on the issue of constructability. She said people do not think enough about constructability because they are too busy thinking about time and money. She said that every detail is used and that one little

mistake causes big problems. The drawings that contractors receive are a road map, according to Rizzo. The analogy she gave was to draw a map of the United States, leaving out Oklahoma (Interview).

During the discussion, Cronin spoke about the differences between the architects and engineers in terms of constructability. "I think the main constructability and involvement issues early on are constructability and I think a GC could point out constructability issues more than architects just because [we're] in the field and we're out there doing it all the time and I know architects don't get a chance to get out there a lot and they don't generally work out in the construction field as much as a CM would. At the same time I think you see engineers, regardless of if they work in the field or not, [not have as] many constructability issues. I think it's mainly constructability with architects that's the problem not with the MEP's." Again, the topic of constructability is also rooted in communication and coordination. If the contractors and the architects discuss the project throughout every stage, there may not be as many constructability issues. This topic will be addressed further in the section entitled Early Involvement: Engineer and GC/CM in CHAPTER 4 – HOW CAN THIS PROBLEM BE SOLVED?.

Timely Constructability Reviews and Responses

Another problem according to architects and engineers is that contractors do not conduct timely constructability reviews. They also do not provided timely responses. One participant stated, "My view is that the more people review[ing] a set, bringing their experience and bias, will improve any set of documents. Based on my own research and experience, the most significant improvements can be achieved

by having constructability reviews done by construction professionals. Studies have shown that the savings could be as high as 5 times the cost of the reviews" (Survey). Conducting these reviews in a timely manner could help increase the quality of construction documents. This topic also is tied into communication. The contractor needs to communicate constructability issues to the architect. In terms of timely responses, one engineer stated that the "GC/CM could provide field verification in a timely fashion" (Survey).

Owners

Owners play a significant role in the production of construction documents as well as with how a project is actually run. Obviously, without the owner's backing the project could not be conducted at all. A lot of projects can live or die depending on the type of owner that is involved and whether or not he or she has a good understanding of construction and the money and time involved. This section will discuss owners more in depth.

Uneducated Owners

Uneducated owners are a big problem to the professionals involved in a project. It is sometimes difficult to get them to understand things such as adding more money up front. Their bottom line is achieving the lowest cost possible, which would be anyone's objective. C. Steven Suprenant, president of owner's representative HDR Project Development Services Inc. in Alexandria, Virginia stated, "'I would say the single largest problem in construction today is the uneducated owner. The second largest problem is the owner's low-bid mentality that stretches to architects,

engineers, general contractors and subs'" (Post 36). The issue of an owner's low-bid mentality will be discussed in the section called Owners Understanding Cost.

Architects feel that the owners they work with should be knowledgeable about the construction process and how much items should cost. According to one survey participant, owners should also be knowledgeable about the people they are working with: "Owners don't seem to know that from a CM they should expect money back if the building system can be swapped to a lower cost alternative. A GC does not have the option of swapping building systems and therefore won't be inclined to give back cost" (Survey).

Karlstad gave an example of how uneducated owners can react when something goes wrong and they do not understand it. "Someone misspoke and told a client that they could use the attic space for storage which you can't do because of code issues. So now these owners think they can put all . . . of this storage in their attic. It's a truss attic system. It's a 10,000 s.f. building. They want all the open floor space they can. They don't understand why we can't cut the bottom truss member out so they can walk across and store all their [items] up there. So you have to educate them structurally and dozens of memos and letters and pictures and sketches go out and it took 3-4 weeks to fix a 20 second blurb and thousands and thousands of dollars. And the owners think we screwed up because they can't store as much stuff in the attic as they wanted to" (Luncheon). This can obviously lead to added time and money as well as adverse relationships between the owners and the parties involved in the project.

John Miller, an owner that participated in the discussion, also commented on the subject of uneducated owners. He said, "They don't know how the process goes on, they just know what they want and that then conflicts with their ideas when they are constantly changing the process."

Owners Understanding Cost

An owner understanding the cost is one of the major problems within a construction project according to the general contractors. These results can be viewed in Figure 12 below.

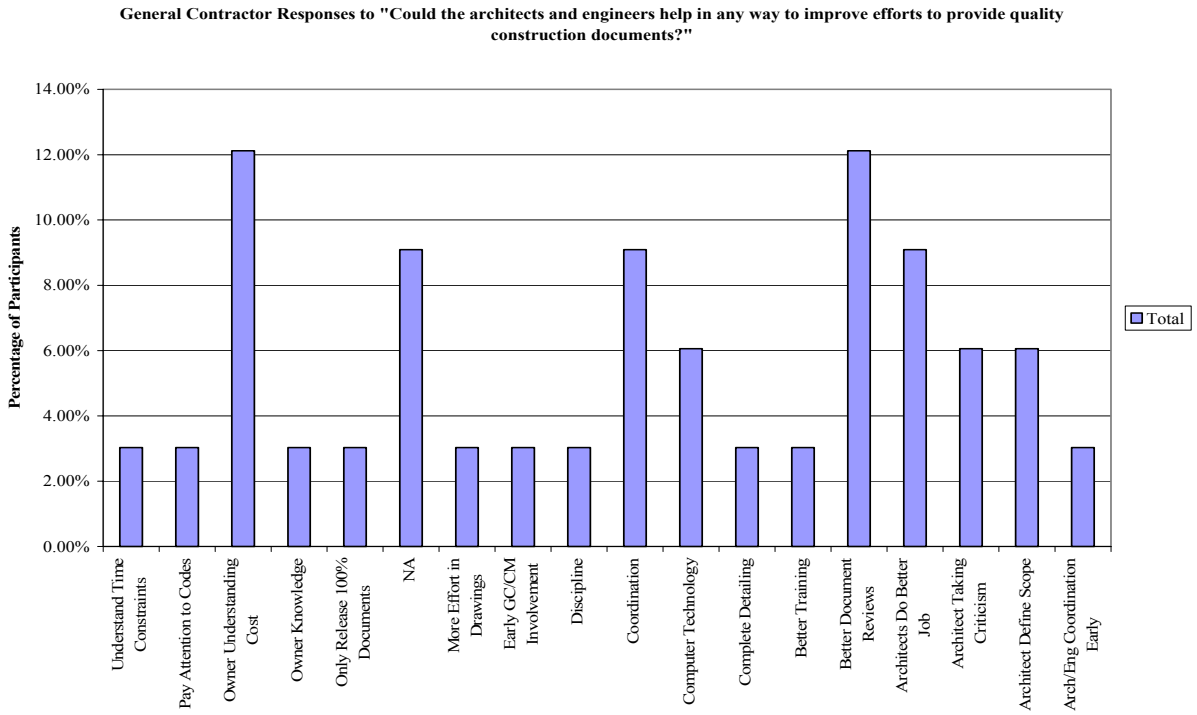

Figure 12: General Contractor Suggestions for Architect/Engineer and Owner Improvement

One participant summarized it best when he said "Until owners realize this problem and are willing to put more money in up front to designers and architects to assure better documents, the problem will not be solved. Owners may not be fully aware of

this problem or the causes, so getting them to change their ways (i.e. awarding design and construction to the lowest bidder or smoothest talker) will be a slow process" (Survey). Basically, owners need to realize that they can either pay the extra money up front and receive quality construction documents or end up paying more money in terms of items such as change orders in the end.

The luncheon discussion also touched on the subject of owners not providing adequate funds for what they want. Karlstad discussed how the architects receive 7-12% of the total project cost of fee. He then said, "The owner's scope changes as the design goes through and . . . trying to get money out of that same owner to cover that cost over and above your 7-12% is like pulling teeth." As the saying goes – You get what you pay for.

Owner Pressure

As shown in Figure 7, 12.12% of the general contractors feel that the owner puts a lot of unnecessary pressure on the architects and engineers. This comes in the form of time pressure to "decrease" the cost of the project as well as changes proposed mid-design. One contractor responded "In the overall design/construction process the Owners generally get what they pay for. Use of less qualified firms at the initial cheaper price, demands for unrealistically low budgets or fees and demands for quicker than possible turn around all contribute to deficiencies in documents on the design side and budget/time impacts on the construction side. Quality is achieved through competent people who gain insight into the project objectives and are provided the appropriate compensation and time for implementation" (Survey). In

the luncheon discussion, Miller admitted that owners do put pressure on the project participants “At times.”

Owners feel that since everybody has access to technology and computers that the architects and engineers should be able to produce the documents quicker than in the past. They do not understand that because of this technology the drawings are now more detailed and they still take a significant amount of time to complete accurately. This aspect of owner pressure is discussed further in the Communication section of CHAPTER 5 – COMPUTER IMPACTS ON CONSTRUCTION DOCUMENTS.

CHAPTER 4 – HOW CAN THIS PROBLEM BE SOLVED?

In addition to providing the reasons behind the problem with the quality of construction documents, the research, survey, and follow-up interviews provided possible solutions to the problems presented in the previous chapter. One participant of the survey stated he did not feel the problem could be solved. All the solutions that were found are discussed in the following sections.

Architects

There were many responses received in the survey regarding the architects and their role in the production of construction documents. The majority of these responses were given by the general contractors, not the engineers, because they are on the other side of the process.

Define Scope and Do a Better Job

Many contractors feel that architects need to define the proper scope better. They feel that this is a major contributor in the declining quality of construction documents. If the scope of a project is not well defined early on then the project will most definitely run into a wide variety of problems that could have been avoided. This view of the contractors was shown in Figure 12.

The contractors also feel that the architects could do a better job in a variety of different areas. Some of these comments are listed below:

- Architects need to re-think their true role in the industry. Builders are paid to put things together, not decipher plans that don't work and not to make design decisions because the architect who was supposed to be on the job site had too much going on and sent a lackey intern who doesn't have a clue! The

almighty dollar has caught hold! The customer ultimately ends up losing! Don't get me wrong, we need architects, but we need them to perform their job completely.

- I would love to say additional time, but I really think it is experience and focus to giving the client a better product. Improvement of listening skills would be very helpful.
- Yes. They are the 'bookbinders.' They staple that set of blueprints together a little too fast, I believe. At the end of most projects, I have a file drawer full of spec sheets, change of work orders, and a few spare parts.
- Yes, but first they need to realize how much time and money they waste because the documents are poor in solving problems. It takes twice as long and costs twice as much to fix a problem, instead spend only 1/2 the money up front to do it right. This will eventually payoff propelling the architects and engineers to the top of their field and getting new work based on reputation.

(Survey)

In addition to the previously mentioned items, other aspects more specific to the drawings could be improved. These aspects include issues like the type of information on the drawings. Some "contractors say they get information they don't need but not information they do. On exterior walls, 'every little nuance of the window extrusion is not necessary,' says engineer Paul Millman. Head and sill details are, he adds" (Post 39). Along the same lines, Thomas Kane of Cives Steel Company in Roswell, Georgia says he "wants to see more engineering information on structural drawings: floor openings, positions of beams and equipment, and geometry. 'Scaling up is not precise enough,' he says. 'We need to know everything to 1/16 in., not to 1 or 2 in.'" (Post 39).

Take Criticism

Relationships are a main characteristic of the construction industry that is important to its survival. In order for the relationships to remain healthy, people need to communicate effectively as well as take criticism from each other. Contractors feel the architects need to improve is their ability to take criticism. Once again, this result

was shown in Figure 12. One participant thought that architects should "listen to what is directed back to them versus taking a stance that their word is final. If people actually practiced the buzz words, such as partnering, there would be improvement" (Survey). Many feel that the architects are not open to advice and think relations would improve if this were not the case.

Architect/Engineer Coordination Early

This solution is similar to bringing in a GC/CM early which is discussed later in the section called Early Involvement: Engineer and GC/CM. Basically it is not just the architects and engineers that need to coordinate early, but everyone. The problem of not enough coordination early was discussed in the Coordination section of CHAPTER 3 – PROBLEMS WITH THE CURRENT STATE OF CONSTRUCTION DOCUMENTS.

Only Release 100% Construction Documents

In a perfect world, only 100% documents would be released in a project. One participant thought there should be a better definition of 100% construction documents. He stated, "Don't release documents until they are 100%" (Survey). In order for 100% documents to be released, however, time and money would have to be increased dramatically and that is not something that owners will agree to.

During the discussion, however, Cronin stated that this would never happen. "There will never ever be a point in construction where the building is going to be done without a single change and without a single discrepancy; it's just the nature of construction. My personal opinion is that there are never even construction

documents that are 100% and there never will be. Everybody needs to understand that process." This can be tied back to communication as well. If everybody had a mutual understanding of this aspect of construction, the projects could be run more efficiently despite problems with the documents.

Create Quality Programs

One of the problems discussed in CHAPTER 3 – PROBLEMS WITH THE CURRENT STATE OF CONSTRUCTION DOCUMENTS was the review of the documents before they were released. In order to fix such a problem, quality assurance programs could be implemented in the companies that produce these documents. The contractors that participated in the survey agreed with the topic of Better Document Reviews which was seen in Figure 12. One engineer feels that each company should have a quality program in place to ensure the quality of construction documents. "Quality does not happen by chance. Quality only happens when a firm has a deliberate and dedicated quality program" (Survey).

Another possible solution along the same lines as creating quality programs may be to coordinate the architect and the general contractor so they both agree on a set of documents. Cronin stated, "If we cause an owner to pay out $1 million more for something that they thought would have cost $1 million less and they don't feel they get much more value for it, it's obviously going to reflect on us. The way to minimize that is to have documents that both the architect and the contractor agree on" (Luncheon).

In addition to the quality programs, quality measurement processes should be created. One such measurement process is the objectives matrix. The objectives

matrix can be used to analyze the quality of construction documents. There are four components of the objectives matrix:

Criteria – what is measured

Weight – relative importance of the criteria to each other and the overall objective measurement

Performance Scale – compares the measured value of criterion to the standard or selected benchmark value

Performance Index – the calculated result used to indicated and track performance

The analyst can select the criteria and weights of the criteria to his or her specifications. The Performance Scale is from 0 to 10 where 10 is perfection and 3 is average. A value of 3 is average in order to allow more opportunity for improvement (CII 8-1, 9-12).

In order to rate the quality of construction documents, the analyst will rate each criterion on the scale of 0 to 10. Then these values will be multiplied by the selected weight. These values will them be added together in order to obtain the Performance Index. A score of 300 would be average while a score of 1000 would be perfect (CII 8-1, 12). An example of an objectives matrix from the Construction Industry Institute is shown in Figure 13 below.

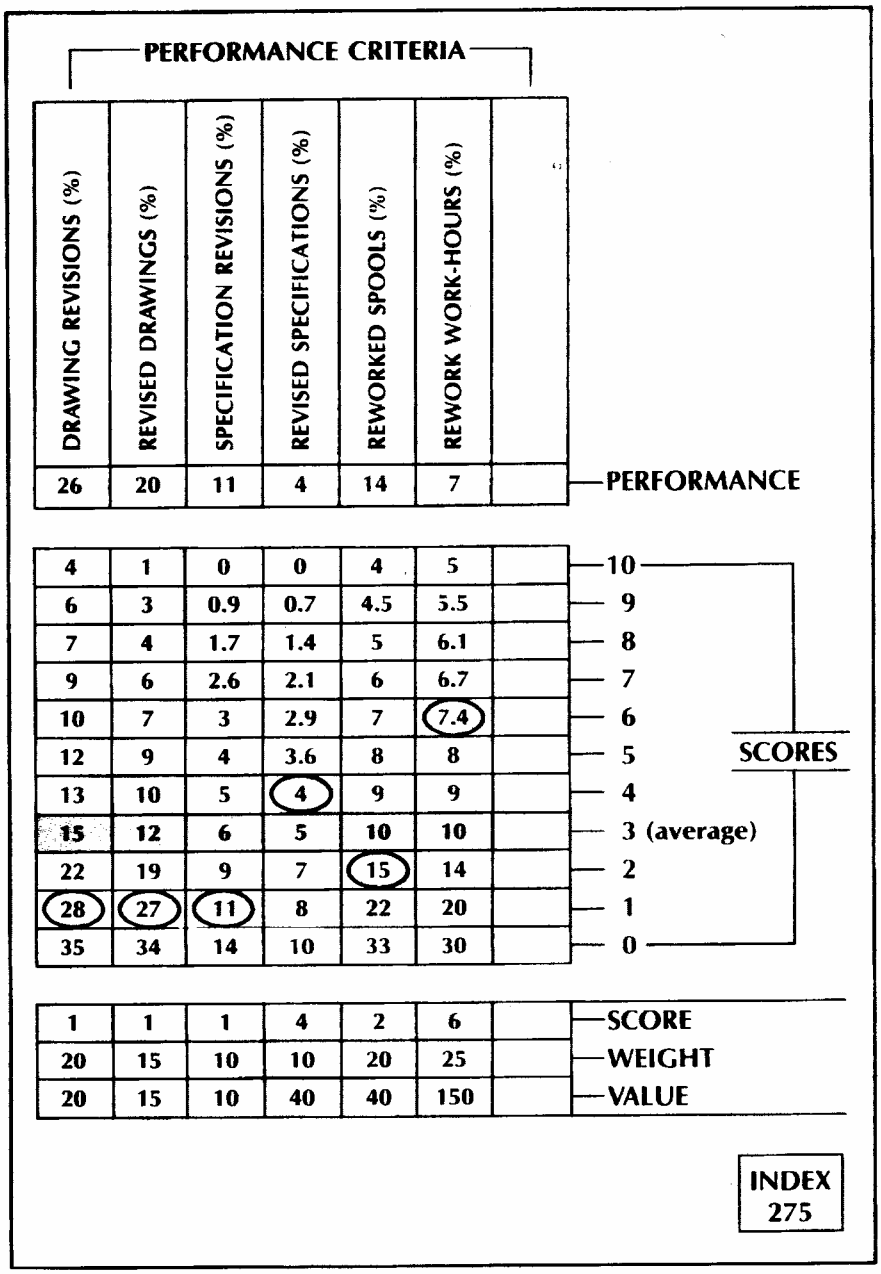

Figure 13: Objectives Matrix Example

Employ a Construction Manager

A possible solution to this problem from the architectural side may be for the firms to hire a construction manager to deal with the constructability issues that the architects themselves may not be able to solve. Barry B. LePatner, a construction

lawyer in New York City, "suggests that A-E firms hire construction managers and assign them to projects, to review plans for constructability and act as an interface between the field and the drawings. He calls this role, the 'executive architect'" (Post 46).

George C. Cavallo, vice president of Gilbane's Philadelphia office, disagrees with LePatner. He thinks that "architects can't afford their own personnel, let alone an experienced CM, who conceivably could command higher compensation than a design principal" (Post 46). So this solution may turn out to be more about money than fixing the constructability issues that these firms face.

Owners

There were many problems involving owners that were discussed in CHAPTER 3 – PROBLEMS WITH THE CURRENT STATE OF CONSTRUCTION DOCUMENTS. The solutions to these problems are presented in a similar format and are discussed in depth in the following sections.

Educate the Owners

Owners should be involved in the construction process from the very beginning. Blondin said that some owners can be easily convinced about what needs to be done in order for them to save money, but that some cannot understand the construction process. Blondin works directly for the owner. She says they try to explain the process to the owners to some extent; they explain the big ticket items to them. To show how difficult it is to convince an owner, she discussed how her

company does not make a profit from the owner, yet they still question everything she does (Interview).

Chabot, in her phone interview, also discussed the topic of early owner involvement and trying to get the Owner to understand the process of how different disciplines' work may affect the layout of the building, for example, the structural engineer. She believes that owners should be involved in decision making early instead of having decisions made for them during the final design process based on a constrained layout. She also feels that a third party should be brought in for the owner that understands the design process, who is not also working on the design. This would be similar to having a CM to work alongside the owner.

Make Owners Understand Cost

A main issue that was discussed in the previous chapter was the ability of the owners to understand the costs involved with a construction project. Suprenant discusses how his company deals with costs and how owners do not seem to understand. "'We tend to build in a 5% margin of error in our master budget. Our projects typically run 2 to 4% over. Owners don't understand that under 5% with errors and omissions is a damn good rate" (Post 45).

As was seen in Figure 11, the majority of contractors felt that it was very important for the owner to understand the costs involved in producing quality construction documents. Below are a few comments that were made about this topic:

- [Architects] can inform owners that the more money spent on better documents, extended design time, and focus on details and coordination of drawings and specifications will yield a better project with fewer changes and issues during construction.

- [Architects] need to educate Owners about the value of complete documents and properly and thoroughly document their design and carry enough money in their budgets to assign ample staff to do so.
- Owners need to expect to pay for good documents in order to get a good job.

(Survey)

During his phone interview Winters discussed the object of cost and felt that perhaps it would be easier for an owner to understand cost if they were shown a graph with the percentage of change orders versus time up front. This could help the owners understand that if they put more money in up front they will save more money in the end.

During the discussion, Cronin stated, "You can't educate every owner completely on what every cost is going to be and you can't ask every owner to give you an extra year in design. You can increase money minimally and get a much better document out of it in my opinion." Karlstad responded from the architect's point of view. "I've got to agree with putting more money in up front. You want to end up paying an architect 15-20% of the fee to get the job done right first and save thousands and thousands of dollars at the end." Cronin concluded by saying, "You'd have to have a series of projects in one field of construction or another where they gave more money and they didn't have a single change order and they had a half a percent of change orders at the end of the job for them to realize that this is the way to go. It's up to the owners and I don't see that changing in the future." The participants in the construction industry are very set in their ways and as Cronin said, it will take a very long time for a revolution such as this to take place.

Decrease Owner Pressure

Owners push everyone on the project so hard because every additional day adds more cost to the project and that is the owner's number one priority. At some point, however, the people working for the owner need to let them know that they've gone too far and that the project will suffer because of it. Robert P. Sanna, executive vice president of Forest City Ratner Cos. in Brooklyn, New York says, "There will always be pressure from market conditions to accelerate drawings and production. It's the professional's responsibility to let the consumer know when it has crossed the line. Stick to your guns" (Post 36). Robert E. Selsam, senior vice president of Boston Properties Inc. in New York City agrees with Sanna. "Developers will always push designers because 'every additional design and construction costs money'" (Post 36). He also feels that it is the responsibility of the "design professionals to educate the client and to hold firm when pushed beyond 'the point where they really feel quality will suffer'" (Post 36).

Another way to possibly decrease owner pressure is to try and hand-pick the best subcontractors that you can to reassure the owner that the best people are out there working on their job. Kevin M. Lasater, senior vice president of McCarthy in St. Louis says, "It's even better to identify the sub's personnel. I say, 'I want Billy Bob and I want your other good foreman for my job' and I negotiate with a sub on that basis" (Post 45).

Communication

As discussed in the previous chapter, many references were made to communication being a main problem with the production of quality construction

documents. Communication is also the underlying issue of many of the other problems discussed. Many of the architects and the engineers that responded to the survey referred to communication which can be seen in Figure 14. Below are some of the comments made by the architects and engineers in regards to communication:

- Better communication. There are projects with too much communication and the civil engineer is copied every piece of correspondence and invited to every meeting (this drives up design costs). Then, there are projects where I never meet the design team and only get feedback/schedules, etc. when I asked or when the deadlines are imminent. The solution falls somewhere in the middle.
- Absolutely. Communication is a key, and so is timely exchange of information.
- During construction, regular (monthly or every other week) technical issues meetings are helpful to collaborate ideas and address issues in a timely manner. Construction details can be worked out if unclear. For future projects, the field information (i.e. - design changes) needs to be conveyed back to the home office or wherever the design originated.

(Survey)

Many believe that if communication was increased, many of the problems the industry now faces would decrease.

Cronin discussed the topic of communication and that perhaps there should be one point person in charge of a project to make sure everyone has all the information that they need. "There's communication between engineers and architects, which is necessary at all points. If you stop communication with your engineer assuming that he's going to go and design all you plumbing . . . there [could be] a problem because he could design something you don't want or in a way you don't want or he could put a pipe where you don't want. So there needs to be constant communication" (Luncheon).

Another aspect of communication that was brought up during the discussion was communicating your capabilities to your fellow employees. Karlstad stated,

"You get people out of school and you assume that they know something, but they don't know anything yet and you ask them to do something and most of the time they butcher your drawings and you have to go back and fix them. Everyone should know what everyone else is capable of doing when new people come on board. I think resumes should be passed around . . . so that doesn't happen. Someone comes in . . . at a certain level and you expect them to be able to do things so it's . . . up to the people hiring to get that information out."

Coordination

Coordination is a problem that goes hand-in-hand with communication. From the survey, the architects, engineers, and the general contractors all made references to coordination which are shown in Figure 12 and Figure 14. The solutions involving coordination are discussed more in depth in the sections entitled Architect/Engineer Coordination Early and Early Involvement: Engineer and GC/CM.

Constructability

Architects feel that general contractors should stick to the constructability of a project. One responded, "If they were to limit themselves to 'constructability' issues and not attempt to redesign the building, and perform timely, comprehensive document reviews, that would be a welcome contribution" (Survey). Basically, architects want to be the only people designing the building and feel that contractors should allow them to do so.

In order for everyone to have a better understanding of constructability and what it involves construction lawyer Michael S. Zetlin "has written a standard

contract language for preconstruction-design review meetings. It begins: 'Prior to the start of construction, Contractor shall meet with Architect-Engineer and its consultants (the "Design Team") for the purpose of conducting a constructability review of the entire project. At such meeting(s), the Contractor and the Design Team shall endeavor to identify, clarify and resolve all design and constructability concerns of the contractor. . .'" (Post 42, 45). If such meetings were held, it could help improve overall communication throughout the project as well as decrease the number of adverse relationships that can be created because of these constructability issues. In addition, if this communication is improved, constructability reviews could be conducted in a timely fashion and the overall responses to inquiries could be given more quickly.

Early Involvement: Engineer and GC/CM

Having engineers and contractors on board from the beginning of a project would help communication, coordination, and constructability issues. One survey participant stated, "Architects could make the design process more inclusive to inform the engineer early about the goals stated and unstated of the project. Get the engineer involved early to conceptualize the project and the approach and the compromises" (Survey).

This category was also one of the most popular responses in the survey. This can be seen from the architect and engineer responses shown in Figure 14. The contractors also discussed this as a possible solution which was seen in Figure 12.

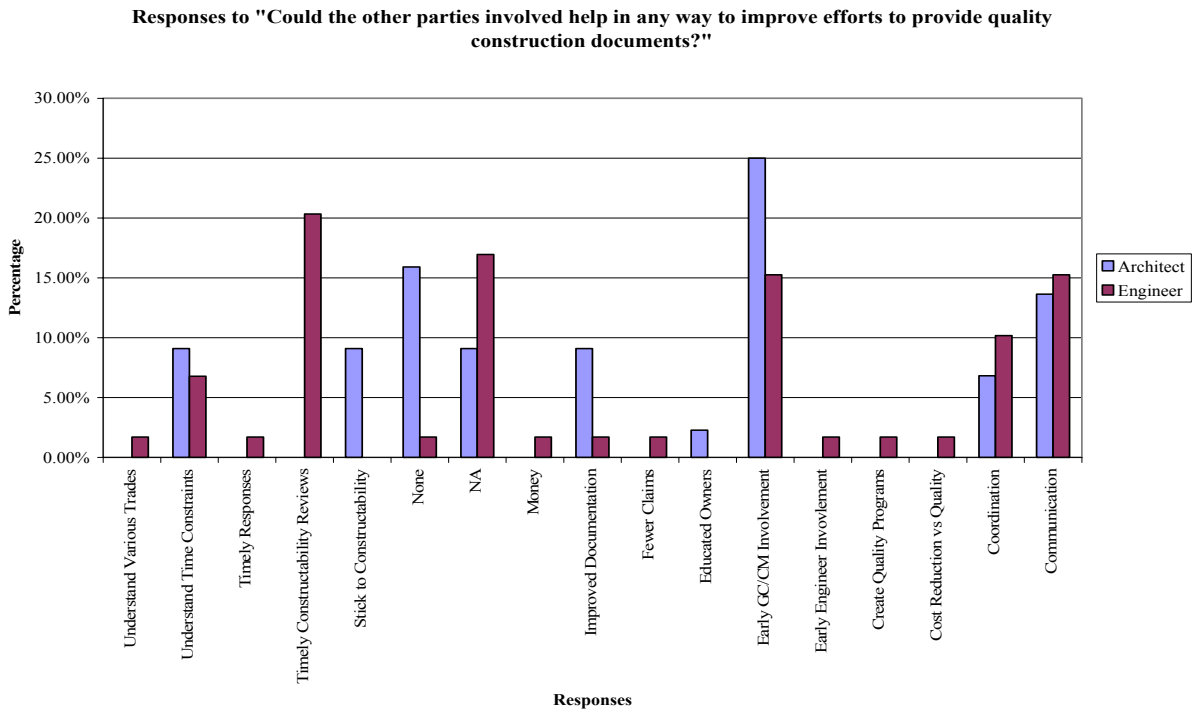

Figure 14: Architect/Engineer Suggestions for Contractor and Owner Improvement

If a GC/CM is brought in during the design phase they can provide input with cost estimates as well as constructability reviews. One participant stated, "Projects that utilize a construction manager, in my opinion, result in a better product at a better price" (Survey). Also, if a GC/CM is involved early, you could "avoid getting into situations where the GC is unclear how to complete a task" (Survey).

One example of people getting involved earlier and its implication on cost was provided by Sid Dickerson, senior vice president at Hirschfeld Steel Co. Inc. in Irving, Texas. "The cost of having the steel fabricator involved in preconstruction, rather than having it donate its services, is between 0.1 and 0.2% of the total cost. The cost of everybody's attorneys, even to mediate the claims at the end of the job, is probably around 10 times that" (Post 45).

Blondin discussed how she feels that everyone should be involved in the process from the beginning, including the owner. That said, however, she did feel that the CM's are not doing their jobs because they are not as involved as they should be. She is also a big advocate of Design/Build and feels that this could help solve the problems with construction documents (Interview). This could help with the communication and constructability issues mentioned, but as discussed by Cronin earlier in the Communication section of CHAPTER 3 – PROBLEMS WITH THE CURRENT STATE OF CONSTRUCTION DOCUMENTS, people working within the same office still have communication issues.

Cronin expanded on how to fix early on coordination in addition to "having more coordination or review in the architecture or design phase. The other process would be to possibly get the contractor involved and let them look at the drawings and try to time those things earlier on" (Luncheon).

Winters touched on a topic very similar to Cronin's suggestion. He feels that drawings should go to a contractor that is not bidding on the project to be checked thoroughly before bidding even begins (Interview). This could decrease constructability issues as well as possibly decrease the cost of the bids if everything in the drawings has been verified and checked.

Improved Documentation

Improved documentation could mean improving the quality of the documents all together or improving the documentation of the entire process so people are able to review the process more effectively and have a better understanding of what has gone on with a project. One architect thought that improved "documentation of Phasing

the Construction" could help improve the situation with construction documents (Survey).

Documentation is extremely important in terms of electronic plans. When items are changed people need to be informed of those changes. One engineer asks architects to "Document and inform us of changes on updated electronic progress drawings" (Survey). The topic of electronic drawings is discussed more in CHAPTER 5 – COMPUTER IMPACTS ON CONSTRUCTION DOCUMENTS.

Better Document Reviews

As discussed in CHAPTER 3 – PROBLEMS WITH THE CURRENT STATE OF CONSTRUCTION DOCUMENTS, contractors feel that architects and engineers are not performing the appropriate document reviews in order to ensure quality construction documents. This includes paying more attention to codes, providing complete detailing, and overall clear documents. Also recall that Karlstad disagreed with the architects admitting that the reviews possibly were not conducted as often as shown by the survey (Luncheon). So simply conducting these reviews could improve the quality of the documents. One contractor discussed possible solutions and stated that there should be "More complete detailing earlier on in the project. Typically questions are answered at the drop dead hour and often solutions mean other work (done previously thinking a typical solution would be chosen) needs to be redone. The cost of detailing will be incurred sooner or later. Better sooner than later" (Survey).

Understand Time Constraints

As was discussed in the previous chapter, time constraints was one of the topics believed to be causing the problems with the quality of construction documents. While one solution to this may be to acquire better time management skills, others in the industry could understand that time constraints is an issue and work around it. However, in most cases allowing more time to complete the documents is not a feasible solution. One architect felt that this time pressure came from the general contractors. His solution was as follows: "Be more realistic in early/conceptual stages of project estimating, so that [the] design intent can be fully realized, rather than having a disappointing [value engineering] phase which leaves everyone disappointed/frustrated and out of time for good [construction documents]" (Survey). Another architect agreed and added, "Allow the necessary time to complete detailed and accurate drawings that are WELL coordinated with the other trades. Most of the time final details for installation are left to the contractor installing the system or component without having prior information of the proposed installation to review and comment on for improvement" (Survey).

As Figure 14 showed, engineers also feel that others should understand the time constraints involved in the construction process. One engineer feels that "taking time to properly coordinate the construction documents will save time in the long run" (Survey). Engineers also need to be allowed the appropriate amount of time to do their work after the architects are done with theirs. "Allow the proper amount of time for our work to be executed which generally means we need time after the architect is complete with their work." (Survey).

General contractors also believe that more time should be allowed for the design phase. They feel that architects and engineers should be "working together and putting the time [in] that is needed" (Survey). This result was shown in Figure 11.

Modify the Construction Process

Many people within the construction industry feel that the entire construction process should be revamped. They feel that issues such as fixed-price contracts, the duplication between shop and construction drawings, and the fast-track method are definite items that should be rethought.

Some feel that the construction process as a whole is very illogical and that that has a lot to do with the decreasing quality of construction documents. "Modify the process, and 'drawing quality would improve substantially'" says G.P. Horst of Baker Concrete Construction in Ohio (Post, 35). Sid Dickerson agrees with Horst and feels the whole process needs to be recreated because "Instead of design-bid-build, 'what I now do, nine times out of 10, is design-bid-build-litigate. It is not fun" (Post 36). Again, this issue seems to tie back in to communication. If the people within this community were able to communicate effectively there may not be as many problems within the process. "We, as a community, need to pick apart the process more and understand and communicate with one another better about the hierarchy of decision-making" says Joshua Horowitz, senior vice president of Tishman Construction Corporation in New York City (Post 42).

The Duplication of Shop and Construction Drawings

The duplication of shop and construction drawings seems to be unnecessary. This simply causes a greater factor of error when items are being transferred from one set to the other and adds to more confusion and communication problems later on in the project. Charles Thomsen of 3D/International in Houston, Texas "recommends reducing 'the silly wasted duplication' between an architect's construction drawings and shop drawings. 'If we develop a process where the trades are selected either by bid or negotiation, during the development of construction documents we can integrate their knowledge and their drawings into the process. That will eliminate duplication and add collaboration with knowledgeable people'" (Post 46).

The Fixed-Price Contract

Another topic that people think should be changed is the fixed-price contract. They want to replace it with a negotiated-price delivery system. The negotiated-price delivery system allows subcontractors to be a part of the design. Cavallo stated, "'The architect develops design documents as shop drawings are developed'" (Post 42). As can be seen from Cavallo's comment, this can also help with the duplication of construction and shop drawings.

The Fast-Track Delivery Method

Finally, people think that the fast-track delivery method should not be used anymore. They feel that it moves too fast and causes more problems than it is supposed to fix. Hines, a large developer in Houston, is one company that does not use fast-track and has seen no decrease in the quality of their documents. Executive

vice president of Hines, John Harris, states, “Fast-tracking is the ‘dumbest, silliest thing ever perpetuated. We insist upon 100% complete construction documents. [Documents are] as good today as ever’” (Post 36-37).

The fast-track delivery method can have a direct effect on the construction documents that are produced due to the advanced schedule and the order in which documents are created. Lawrence Griffis, senior vice president and director of structural engineering at Walter P. Moore in Houston, Texas states, “‘When you produce documents out of sequence to facilitate construction’ there are going to be changes” (Post 36).

CHAPTER 5 – COMPUTER IMPACTS ON CONSTRUCTION DOCUMENTS

As stated previously, the survey was designed to find out what all of the issues surrounding the quality of construction documents were instead of simply limiting it to the role of computers. From there, computers were introduced to the participants. This section presents the issues surrounding computers as well as how computers could be a solution.

Problems Surrounding the Computer

Through the research it was found that there were many problems that could be attributed to the computer. These issues range from inexperienced personnel to time issues to accuracy and are presented in the following sections.

Inexperienced Personnel

One possible issue is that the people working with programs such as CAD may not have the training or the knowledge that they need in order to produce quality construction documents. "Many firms don't have the time or the resources to train CAD operators to produce adequate drawings" (Post 46). Paul Millman, principal of Superstructures, a New York City-based exterior wall consultant, stated, "People come out of school who are fluent with a computer as if it's a video game. But if you analyze it, you realize the operators are only drawing lines on paper – not walls, floors and columns" (Post 42). Figure 15, however, shows that the participants of the survey feel that the engineers creating the documents are skilled to very skilled.

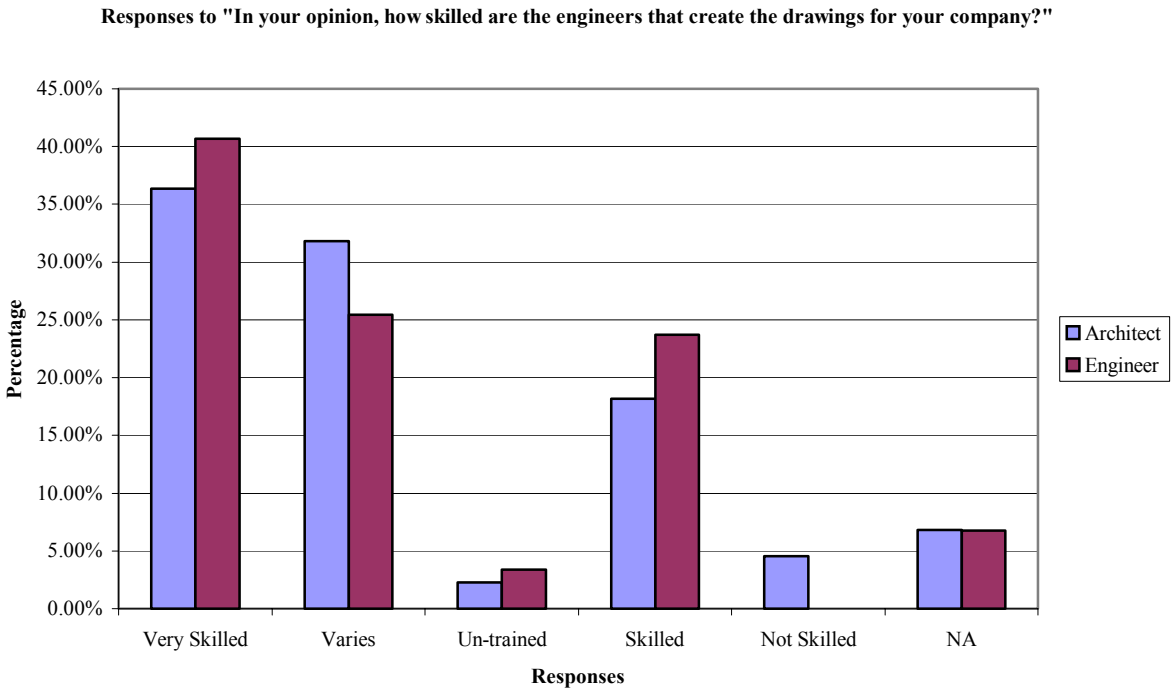

Figure 15: Architect/Engineer Responses to the Skill Level of Engineers

During a phone interview, Chabot discussed how she learned CAD. She said that she started with just learning the program and not the engineering behind it. She said this could be the case with others as well, that maybe they are not learning the design first.

Barry has first hand experience in training people on CAD. He said, "I know when I set up the AutoCAD course I had the problem of we didn't have anyone that could draft in the engineering department and I didn't know what a drawing was but I was teaching them AutoCAD so I produced someone that could do AutoCAD but they didn't know how to set up a drawing" (Luncheon). This is another good example of how people may not be as well trained as they should be.

One author, however, disagrees that the computer and the people using it are causing the problem. He first begins by comparing it to the calculator. He states that some people believed that "the calculators would lead to a generation of practitioners who would no longer be able to perform mental arithmetic" (Altabba 31). He goes on to say that "It has been estimated that a person, on average, makes about one error in every 10 calculations performed. It would be foolish to think that human error is increasing, or for that matter decreasing, with advancing technology. It is thus meaningless to focus on computers, which are simply tools, and very useful – if not indispensable – ones at that" (Altabba 32). Altabba believes that many of these errors could be avoided if there was a second set of engineers performing the same task independently so the two could be compared at the end.

Altabba also goes on to discuss competent engineers. He says, "Universities certainly carry a heavy and complex burden and are making changes in curricula to meet today's challenges. However, industry must bear the larger load in developing its engineers. We need to have a well thought out, formalized mentoring program for the new graduate" (Altabba 32-33). The participants of the luncheon discussion also defended the engineers creating the drawings. Cronin said that the engineers were "very skilled."

Cut & Paste

Another major issue that has been found with the computers is the ability for parties to simply cut and paste objects into the drawings. According to the survey, many general contractors feel that the CAD operators today are simply cutting and

pasting the documents together. This was shown in Figure 7. Below are some of the comments provided in the survey:

- I believe that younger people are too reliant on CAD to develop details without simply sketching out some details to see if it makes sense.
- The drawings today seem to be a cut and paste function of the CAD operator as opposed to a design function.
- There are several reasons why the documents we receive are mediocre. Most earthwork and site prep specifications are very basic, and are usually 'cut-and-paste' specs from a previous job. I worked for several years in an AE firm, and as a matter of economics, we were reminded not to 're-invent the wheel', that is, do not spend any time trying to refine something which has been already been done successfully.

(Survey)

Rizzo mentioned that architects definitely cut and paste because they include things that are not on the project (Interview). Blondin also gave an example of cut and paste when she discussed a reference to the New York code on one of her drawings that was for a project in Rhode Island (Interview).

Accuracy

Some people think that the computer has decreased the accuracy in the construction documents. "Steel fabricators talk about structural drawings with no dimensions, and of "CAD-astrophies" with electronic drawing files that do not scale up to the level of accuracy required" (Post 34). During the luncheon discussion, Karlstad made the comparison between hand drawings and computer drawings. "[Hand drawings] were [much] more agreeable and a lot more clear and concise in their detail than the computer drawings you get today."

Accuracy also comes into play when drawings are changed. This goes back to communication because if one object is changed on one drawing, everyone that that will affect needs to be contacted. Professor Jayachandran, who participated in the

luncheon discussion, stated, “Computers have added to these levels of complications because there are many levels of drawings so if you make changes in one layer you have to make sure all the changes have been made.” Barry also commented on this topic. “Also one of the computer problems I notice is that things are revised in the computer and no one points it out so a lot of times I get a set of drawings and a couple of months later someone says, ‘Hey, you know that room changed?’” Cronin agreed and added, “The technology allows you to . . . get complacent. If it’s not perfectly done or not clouded or you’re not notified, obviously, you’re not going to see a big difference. The technology lets people get a little too lazy in the areas of changes.” This was also discussed in a phone interview with Winters. He said that CAD overall hinders the process making architects not as conscious.

Incompatibility

Within the construction industry all of the different parties use a different type of technology. Some use AutoCAD while others may be using Revit. Cronin stated, “You get different technological issues; the architects might say that ‘in the future we’d like to have a website with all the drawings on it.’ Then the contractor would say, ‘We need paper copies.’ And then your subcontractor might not even have a fax machine because he’s so far back in the dark ages” (Luncheon). The fact that everybody is on a different page in terms of technology causes major problems, obviously including communication.

Communication

While email has revolutionized communication throughout the world, some feel that it is an impersonal way to communicate. Others have become much too reliant on email and they use it to over-communicate. Responses could be received much quicker if a phone call was made. Blondin stated that she received fifteen emails on a subject that one phone call could have solved (Interview).

Owners also feel that the use of computers enables the professionals to design the buildings faster. It is difficult to communicate to the owner that this may not be the case as was discussed the Owner Pressure section of CHAPTER 3 – PROBLEMS WITH THE CURRENT STATE OF CONSTRUCTION DOCUMENTS.

Advantages of the Computer

While there may be some inherent problems with computers, technology is advancing so much and so fast that people are not going to have much of a choice. Companies will need to invest in these technologies and figure out how to function effectively with them or go out of business. There are many products that are out or are coming out that attempt to improve the construction industry. These programs are discussed in the following sections.

4-D CAD

Four-dimensional CAD combines 3-D CAD and the ability to run a schedule. The characteristics of this make it seem like a good investment, but a lot of time must be spent in order to learn the software. The resistance to change that is already present within the construction industry may only increase with 4-D CAD because of

the initial time investment that must occur (Roe "Building" 29). While the initial time investment may be large, the time investments on the other end definitely decrease. William Cook, senior vice president for URS Corporation in Los Angeles stated, "'time investments can drop from several weeks to several days as 4D tools mature and more projects are designed in 3D'" (Roe "Building" 31). One benefit of 4-D CAD is that it helps decrease conflicts in the design (Roe "Building" 30). One 4-D CAD product that will be introduced some time in the future is Disney's InviznOne tool (Roe "Building" 29).

4-D CAD is more beneficial if used on complex projects. Peter Allen a project manager for DPR Construction Inc. in Redwood City, California discusses one example of its success. "On the $72-million Bay Street Entertainment and retail complex in Emeryville, Calif., DPR used 4-D CAD to help win the job and shave several weeks off the project schedule" (Roe "Building" 29).

An advantage of 4-D CAD is that it is compatible with other software. For example, "3-D CAD data from AutoCAD, Microstation, and other platforms can be imported into the 4-D software and arranged so building components correspond with construction activities. A concrete floor slab, for example, might be subdivided into pour zones, rather than shown in its geometric design layout. Schedule dates can also be imported from various platforms such as Primavera Project Planner and Microsoft Project as well as generic text files. Each activity in the schedule can be linked with one or more corresponding objects in the 3-D model" (Roe "Buildings" 29). The ability to import from Primavera is a great addition because many professionals in the business are familiar with that program or those that are similar.

DrChecks

DrChecks stands for Design Review and Checking System and was developed at the Corps' Construction Engineering Research Laboratory in Champaign, Illinois. It links all the parties involved in the drawings (designers, reviewers, project managers, etc.) through the Internet to keep track of the review of construction documents (Roe "Corps" 55).

Users can log on to DrChecks to check project review status, make comments, and respond to other comments. They can also sort the information by date, discipline, reviewer as well as other categories. In general, this process works as follows: the project manager creates all the review phases for the project; the reviewer then submits comments for each phase; the designer then evaluates the comments and responds. All communication is kept in a database and files (drawings) can be attached with the comments (Roe "Corps" 55).

DrChecks includes a Lessons Learned (LL) section in order to help the users who encounter similar problems others have already experienced. "Each potential 'LL' item is sent to discipline-specific experts to determine if the item is technically accurate and likely to impact operations. If accepted, the LL is forwarded to other parties and added to a knowledge base accessible via the Web" (Roe "Corps" 55).

DrChecks is also said to be able to save a lot of money on projects. Robert Clarke, an architect and design information technology manager at the U.S. State Department's Overseas Building Operations in Rossyln, Virginia thinks, "DrChecks can save up to $500,000 on a $100-million project through efficient reviews and improved design, which decreases change orders and delays" (Roe "Corps" 55-56).

Pete Rossbach, a structural engineer at the Corps' Washington, D.C., headquarters finds similar savings. He found that on a $3 million project, savings of about $50,000 could be obtained. Approximately $6 million was saved on a project in Fort Meade, Maryland (Roe "Corps" 56).

There are also opportunities for timesavings if using DrChecks. On smaller projects, DrChecks could decrease the review period from weeks to 48 hours (Roe "Corps" 56).

DrChecks is available to government agencies for an annual fee that ranges from "$10,000 to several hundred thousand dollars per site, depending on the number of users" (Roe "Corps" 56).

Revit

Autodesk Revit is a relatively new parametric modeling program that is being offered to the construction industry. Many feel that it is the future of construction and could eliminate many of the problems that were discussed in previous chapters. It can help increase productivity and influence better coordination and communication (Autodesk). It can also be used by everyone in the construction industry including architects, engineers, and general contractors.

There are many benefits that are provided by Revit. One can do "Concurrent design and documentation, powered by parametric change technology. You enter information once—in the familiar language of drawing and sketching—and it is captured for use throughout the entire project. You can make a change to any part of the design—including sections, elevations, and drawing sheets—and it's updated everywhere else" (Autodesk). It can be seen from the previous statement that this

program could improve the issues with changes being done on electronic drawings and other project participants not being aware of those changes.

Revit also provides many unique features that programs such as AutoCAD do not. These features from the Revit website are provided below:

Immediate Productivity

- Intuitive, easy-to-use interface, based on Microsoft® Windows® conventions.
- Dimensions that always reflect actual building geometry; edit a dimension and the geometry changes accordingly.

Fully Integrated Project Model

- Detail drawings created directly in the model using powerful 2D drafting and parametric detailing tools.
- Worksets enable multiple team members to work together on the same model, while their work is fully coordinated.
- Model linking connects separate Autodesk Revit models into a single integrated project for project scalability.

Design and Management Control

- Expressive geometry and design supported by real-world, constructible materials and systems.
- Detailed graphic control and view-specific graphics that make drawings look exactly the way you want them to.
- Fully configurable to office standards for graphic style, data and layer export, and other drafting and CAD standards.

Visualization

- Integrated AccuRender® raytracing and radiosity for on-demand visualizations.
- Rendered walkthrough animations exportable to AVI files.
- Instant color-plan diagrams of program assignments or any other room data.

Data Sharing

- Industry-leading DWG compatibility using the Autodesk ObjectDBX™ toolkit, as well as output to DXF™ or DGN file formats.
- Output to any ODBC-compliant database product to communicate with third-party applications.

- ASTM Uniformat II classification for mapping to cost-estimating and other assembly-based data.

Building Component Content

- Thousands of building component families for every project type.
- Graphical parametric component editor that allows component creation by simply drawing.

(Autodesk)

As can be seen from these features, Revit can be a valuable tool in the construction industry. It can also be easily integrated with AutoCAD. If the program becomes commonly used by all those involved, that will help with the incompatibility problem found.

In order to purchase this program a subscriber can download the program and obtain a license from month to month. You could also have a CD and a new license sent to you through the mail. A license per month is less than $500 and also depens on the number of licenses purchased. Revit also provides training classes for those that wish to do so (Autodesk).

During the luncheon discussion, Karlstad could not say enough about Revit. He discussed a colleague that was currently back at the office fixing little details on every drawing which would take a long time. "With Revit it's instantaneous. It can't be wrong. It's beautiful. And that saves 8-16 hours on an average set of drawings. You know time is money. And it has automatic conflict alerts so you'll know when you've got ducts running through a 12 x 54."

Cronin thinks that Revit is a very impressive product from the little time he has been exposed to it. He feels that "it's going to be a long, long evolution" to get

everyone to that same level of technology as was discussed in the Incompatibility section (Luncheon).

Electronic Plan Rooms

There have also been advances in the construction industry to try and reduce the amount of printing and copying of paper drawings and specifications. Electronic plans are a way to reduce all of the paper documents. A source at the AGC says there are approximately 50 Internet plan rooms contacting them to be able to be put on the market (Sawyer 31).

Electronic plan rooms include aspects that reduce the time it takes to access files as well as estimating and project management software. Contractors are endorsing the electronic plan rooms by saying "electronic plans can help them find, bid and perform their work more efficiently" (Sawyer 31). Celia Padilla, a project manager with Marek Brothers Systems Inc., stated, "We use them for estimating and quantifying our costs and communicating with our people in the field through color-coded drawings. Everywhere we go, people are talking about this and think that five years from now it will be the norm, but no one seems to be leading the charge " (Sawyer 31). This statement goes along with what Cronin described as a long evolution for different aspects of the construction industry to change. Many contractors will always want to use paper plans simply because they are comfortable with it and like working from them. They also like delivering the plans in person because they like the environment of the community (Sawyer 32).

There are some initial concerns about electronic plan rooms from the architectural side. Architects are worried that someone will steal their designs or

property rights if they are simply posted on the web. Therefore, security is a big issue with the electronic plan rooms. They re also worried about the drawings being edited online without their consent or knowledge. Also if the drawings are scanned onto the plan rooms, the quality might be poor and illegible to the recipients. Richard Thevenot, executive director of the Louisiana chapter of the AIA thinks "scanning would be unnecessary if designers released secure, uneditable versions of their CAD plans in read-only formats" (Sawyer 31).

As stated previously, the contractors feel that the electronic plan rooms help with their efficiency. In turn, they can also help them economically. Leslie Bloom, vice president of business development for AGC's Carolinas chapter, says "The contractors need to see more work so they can get more work, and they need to be able to do that more efficiently" (Sawyer 32).

The following excerpt discusses how the services are focusing on contractors as well as more about what the plan rooms do:

> The online services that are competing for contractor groups are using new software techniques to present searchable catalogs and crisp images of plan sheets that quickly deliver a wealth of information about jobs over the Internet, even via relatively slow modems. Bloom says the process can be broken down into either negotiated-bid work, where plans are circulated privately by designers to contractors or subs, and publicly bid work, which is generally awarded by law to the low bidder and is required to be open to any qualified contractor. Plans and specs for public-bid work are the stock-in-trade of plan room operators.
>
> (Sawyer 32)

As discussed previously, these plan rooms can increase efficiency. However, it was also noted that the fast pace of the industry may be causing problems with

construction documents. So if these plan rooms are going to be adopted by the industry, caution needs to be taken in order to maintain the coordination and communication that is necessary for projects to be successful.

Electronic plan rooms also help with the issue of delivering the actual drawings when they are completed. This would also decrease the amount of time and money utilized in the drawing process. Chip D'Angelo, vice president of business development for the McGraw Hill Companies' Construction Information group said, "Delivering plans and specs is a painful process. It's cumbersome, costly and takes resources. Then there are change orders and new sets have to go out. It's always been a bottleneck that screamed for more efficient tools" (Sawyer 32). This way, the recipients can just download the drawings themselves.

There are many different electronic plan rooms available. These include On-Screen Takeoff which is an estimating program developed by On Center Software Inc. in Houston. On Center has also developed an electronic plan room called Virtual Plan Room (Sawyer 31). F.W. Dodge is the country's largest supplier of plan rooms. They were releasing Dodge Plans on their website *Construction.com* on June 17, 2001. Other services competing with Dodge include The Blue Book and CMD (Construction Market Data). *Buzzsaw.com* is a web-based collaboration of services that is also competing.

Handhelds

Handhelds are also becoming a noticeable accessory on construction sites. They help people communicate better between offices and actual job sites when they need to view items such as pictures or drawings. This saves time because individuals

involved do not have to spend their time going back and forth between the office and the job site. This also saves time for the trades waiting for confirmation on objects before they can start building them.

The California Department of Transportation adopted handhelds early. They have sent out approximately 800 handhelds in the last five years. Most of the PDAs use the ePeg construction diary system accessible through Bear River Associates Inc. in Oakland, California (Roe "Handhelds"). The following excerpt discusses how ePeg is run:

> The mobile portion of ePeg runs on pen-based computers that support Windows CE, Microsoft's scaled-down operating system for mobile devices. Field users collect project information such as pay items, labor and equipment, and build electronic diaries that are uploaded to a central database via a serial connection. Once there, diaries can be electronically edited, stored and retrieved. ePeg costs $2,300 per user but is sold as an entire Oracle database system for an enterprise.
>
> (Roe "Handhelds")

As can be seen, ePeg is a valuable tool for communication between parties on and off the construction sites.

Another system that can be used is Prolog Pocket which was developed by both Meridian Project Systems in Folsom, California and Onsyss Mobile Computing in Greenbelt, Maryland. This program "'eliminates the clipboard and allows you to access your calendar, addresses and other important information,'" says Troy Tyler, the marketing manager. Prolog Pocket costs $299 for Palm devices and $395 for Windows CE (Roe "Handhelds").

Two other products on the market are SitePad for Palms and FieldPad for Windows CE devices. These were developed by Info Tech Inc. in Gainesville,

Florida. "While similar, SitePad is a newer offering that fits with the company's SiteManager integrated construction management suite. FieldPad was introduced last year as part of the FieldManager suite tailored to field offices. Both applications are part of the *Trns.port* program sponsored by the American Association of State Highway and Transportation Officials." FieldPad is $595 while SitePad is $10,000 for a Department of Transportation license through AASHTO for unlimited users (Roe "Handhelds"). Again, these management products can help with the communication aspects of construction.

A product relevant to the production of construction documents is PocketCAD which was launched last year by Arc Second Inc. in Dulles, Virginia. Through this program the users can "create, view and edit cad files on Windows CE devices" (Roe "Handhelds"). This tool could be invaluable to those working in the field when there are last minute changes to the drawings and they need to get to the contractors immediately. The product Fieldworks from XYZworks in Bellvue, Colorado is a newly introduced add-on to PocketCAD. It "allows PocketCAD users to connect handheld computers to survey instruments and simultaneously collect survey data and create maps in the field" (Roe "Handhelds"). This add-on could be incredibly useful for the unforeseen site conditions that cause changes that were not anticipated for in the beginning. These conditions could be quickly documented so the project could continue quicker than before.

CHAPTER 6 – CONCLUSIONS & RECOMMENDATIONS

In conclusion, this thesis reviewed the current state of construction documents and the reasons as to why the quality is perceived to be decreasing. There were many reasons given for the problem that ranged from inexperienced computer operators to the scope of the project not being defined. The issue of computers was also introduced to all of the participants to see whether or not the computer was a major problem with the quality of construction documents. The question: Have construction documents improved with the introduction of computers or have they simply added to an already existing problem? From the results of the survey as well as all the interviews, the answer to this question appears to be that computers have already added to an existing communication problem.

From this research, the main problem with the production and the quality of construction documents seems to be communication. 32% of architects, 32% of engineers, and 3% of contractors specifically responded with communication in the survey, overall being the most consistent answer. These percentages do not include all the other responses that can be linked with communication. Whether it is with a contractor or an architect or even an owner, communication is the backbone of the entire industry. If the participants of a project cannot effectively communicate with each other, the quality of the documents as well as the quality of the entire project will decrease.

For communication to be successful between all the parties working on a project, communication needs to work with the employees at the same company or of the same trade. For example, architects need to make sure that they communicate

their drawings to one another effectively when they are performing the design checks. The majority of the architects and engineers said that they performed design reviews, yet the contractors said they would like those groups to do it better. This is a sign that things are not being communicated within those departments and that it is an area that could be improved.

One way to improve communication on a job site would be to get all the participants of a project involved from the very beginning. This would help with issues such as constructability. Having specific point people on a project for each discipline could also help with communication. However, this may not be feasible to have one person working on only one specific project.

Another way would be to implement the handheld tools that are available. This would decrease the time it takes for individuals in the field to receive the necessary drawings which is vital, especially when drawings are changed and need to get to the site as soon as possible. They could also help with the surveying aspect of construction by allowing users to create maps right in the field and send them to the office.

Project websites can also help with job site communication, especially in terms of construction documents. If the project managers had access to the project websites in the field, they would be able to view the latest version of the drawings themselves without having to wait for the architect or engineer who made the change to inform them that the change had been made, if they do at all.

Communication also goes hand-in-hand with coordination. Projects cannot have one without the other. If the people involved with the project could coordinate

with each other better, issues such as time management could be improved. This coordination would allow people to have a better understanding of how long an item should take and be able to schedule their time accordingly. This may assist with project management skills as well. If some of the areas where it was found that communication was difficult were remedied, individuals may have a better grasp on how to communicate other aspects of a project, in turn improving these skills.

The addition of the computer to this process may have introduced a major time issue to a process already short on time. If employees of a company utilize computers, clients feel that items, whether it is drawings or reports, should be produced quicker than in the past. This is a valid point; however it seems that many companies have used this efficiency to take on many projects at a time, actually increasing the time crunch they originally felt. Also, email has added a new dimension to communication. As was stated in the report, fifteen emails could be sent to get an answer on a question that one phone call could have obtained. Email is a great tool, but should be used more responsibly.

The computer can also be an advantage however. This is apparent with 3-D parametric modeling such as Revit. Revit can decrease a lot of the problems with documents such as items crashing into each other from drawings prepared by different trades. Revit also allows the designer to create the building in a shorter amount of time, decreasing the pressure discussed in the previous paragraph. In order for Revit to be successful, however, a majority of the industry would have to utilize it or at least understand it. The construction industry needs to be at the same level technologically in order for everyone involved to communicate effectively.

The issue of inexperienced personnel was also discussed. Overall, the skill of these employees was found to be skilled to very skilled. However, companies need to make sure that they have intensive training programs for the new employees. It is not good enough for only some of the employees to simply know AutoCAD; it is vital to the company's success that everyone is fluent in the concepts that are behind these drawings. It would also help if these individuals also understood the nature of the construction process as a whole so they would understand how their drawings actually affect the project and what impact poor drawings would have.

Another issue that involves computers and communication is when changes occur on drawings. Everybody needs to be aware when such a change is made. Also, these changes need to be made on all of the drawings so that they are all coordinated with each other. Computers themselves could actually help solve this problem with the introduction and adoption of programs such as 3-D parametric modeling as previously discussed. Project websites could also help when items are changed on a drawing because the participants could be able to view the most recent drawings from that page.

Many different opportunities for future work have been identified through this research. Possibilities could include specifically investigating communication issues and possible ways to improve them. In addition, potential computer advances and how the construction industry as a whole could adopt them could be researched.

The transition from AutoCAD to Revit may be along the same lines as converting from hand drawings to AutoCAD. Research could be conducted on what the potential problems of this transition could be and if they would be similar to the

first transition. One could also investigate how the construction industry as a whole would react to such a transition. The industry could benefit from this by knowing what to expect and how to possibly avoid many of the problems identified to make the transition smooth (Barry).

The affects of switching to a 3-D or 4-D system could also be researched, especially along the lines of how it would impact the construction industry. For example it "looks great in the office, [but] how does the man/woman in a 10' trench laying out footings, in 20 degree weather, with freezing rain pelting down use it?" (Barry). Also, how will procurement and QA/QC procedures be affected by the transition? For example, "how will you do takeoffs; will trades be broken out anymore? What kind of new review strategies will be needed?" (Barry).

Finally, the issue of uneducated owners could also be an interesting topic. Research could be performed to determine how an owner becomes educated and what characteristics define and owner as educated. How the construction industry goes about attempting to educate owners could also be researched. A possible template on how to educate owners could be created (Barry).

In conclusion, the construction industry is probably one of the most complex in the world. There are many different parties involved that need to be able to communicate effectively in order to get work done. With the addition of new technology, this is becoming more and more challenging. The industry needs to figure out a way to successfully incorporate these new technologies and use them responsibly while still maintaining the level of communication that is necessary.

CHAPTER 7 – REFERENCES

Adams, L. Allen. "Tools." Journal of Computing in Civil Engineering October 1998: 179-180.

Altabba, Bashar. "Don't Blame the Computer for Mistakes!" Concrete International December 1, 2002: 31-33.

Angelo, William. "Broadband Casts Broad Net Over Construction Jobsites." Engineering News-Record 11 June 2001: 41-42.

Angelo, William. "Webcams Cast Unblinking Eye on Good and Bad Project Events." Engineering News-Record 26 Feb. 2001: 56-61.

Archibald, Russell. Managing High-Technology Programs and Projects. New York: John Wiley & Sons, 1976.

Autodesk: Autodesk Revit. 4 Apr. 2003. <http://usa.autodesk.com/adsk/servlet/index?siteID=123112&id=2436329>

Bailey, James. After Thoughts: The Computer Challenge to Human Intelligence. New York: Basic Books, 1996.

Barry, Chris. "Kenniston thesis." E-mail to Guillermo Salazar. 18 Apr. 2003.

Blondin, Cynthia. Telephone interview. 21 Feb. 2003.

Bubshait, Al-Said, and Mohammed Abolnour. "Design Fee Versus Design Deficiency." Journal of Architectural Engineering June 1998: 44-46.

"Can't Shift Design Flaws to Contractor." Engineering News-Record 28 Oct. 2002: 18.

Chabot, Cynthia. Telephone interview. 7 Mar. 2003.

Construction Industry Institute. "CAD/CAE in the Construction Industry." September 1989: Publication 8-3.

Construction Industry Institute. "Evaluation of Design Effectiveness." July 1986: Publication 8-1.

Construction Industry Institute. "Measuring the Cost and Quality in Design and Construction." May 1989: Publication 10-2.

Construction Industry Institute. "The Cost-Trust Relationship in the Construction

Industry." September 1994: Source Document 100.

Cronin, David. "Quality of Specifications." Online posting. 21 Feb. 2003.

Dunlop, Charles and Rob Kling eds. Computerization and Controversy: Value Conflicts and Social Choices. New York: Academic Press, Inc., 1991.

El-Shahhat, Rosowsky, and W.F. Chen. "Accounting for Human Error During Design and Construction." Journal of Architectural Engineering June 1995: 84-92.

Heroux, Jason. "Power and Responsibility: Facing the Challenges of Modernization." Journal of Computing in Civil Engineering October 1998: 177-178.

Huang, Y. Henry. "Assessing the Accuracy of Computing in Structural (Seismic) Engineering." Journal of Computing in Civil Engineering October 1998: 175-176.

Kenniston, Jody. "The Quality of Construction Documents." Luncheon Discussion. Worcester Polytechnic Institute, Worcester. 6 March 2003.

Kenniston, Jody. Survey on The Quality of Construction Documents. Worcester Polytechnic Institute, Worcester. 13 Jan. – 18 Feb. 2003.

Korman, Richard. "Industry Dot-Coms March to Slower, Steadier Pace." Engineering News-Record 11 June 2001: 36-38.

Kratky, R.J. "Prudent Computer Usage to Prevent Engineering Problems or Failures." Journal of Computing in Civil Engineering October 1998: 173-174.

Krizan, William. "Liability Disclaimers Lead Way as Digital Age Issues Weigh In." Engineering News-Record 26 Feb. 2001: 41-45.

Moll, Edward. "An Integrated Building Structural Engineering Design Environment: Current Practice and Applications." Thesis. Worcester Polytechnic Institute, 1996.

Overy, Charles. "Re: Views on Computers." Online posting. 3 Mar. 2003.

Overy, Charles. "Re: Quality of Specifications." Online posting. 5 Mar. 2003.

Phair, Matthew. "New Laws, Technologies Push Signing on the Dotted Screen." Engineering News-Record 26 Feb. 2001: 47-50.

Post, Nadine. "No Stamp of Approval on Building Plans." Engineering News-

Record 1 May 2000: 34-46.

Puri, Satinder. "Avoiding Engineering Failures Caused by Computer-Related Errors." Journal of Computing in Civil Engineering October 1998: 170-172.

Rizzo, Adria. Telephone interview. 24 Feb. 2003.

Roe, Andrew. "Building Digitally Provides Schedule, Cost Efficiencies." Engineering News-Record 25 Feb. 2002: 29-31.

Roe, Andrew. "The Corps' Doctor Will Make House Calls to Check Design." Engineering News-Record 3 June 2002: 55-56.

Roe, Andrew. "Free or Low-Cost Tools Increase High-Tech Return." Engineering News-Record 11 June 2001: 47-48.

Roe, Andrew. "Handhelds Hold up Well for Variety of Site Uses" Engineering News-Record 5 Nov. 2001. 24 July 2002 <http://enr.construction.com/itnews/econ_110501b.asp>

Sawyer, Tom. "A Whirlwind of Change is Transforming Plan Rooms." Engineering News-Record 11 June 2001: 31-35.

Sawyer, Tom. "Protecting Electronic Data Becomes A Burning Issue" Engineering News-Record 5 Nov. 2001. 24 July 2002 <http://enr.construction.com/new/coverstry_110501.asp>

Sawyer and William Angelo. "Revolution." Engineering News-Record 31 Dec. 2001: 36-38.

Sawyer, Tom. "States Turn Onto Web for Highway Bidding." Engineering News-Record 26 Feb. 2001: 53-54.

"Schedule School to Fill Skill Gap." Engineering News-Record 16 Sept. 2002: 13.

Senecal, Richard. "Re: Quality of Specifications." Online posting. 17 Mar. 2003.

Senecal, Richard. "Re: Views on Computers." Online posting. 17 Mar. 2003.

Sippel, Jim. Telephone interview. 28 Feb. 2003.

"Site Collects Technical Papers" Engineering News-Record 22 July 2002. 24 July 2002 <http://enr.constructon.com/itnews/it072202d.asp>

Templet, Steve. "Re: Quality of Specifications." Online posting. 5 Mar. 2003.

Tulacz, Gary. "The Top 100." Engineering News-Record 18 June 2001: 48-62.

Walesh, Stuart G. Ph. D., P.E. Engineering Your Future: The Non-Technical Side of Professional Practice in Engineering and Other Technical Fields. 2nd ed. Reston, VA: ASCE Press, 2000.

Winters, Mike. Telephone interview. 24 Feb. 2003.

Zolin, Roxanne. "Trust in Cross-Functional, Global Teams." Center for integrated Facility Engineering April 2002.

CHAPTER 8 – APPENDICES

Appendix A – Organization Matrix

Problems	Reasons	Solutions
Availability of necessary cross-referencing between documents	Uncoordinated drawings (allow ductwork to crash into beams; ceiling plenums "filled" overcapacity)	Better communication
		Have a steel fabricator involved in preconstruction
		Stop the duplication of construction and shop drawings
Architectural drawings don't "close" (means the parts don't add up)	Designer is too busy covering tracks or keeping paper trails in case of disputes	Should hire CM for the projects to review plans for constructability and to act as an interface between the field and the drawings
	Mid-90s major layoffs, economy recovered and architectural firms weren't ready for the amount of work	
Diminishing accuracy and detail of construction drawings	Lack of dimensions	Provide information that is needed instead of information not needed
	Arch and Eng fail to communicate and they think the other is responsible for dimensions	
	Causes speculative and inflated bids	More engineering information on drawings (scaling up is not precise enough)
	Economic pressures and shortage of inexperienced design professionals	
	In today's market, major pressure on A/E's to produce plans that may be less detailed than desired	Utilize method such as the objectives matrix to make sure drawings meet the required standards
	Nature of the process is changing, affecting what construction documents need to be	Implement a design and review system for drawings like DrChecks

Uneducated computer operators	To save $, computer owners are using inexperienced personnel	Training programs
	Many firms don't have time or resources to train CAD operators to produce adequate drawings	
	People come out of school fluent with computers as if they are video games. They are only drawing lines on paper - not walls, floors and columns	
	Programs becoming more sophisticated. The more dependent people become, more likely errors, and more difficult double-checking becomes	Hiring experienced personnel despite the cost
Fast-track delivery method	Results in many claims and disputes	Modify the delivery system process
	Produce documents out of sequence, causing many changes	Better communication

Uneducated Owners and their low bid mentality	Want to save money at all costs and don't realize when they are going too far	Develop common understanding between the owner, designer, and contractor concerning the design and conduct a constructability review of the project
		Design professionals must advise client and hold firm when pushed beyond "the point where they really feel quality will suffer."
		Allow them to select subcontractor personnel
Money	When the budget is spent, the work stops (regardless of if drawings are done)	Provide more realistic budget from completed drawings

Appendix B – Follow-up Interview Questions

Name: _____

Date: _____

Profession: _____

Do you agree/disagree with the results that my survey has produced? Which aspects do you mostly agree with? Why?

Do you personally see a problem? Do you know how long some of the results have been a problem in this industry?

What do you think can be done in order to improve these problems? (If no, why don't you think so?) Be as specific as possible.

What are your opinions concerning the use of computers in the industry? Helpful, hurtful? Do you think computers have just added to an already present problem?

Appendix C – Luncheon Handout

Architect

Architect Results (44 responses)

Experience			Type of Work			Volume		
0-5	4	9.09%	Private	6	13.64%	0 to 10	18	40.91%
5-15	11	25.00%	Public	4	9.09%	10 to 100	9	20.45%
15+	28	63.64%	Public/Private	33	75.00%	100+	3	6.82%
NA	1	2.27%	NA	1	2.27%	NA	1	2.27%
						Unknown	13	29.55%

Question 6: In your opinion, how skilled are the engineers that create the drawings for your company?

Responses	Frequency	Percentage
Very Skilled	16	36.36%
Skilled	8	18.18%
Varies	14	31.82%
Un-trained	1	2.27%
Not Skilled	2	4.55%
NA	3	6.82%

Question 7: What type of review process (if any) does your company use?

Responses	Frequency	Percentage
Several Person Review	19	43.18%
QA/QC	10	22.73%
Milestone Check	6	13.64%
Limited	5	11.36%
NA	4	9.09%

Question 8a: Is enough time allowed to produce accurate drawings?

Responses	Frequency	Percentage
Yes	15	34.09%
No	4	9.09%
Sometimes	24	54.55%
NA	1	2.27%

Question 8b: If no or sometimes, are items omitted in order to meet deadlines?

Responses	Frequency	Percentage
Yes	20	45.45%
No	4	9.09%
Not Sure	3	6.82%
NA	17	38.64%

Question 8c: Also, if you answered sometimes to 8a, what percentage of the time is enough time allowed?

Responses	Frequency	Percentage
10-20	1	2.27%
20-30	4	9.09%
30-40	2	4.55%
40-50	1	2.27%
50-60	3	6.82%
60-70	4	9.09%
70-80	5	11.36%
80-90	4	9.09%
90-100	0	0.00%
NA	20	45.45%

Question 9: Are there any particular aspects of the design that are difficult to communicate to owners and contractors in the construction documents?

Responses	Frequency	Percentage
Communication (ALL)	4	9.09%
Communication with Clients	7	15.91%
Complex Geometries	9	20.45%
Coordination	5	11.36%
Details	5	11.36%
Details (Use 3-D to solve))	5	11.36%
Final Product	1	2.27%
Standards	1	2.27%
NA	7	15.91%

Question 10: Could the GC/CM or engineers help in any way to improve efforts to provide quality construction documents?

Responses	Frequency	Percentage
Communication	6	13.64%
Coordination	3	6.82%
Educated Owners	1	2.27%
GC/CM Early Involvement	11	25.00%
Improved Documentation	4	9.09%
None	7	15.91%
Stick to Constructability	4	9.09%
Understand Time Constraints	4	9.09%
NA	4	9.09%

Comments

Question 6

- "They are of varying abilities, some are very capable and require little supervision. Other groups require much more time reviewing drawings and demanding that work be done. The projects that I work on are typically small and some of the engineering firms do not want to give these projects their proper attention."
- "Some are better than others, what's the scale? You get what you pay for. Or, you get what your client pays for."

Question 7

- "We have a QC (Quality Control) process which works well to coordinate our work and that of in-house and outside consultants. Most projects go through this process. Some, because of tight scheduling and deadlines, are not put through the process. This can take as long as a week on some projects. Schedules usually include necessary time for QC."
- "In-house reviews consist of peer to peer review of the drawings at least once a month. This is a small office and we are able to do it with some regularity. It would be a huge issue at a larger firm. A 'clean' set of eyes can quickly point out errors/omissions/deficiencies as well as outstanding work."

Question 9

- "In my experience at other firms, any type of complexity in design, whether architectural or MEP, is difficult to convey. Since architectural fees are fixed (along with the budget for production), there is a limit to what can be put on the drawings. The problem is that architects fail to plan for the most important elements that need to be included in the drawings to insure project success. Thus, a lot of time is spent detailing ordinary construction, which contractors and tradesman know well, and the hard details are ignored - in part because the production is done by less experienced staff who have no idea how to do the hard details. But, it's the hard details (or wall sections etc.) that are most important to be illustrated."

- "Owners: The process is very complicated. It is difficult to produce "perfect" documents even if you have sufficient time. Time pressure to complete directly reduces the quality of the output. Contractors: The process of documentation has become very performance orientated. This can be difficult for inexperienced bidders. The bidders really need to take sufficient time to review the bid documents."

Question 10

- "Yes: coordinate all MEPF disciplines before releasing to Architect; coordinate their work with that of the Architect. Engineers: be more pro-active in dealing with Architect, rather than waiting for Architect to send completed drawings. GC/CM: Be more realistic in early / conceptual stages of project estimating, so that design intent can be fully realized, rather than having a disappointing VE phase which leaves everyone disappointed / frustrated, and out of time for good CD's..."
- "Engineers need to be more creative in response to architects' stated needs, and to help architects understand their designs. GC/CM's are only useful if the project is using a design build process so they are involved from the start. Their best contribution would be to help with "buildability" of designs - what works and what's too complicated or expensive. The individual most able to help with improved quality is the owner. It is their money, their building, and ultimately they can control the process better by setting the right goals at the start. They must: 1) pay the architect sufficient fees so that the design can be properly worked out; 2) be very involved so that they know the problems and difficulties of the design and construction process, and contribute constructively; 3) be realistic about what their budgets can provide in the way of a finished building (especially public clients who usually have about 80% of what they need to build their desired building.)"
- "I don't think so! Generally, in my experience, GC's/CM's do not have any ideas until you draw something and then they have 3 ways to do it differently than what you drew. Getting the GC/CM involved too early increases the difficulty of producing good documents within the Owner's design budget. It also puts undue pressure on the design document schedule. Engineers need to see their work as something that is built, not just designed. Many can work out problems in the field, however this is always costly to the Owner."

Engineer

Engineer Results (59 responses)

Experience			Type of Work			Volume		
0-5	2	3.39%	Private	6	10.17%	0 to 10	18	30.51%
5-15	14	23.73%	Public	9	15.25%	10 to 100	22	37.29%
15+	43	72.88%	Public/Private	44	74.58%	100+	14	23.73%
						Unknown	5	8.47%

Question 5: In your opinion, how skilled are the engineers that create the drawings for your company?

Responses	Frequency	Percentage
Very Skilled	24	40.68%
Skilled	14	23.73%
Varies	15	25.42%
Un-trained	2	3.39%
NA	4	6.78%

Question 6a: Are you given enough time to create complete and accurate construction documents?

Responses	Frequency	Percentage
Yes	23	38.98%
No	2	3.39%
Sometimes	34	57.63%

Question 6b: If no or sometimes, are items omitted in order to meet deadlines?

Responses	Frequency	Percentage
Yes	17	28.81%
No	17	28.81%
Not Sure	3	5.08%
NA	22	37.29%

Question 6c: Also, if you answered sometimes to 6a, what percentage of the time is enough time allowed?

Responses	Frequency	Percentage
10-20	3	5.08%
20-30	0	0.00%
30-40	4	6.78%
40-50	1	1.69%
50-60	6	10.17%
60-70	6	10.17%
70-80	6	10.17%
80-90	7	11.86%
90-100	2	3.39%
NA	24	40.68%

Question 7: What type of review process (if any) does your company, or you personally, use?

Responses	Frequency	Percentage
Value Engineering	1	1.69%
Several Person Review	20	33.90%
QA/QC	25	42.37%
Milestone Check	6	10.17%
Limited	3	5.08%
Individual	2	3.39%
NA	2	3.39%

Question 8: Are there any particular aspects of design that are difficult to communicate to owners and contractors in the construction documents?

Responses	Frequency	Percentage
Communication (ALL)	3	5.08%
Communication with Clients	9	15.25%
Construction Staging	1	1.69%
Coordination	4	6.78%
Cost versus Quality	1	1.69%
Design Intent	1	1.69%
Details	12	20.34%
Equipment	1	1.69%
Isometrics	1	1.69%
New Technologies	1	1.69%
None	8	13.56%
Permitting	1	1.69%
Risk	1	1.69%
Specifications	4	6.78%
Standards	1	1.69%
Unforeseen Conditions	4	6.78%
Utilities	1	1.69%
NA	5	8.47%

Question 9: Could the architects or GC/CM help in any way to improve efforts to provide quality construction documents?

Responses	Frequency	Percentage
Communication	9	15.25%
Coordination	6	10.17%
Cost Reduction vs Quality	1	1.69%
Create Quality Programs	1	1.69%
Early Engineer Involvement	1	1.69%
Early GC/CM Involvement	9	15.25%
Fewer Claims	1	1.69%
Improved Documentation	1	1.69%
Money	1	1.69%
None	1	1.69%
Timely Constructability Reviews	12	20.34%
Timely Responses	1	1.69%
Understand Time Constraints	4	6.78%
Understand Various Trades	1	1.69%
NA	10	16.95%

Comments

Question 5

- "Good. Most civil design is basically the same once you've done a few projects. The damage lies in assuming a project's simplicity or a young designer's capabilities. A cautious approach to a new project is key. Identify all the issues before deciding on the appropriate design path."
- "All varies with experience level. We try to structure teams which combine staff with 4 to 8 years of experience with those with lesser year's experience. With that type of structure the documents are in solid shape before they undergo the final independent QC review."

Question 7

- "Drawings that are created are reviewed by the plan production supervisor for format, accuracy of presentation, content and adequacy with the historic standards of the Client. Prior to going to bid, drawings are reviewed by the project manager or engineer, although not to the extent sometimes that they should be reviewed! Regarding the above time criteria, there is often not enough time budgeted to conduct thorough (and objective) reviews by qualified staff."
- "Drawings are supposed to be checked by the Project Engr. and signed off. All too often this is skipped to meet deadlines, or they are only checked to be sure nothing major is missing."

Question 8

- "No. This should not be an issue if the contract documents have been prepared accurately."

- "Mostly it is the owners specific requirements related to the institution in which the work is to be performed. A good contractor typically has the skill to interpret construction documents."
- "Sometimes, it is difficult for owners, architects and contractors to realize that spending extra money up front during the investigation phase of a project has the potential to save a lot of money later. There is pressure to do designs for less money. The Architect may feel he is saving the Owner's money by not spending additional money up front, however, in many cases, the extra money is needed to properly address the risks on a job."

Question 9

- "Better communication. There are projects with too much communication and the civil engineer is copied every piece of correspondence and invited to every meeting (this drives up design costs). Then, there are projects where I never meet the design team and only get feedback/schedules, etc. when I asked or when the deadlines are imminent. The solution falls somewhere in the middle."
- "The more involved the architect is during the design process the better the documents tend to be. Frequent coordination with the Architects is imperative to construction documents being accurate. Architects tend to make changes sometimes without letting the Engineer know until we either notice the change or the Contractor calls about discrepancies in the plans."
- "Absolutely. Communication is a key, and so is timely exchange of information. The design team must be on the same page regarding satisfying the Owners requirements and expectations, while remaining in budget. If time constraints for the design period weren't as tight as they typically get to be, the design of the building structure & shell could be finalized before the infrastructure (HVAC, plumbing, fire protection, electrical) were completed, so that space for chases, equipment, etc. could be worked out, and adequate time would be available to complete the design. Too often, the building and the spaces inside evolve right up to the time the design goes out to bid. If Owners and the design team worked together in this area, the quality of construction documents would improve."
- "While the use of more industry standardized documents might prove helpful, owners and engineers will always be looking to improve the quality of construction products delivered. Quality documents tend to be those that have been proven through the successful implementation during construction; however, they are still going to be subject to interpretation by the various members of the construction and engineering teams. It is important to understand the existing roles/relationships that exist with owners in the marketplace(i.e. General Contractors, Construction Managers, Architects, Engineers, Filed-SubBidders, design builders, etc. all have discrete roles in the process and while each is capable of positively/negatively impacting the overall outcome of the construction project not all parties can impact document quality)."

General Contractor

General Contractor Results (33 responses)

Experience			Type of Work			Volume		
0-5	9	27.27%	Private	14	42.42%	0 to 10	6	18.18%
5-15	6	18.18%	Public	0	0.00%	10 to 100	10	30.30%
15+	18	54.55%	Public/Private	19	57.58%	100+	15	45.45%
						Unknown	2	6.06%

Question 5: On average, how would your rate the quality of construction documents your company receives?

Responses	Frequency	Percentage
Above Average	2	6.06%
Average	20	60.61%
Below Average	9	27.27%
Poor	2	6.06%

Question 7: What do you attribute this problem (if any) to?

Responses	Frequency	Percentage
Architect Coordination	1	3.03%
Cut & Paste	5	15.15%
Lack of Communication	1	3.03%
Lack of Details	3	9.09%
Lack of Knowledge	6	18.18%
Lack of Time	8	24.24%
Lack Time/Money	3	9.09%
Owner Pressure	4	12.12%
Unchecked	1	3.03%
NA	1	3.03%

Question 8: How does the quality of construction documents affect your job?

Responses	Frequency	Percentage
Litigation	1	3.03%
Money	3	9.09%
Owner Dissatisfaction	5	15.15%
Time	5	15.15%
Time, Money	6	18.18%
Time, Money, Relationships	13	39.39%

Question 9: Are there any particular aspects of design that are difficult to communicate to owners and contractors in the construction documents?

Responses	Frequency	Percentage
Arch/Eng Coordination Early	1	3.03%
Architect Define Scope	2	6.06%
Architects Do Better Job	2	6.06%
Better Document Review	3	9.09%
Better Relationships	1	3.03%
Better Training	1	3.03%
Can't Be Solved	1	3.03%
Clear Documents	2	6.06%
Complete Detailing	1	3.03%
Computer Technology	1	3.03%
Coordination	2	6.06%
Early GC/CM Involvement	2	6.06%
Hold Architect Liable	1	3.03%
More Time for Design Phase	3	9.09%
Owner Understanding Cost	10	30.30%

Question 10: Could the architects or engineers help in any way to improve efforts to provide quality construction documents?

Responses	Frequency	Percentage
Arch/Eng Coordination Early	1	3.03%
Architect Define Scope	2	6.06%
Architect Taking Criticism	2	6.06%
Architects Do Better Job	3	9.09%
Better Documents Review	4	12.12%
Better Training	1	3.03%
Complete Detailing	1	3.03%
Computer Technology	2	6.06%
Coordination	3	9.09%
Discipline	1	3.03%
Early GC/CM Involvement	1	3.03%
More Effort in Drawings	1	3.03%
Only Release 100% Documents	1	3.03%
Owner Knowledge	1	3.03%
Owner Understanding Cost	4	12.12%
Pay Attention to Codes	1	3.03%
Understand Time Constraints	1	3.03%
NA	3	9.09%

Comments

Question 7

- "I think the problem can be attributed to the pressure on design and end use. It appears that Owners put pressure on the Architects and engineers to prepare documents that show the final project and are not as concerned with the "dirty" investigative work that is the existing structure."
- "The attempt to push all responsibility to the GC, the architect's experience, and the owner deadlines for state money drive the documents further towards poor. The deadlines put the architects in situations where they are rushed to complete or produce documents. The architects in general I feel are getting worse, it is becoming a cut and paste world with no thought behind the documents and no licensed architect drawing them. More often than not the people creating the documents have little experience, no license / stamp, no field experience. The architect is trying to hold the GC responsibility for everything, sometime including performing their job. They do this by putting work in our specification that really is part of there contract obligation such as design coordination."
- "The use of Owners representatives to administer contracts on public school projects have raised the level of conflict on these projects as the Owners today seek to have scope and omission problems paid for by the designers or the contractors as long as it is not the change order contingency. The drawings today seem to be a cut and paste function of the CAD operator as opposed to a design function."

Question 8

- "Poor drawings or drawings that lack significant coordination and existing conditions investigations affect all of the above. Unexpected changes directly correlate to additional time and additional money. Depending on the expectations of the design and owner team, these two issues can create tension and possibly deteriorate relationships. The general contractor sees the relationships deteriorate from both sides."
- "If drawings do not accurately depict what is to be constructed, questions will arise during the construction. This takes time, delays the schedule, and ultimately adds cost to the project. Also, an unclear or incomplete set of contract documents cause subcontractors to add contingencies which inflate the cost. Finger pointing occurs and relationships deteriorate. Lawyers are happy as they have a steady stream of work."

Question 9

- "Architect should spend more time ensuring the proper scope is covered and the owner should engage the contractor earlier in the process."
- "I don't. Documents seem to be getting continually worse, especially from larger firms who control a larger share of the market. Until owners realize this problem and are willing to put more money in up front to designers and architects to assure better documents, the problem will not be solved. Owner's may not be fully aware of this problem or the causes, so getting them to

change their ways (i.e. awarding design and construction to the lowest bidder or smoothest talked) will be a slow process."

- "Architects need to re-think their true role in the industry. Builders are paid to put things together, not decipher plans that don't work and not to make design decisions because the architect who was supposed to be on the job site had too much going on and sent a lacky intern who doesn't have a clue! The almighty dollar has caught hold! The customer ultimately ends up losing! Don't get me wrong, we need architects, but we need them to perform their job completely."
- "I would love to say additional time, but I really think it is experience and focus to giving the client a better product. Improvement of listening skills would be very helpful."
- "More time must be spent in the design phase at the beginning. "7 P's - Proper pre planning prevents piss poor performance." This may cost added money upfront but will save money and time in the end for all, including the architect."
- "Better educated Owners that buy complete coordinated designs from Architects, not just buy low bid fees. Better educated architects that know how buildings are constructed. More involvement of CM's in design phase - add constructability and coordination reviews to design phase services and schedule."

Question 10

- "Architects are usually the cause of the problem, so yes."
- "YES! They can inform owners that the more money spent on better documents, extended design time, and focus on details and coordination of drawings and specification will yield a better project with fewer changes and issues during construction. Also, an architectural firm should be responsible for the quality of their documents. If there was a way to track the discrepancies throughout a project and hold the architect responsible, this would change things for certain. However, this is also unlikely since the most widely used contracts are written by the AIA, and they would most likely never include any clauses that make architects directly liable for the documents. Unfortunately the contracts take responsibility in terms of documentation away from the architects and place it on others."
- "Since they produce the construction documents-sure! There are really no standards as to what is considered a good set except that they are good if no addenda are necessary."
- "The cost of detailing will be incurred sooner or later. Better sooner than later."
- "Yes - a better definition of 100% construction documents. Don't release documents until they are 100%."

Appendix D – Luncheon Discussion Transcript

Participants:

JK: Jody Kenniston	WB: William Barry
GS: Guillermo Salazar	DC: David Cronin
PJ: Prof Jayachandran	REK: Richard E. King
JA: Joao Almedia	JM: John Miller
RK: Russ Karlstad	ET: Emelia Tran

JK: If you want to go around just briefly and introduce yourself so everyone knows who is who. Fran got called to a job site this morning so he can't make it anymore and Cynthia also can't make it. So, Dave we will start with you.

DC: I'm Dave Cronin with Cutler Associates. I'm an assistant Project Manager there and I've worked there just a little over a year now. I'm currently working on a project just down the street from here at Assumption College, the Science and Technology Building. It's about a 64,000 s.f. science facility.

REK: Hi, my name is Rick King. I'm with Bacson Incorporated in Framingham, Massachusetts. We are the reprographics side of this. We do all the copying and documentation in large and small format. You see Joshua Guzzetti; I'm associated with Josh. Actually he may still be making it today. But we make all the big plans and the small onesies twosies as well as multi-set plans. To give you an idea, the last large project we did was the Concord Regional High School project. There was 455 pages, 30 x 42's. There ended up being 192 sets. So it gives you an idea of the volume we can do down there. We have one of the fastest machines out in the market right now. It's called the (inaudible) 8000 which is 22 (inaudible) a minute so we can handle the volume out there. You know, anything I can add to . . . the subcontractor or the architect and engineer I'm kind of the middle man and I hear from both ends of the story at all times.

RK: I'm Russ Karlstad. I'm the lone architect here with Daniel Architects in Natick. I've been in the field about 16 years. I've worked on everything from Mall of America to cruise ships. I also have my construction school license so I've worked on that side of the coin also, so that is it in a nutshell.

PJ: I'm Prof Jay in Civil & Environmental. I'm a structural engineer by trade so I work with design. I've worked with several tall buildings in St Louis . . . one of my old students here.

WB: I'm William Barry. I'm a structural engineer for DMBerg Consultants. We're a small engineering and consulting firm. So I pretty much work on buildings but also . . . what are you looking for? Is that it? I just came in.

JK: Yes that is it.

JM: I'm John Miller, I manage physical plants at WPI.

GS: I'm Guillermo Salazar, professor of civil engineering and construction management and I'm currently advising Jody on her thesis.

JA: I'm Joao Almedia. I'm a PhD student with a (inaudible) background looking to get into construction.

ET: I'm Emelia Tran and I'm an undergraduate student working on my IQP.

JK: And at the end I think she has a little survey that you guys might be able to help her out with.

Did everyone have a chance to look at the results at all? And I've also given you the tabular results which are also on the website, just so you can see them because some of the charts aren't as clear on the handouts as well as some of the more interesting comments that we got that I thought people would like to see. So if you guys would just like to look at those and then we'll get started.

Now that everyone is here and has their lunch and we've all been introduced, these are the four topics I would like to discuss. Like I was saying, disagreeing or agreeing with the results and what you think, whether or not they are accurate to kind of verify the results of the survey. The second thing is what you guys personally see as the major problem out of everything that was mentioned. The majority of our respondents had 15+ years experience so it was a pretty experienced pool. So we're wondering if some of these problems have been problems long before the introduction of computers. Basically, my thesis involves computers. And originally when we started this, our main question was "What role are computers playing in the production of construction documents?" As we did the literature research and started the survey we did it kind of vaguely to see if people would indicate that the computer was the main problem and that hasn't seemed to be the response that we have gotten. So now it's kind of like "Is the computer the main problem or has it just added to an already existing problem and it's just made things more complicated?" So that is what that means. Solutions that you think, as specific as possible as you can get, on how this problem can be fixed. If you think it can be fixed, if you don't why not? And finally we get to the use of computers. Do you think they've been overly helpful? Do you think they've actually hurt the process and just your opinions on computers so we can answer that question. Are there any questions so far? Alright, so we'll get on with these results.

Here is the first chart that I've made and they are all on the handout that you have as well. So this is the engineers and architects responses about how skilled the engineers are in their companies. Because one of the things that was indicated as a problem was the skill of the engineers either with the computers or without. The results that we've gotten with this is that the majority think that they are very skilled

or that they are skilled or that it varies. Does anyone want to comment about that? Is this going to be like a college class where no one wants to say anything?

JM: I'm not shy. When you try to describe the skill of the engineers, are you trying to describe just their technical background or their ability to translate their technical background into clear drawings that are (inaudible) the field can understand?

JK: Right. This was exactly how the question appeared so some people went into that and then others didn't. A lot of people just said that "it varies" or "very skilled." A lot of them that said varies said that some of them were capable on computers but they don't have the background to know what they are doing. So these categories right here are what, when I went through and read their responses, I tried to put them into categories as best as I could. So that is how you see these.

GS: So I guess one of the questions that we might have for the panel is if you can try to answer that yourselves. In other words, just what you asked. I think that is a very good statement. Whether people come with skills to produce drawings or they have skills to translate design intent into drawings. And so perhaps you want to comment on that and see what your perspective is as to whether the labor force has that skill, just technical skill, or have the understanding of what they are doing.

DC: I have some comments. I think, at least most the engineers I've worked with going over spec or types of engineers: structural, HVAC, mechanical, MEP type of engineers, I think most of them are very skilled in their areas. I think often times they are skilled in terms of knowledge and school and things like that more than they show when they put it in the drawings sometimes. Sometimes things aren't conveyed. I think one thing that has to be understood is that a lot of times when they put something on a drawing they have to understand that it is typically for somebody who is not an engineer to build and construct. So sometimes there is something lost in the translation of drawings. I think most engineers keep that in mind and understand that they have to be very specific with what they are drawing and how they detail things, but sometimes that is lost. When that happens you have problems with litigation of what was intended to be there and what wasn't intended to be there. You have problems with animosity between engineers, architects, and contractors, mostly over money. As long as things can be conveyed and conveyed accurately or the problems are caught early on in the construction process there shouldn't be a problem but I think generally, most engineers are very skilled as far as drawings and the construction process.

RK: I worked about 7 years of my career as a mechanical engineer at Cosentini. I did mechanical layouts and ductwork design and that kind of stuff. And I would have to say that engineers are more skilled than the architects are in my experience. Part of the problem is that the engineers have a (inaudible) task to get that done and function: heating, cooling, plumbing, structural whatever it is. The architect has to take all that into consideration and balance it and get a drawing out with all the information that can be read in the field and understood. So we are working under time constraints

and timeliness issues so a lot of time stuff goes out and it is missing information or scope is not well defined or intent isn't across the board on all traits so there are some problems. So just to answer the question "Are the engineers producing the drawings skilled?", I would say yes, very skilled. Plus the hand drawings versus the computers, just to get into that one, when I was at Consentini I was doing hand drawings, and those drawings were a hell of a lot more agreeable and a lot more clear and concise in their detail than the computer drawings you get today. Because it was direct from you hand, eyes to your hand, onto the paper. None of this lineweight and layering and "Is this guys printer going to print the same as mine?" So I think the computer has added multiple levels of error into the industry and it's only a good thing for the lawyers.

PJ: One thing I noticed here was the, from the experience, 15+ about 63% of the sample space you have. And the public/private 73% so maybe it reflects the answers of the architects and the engineers because they are highly skilled and their experience level is over 15 years, almost 63%. They are highly skilled architects and engineers that are answering your questions. So that might reflect on the first bar that you have there. It's the beginning engineers that may be a little different because they aren't as experienced. The other thing I would like to support his comment with, I used to work for a structural firm in Houston and we had a lot of drawings and in those days we used to do them by hand. Our draftsmen did them by hand. Computers were just coming in when I left in '83. So yes, computers have added to these levels of complications because there are many layers of drawings so if you make changes in one layer you have to make sure all the changes have been made. We did them carefully by hand, but now computer can do them very quickly.

WB: With our firm, I think what I was, what I probably answered was fairly skilled because I think we've had a turnover of the lower skilled people. I don't think they tended to come up to standards and we've let them go or they've moved on. So we kind of have a core of engineers that have stayed over 5-7 years and there are 4 or 5 of us that have been there almost that long and then we've had a turnover of the less skilled people. And the people that stayed are skilled and are used to the way we do drawings. I don't know if coming out school, I think the drawing part of it, I know when I set up the AutoCAD course I had the problem of we didn't have anyone that could draft in the engineering department and I didn't know what a drawing was but I was teaching them AutoCAD so I produced someone that could do AutoCAD but they didn't know how to set up a drawing. So I know that that was a problem of (inaudible) probably covered more of the drafting concepts. Number two at my office I don't do much drafting. We have people that just do drafting. So the quality of the drawings, I don't think is that much different in the sense of, I still want the final product to look the way it looks, I don't really get into how it is produced, it still is supposed to convey the same information. There is a whole separate set of issues that have come up that we are going to get into later.

JK: So the next one is the timely review process because another thing that came up was that maybe these documents aren't being reviewed properly or at all. But as you

can see here, pretty much everyone had some sort of review process in place. So if you guys have any comments on that or no, we can just move right along, or if you feel there is something here to say. . .

RK: I don't know where the other architects are coming from, but I don't see 40% on that several person review. There's a pretty broad scope (inaudible). From the firm I just came from, there were probably one or two reviews, the second one was probably the day before it was going to be printed. (Inaudible) probably one of the principle designer or whoever it was wanted to sign off on the design. In between those two points there is no coordination, very little coordination. You have teams working on their stuff and then it goes out to bid.

GS: Can I ask you? When you have a review, is the same person that does the first review that does the second?

RK: Highly unlikely.

GS: Is that good or bad?

RK: It's horrible. When I was at Arrowstreet it was that way, when I was at 100+ person firm or a 40-person firm it was that way. This firm I'm at now they don't know what a review is, that's why I have a job.

REK: There's one thing that I know from being outside of the industry. I'll give you an example. Perini Corporation. They have a lot of checks and balances on their plans going out for obvious reasons. Some of their plans are going across the country others are going on the other side of the world. So they have their checks and balances built in. How exactly they handle that, I don't know them in that aspect of the business, but I know they have a checks and balance before the plans even get submitted to us for printing. There are very few revisions coming through for Perini. So it gives you an idea of what they're doing out there and they recognize that problem. The checks and balances out there. The other issue, another couple of companies I have revisions coming back 4, 5, 6, 7, 8. I think with one I'm up to 9 addendums now coming back on one job. So the things are changing constantly because they can't do things as architects designed it. I just see on the other side and it's up to us to get them out that day because the process is so behind right now because of all these things coming in. From my aspect of it, it would be great if we could do it once and get it done. On the other side of the coin it is great for the dollar figure. We try and schedule ourselves according to jobs. In my shop, we have about 100-125 walk-ins per day. People that have plans or changes that are happening. So that gives you an idea where the scope is and where the changes are coming. People are changing things constantly and walk it in and want those changes that day and they need to get the prints out and have to get a copy to so and so and so and so and so and so and so. I see it from the other side. The smaller firms don't have the checks and balances. The larger firms that are in it for the long haul, their names are put on that

reputation for the job and they want those checks and balances in effect to have it a little more swifter out there than opposed to coming up with a problem.

GS: One question about Perini. Perini is doing design work or doing construction or doing Design/Build?

REK: They do both.

GS: So I assume that when they do design, they do Design/Build. Not just design because they aren't a traditional design firm.

REK: They are actually (inaudible). They have a bunch of engineers on staff, civil as well as . . . and I know they have some architectural.

RK: They have a couple of architects, they have a drafting pool, they have a number of engineers for roadwork and power plant work and all that stuff (inaudible) in Framingham.

REK: So they can go . . . once you put it in that facility, they go right around the circle.

RK: They actually have a good system over there. Because they are dollar based. Architects aren't dollar based. We're design based.

DC: One thing about the review process, I know this issue came up with the project I work on, is coordination between architects and engineers before the project even starts. I see a big problem on both this job and other jobs within my company. The fact that for all the labs we've installed, there are several pieces of plumbing fixtures that appear on the wall in the architectural drawings but if you look on the mechanical drawings they aren't piped. From a contractor's side, the contractor says "well they aren't drawn I don't own it." The architecture side says, "It's on one of the drawings, you should've known to pipe it." To me, that's a red flag that says they don't do coordination early enough and that they didn't spend enough time on coordination to give me a complete set of drawings. I haven't seen it as bad on my job right now as I have on other jobs, but I know that that's one big issue that's very contentious down the road is that the architects need to talk to the mechanical engineer and tell them where they want things and then the mechanical engineer has to design it. Generally, 90% of the work is done that way, and then there are obviously things added or subtracted in value engineering or owner's scope that they want added. It's got to do with time constraints for one thing and it also has to do with a lack of people talking together. I find it even odder; I know the company that I work with has in-house design. The fact that they have those kind of problems and the person is actually sitting in their office somewhere and they could've just held a meeting or discussed it directly is a definitely problem that I see. And like I said, it just goes down the line. We get construction documents and you get halfway through a project and find things like that it just gets very messy. So one problem I see is early on coordination and

one way to fix it is simply having more coordination or review in the architecture or design phase. The other process would be to possibly get the contractor involved and let them look at the drawings and try to time those things earlier on. And obviously it would (inaudible) and extra costs down the line.

JA: Who would coordinate that meeting?

DC: Well, if for the things that are missed, examples are things on architectural drawings that aren't on mechanical, electrical, or plumbing drawings, the person that would coordinate that would generally be the architect in my opinion. Since they are kind of leading the project and have to put everything together, they should be the ones that would have to go in and say, "Ok, we've added these fixtures, we've added these outlets, we've added these lights. We have to go to the electrical engineer or the mechanical engineer and we have to say, 'this is what we've added. Please make sure that it works. Make sure that it's correctly drawn on and that everything is on, you know; if it's on this drawing make sure it corresponds with the electrical or mechanical drawing.'" And that's not always done. So I think it's up to the architect early on because obviously the engineers (inaudible) about the architect, tell them, so nobody will know about it.

WB: I think time, obviously time constraints become a big issue with this type of thing. And also one of the computer problems I notice is that things are revised in the computer and no one points it out so a lot of times I get a set of drawings and a couple of months later someone says, "Hey, you know that room changed or that." You know that really didn't stand out. And it used to be when I used to get, when I first started we were doing a lot more paper-based things, I would get a set of drawings with revisions and they would draw a cloud around things. "Oh by the way we moved this toilet so now your beam has to move and (inaudible)." A lot of times not you just get files. "Here's a file, you figure it out." That depends on the client of course, which architect we're working with and the pace of the project, but that's how things fall through the cracks a lot of the times.

DC: That's another thing I see. A lot of times in our project there is often literature in the specifications that say, "Discrepancies in drawings should be brought up as early as possible and if they are brought up too late it shouldn't be the architect's fault." There's tricky wording is some specs especially when you get on bigger projects and obviously it's to protect certain people. One problem is that, I know from my company, we don't generally use AutoCAD to, you know; we get actual drawings, I'll get a set, my superintendent will get a set. We don't deal with the electronic versions regularly. So for us to try and find those things, we would have to overlay the drawings or just really scour the drawings to find these things. And that's how we found it on my project, my superintendent just happened to be looking through, noticed a fixture that was wrong and then looked on the mechanicals and saw it wasn't there. He started to look closer and found out 100 of them weren't there. It's hard to find if you're a contractor. It's easier to find on AutoCAD if it's clouded or if you can do an overlay, but like I said, the technology allows you to

probably get complacent. If it's not perfectly done or not clouded or you're not notified, obviously you're not going to see a big difference. The technology lets people get a little too lazy in the areas of changes.

WB: From the review point of you, (inaudible) structural, what I'm actually producing is usually correct. It's usually things that have changed that cause problems. So usually when the mechanical usually works, there's really not an issue there, it's just getting all the pieces of the puzzle together at the same time.

DC: Right. If somebody doesn't tell you that it changes, and they didn't notice it on the drawings or they didn't write it, obviously you aren't going to find out. It's got to do with really keeping track with how things move through a process and through the drawings.

RK: What happens on the larger projects is that you get many point people and the communication lines are blurred. If this (inaudible) project manager for the project that's the person that every bit of information that comes in and out. For any, whatever field it is. . . I'm in a new position of a company in the last eight weeks and there are only four people and the principal is used to taking calls. So we're just going through a public bid process and there are legal questions coming up and he's been answering them on the phone. I told him not to answer the questions anymore and to send them to my phone. It's your company, but I'm handling the information. You have to put your foot down and take control of the situation. (inaudible) information is not transferred. In larger firms you'll have a project manager and a senior project manager and they'll have people in charge of transportation and people on doors and windows and everyone has their own little fiefdom and no one talks to each other and that's when you start getting huge issues.

WB: You can even have conflicts within the architectural sets. Windows over here and this plan doesn't show windows.

RK: That never happens. (Laughing)

JK: The next thing that was asked was is there enough time to complete them. And you can see . . . I'm actually just going to move to the next.

GS: You consider that to be answered?

JK: No, no. These three kind of go together so we can look at these three and then we can go. This is items omitted because of these time constrains; items that are totally left off the drawings knowingly. They have yes, people that did know, no, and people that answered yes on the first question didn't answer this one. And then this one, finally, is the percentage of the time that enough time is allowed. Again, all these NA's are the ones that answered Yes on the first question. So are there any comments on this?

JM: Is there a contradiction between the statement that yes there is enough time allowed but in all there are too many mistakes. Could you just go back? "Is there enough time allowed?" Yes and Sometimes seem to predominate on this one. Ok the next one. "Are items omitted?" Yes! So if you have enough time, then why are items being omitted? It seems to be a contradiction.

JK: The people that answered Yes on this one are NA's on this one. So the people that answered Sometimes and No on the first one are who answered this one. And for this question, all of these NA's are the ones that answered Yes and No and this percentage is from the people that answered Sometimes. So then the sometimes, this is how much of that sometimes, enough time is allowed. So are there any thoughts here about whether or not . . . you guys touched on that you might think it is more of items being changed or is it items are really being left off?

WB: A lot of times it depends on where you are in the project. And if a permit (inaudible) building permit, sometimes we'll end up putting a bunch of notes that say we'll cover this much steel for roof top units because there's not enough time to design it. But we kind of try to get something in there that at least indicates that we are designing it and that it will get on there on a later date. Because of the way drawings and deadlines have to be done I think drawings go out with items missing because you don't always have the luxury of getting everyone done at once. Not to mention, as we did say, changes occur and so sometimes you don't want to get everything designed right at the beginning because you know that that may not be the finally design so you don't want to frame an entire building and then go "oh well everything moved 2' here. . ." So we try to have everything done by the final date when you send the actual construction documents you hope that you're getting pretty close to being done. But I'm sure there are times that things have gone out that there is stuff missing but it isn't always intentional by that point. Do you guys agree with that?

DC: Could you go back to the last slide? I notice that there is about a 15% difference in the Yes on the architect's and the engineer's side. I notice that less engineers say that things are omitted. I think that this goes back to what I was saying. I think that engineers generally don't omit things. Obviously they are liable too if they are the engineer of record for omissions and things like that especially if it's life safety or something. So they obviously have to have things like that in there. And architects have a lot higher response. I think that goes back to the point that because of time constraints, they don't always have the time to coordinate so they have something that might not be completely necessary to the plumbing or the HVAC but it's something that the owner wants or that they want, but it's not always in there. So I think on the architectural side more things are omitted and on the engineering side things aren't omitted from them, but they're omitted through the process that the architect didn't tell them. I think generally the engineers have a better percentage of not omitting things than architects do. I think it's pretty accurate on that.

WB: I have a question for the architect. Do you think some of the omitted items might be the framing details, window schedules that isn't going to change the building significantly? That kind of stuff seems to show up later.

RK: Well I would have to answer yes because there is always enough time because we set the time limit. The problem is we start to go through and everyone starts to get their fingers in the design or the owner changes stuff and the scope changes and whatever happens and you start running out of time. So yeah, we set the time limit, but most of the time (inaudible). A lot of stuff does get omitted and a lot of stuff is covered in verbiage in the spec and doesn't make it to the drawings and a lot of architectural legplans (inaudible) typical rule of thumb, the spec rules, when it suits them. So we put it in the spec and we don't put it in the drawings and they own it and they have to read our minds as to what we want. There's always enough time, but do we make the best use out of that time? Most of the time, no. Are things left out? Oh yeah, all the time. And it's not just the trimming stuff. It's more like a new foyer or a different level of door or window hardware. And we always leave dimensions out. And then we say not a scaled drawing.

WB: One of my co-workers wanted to put a note somewhere saying contractors don't (inaudible) a computer in AutoCAD and the drawings are provided (inaudible) dimensions (inaudible) where's this over here?

RK: Stuff omitted is all over the board. It's mostly architectural stuff. I'm getting a lot of questions on a couple of projects now on sitework, on things like that. People are asking me about cut and fill calculations. I send them away. That's just a real fluffy area for us.

WB: I know from the engineering point of view, like my office, it's more of the same process that we go through in the structural design. So usually the things that aren't in there are the last things we get to. Or details that would make something a lot easier to understand. So one of our expressions is "Own it on plan" which leads to sometimes you have connections that you really need to draw something but that doesn't happen so you end up issuing a new sketch when they actually go to figure it out but when you're (inaudible) you've got something but it really needs to be on the drawings so that is something that could really be under those omissions.

GS: I would like to ask John who's an owner. Do owners pressure (inaudible) to produce drawings in an unreasonable fashion? Are owners guilty of contributing to the problems of the things not on the plans?

JM: At times.

GS: But when you have a contract you overly-anticipate that from an owner? So when you say at times you pretty much take that responsibility?

RK: Right. The architects set the time frame. So if there's not enough time you didn't manage the job right or you didn't have a clue as to what you were doing. There's no excuse. Honestly. They get out of control. I always try to build in at least 50%. If they say it's a 12 week process I'll go 18 to 20 weeks because there will always be things that get messed up.

JM: I know from my personal experience (inaudible) involvement of the development of plans as an owner, but I would think you could respond to that, that many owners are hiring architects to do something that is not totally technically involved. They are ordering something, they're ordering a car that they don't know how it's going to be put together and it's your job to put it together for them and they don't know how the process goes on, they just know what they want and that then conflicts with their ideas when they are constantly changing the process.

RK: Right. "Couldn't you just do this?"

JM: Yeah, "Just do this or just do that."

RK: "Well that's going to raise your price 10%."

JM: "How?" And it also affects that time and it goes on.

RK: Yeah when you set up your time in the beginning you have to set up your Owner Factor. Someone misspoke and told a client that they could use the attic space for storage which you can't do because of code issues. So now these owners think they can put all kinds of this storage in their attic. It's a truss attic system. It's a 10,000 sf building. You'll love this one. They want all the open floor space they can. They don't understand why we can't cut the bottom truss member out so they can walk across and store all their crap up there. So you have to educate them structurally and dozens of memos and letters and pictures and sketches going out and it took 3-4 weeks to fix a 20 second blurb and thousands and thousands of dollars. And the owners think we screwed up because they can't store as much stuff in the attic as they wanted too. So that's one of the things that add to time. I like to get the owner and talk to them, get their check, send them away for about 8 weeks, bring them some drawings, send them away for another 8 weeks and everything is fine.

PJ: There are also owners who we used to work with (inaudible) Donald Trump, they are developers. And those people are somewhat influential on the architects. So often they have their own ideas and the come back with them after we do the preliminaries. One of the favorite things of owners is to eliminate the corner columns of high-rise buildings, but that's where most of the overturning and shear forces go through. "Why can't you just keep columns in the middle?" (Inaudible)

JK: You guys have all sort of touched on a lot of these things already. We asked the architects and engineers if there was anything in particular that was difficult to communicate to the contractors or the owners. Originally we wanted to ask them

what they thought of the quality of their drawings, but we thought it would be sort of a biased opinion like "Our drawings are great!" So we tried to make it sound like they weren't criticizing their own work and maybe it was just something that was hard to do. So these are some of the things we got. We got the details, which would be the dimensions. They talked about coordination. They also talked about communication with clients and with all the other parties involved. So those are the major things. The architects also talked about the complex geometries. Is there anything to add besides the things that you have already discussed? Like the details or communication? There hasn't been much about communication. You've touched on coordination a little bit so is there anything else?

DC: I think communication and coordination go hand in hand. Especially during the design and architecture phase. There's communication between engineers and architects, which is necessary at all points. If you stop communicating with your engineer assuming that he's going to go and design all your plumbing, then if you're not looking over that process there's a problem because he could design something you don't want or in a way you don't want or he could put a pipe where you don't want. So there needs to be constant communication. I think like you said, there needs to be a point man or a point person on the project. Someone who channels all the information. A project manager or a project engineer or a project architect who has to decipher everything and ultimately make most of the decisions so you don't have 10 chiefs making decisions in different departments and then nothing is coordinated. I think there needs to be one point person. Especially in architecture with the different divisions of architecture: you have interiors, exteriors, and general architecture. Usually there is a main person for each one of those and I don't think they talk enough where they coordinate the general architecture together. Then you get the same issue with engineers doing specialty engineering. I think that communication is a big problem that goes along with coordination.

GS: One question. If communication and coordination are so important and doesn't seem to be happening in many projects, is this because it is very hard on one person to really control the whole process and keep people informed of everything? Is it because communication and coordination is a process that requires time and effort and there is not that time and effort? What could be the problem there?

DC: I think the problem is, generally you see (it happens in both construction management and architecture and engineering) you never have one person working solely on a project. Usually people work on two or three or four projects at a time. It's very rare, unless you have a very large project, that you're going to have an engineer completely dedicated to your project, or an architect. A lot of times if you have to tell an architect that it is your project, you have to manage all aspects of this during design, they can't do that because they have to manage their time between so many different other things. I think that's a problem maybe internally in a lot of companies where if they have a $15 or $20 million project that's very large and there's a lot of decisions to be made they should dedicate a single person to be the decision making person the point person on that project. I know that's not an easy

thing and it's not an easy thing to organize business-wise, but I know that's probably the best way to do things. And generally it's not done. I know generally when I work with architects, I'd like to think they're the person working on my project 40-50 hrs a week, but I know they're working on this project and this project as well and that if they were the point person on all three of those that the communication would be lax right there because they wouldn't be able to get everything we needed anyway. You know it's an internal problem with companies; they have to dedicate a person to one thing or another and if they want to spread them out to three or four different areas you're probably going to see problems with communication and coordination.

JM: (Inaudible) One area of conflict in construction drawings, which I go along with what you said earlier about the transition from drawing it by hand because when you draw it by hand you're creating it as opposed to drawing it on a computer. I think that one area that's always a time-sink, a money-sink, and invariably causes conflict and problems is that the general for MEP, fire protection what have you, are shown in plan view. Architecture drawings are shown in plan view and elevation. You almost never see any representation of MEP drawings in elevation. When you get to this issue of coordination drawings and working with restricted floor-to-floor height, ceiling height, this space, well just get all your stuff in there (inaudible) sprinkler lines and it's conduits and it's air powered boxes. And invariably what is happening is everybody is defaulting to the contractors "Well it's your job to get it in this space." A lot of conflict, a lot of time wasted in the field that maybe could've been done better in the design process and the coordination (inaudible)

RK: We used to draw by hand at Cosentini. We sectioned every beam crossing. At that time (inaudible) to see what's going in there. We don't do that with computers today. The intelligence is there. It's not that hard to a piece of software (inaudible) it just isn't done.

JM: (Inaudible) If you walk in our Odeum up here you'll see that the columns are spaced slightly inside the room. But the bi-folding doors have to go to the outside edge. Well it was quite a revelation that the bi-folding doors had to go through the main support beam (inaudible) the architect and the structural guy and it just didn't work that way.

RK: We're going through a (inaudible), and you can't work on just one job because you can't make money that way. You have to phase responsibility to keep stuff clear. And I think it's better to work on more than one job because otherwise you get stale and you get bored and you forget things. We like to phase projects in varying sizes so you'll be in design development in one project, you'll be in CD's on another, and you'll be the CA on a third or maybe a fourth. You can probably cover a couple of construction jobs; you can probably do three or four jobs in a shot. It would be great if you could have one job at a time but financially it's impossible. (Inaudible) Today it's those things like communication and stuff. People come out of school, I had someone come out of the GSD, they had a 5-year architecture degree, and then they went to the GSD and got their masters and they came in and worked on my team

when I was at Arrowstreet and I asked the person to detail something. So I kept going to see how this person was doing, "How you doing? How you doing? How you doing?" About two weeks later I finally forced the issue with her and she had nothing done. She didn't know what I was talking about. She didn't know what an expansion joint was. So I was asking her to check out the expansion joint conditions. We had a 6" gap or something; all I wanted her to do was spec out some expansion joint (inaudible) something simple that would take her 2 hrs to do (inaudible). I was letting it go because I didn't want to force the issue or pressure her or anything. Then she came back and told me that she didn't know what an expansion joint was. And I said, "Two weeks and you couldn't tell me you didn't know what an expansion joint was?" So I got her a copy of the records and a copy of Alan's book and told her to go and read those and find out what an expansion joint was. So she educated herself. So I didn't have to do that. So you get people out of school and you assume that they know something, but they don't know anything yet and you ask them to do something and most of the time they butcher your drawings and you have to go back and fix them. I don't know . . . I mean everyone should know what everyone else is capable of doing when new people come on board. I think resumes should be passed around, experience and that kind of thing, so that doesn't happen. So someone comes in and they come in at a certain level and you expect them to be able to do things so it's sort of up to the people hiring to get that information out. So that's a whole different department, that's not the architect's realm at that point.

JK: Alright. So the final question that was asked was about the other parties involved, meaning the architects were asked what the engineers and contractors could do and the engineers were asked what the architects and contractors could do to help improve the effort. And one of the main things that you can see from the architects was early contractor involvement like Dave was saying. Timely constructability reviews and again communication and coordination or improved documentation. Or the big old, contractors stick to constructability.

JM: But that also speaks to the different philosophies of plan preparation too whether it's CM driven or whether it's lump sum driven.

DC: I think, if you notice Early GC/CM Involvement, you see another big difference between the architects and engineers response. I think the main issue with a lot of the construction documents; you don't generally find a lot of MEP areas that are incorrect. I think most of those problems are found by the MEP contractors later on and I find that the percentage of those mistakes, if there are any mistakes, are minimal on the engineering side. I think the majority of deletions or omissions or things that are incorrect in drawings are on the architecture side mainly because they have the grunt. They manage the whole drawings. But the engineers get to focus on a division. I think the reason you see the engineers responding that way is because I don't think they need as much help with that. I think the do need coordination obviously. I think if the CM or GC gets involved earlier, I think the main constructability and involvement issues early on are constructability and I think a GC could point out constructability issues more than architects just because (inaudible) in

the field and we're out there doing it all the time and I know architects don't get a chance to get out there a lot and they don't generally work out in the construction field as much as a CM would. At the same time I think you see engineers, regardless of if they work in the field or not, because of the knowledge they have, there's not going to be as many constructability issues on the MEP side. I think it's mainly constructability with architects; that's the problem, not with the MEP's.

JK: So that was the end of the architects and engineers and contractors were kind of on their own. This is what they thought the quality of construction documents they received were on average. So you can see that the majority said average and below average. I think the Poor and Above Average was just one each. But then there's why do you think the drawings are the way they are. So this is just some of the things they said: lack of time, lack of knowledge, pressure from the owner, and cut & paste in terms of the computers, which I'm sure we'll get to at the end. But is there anything here that anyone would like to comment on it terms of knowledge or owner pressure or anything else?

DC: When you asked about lack of knowledge, how did you mean that? Did you mean that in terms of constructability?

JK: Lack of knowledge of the architect is what they said, but most likely in terms of constructability. They aren't saying that the architect is incompetent.

DC: Right, just that they don't generally know how it will be constructed and how to build it and if it can be built.

JM: This would sound like all the things that a contractor would say. (Inaudible) plans that he didn't particularly like or cost more than they thought it would cost. It sounds like all the typical things they would say.

GS: So would you defend that?

DC: In general, the way GC's, owners, engineers and architects look at things is completely different. I always tell my architect that when they look at something they don't have a cost in mind or a method in mind for constructing something. They simply say "I know it can be done, you should do it." But obviously GC's are very money driven, very time conservative and time conscious. You could do things one way and it would cost $10,000 and 2 weeks to do or you could do it slightly different and it would take 2 months and $100,000. And obviously we want to minimize those things because it hurts us and it's going to make the whole process longer and tougher. So I think the way people look at things . . . I'm mean GC's get a bad rep for beating people up on cost and time, but that's the way we have to work, that's the way we get things done. Our reputation is based on time, quality, and the money. If we cause an owner to pay out $1 million more for something that they thought would have cost $1 million less and they don't feel they get much more value for it, it's obviously going to reflect on us. The way to minimize that is to have documents that

both the architect and the contractor agree on. When that happens, you're not going to have a contractor that comes back and says that he needs changes on everything, obviously it's going to cost everyone less time and money and stress. Our whole idea is that if drawings are good in the front than everyone will be happy in the end.

RK: I agree with most of that, but architects are well aware of the costs. Number one we have to sign off every dollar that is spent on a project and we're the ones that sign off at the end of the project with the completion certificate when it's done. So no matter what happens we're the ones on the hook. We're the first ones to get sued when something goes wrong (inaudible). So we're well aware of the cost, but our priorities are not cost driven as I said before, we're design driven, space driven. And all of the other issues we deal with so cost can still be (inaudible) unless it's really tight. But I just wanted to clarify on that one.

GS: Is this just one of the irreconcilable issues that is always going to exist?

RK: I've worked on both sides of the fence so it's like a sibling rivalry.

DC: I think you're more understanding than most architects. Actually I've gone to job meetings and I know, for example, I've built these canopies for one building where it's all bent aluminum, it's very thick, and it's all very expensive work to do. It can either be bent or it can be seemed and welded. And if you bend something it could cost so much per linear foot; if you seam and weld something the cost goes up 10 times. And the architect said, "I don't see why that should cost more." I think in general they have an idea of what the cost is, but when you get down to (inaudible) tax and exactly how much time and cost is going to be spent on something I think obviously the GC has a much better handle on it. Obviously, not all GC's are going to want to do the work and they might not always tell the truth, they might say "This is going to cost $1 mil." Maybe it's not going to cost $1 million, they just don't want to do it. So obviously that is where you have problems; some people blow things out of proportion on both ends of the spectrum and that's when you have contentious attitudes come into play. Obviously when people are more honest with each other they can say, "We can do it this way or we think this is a better option" people don't get mad at each other as much. It depends on how people come into the project too. If you come in wanting to make, you know, hoist the profit you wanted to make, obviously you aren't going to be led by the owner or the architect. It depends on the people in the project too and how the people play the game.

JK: Ok, I think you've all touched on this in all of your responses. This is how contractors said it affected their job. The time, money, and relationships and some thought just time and money, some just time, some just money, and the good old litigation and owner dissatisfaction. I kind of want to talk about these more is how they see it being solved and you can see that the main response was the owner understanding cost and a lot of the respondents said, along the lines of that they don't understand that if they put the money in up front to assure that the coordination or the time is allowed or all that stuff that it wouldn't cost them as much at the end. So

basically they said that they couldn't get them to understand that. They think that if they don't pay the money up front they won't have to; they think that everything will run smoothly. So are there any comments on that?

DC: I think owner understanding the cost is very accurate. Obviously you were saying, I guess, the amount of money you put into the design you get what you pay for. If you allow a designer to have plenty of time to design things, say 4 years instead of 2 years, which I know almost never happens. Obviously if you allow the money to be given, you're going to have better construction documents, you're going to have a happier GC when it goes out to bid, you're going to have happier subcontractors and everybody involved in the process. But obviously people are limited by budget and time and money and everything else. The other way is to get people involved earlier and keep communication open. You know, you can't educate every owner completely on what every cost is going to be and you can't ask every owner to give you an extra year in design. But a little bit more money and maybe negotiating involvement with a GC or something that will allow the process, with minimal cost increase, to greatly increase the quality of documents is a way to convey that to owners; that would probably be the best way to solve that. You can increase money minimally and get a much better document out of it in my opinion.

RK: Architects usually run 7-12% of total project cost on fee. GC's usually run quite a bit more than that with overhead and profit on a job. It's interesting to see the owners understanding cost issue come up (inaudible). One of our issues is we conceptualize the building, design the building, create the building and we know what it is before the first shovel of dirt is taken; you know we've already been inside it. The building wouldn't be there if it wasn't for us, number one, and the owner and his money and his attorney. The owner's scope changes as the design goes through and stuff and trying to get money out of that same owner to cover that cost over and above your 7-12% is like pulling teeth. And again that goes to time and quality of the documents as these exchanges happen. You look at the other end of the scale and the GC will get a set of documents maybe 95% complete and create the building and they can take that other 10-15% of undone stuff and go do change orders and (inaudible) that's a real sore spot for architects. So I've got to agree with putting more money in up front. You want to end up paying an architect 15-20% of the fee to get the job done right first and save thousand and thousands of dollars at the end.

DC: Right, a lot of people don't look at, you know, you can have a project that has 100 changes that might only be $2,000-$3,000 each, when you figure in that the GC gets 10-15% overhead and profit on those changes and the sub gets an automatic 10% from what it was priced, if you look down the end line to see how much you spent at the end of the job versus if you had put a quarter of the money in the front and you wouldn't of had any of those problems that's where you get your comparison. But that's very hard to convey, I mean hindsight is 20/20 obviously, but it is hard for an owner to see how that's possible to give a little bit more money and save so much extra at the end. I mean it's easier for construction people to understand it because we know exactly the problems we have day to day, but like I said, obviously the

person who holds the check is going to make all the decisions and if they only say that you have 7-8% of the total cost than that's not going to change. For that to happen it has to be a culture change. You'd have to have a series of projects in one field of construction or another where they gave more money and they didn't have a single change order and they had a half a percent of change orders at the end of the job for them to realize that this is the way to go; giving more money up front is the best way to do things. Like I said, it's just the history of construction. If you look back at it, owners have never given more money for that and unless projects start to come out like that it would take an owner that really understands the process and willing to donate the money up front and it's not going to happen. It's up to owners and I don't see that changing in the future.

WB: One thing that is always said about construction compared to other things, architects and engineers produce a set of instructions effectively. They only get used once. So it's hard to get where you get those improved. Now where I've got a three-phase project where say the (inaudible) and the floor plans are very similar. The issues that came into the construction in phase one were updated into the drawings so in phase two it's gone a lot smoother. And so I would expect phase three to update even more. So that's a lot of learning curve where everybody on the team is the same, the contractors are the same (inaudible). The next time we get around to building another building we're going to see how smooth this goes. So you don't have that in a lot of buildings. One shot, that's it. It's like when you buy your kids toys and you get a set of directions, those hopefully get refined when people call in and say, "This doesn't work here." Well they're selling millions of those where as we build one set of directions. So it's hard, I think, to improve on this. I know we try to.

RK: The reverse is true too. We just did 750 units down on the Cape and condos (inaudible). The first ones went off all right, the second ones went better and now we're at the point where you just stamp the drawings and send them out. As the drawings got mailed out and they were 100%, there was nothing wrong with the drawings honestly. Now the construction quality is dropping off. But they know they have another 200 to go and they're locked in by contract and then allow the paint to (inaudible) and they go in there and touch it up. So there's this little window of opportunity where there are beautiful units built and there's not a stray piece of paint or everything is in straight and all the trim is perfect.

JM: So you know which ones to buy?

RK: Those are already sold. I know we just sent some drawings down and I'm going to have to go down in a couple of weeks and just run a line down the foundation wall because they're starting to low-ball everything because they have the price so damn tight now they know they want to make a small profit on it.

DC: That's not a documentation issue though that's a contractor issue.

RK: That's a contractor issue.

DC: That's a bad contractor.

GS: Let me just ask John. You're an experienced owner now so . . .

JM: Why because of my gray hair?

GS: There you go. So you have learned all of these lessons so are you one that by learning (inaudible) is now willing to provide more time for the design part of it as opposed to what typically most owners will try to do? And is this typical behavior of owners that (inaudible) people are more experienced?

JM: I'm in a category of one right now that, I think, coming at it and learning year after year doing different things, and I've not done a lot, but you can see your skills increase and your experience increase and you see the greater value to going slow and making sure everything is done right. The faster you go the more behind you get I always say and it's certainly true when you're developing construction drawings. (Inaudible) what you were saying, our resident halls right over here, and we tried to have the same components and everything in the renovation between the resident halls and by the time we got to the third one and working with the same engineers and the same architect and everything we had worked all the bugs out of the process so the last one was the best one. But absolutely, if people have the time and patience I think that spending the time and the money will come together and invariably will make the product better. I think back to some of the details and geometrics and some of those things that are so hard for people to put their arms around in the field. So time spent there is better than going out with 3-4 people standing around at $50/hr trying to make a sketch to figure out how the hell to build it.

DC: My opinion is that there will never be a point in construction where, because every building in construction is different, there will never ever be a point in construction where the building is going to be done without a single change and without a single discrepancy, it's just the nature of construction. Every building is different. Even if you're building 7 buildings the same way. Not every piece of land you build on is the same. There are always intangibles. And that's something that an owner needs to understand and I think most of them do to a certain point. The other point, just to play devil's advocate on my part, is that no matter how much time you spent up from no matter how much money you spend, there's always going to be something missed. There is always going to be a problem or a document that's not 100%. My personal opinion is that there's never even construction documents that are 100% and there never will be. Everybody needs to understand that process. If everybody knows that going in but has the attitude that maybe this 20% that's missed, if by spending 10% more of the design money that we're given we can eliminate half that, you're going to save money in the end. That's what people need to understand. A little bit more money up front should mean a lot in the end. Obviously you're going to have projects that aren't that way. There are always certain cases, but that's

my general feeling. A little bit more upfront, a little bit more coordination and understanding and teamwork and collaboration provide a better project and a better value at the end. So that's kind of where I was trying to go with what I was saying earlier.

PJ: This is true in design too. Most of the design is done during the preliminary design in very complicated buildings because that's where you decide, the architects and engineers, where all the main load bearing elements in the buildings go. If you didn't spend enough time developing this properly and you did this in a hurry and went into the final design and drawings and all these pages and connections you'll have all kinds of problems. So it's better to spend a little bit of extra time in the preliminary drawings. It's worth the effort; you'll save a lot of money for the owner. And the GC's know that already.

JK: Ok this is the last chart that the GC's did asking what the architects and engineers can do. And I actually think we've touched on this quite a bit. So what I'd like to do in the last half hour is gear it more toward the computer side of the issue and ask you, because I also see that you guys have already spoke about what you think the problems are and how you can solve these problems so I want to know how long some of these things have been going on and what you think the introduction of computers has done. So basically this last question. What are you opinions? Do you think they've helped in the long run? It could be in terms of communication or just the drawings. Have they hurt? Or do you think they've just added another problem in terms of now they can produce these documents so much faster have they added an unnecessary time constraint that wasn't there before?

RK: There's an unrealistic expectation that an architect can push a button and have a document done by the end of the day. And that's where half or more of the problems come from. "You have a computer don't you?" We deal with that all the time. That and the multiplicity of what the computer can do as far as helping to just keep producing the same errors over and over again. It's just killing everyone; wasting money and time like we've never seen before. But on the good side though, some of the new stuff that's out there, the parametric modeling software that's out there, I've been using some for about a year and a half and I love the stuff and am trying to talk people into using it. Just to toss a brand name . . .

GS: Can I say something? We're pushing the same thing. We're going to start our freshman this term with Autodesk Revit. . .

RK: Don't say Autodesk. It's Revit. Autodesk just owns it. Erase that. (Laughing)

GS: We're using it with the grad students. So I guess that just goes along with what you said, that some of the software has process (inaudible)

RK: At my last firm we were early adopters of Revit. We had Release 1. (Inaudible) This morning I was pulling my hair out because one of my guys was setting up

drawings and he set them up wrong with wrong drawing titles and numbers. And every key on the drawing was wrong so he's back in the office right now fixing each and every one of them. With Revit it's instantaneous. It can't be wrong. It's beautiful. And that saves 8-16 hours drawings on an average set of drawings. You know time is money. So I think there's a lot of hope there. But the industry is so skewed towards the standards the AutoCAD's and all that stuff it's going to take a long time for that to happen. That fact that AutoCAD bought Revit and is now saying that Revit is the wave of the future and there's not going to be anymore AutoCAD, this is the last update of AutoCAD coming out next month hopefully, and that Revit is their new program (inaudible) ArchiCAD out there and those are going to be the two programs that are dominate out there in the next five years and hopefully a lot of that stuff will go away because of it.

WB: I don't know a lot about Revit, but is that predominately architecturally based?

RK: (inaudible)

WB: Because if you look at the mechanical or the structural, we aren't generally working in the 3-D realm, where as I know some of my architectural clients are working with ArchiCAD I think it is, and so they are working with an object based programs so as soon as they send me files I'm drawing beams as a line because I have a separate computer program that models the structure, so it's not part of the architectural so I have to translate the information in there, build that model, and then spit it back out into AutoCAD.

RK: Right and that's the problem. Something like Revit has evolved to be able to take .stl files or (inaudible) in the structural realm . . .

WB: It's a revolution . . .

RK: Right. The MEP guys have something called (inaudible) draw 3-D (inaudible) and all that stuff is going to be input into Revit sooner or later. And it has automatic conflict alerts so you'll know when you've got (inaudible) ducts running through a 12 x 54 so that's the beauty of it. And that's the whole mindset and you're talking about perceptions and that's the way it is and how it's always been and that's the biggest thing to overcome.

WB: You've also got to take that computer information and produce a paper drawing that he's going to build. That's the other problem. The way the industry runs right now, it still all has to be put onto paper . . .

RK: They've got that fixed too. They've come up with a real nice way to output.

DC: Revit is really impressive from what I've seen of it. I think it's the future of drawings personally. But I still think that the way the industry is set up, the entire construction industry, it's going to be a long, long evolution. Because construction is

set up so that every person involved in the construction process is at a completely different level of technology. From what I see, architects are the most technologically advance people in the process. Engineers are next, contractors, then subcontractors. Because you don't have an even playing ground of technology it's not easy to transfer technology from one person to another, like you said. There are no easy ways to format something into a different program. There's not easy ways to convey things without using that program. Unless you force a GC to buy the program, you know, Revit is good with outputs and giving drawings to a contractor, it's good with that. At the same time you get different technological issues; the architects might say that "in the future we'd like to have a website with all the drawings on it." Then the contractor would say, "We need paper copies." And then your subcontractor might not even have a fax machine because he's so far back in the dark ages. So you have a step down at every level of technology that is the biggest problem right now in the industry. The level of technology. If you could work off of email; email is a great thing. AutoCAD is a good thing but it is fatally flawed in many areas and the fact that today not everybody uses it is still a major issue. The people that have adapted, you know, subcontractors that use AutoCAD now and GC's that use it and architects that still use it. So if you have all those people online, AutoCAD, although it doesn't do 3D and it doesn't do this and the outputs aren't that and it allows for complacency, still it can be used at a level that can help. But like I said, it's going to take a wide evolution of everybody involved in the process for everything to work out great and when that does happen in 20 years or whenever that happens and everybody has the technology basis to use Revit to its full potential you're going to see a lot less change orders and a lot less litigation and I think it's going to be the future of the industry. Construction people are stubborn and don't want to change for some reason.

GS: This is for Emilia. What about the project websites?

RK: Buzzsaw and all those guys? Those are great.

REK: We're looking into those right now. We haven't jumped both feet into the picture yet because we're running into the same thing on the technology side with the contractors and the subcontractors. They might have a basic 486 in their trailer that can just get word processing done. And we're seeing it from that side. They don't want to jump in and look at it and they don't want to spend the money on the equipment to get that virtual plan room where all the stuff can be located on and all the changes can be done on there and once your changes are made all it takes is that everybody that's in contact with that website gets an email saying there are changes here. It may not affect you, but it may affect the HVAC guy or the electrical guy or the plumbing guy who doesn't have anything to do with it. But at least everyone got that memo saying there are changes. So the communication level will increase at that point. What we're finding is that they are getting the subcontractors to jump on board. A lot of times these are construction trades that give you a beer and a hammer type of thing and they don't really care.

RK: We don't let our electronic documents outside the loop of the contractor to the subs and stuff and we probably never will just because there is too much at risk liability-wise. Like a drawing got out and somebody modified it and it got back into the loop again and there's some inherent problem. We'll always (inaudible) some kind of security, secured paper document, electronic document.

REK: That's why were trying to get into the virtual plan room. So there's this certain, you release the key to get into that and it's got to be in (inaudible) format so they can't go in and make changes. They can review, but they don't have the capacity to print it. There would also be security locks and what all the industry is trying to get together on the reprographics side, is the authorization name. You just can't go out and print it. So the authorizations have to be a key instance (inaudible). I got set up by your side.

RK: We do that in Buzzsaw and we have another one called QuickBook/QuickBase that we've used for CA work, which is very good. And that's a little easier because it's not like a graphical thing it's more like a database that most of the subs and the GC's can handle on their computer systems and it's great for tracking RFI's and (inaudible) all that stuff. But the documents . . . it's always going to be a paper-based thing for the next bit of time.

REK: Some of the customers I'm also setting up to put in these plan rooms and getting the basic plotter to put in their trailer so at least they can print the documents they need. They go in and start clicking what documents they want and it's already recorded on our property, on the software program, so we know who's getting these drawings. We know when these drawings are going out. And if the architect wants to know who got which drawings it's right there. They can go into the software and look it up themselves. It also helps on the billing aspects of it because they know exactly how many copies are going out. The new one we're looking at right now is more than a $50,000 investment on our half to get into that. So it's not a solution that's provided to everyone out there but there's so many of these programs out there, Buzzsaw was one of the first ones out there, which is (inaudible), format which we don't really like for the industry because it sort of guides it to certain machines. They want more of a generic being out there so all the reprographic machines can handle that.

GS: So you're not going out of business because of electronics?

RK: They'll never go out of business.

REK: Everybody is going to need paper copies eventually.

RK: Unless they get a large scale PDA.

REK: Exactly. I'll sell the plasma screen and put them in their trailers, I don't care. We're trying to open up where the industry is going to go so we'll sell the plotters,

we'll sell the copiers. And if it goes down to in the trailers that you'll need plasma screens, the 42", to see the full documents on the size of the paper, that's the way it's going to go. But you're always going to have consumables built into that. So the smarter companies out there, like we are, are built into a consumable base. We don't make a lot of profit off of machine costs. It's all built into a consumable base. That's where our revenues are. Down the road we have to think where this industry is going to be going to help guide which way things are going to be going. This is what they're doing in the industry this is what people are doing here. This is the concept we get from Perini. Doing stuff all over the world. May give us some foresight to look at that.

WB: I think it's an evolution. Like what you're talking about with these websites. We're only getting into them on some projects. And the biggest problem we have is that maybe the drawings can be updated on the architectural side daily, but I don't want to redesign everything daily. So there's really no need (inaudible) the way it is or the fact that right now a lot of them, we have to go out there to find out what's been updated. In the past I worked for an architect and the architect told me "I updated this plan, here it is, make the changes." Now you're kind of putting it on each party is the one that's supposed to go out and check and say, "Oh gee now they changed that I have to go and find out about it." I think right now it has some inherent problems.

REK: It will until evolution goes past that.

WB: Yeah and that's where we are right now. We're kind of in a transition.

RK: It still goes back to a strong PM to deal with that. My consultants don't get every 15 minute updates because I'm not going to spend money that way. So every Thursday we send them drawings with what's been updated and what they need to do and when they need to get it. So I like to get it to them once a week unless I need to get it to them more often, but I usually don't have to. Because it takes to do an analysis and other stuff so I'm not going to jam the guy up.

WB: Yeah and that's another thing from the engineering side. We have a lot of things that go on behind the scene that don't go on the drawings. So the drawings are produced based on the calculations. So I can spend weeks working on something and not produce any drawings. So it's harder sometimes to get that across to people. "What takes so long all you do is fix the drawing?" That's part of it I think.

GS: I have to run because I have to get to Logan. Please continue as long as you can. Jody you're in charge now. Thank you.

JK: Ok. I have a question in terms of Revit. Now what is it going to do for like the laziness that you were talking about or maybe the cut and paste? Are there still going to be those factors?

RK: There's always going to be cut and paste. That's the beauty of the computer. But the cut and paste (inaudible) when you have to block an object. You should draw it right the first time. And if it's not then you're in trouble.

DC: Revit really helps with the complacency or the laziness. I would say it's laziness on the part of the designer, it's maybe that they made a change and they just didn't track it and then you lose track of that and it causes problems 9 months down the road. The thing that Revit helps with that is that it checks for errors or if you have a conflict. Or you have maybe, like I said, a plumbing fixture that has no piping to it. It's going to identify things like that and that's going to eliminate so many problems right up front. But at the same time, the whole industry has to evolve to a point where everybody can fully benefit from something like Revit. Right now it's generally architects and contractors, which is great for me, but once everybody in the process is able to use it it's definitely going to become one of the best things ever.

JM: Jody, your owner's representative has to go off to another meeting now. Thank you very much for inviting me.

JK: Thank you very much for coming. We're actually probably going to wind down pretty soon too because I don't know if anybody is coming in at 2:00 and I have to clear out all of this equipment. And I don't want to keep you that much longer because I don't know how far some of you are driving. I want to thank you all very much for coming and I think it was very informative and thank you for your input. I think it is going to help out a lot. Does anybody have anything else to say to wrap up? Emelia now has a quick survey and thanks again.

Appendix E – Survey Questions

Architect Survey

1. Job Title
2. How many years experience do you have? (0-5, 5-10, 10-15, 15-20, 20+)
3. What type of work does your company perform? (ie – public, private, building architecture, interior design, full service, etc)
4. What are the approximate annual sales figures for your company?
5. What is your role in the production of construction documents?
6. In your opinion, how skilled are the engineers that create the drawings for your company?
7. What type of review process (if any) does your company use?
8. a. Is enough time allowed to produce accurate drawings? (Yes, No, Sometimes)
   b. If no or sometimes, are items omitted in order to meet deadlines? (Yes, No, Not Sure)
   c. Also, if you answered sometimes to 7a, what percentage of the time is enough time allowed?
9. Are there any particular aspects of design that are difficult to communicate to owners and contractors in the construction documents?
10. Could the GC/CM or engineers help in any way to improve efforts to provide quality construction documents?

General Contractor Survey

1. Job Title (Project Engineer, Project Manager, Project Superintendent, Construction Manager, Other)
2. How many years experience do you have? (0-5, 5-10, 10-15, 15-20, 20+)
3. What type of work does your company perform? (ie – public, private, general trades, sitework, etc)
4. What are the approximate annual sales figures for your company?
5. On average, how would you rate the quality of construction documents your company receives? (Poor, Below Average, Average, Above Average, Excellent)
6. Please briefly explain your answer to Question 5.
7. What do you attribute this problem (if any) to?
8. How does the quality of construction documents affect your job? (ie – time, money, relationships, etc)
9. How do you see this problem being solved?
10. Could the architects or engineers help in any way to improve efforts to provide quality construction documents?

Engineer Survey

1. Job Title
2. How many years experience do you have? (0-5, 5-10, 10-15, 15-20, 20+)
3. What type of work does your company perform? (ie – public, private, mechanical, electrical, landscaping, civil, combinations, etc)
4. What are the approximate annual sales figures for your company?
5. In your opinion, how skilled are the engineers that create the drawings for your company?
6. a. Are you given enough time to create complete and accurate construction documents? (Yes, No, Sometimes)
   b. If no or sometimes, are items omitted in order to meet deadlines? (Yes, No, Not Sure)
   c. Also, if you answered sometimes to 6a, what percentage of the time is enough time allowed?
7. What type of review process (if any) does your company, or you personally, use?
8. Are there any particular aspects of design that are difficult to communicate to owners and contractors in the construction documents?
9. Could the architects or GC/CM help in any way to improve efforts to provide quality construction documents?

Appendix F – Survey Responses by Day

	Notes	Architects	Engineers	GCs
13-Jan	survey sent out (ECAC receives)	1	5	4
14-Jan		0	4	1
15-Jan	ECAC reminded at meeting	4	7	0
16-Jan	BSA gets survey	13	2	0
17-Jan		4	3	1
18-Jan		0	0	1
19-Jan		0	0	0
20-Jan		0	2	1
21-Jan		1	1	1
22-Jan		1	0	0
23-Jan	BSA reminded	1	1	0
24-Jan	AGC gets survey	2	1	4
25-Jan		0	0	0
26-Jan		0	0	0
27-Jan	The Laiserin Letter gets survey	11	4	3
28-Jan		1	1	1
29-Jan		0	0	1
30-Jan		4	2	0
31-Jan		0	0	0
1-Feb		0	0	0
2-Feb		0	0	0
3-Feb	ECAC reminded again	0	4	0
4-Feb		0	12	0
5-Feb		0	2	0
6-Feb	Announced to DBIA	0	2	0
7-Feb		0	0	0
8-Feb		0	0	0
9-Feb	33 Personal Emails	0	1	2
10-Feb		0	1	3
11-Feb		1	2	5
12-Feb		0	0	2
13-Feb		0	1	1
14-Feb		0	0	1
15-Feb		0	0	0
16-Feb		0	0	0
17-Feb		0	0	0
18-Feb		0	1	1

Appendix G – Survey Result Charts

Architect Responses

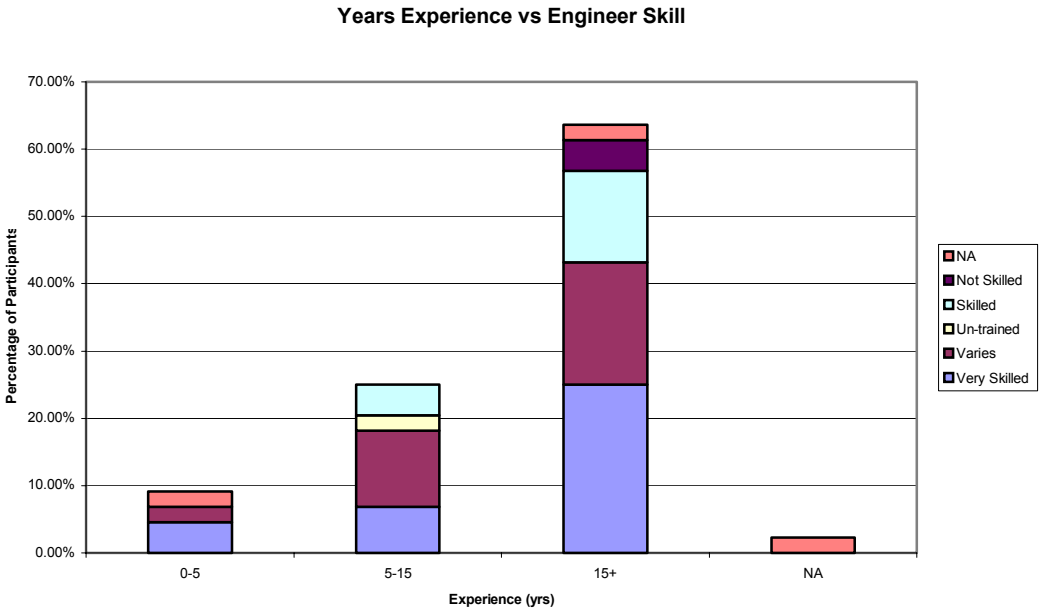

Figure 16: Years Experience vs Engineer Skill

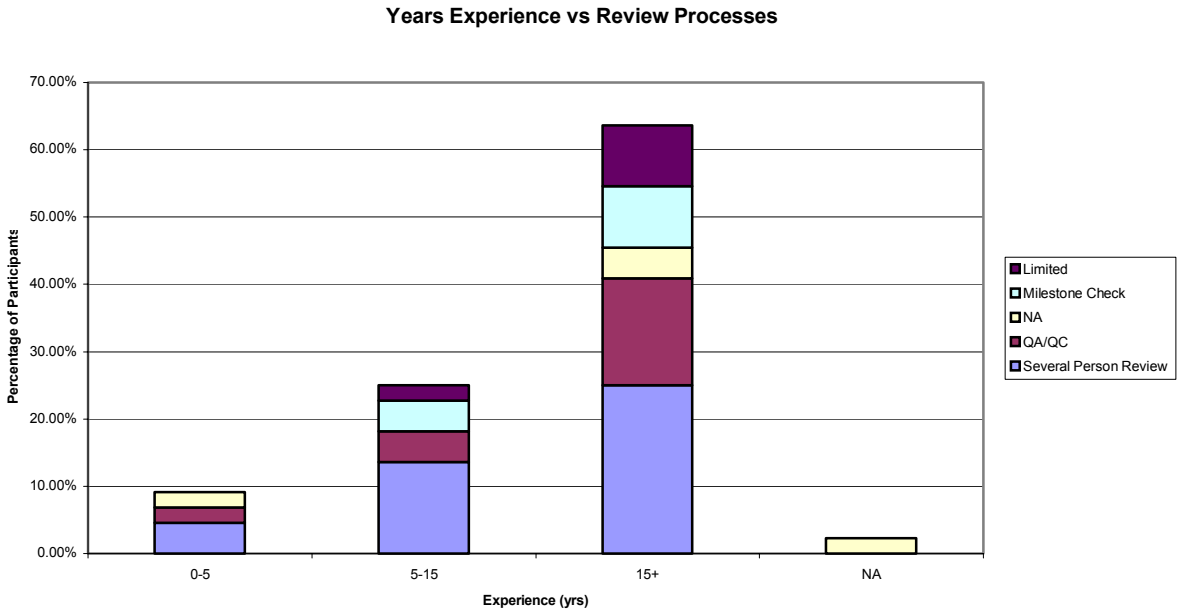

Figure 17: Years Experience vs Review Processes

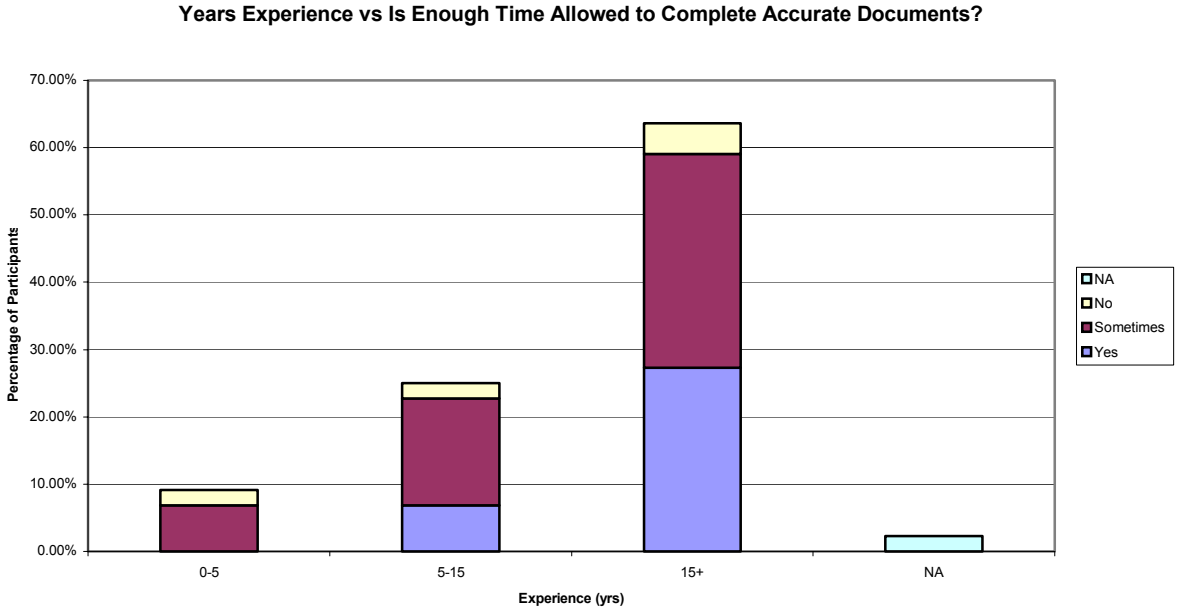

Figure 18: Years Experience vs Is Enough Time Allowed to Complete Accurate Documents?

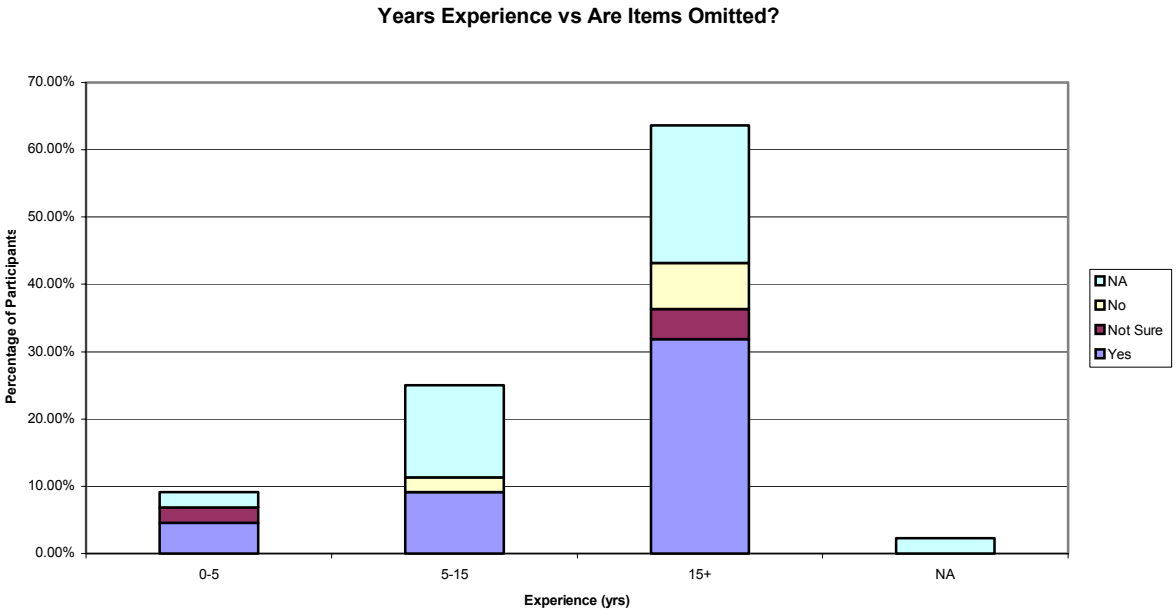

Figure 19: Years Experience vs Are Items Omitted?

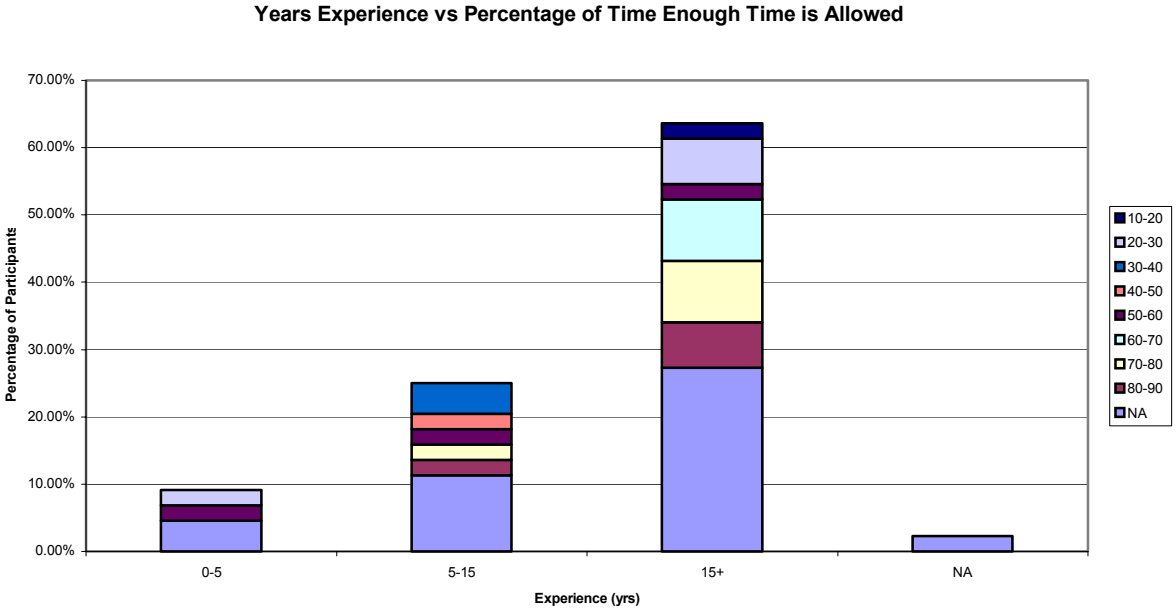

Figure 20: Years Experience vs Percentage of Time Enough Time is Allowed

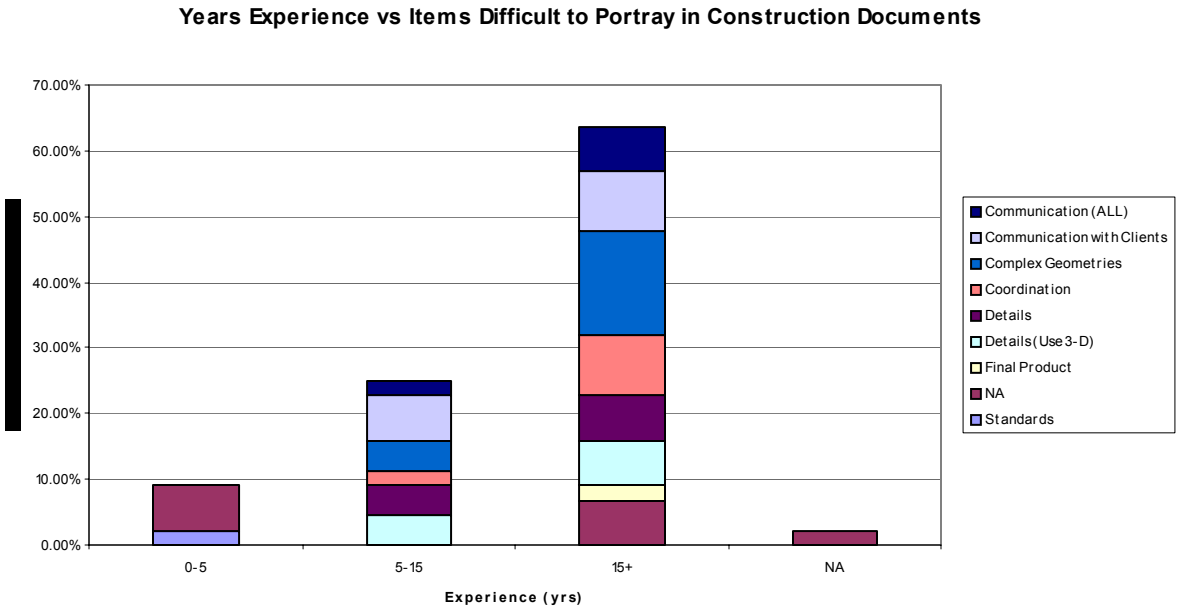

Figure 21: Years Experience vs Items Difficult to Portray in Construction Documents

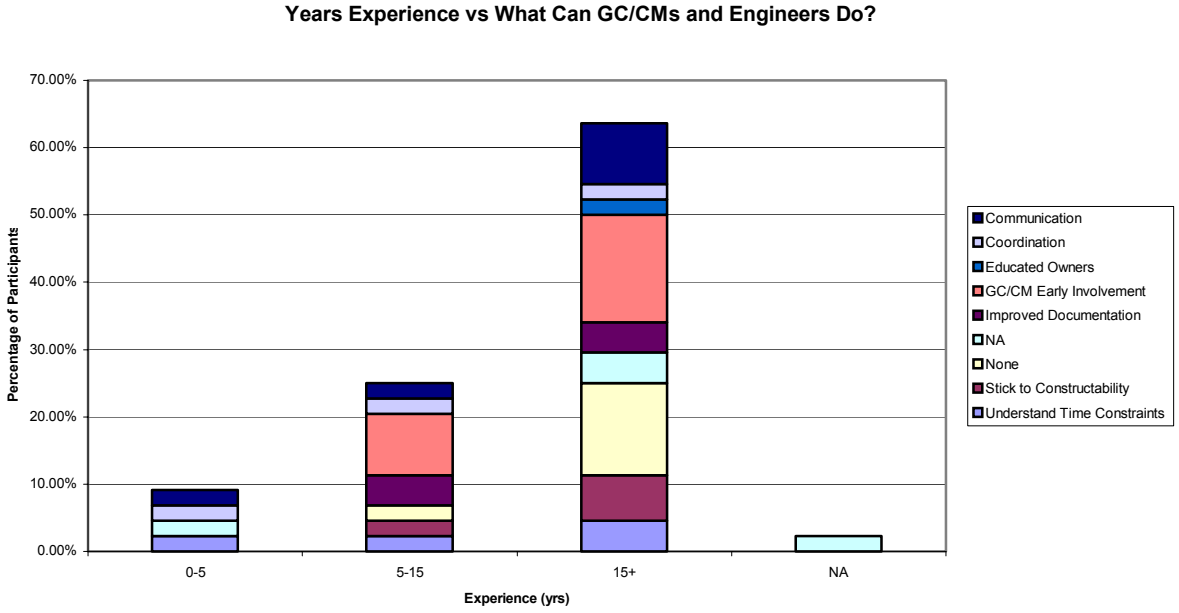

Figure 22: Years Experience vs What Can GC/CMs and Engineers Do?

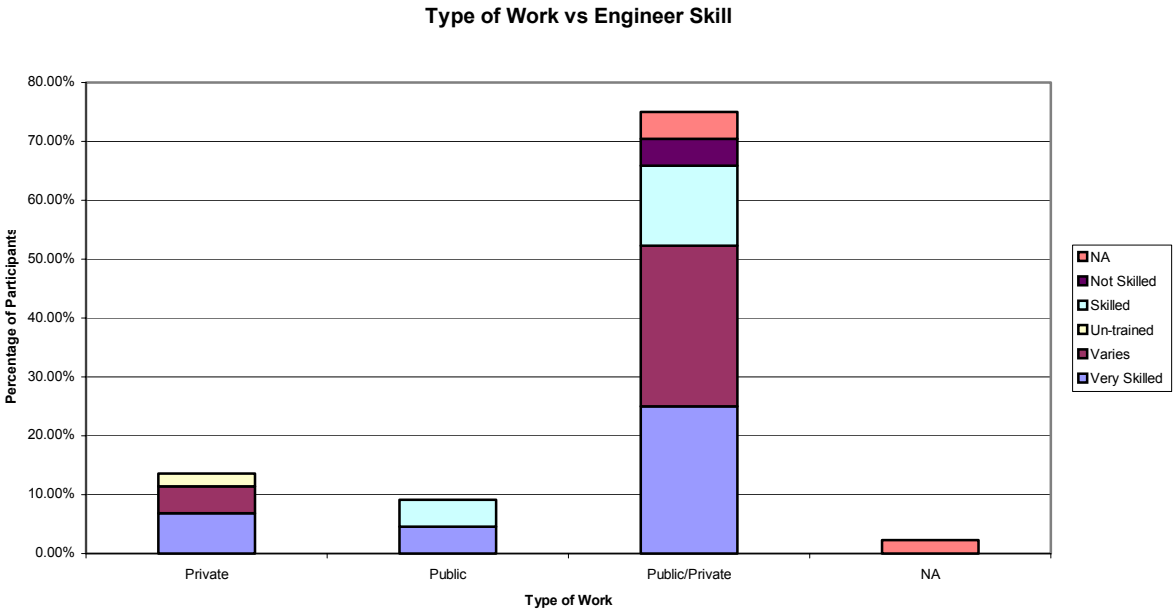

Figure 23: Type of Work vs Engineer Skill

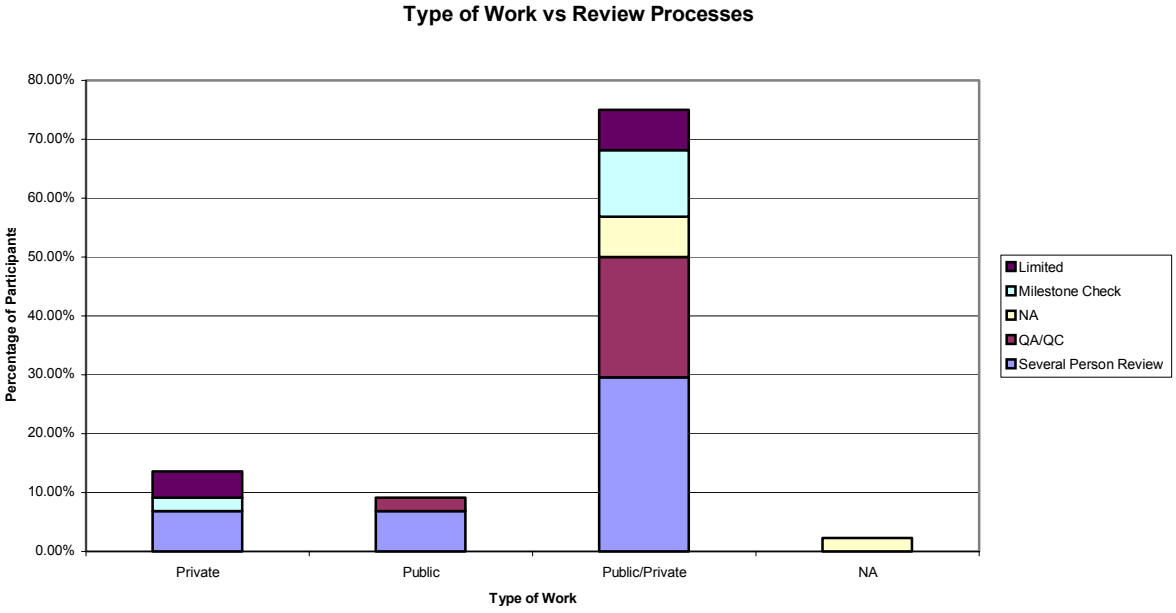

Figure 24: Type of Work vs Review Processes

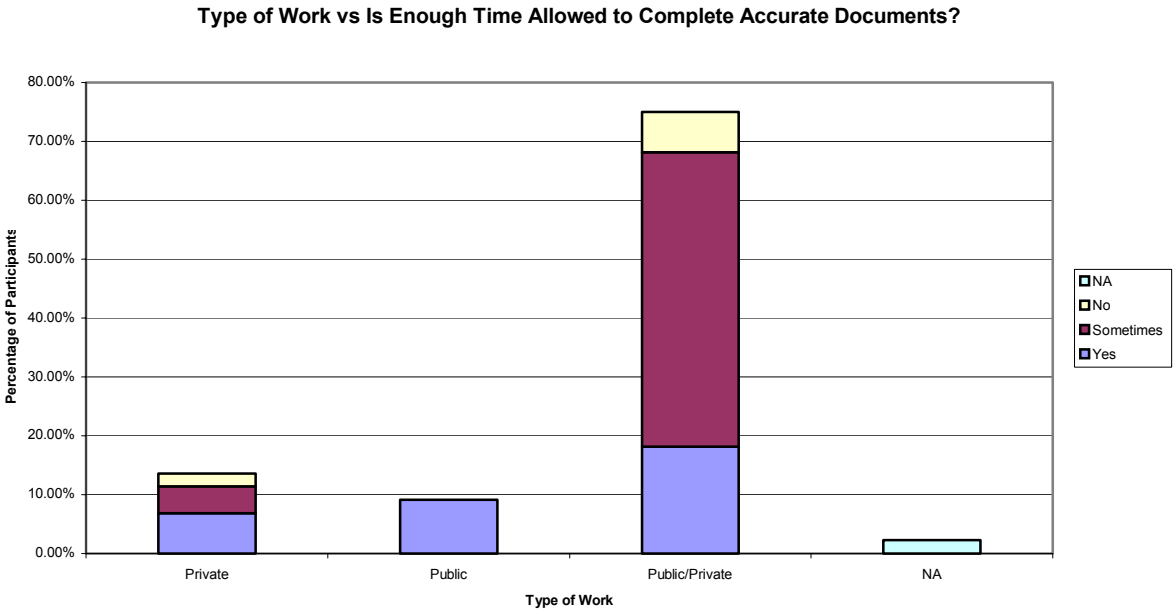

Figure 25: Type of Work vs Is Enough Time Allowed to Complete Accurate Documents?

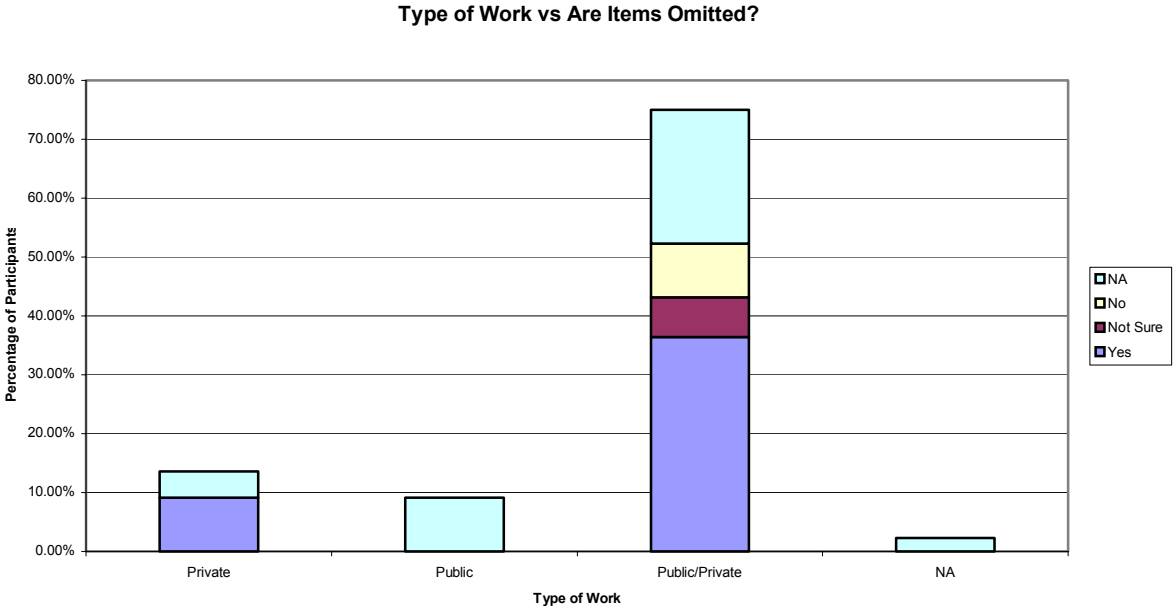

Figure 26: Type of Work vs Are Items Omitted?

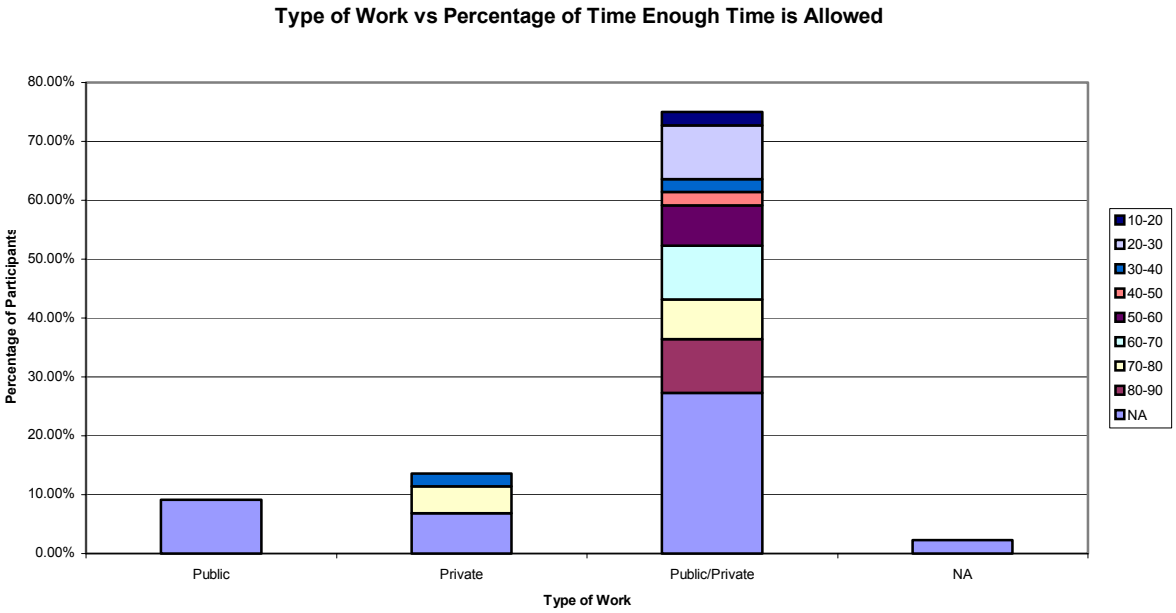

Figure 27: Type of Work vs Percentage of Time Enough Time is Allowed

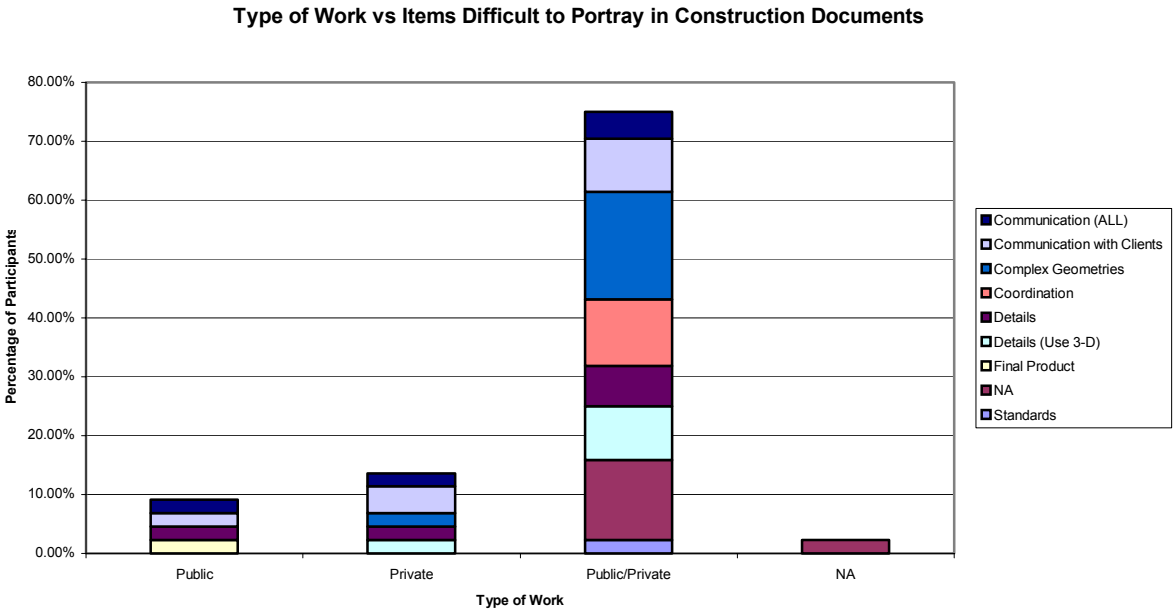

Figure 28: Type of Work vs Items Difficult to Portray in Construction Documents

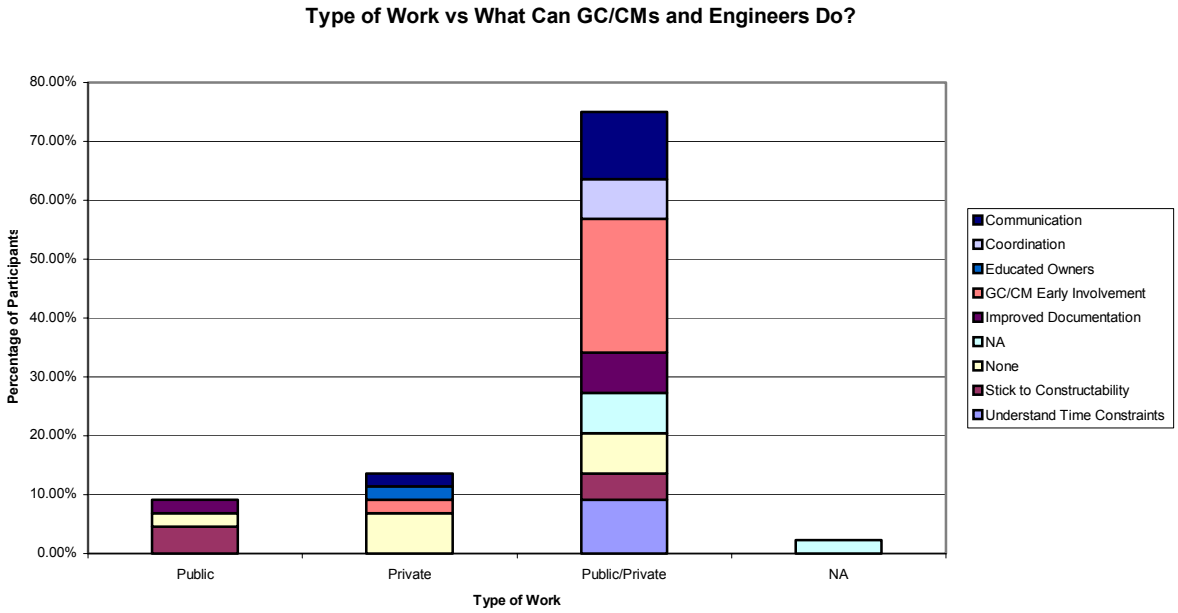

Figure 29: Type of Work vs What Can GC/CMs and Engineers Do?

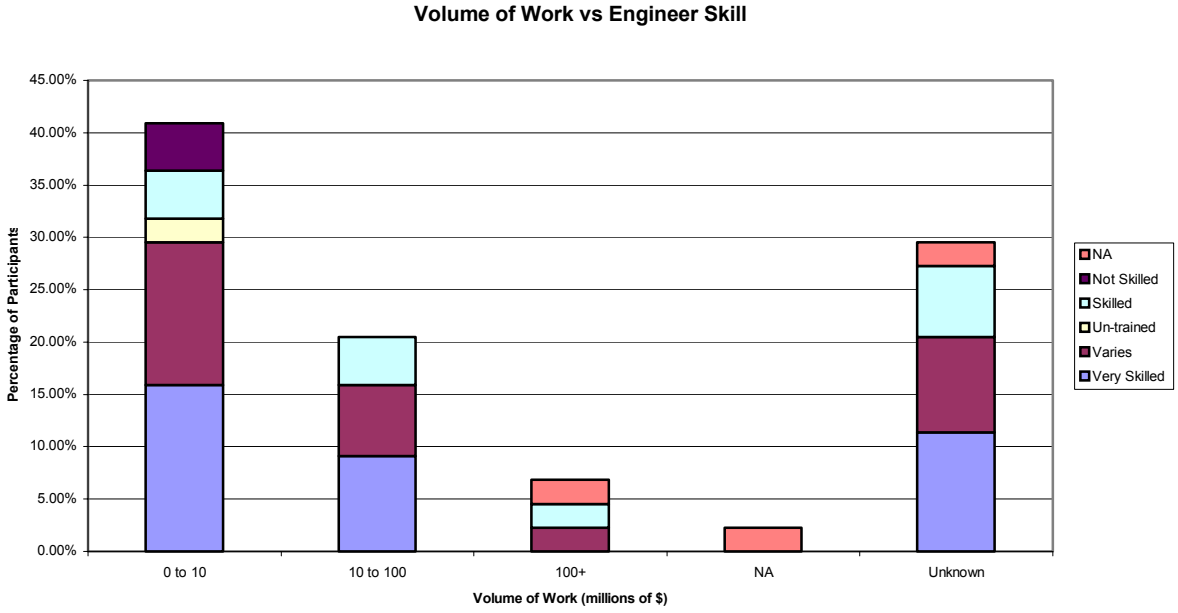

Figure 30: Volume of Work vs Engineer Skill

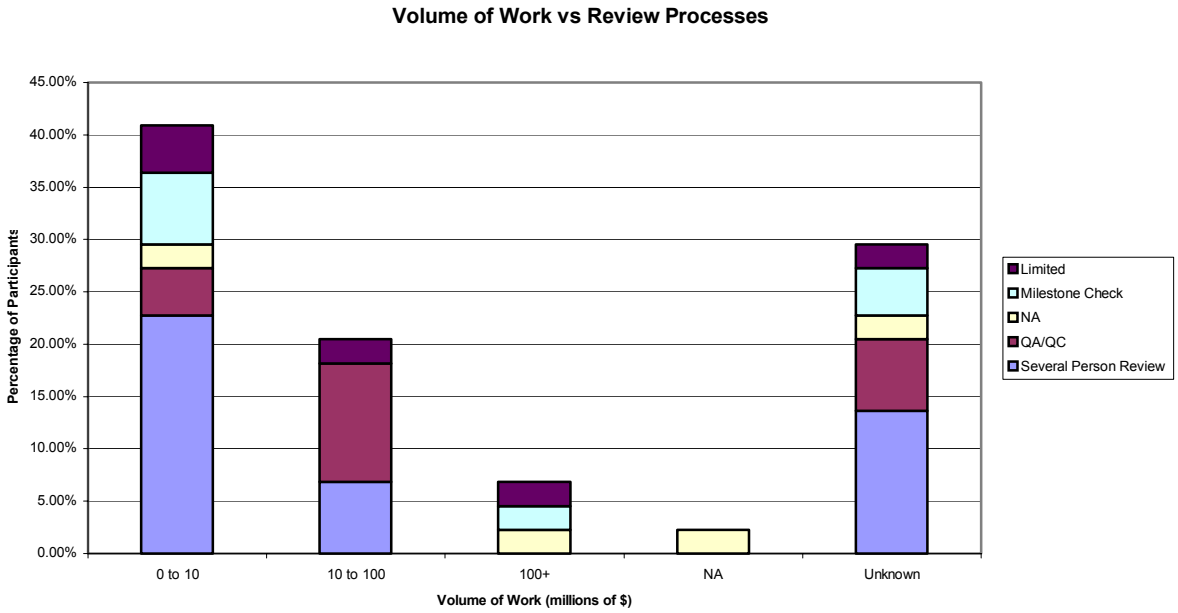

Figure 31: Volume of Work vs Review Processes

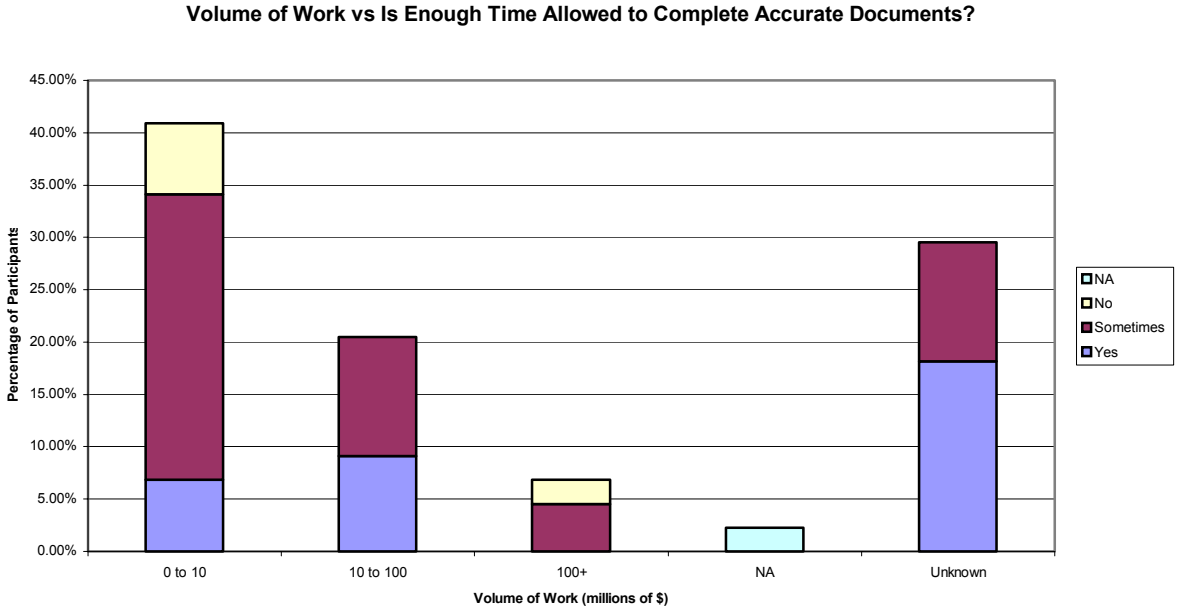

Figure 32: Volume of Work vs Is Enough Time Allowed to Complete Accurate Documents?

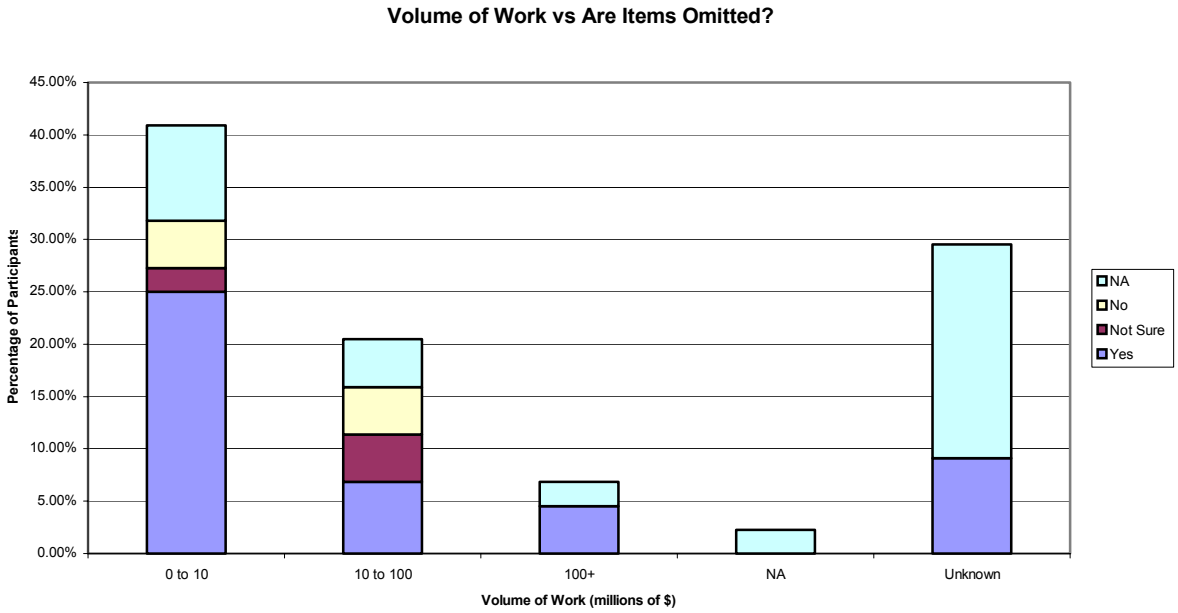

Figure 33: Volume of Work vs Are Items Omitted?

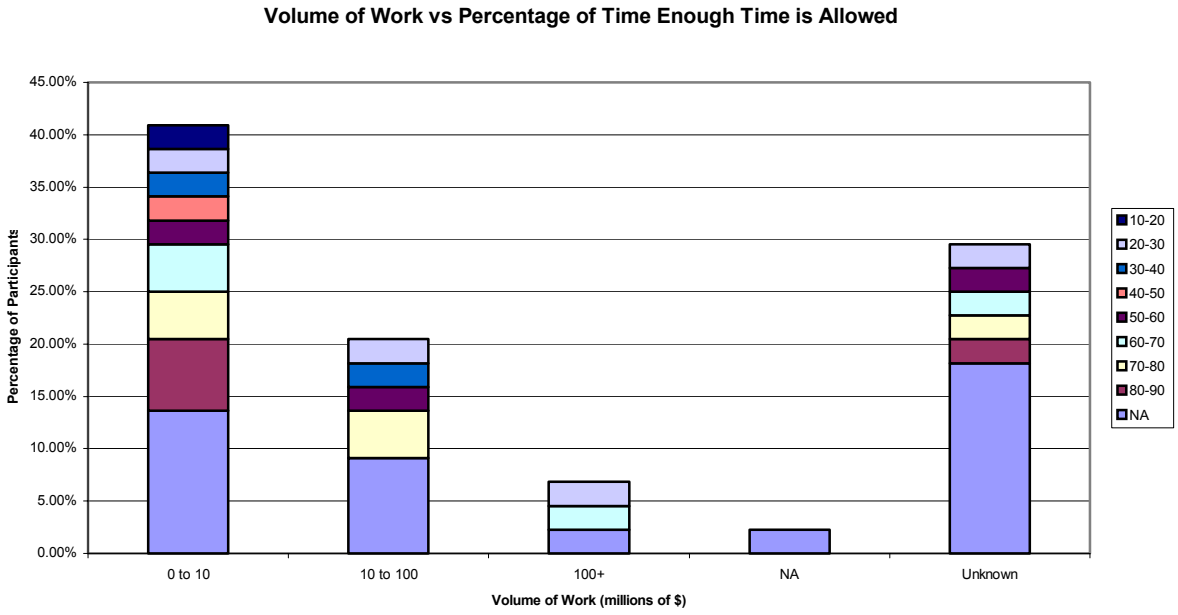

Figure 34: Volume of Work vs Percentage of Time Enough Time is Allowed

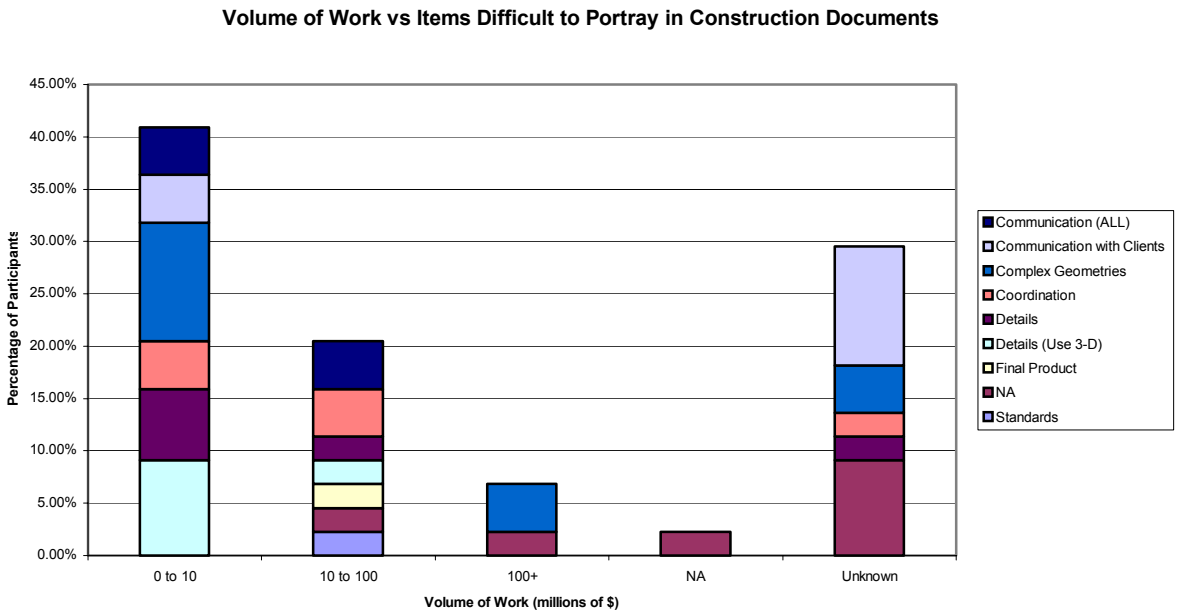

Figure 35: Volume of Work vs Items Difficult to Portray in Construction Documents

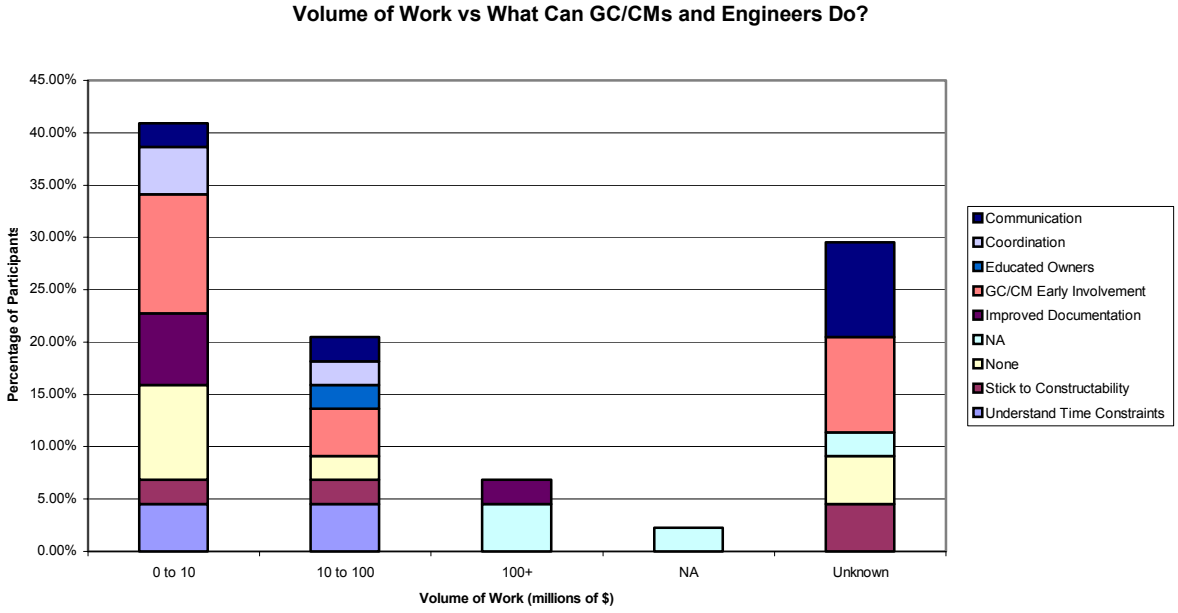

Figure 36: Volume of Work vs What Can GC/CMs and Engineers Do?

Engineer Responses

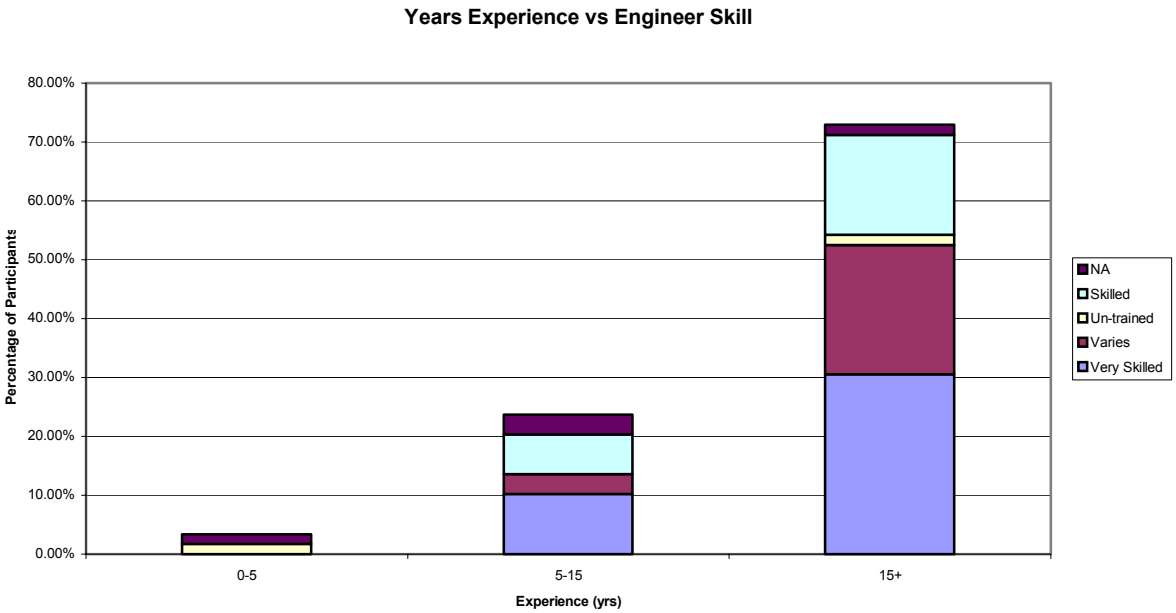

Figure 37: Years Experience vs Engineer Skill

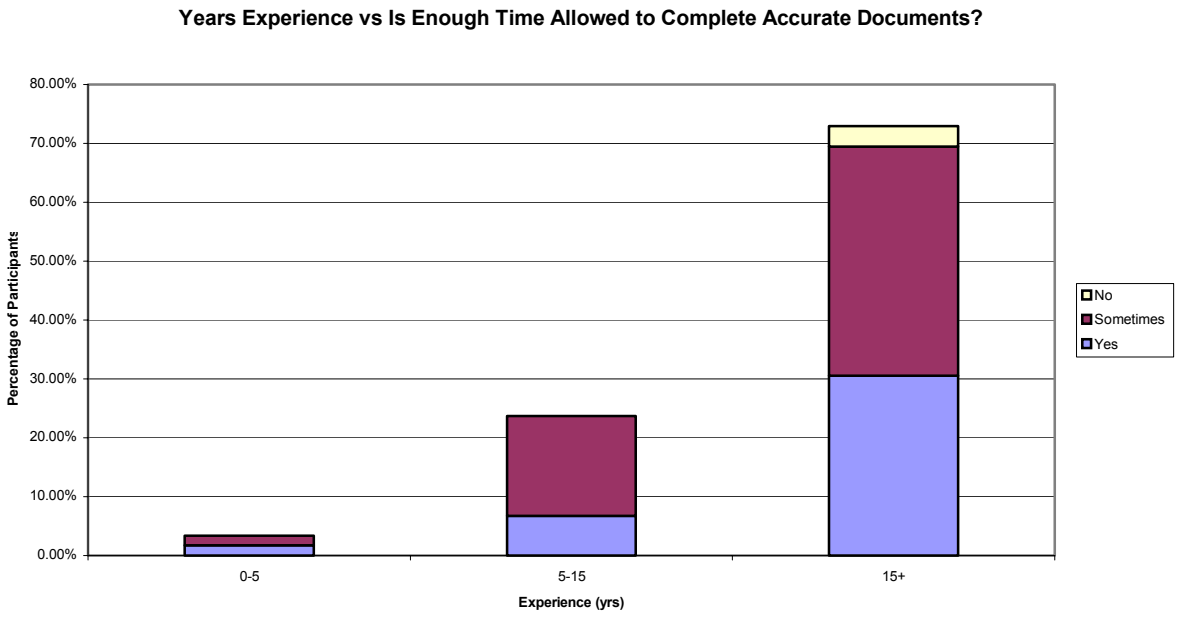

Figure 38: Years Experience vs Is Enough Time Allowed to Complete Accurate Documents?

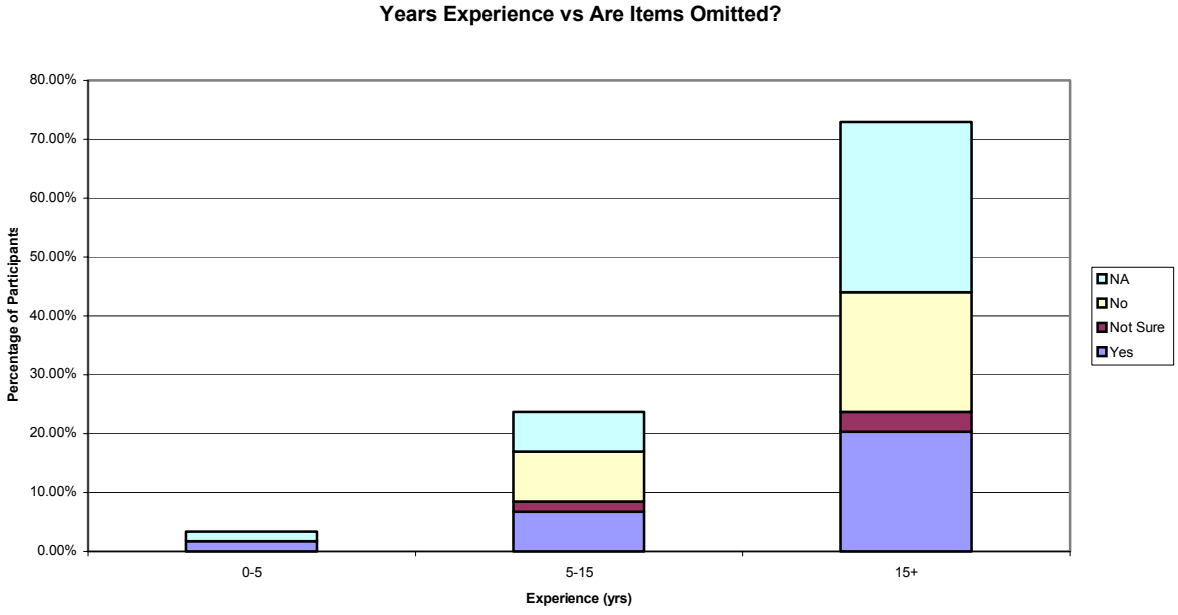

Figure 39: Years Experience vs Are Items Omitted?

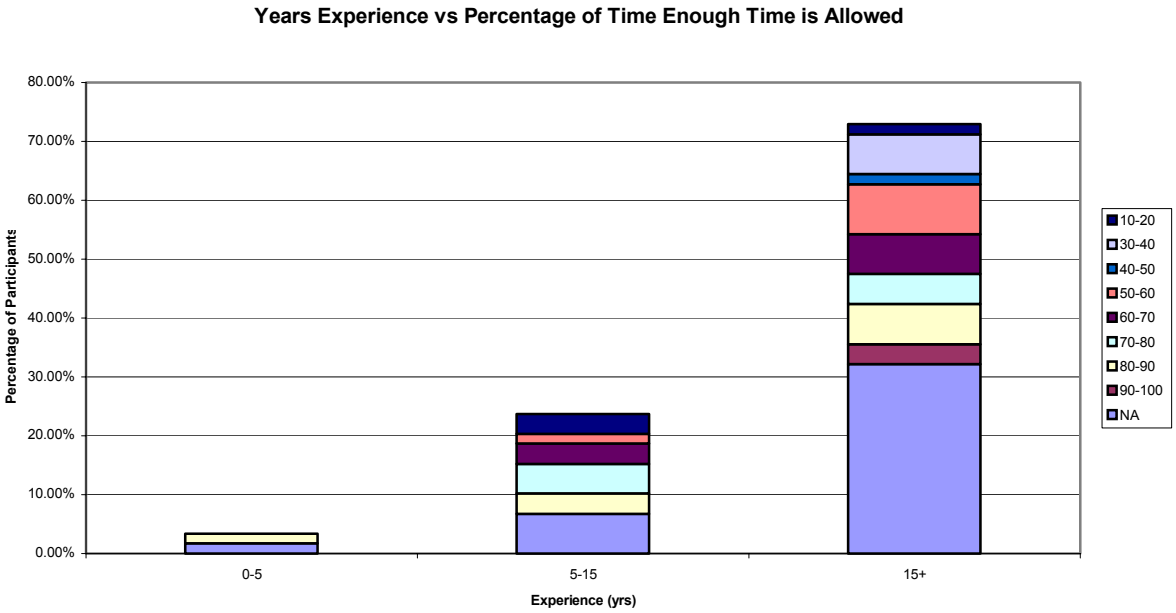

Figure 40: Years Experience vs Percentage of Time Enough Time is Allowed

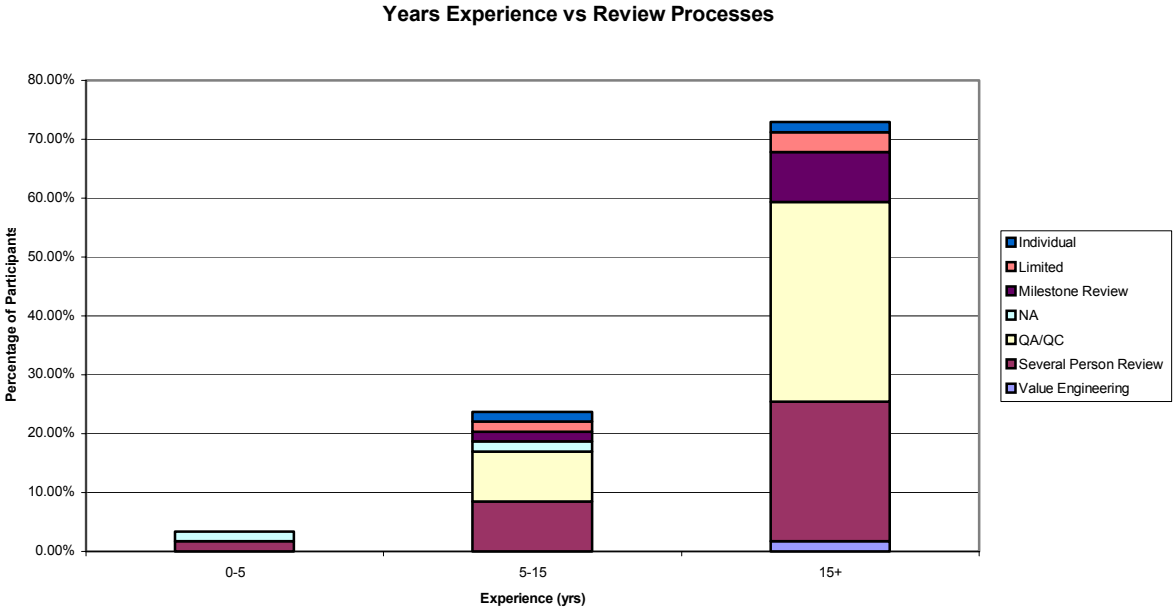

Figure 41: Years Experience vs Review Processes

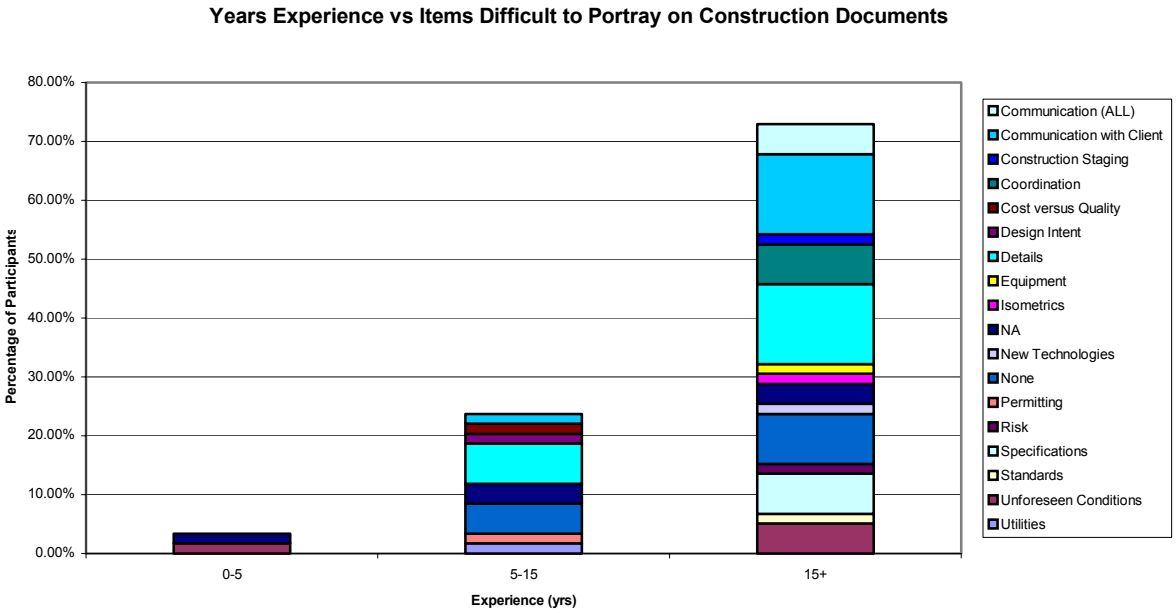

Figure 42: Years Experience vs Items Difficult to Portray on Construction Documents

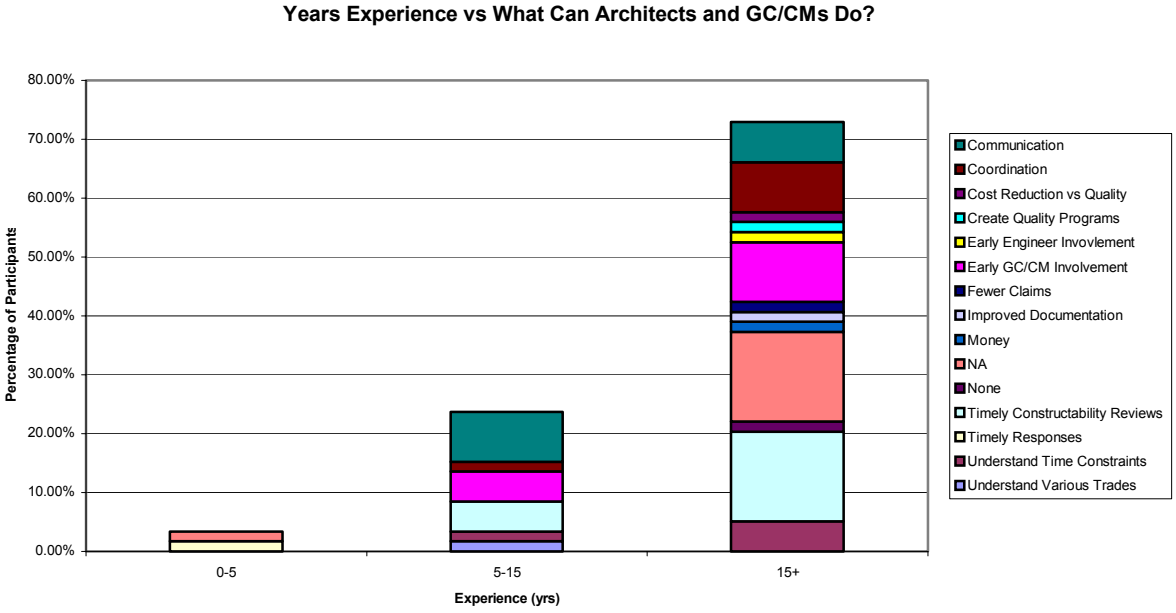

Figure 43: Years Experience vs What Can Architects and GC/CMs Do?

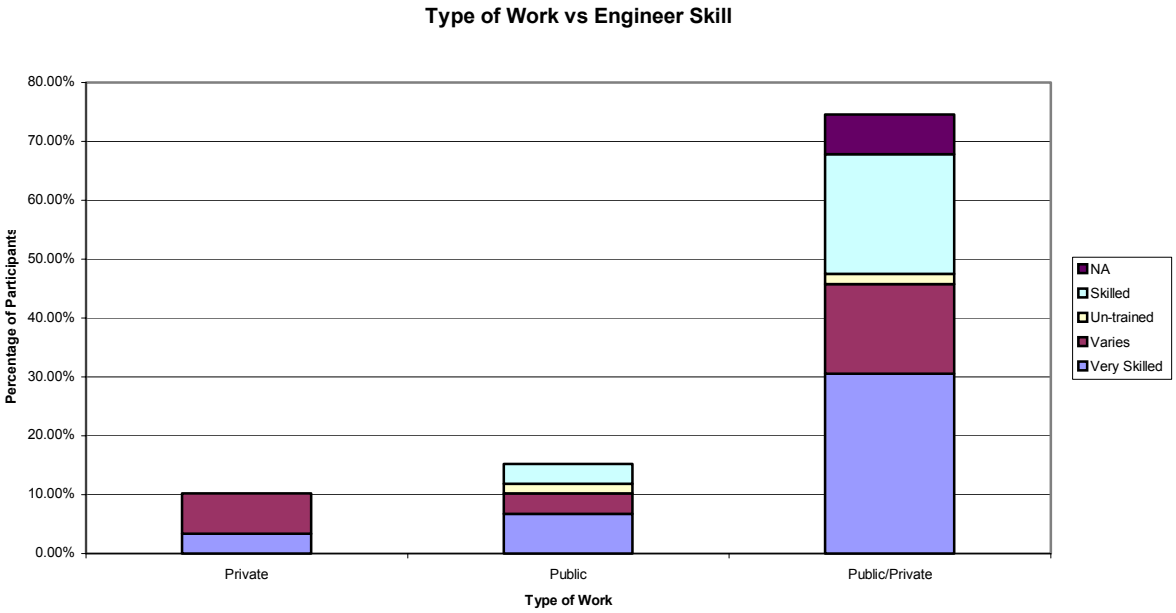

Figure 44: Type of Work vs Engineer Skill

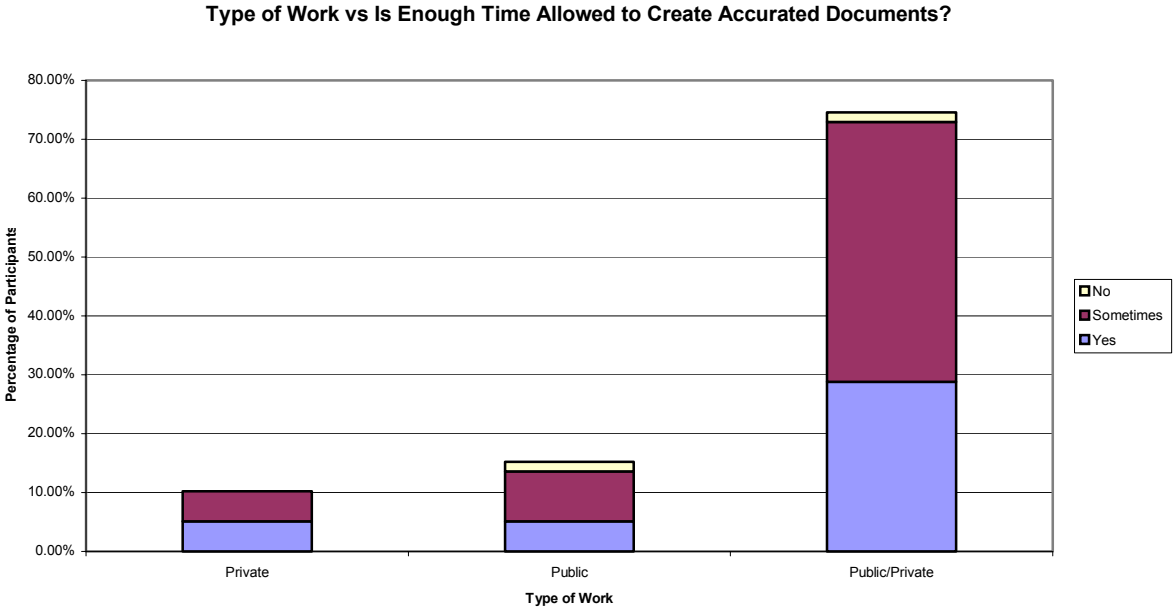

Figure 45: Type of Work vs Is Enough Time Allowed to Create Accurate Documents?

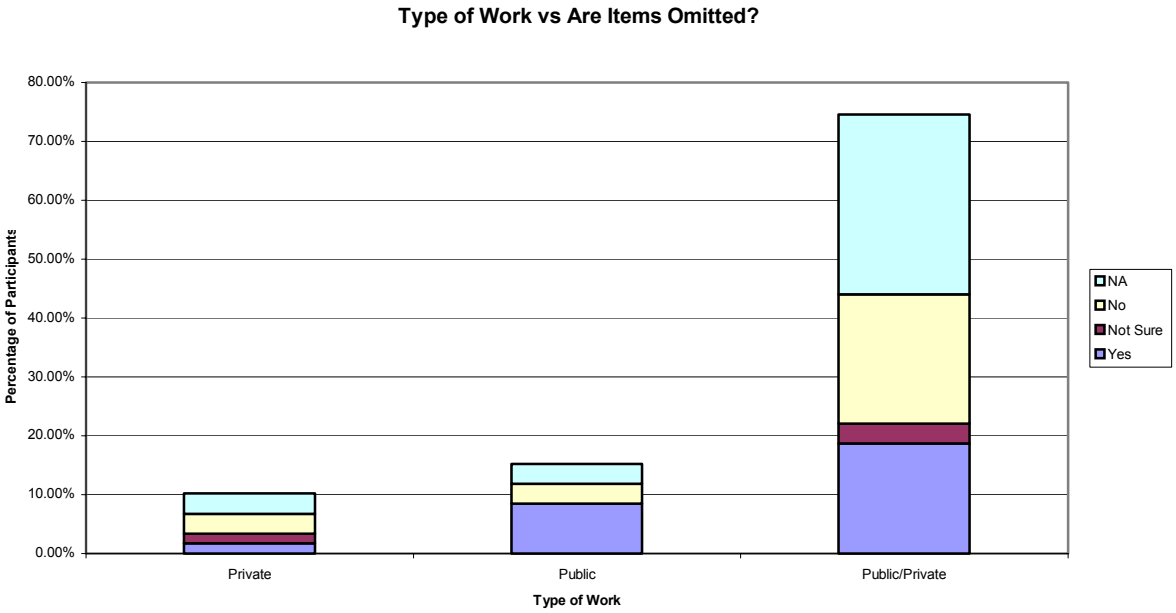

Figure 46: Type of Work vs Are Items Omitted?

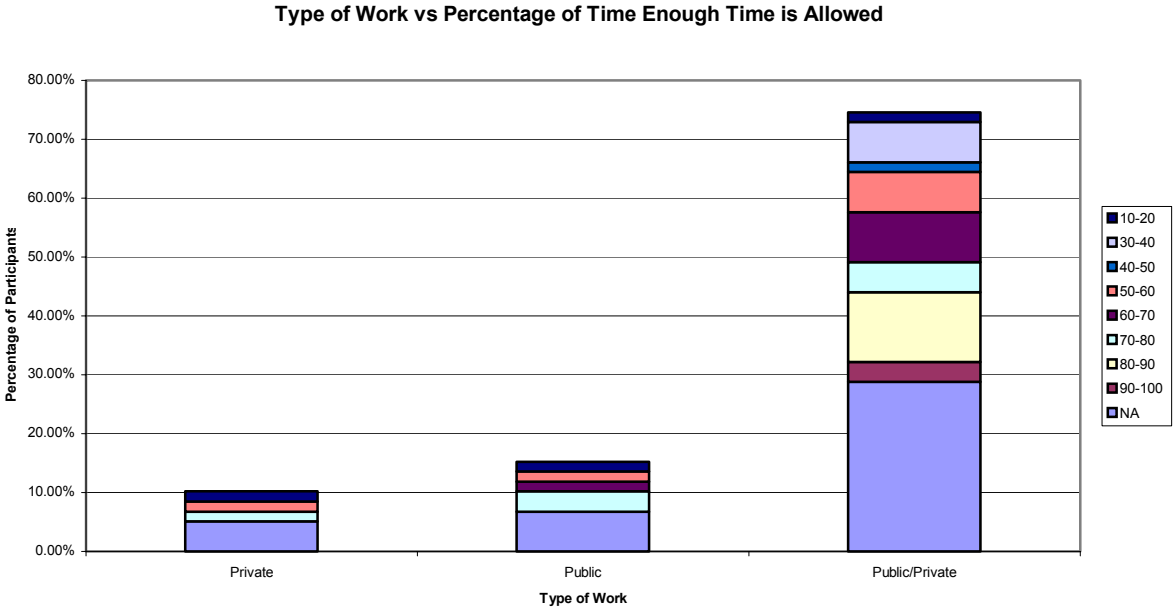

Figure 47: Type of Work vs Percentage of Time Enough Time is Allowed

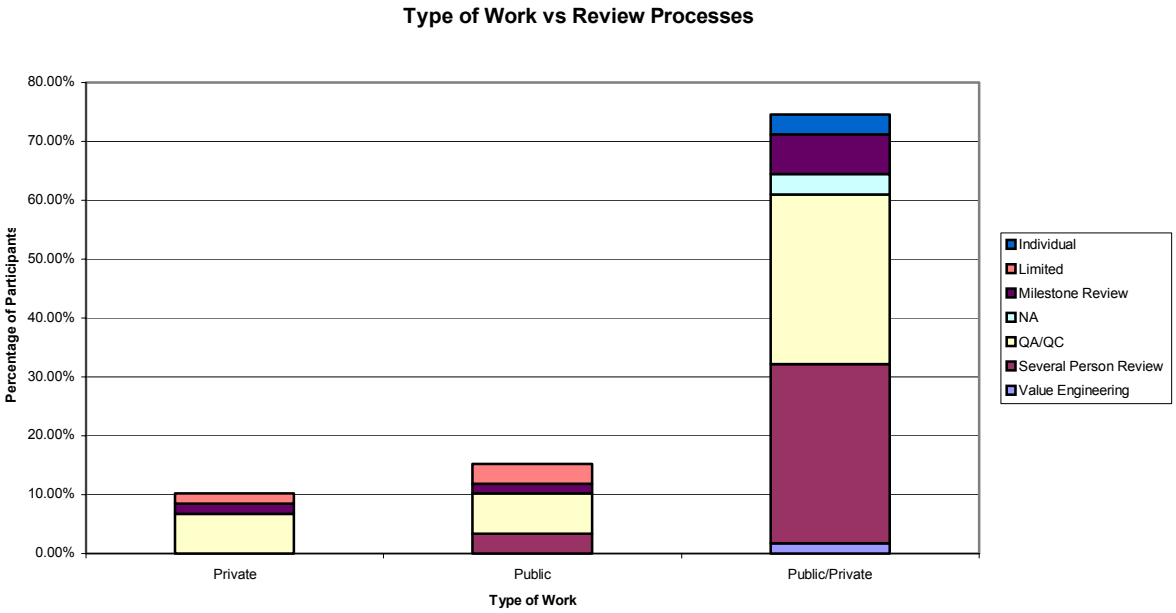

Figure 48: Type of Work vs Review Processes

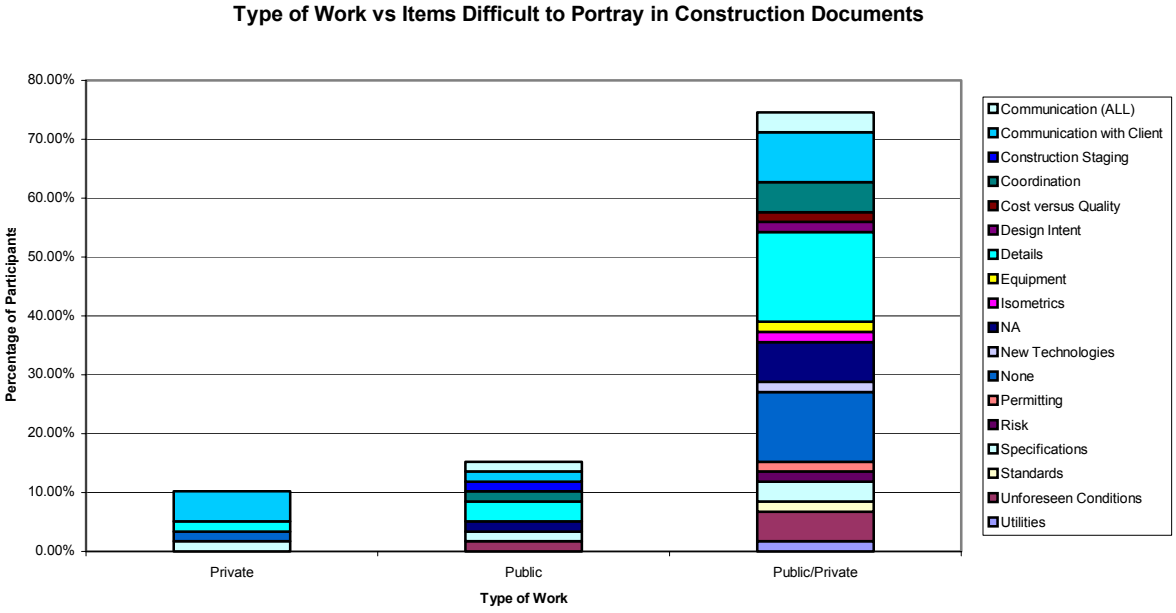

Figure 49: Type of Work vs Items Difficult to Portray in Construction Documents

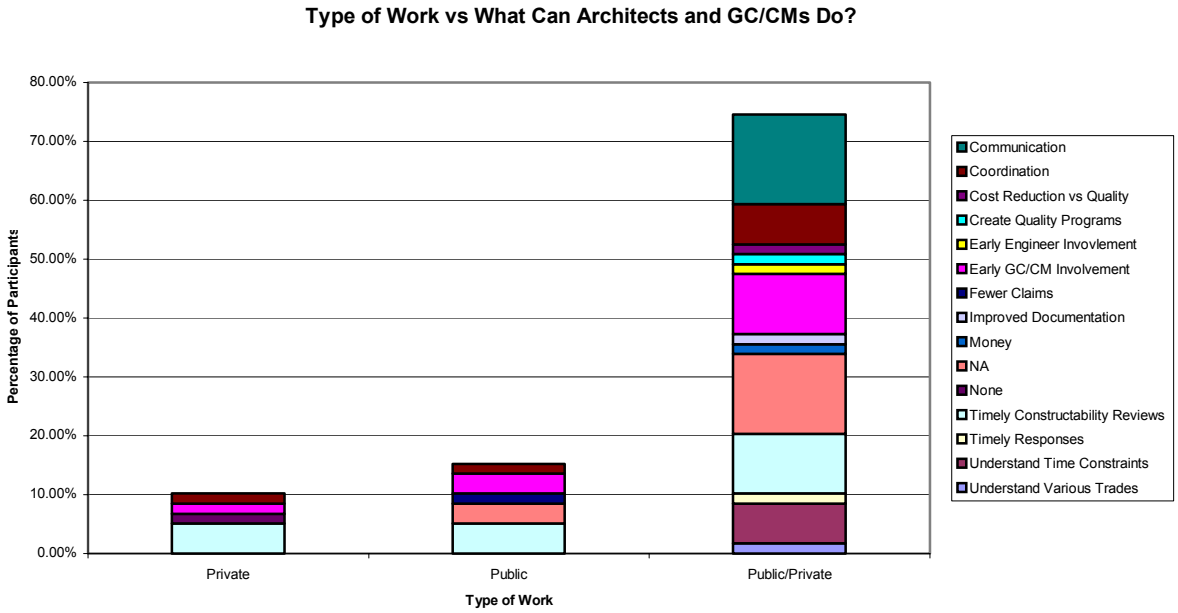

Figure 50: Type of Work vs What Can Architects and GC/CMs Do?

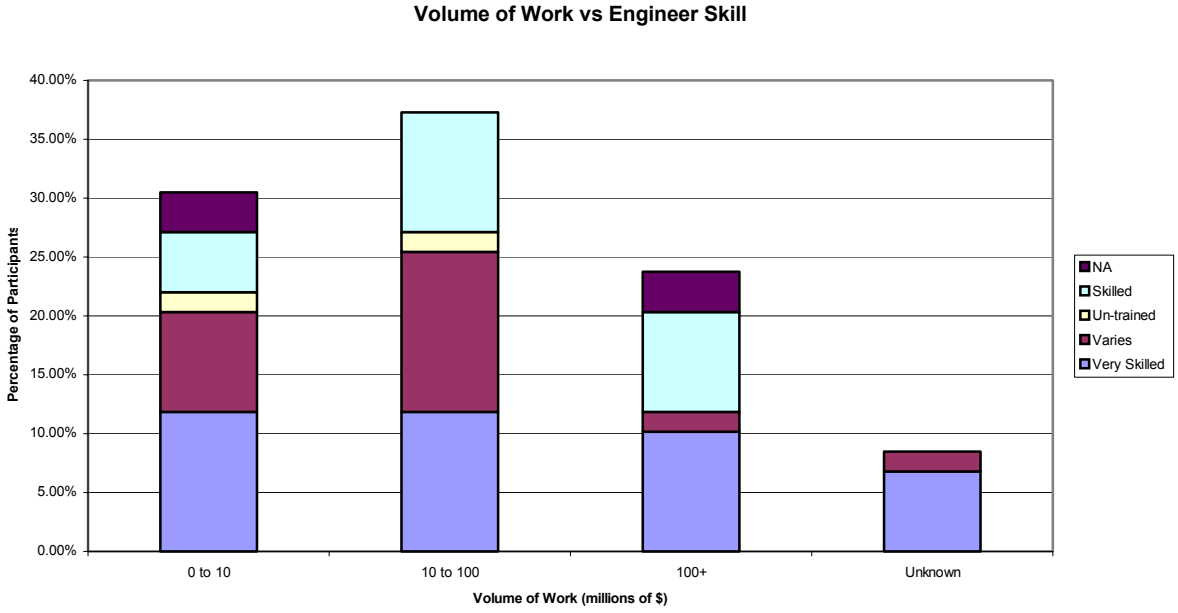

Figure 51: Volume of Work vs Engineer Skill

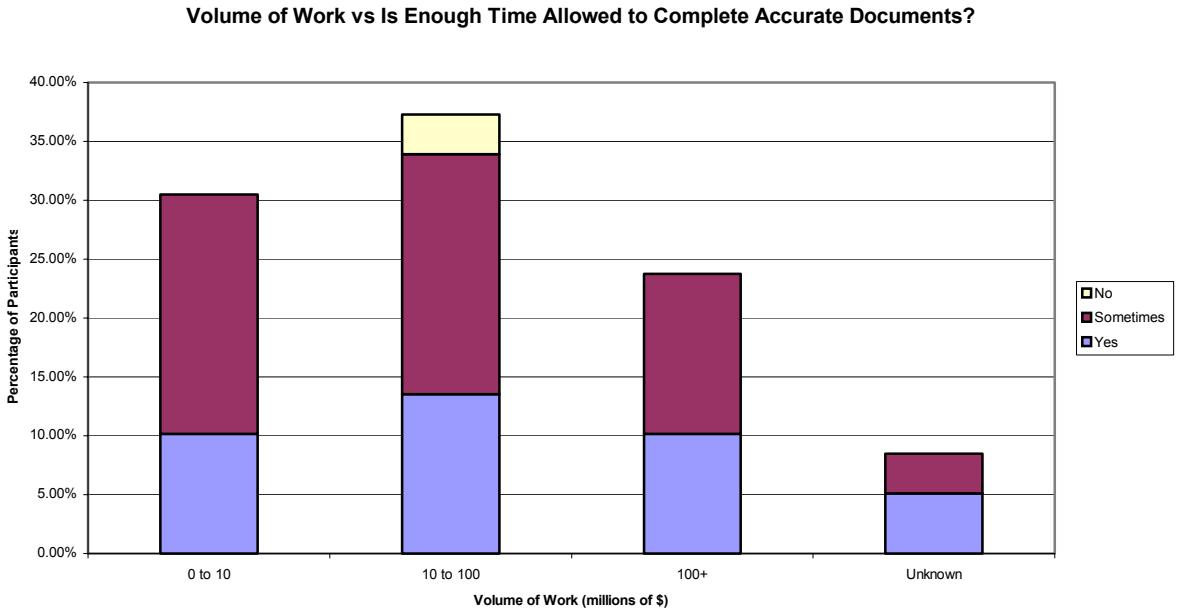

Figure 52: Volume of Work vs Is Enough Time Allowed to Complete Accurate Documents?

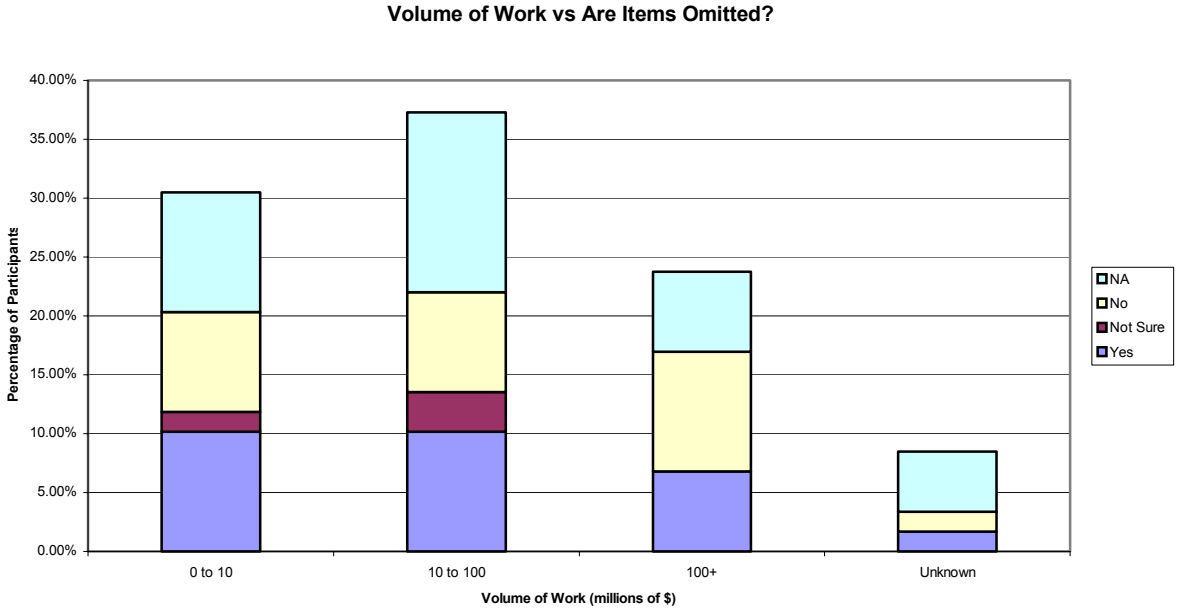

Figure 53: Volume of Work vs Are Items Omitted?

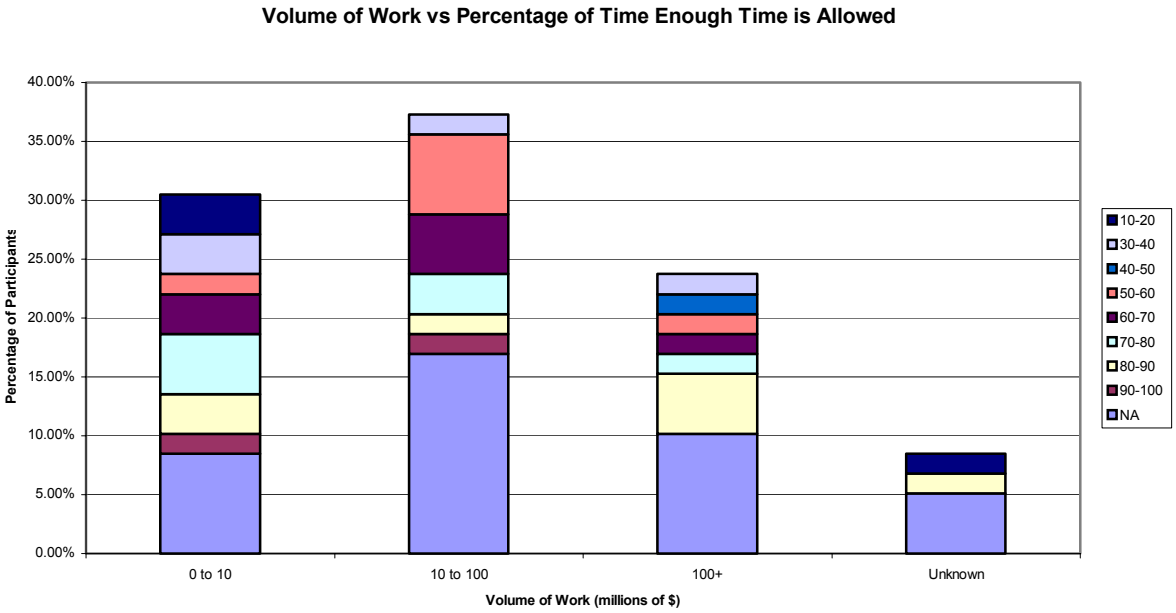

Figure 54: Volume of Work vs Percentage of Time Enough Time is Allowed

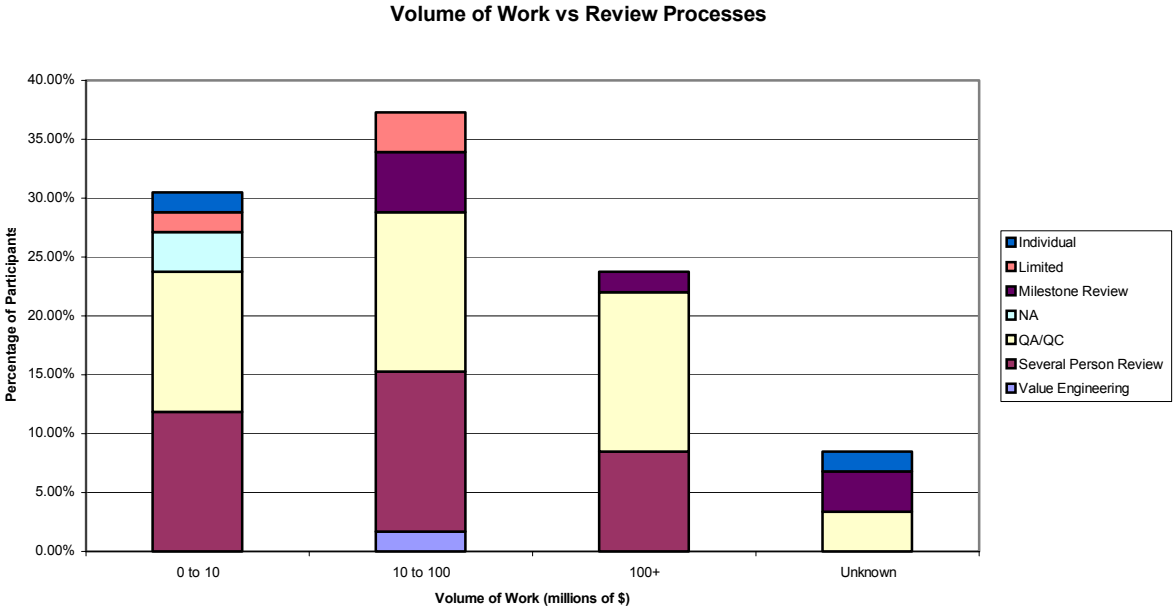

Figure 55: Volume of Work vs Review Processes

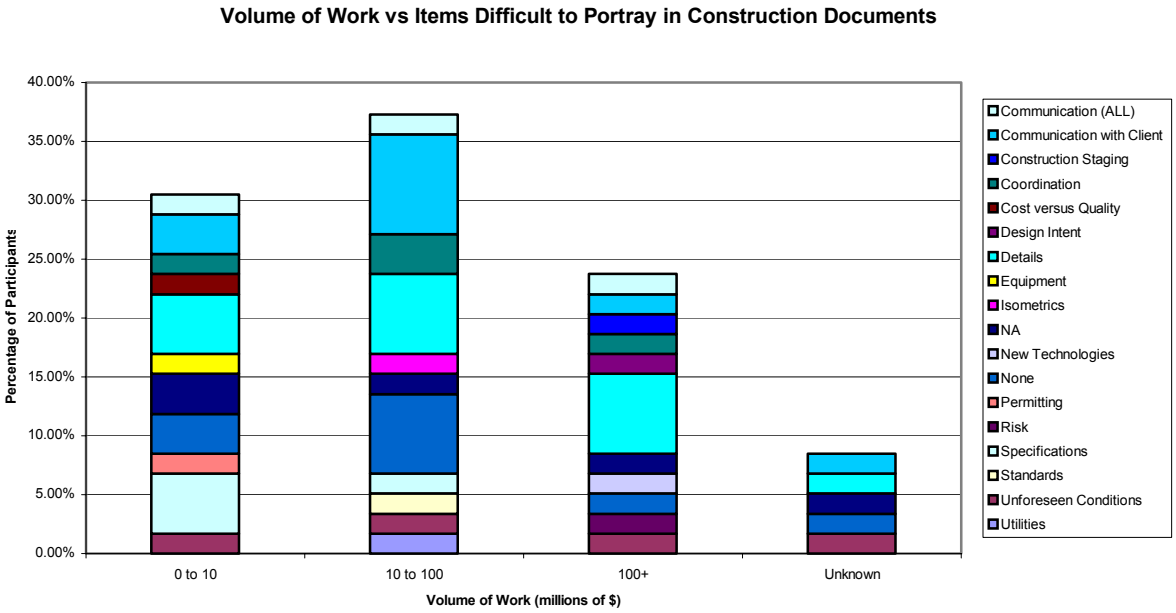

Figure 56: Volume of Work vs Items Difficult to Portray in Construction Documents

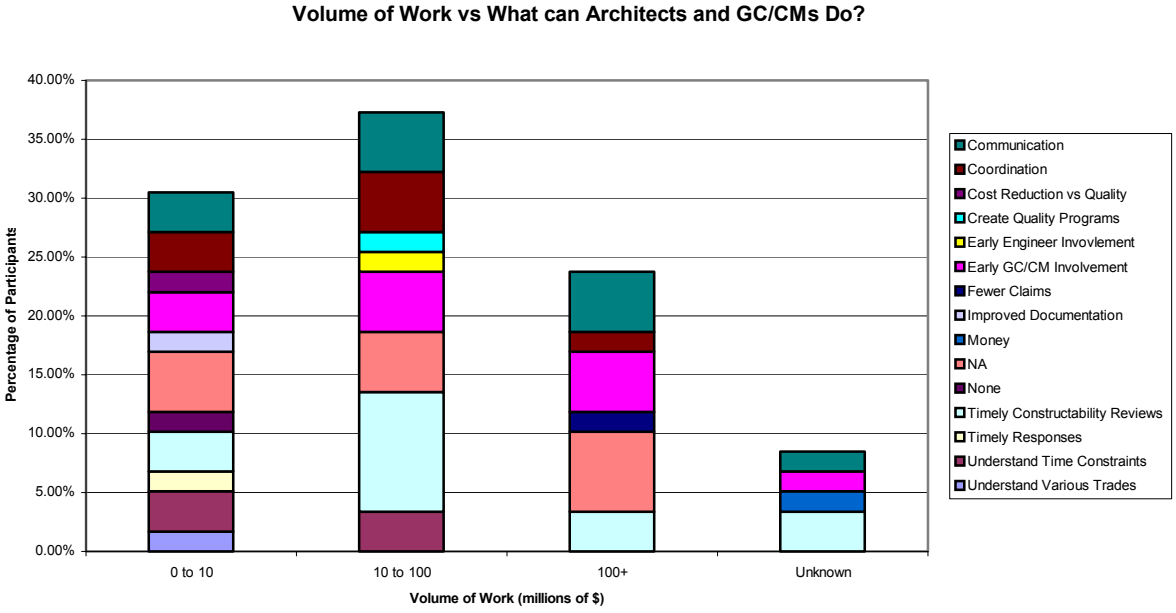

Figure 57: Volume of Work vs What can Architects and GC/CMs Do?

General Contractor Responses

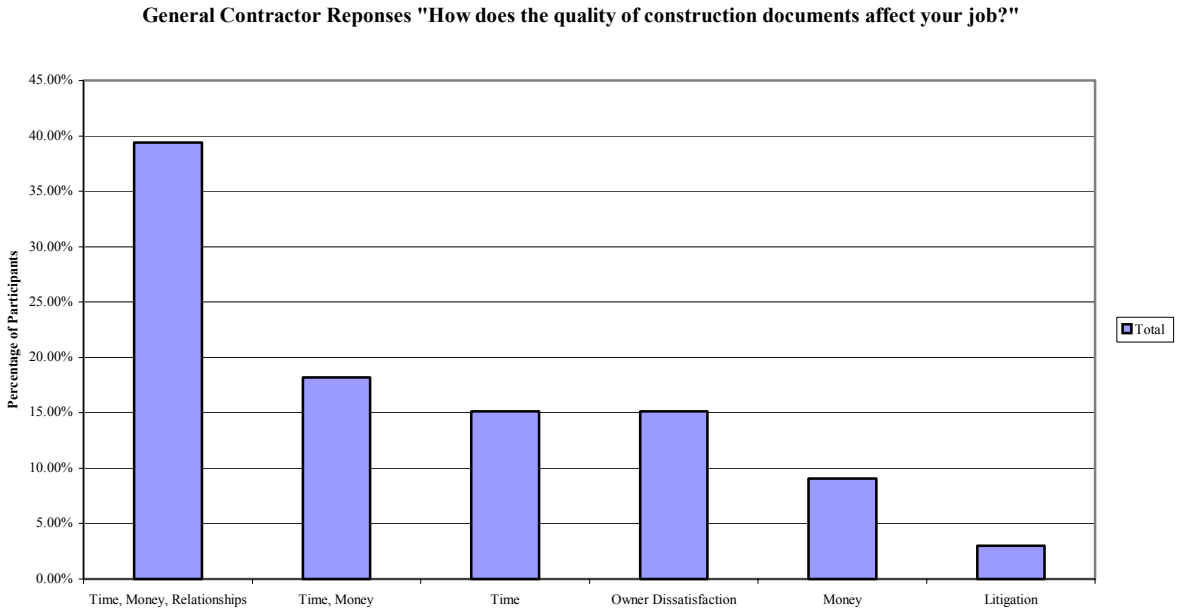

Figure 58: How the Quality of Construction Documents Affects a GC's Job

Figure 59: Years Experience vs Quality of Construction Documents Rating

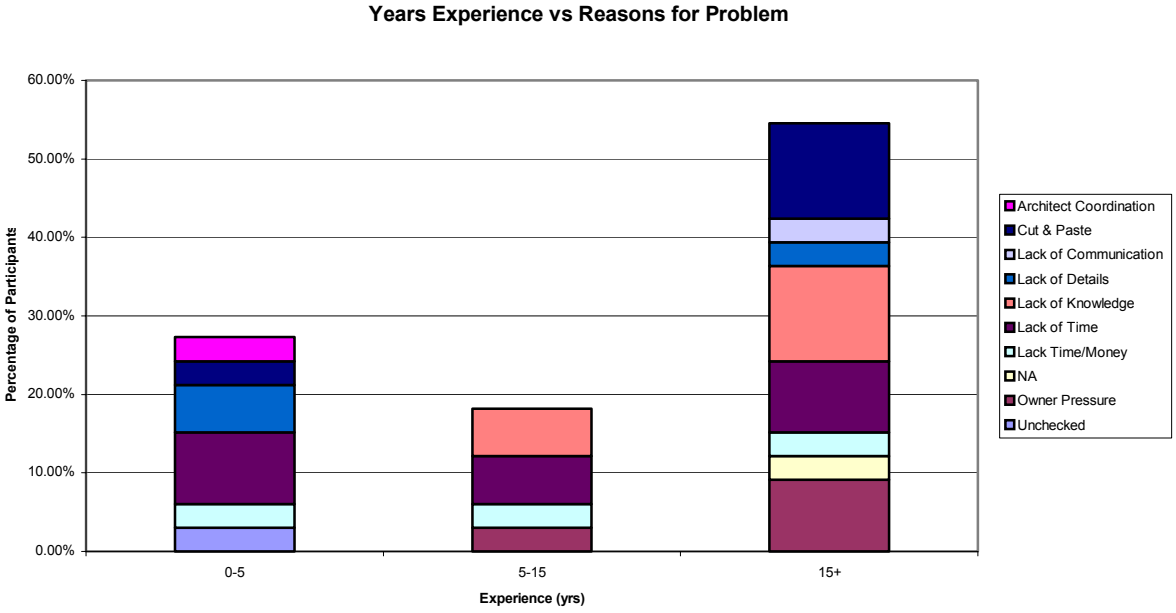

Figure 60: Years Experience vs Reasons for Problem

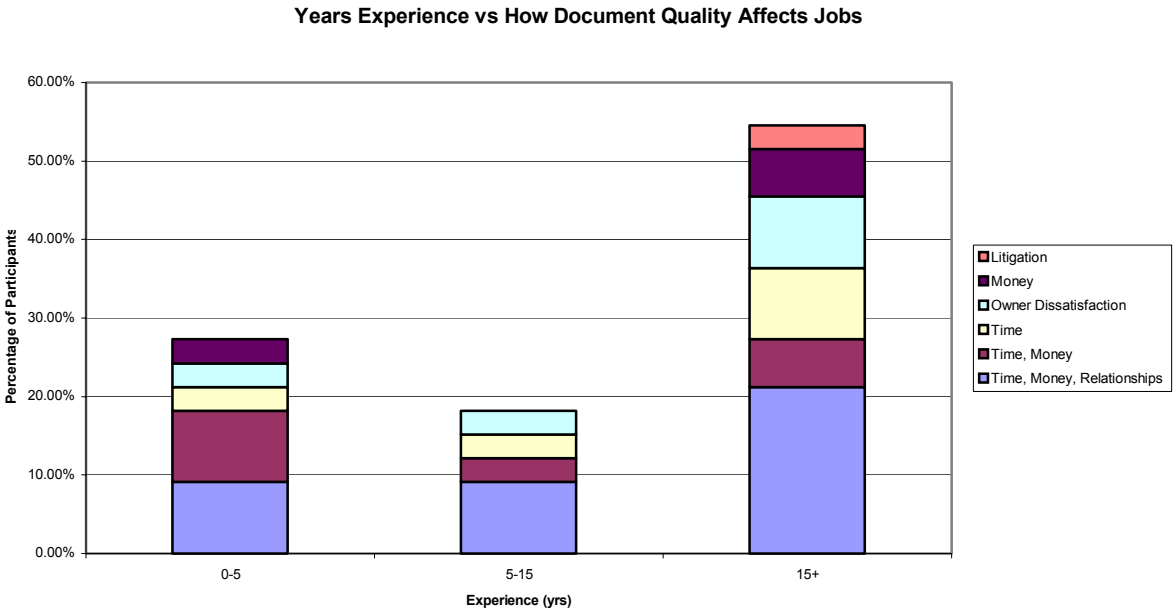

Figure 61: Years Experience vs How Document Quality Affects Jobs

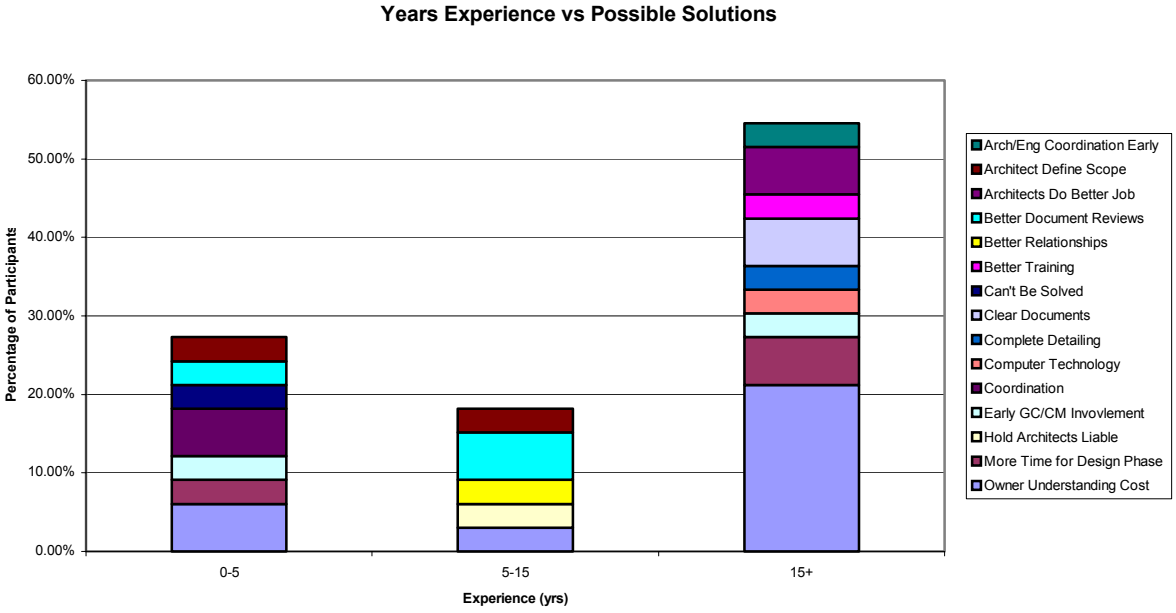

Figure 62: Years Experience vs Possible Solutions

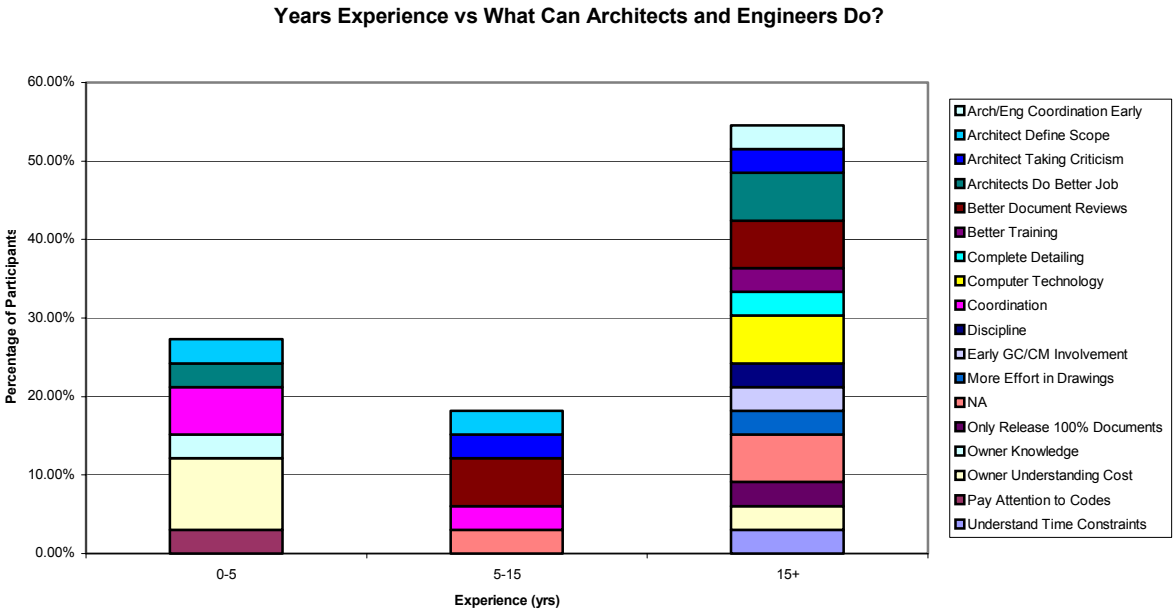

Figure 63: Years Experience vs What Can Architects and Engineers Do?

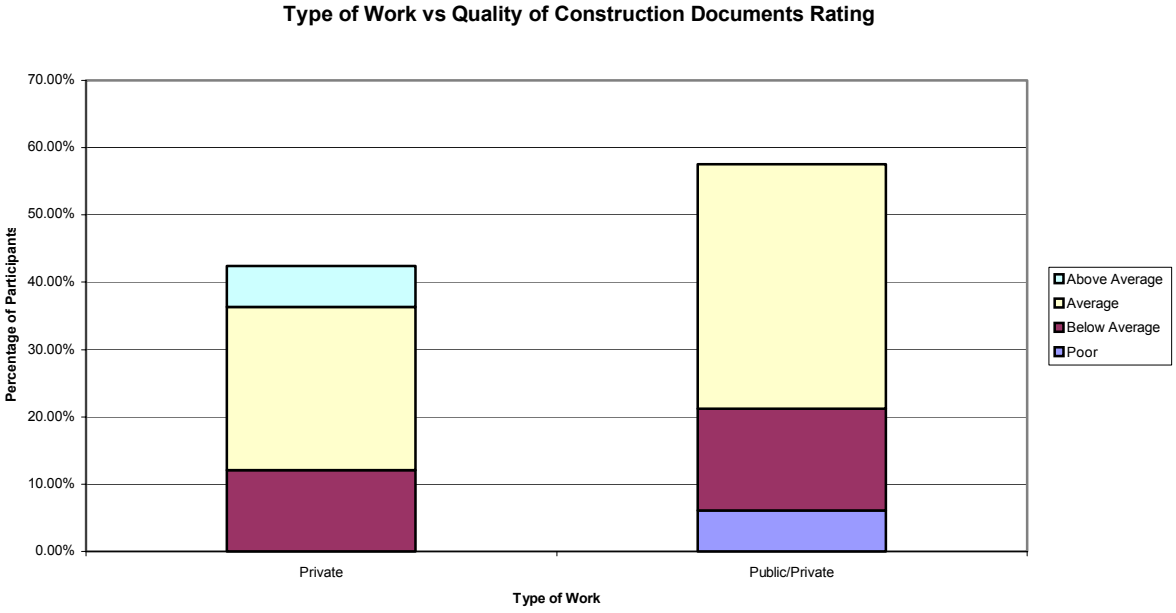

Figure 64: Type of Work vs Quality of Construction Documents Rating

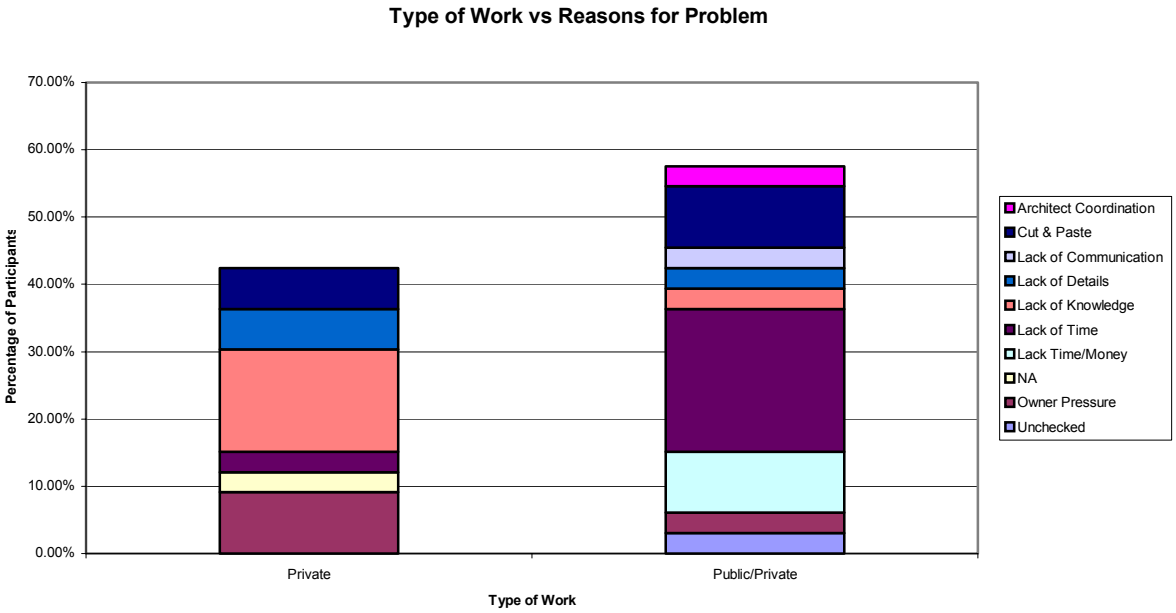

Figure 65: Type of Work vs Reasons for Problem

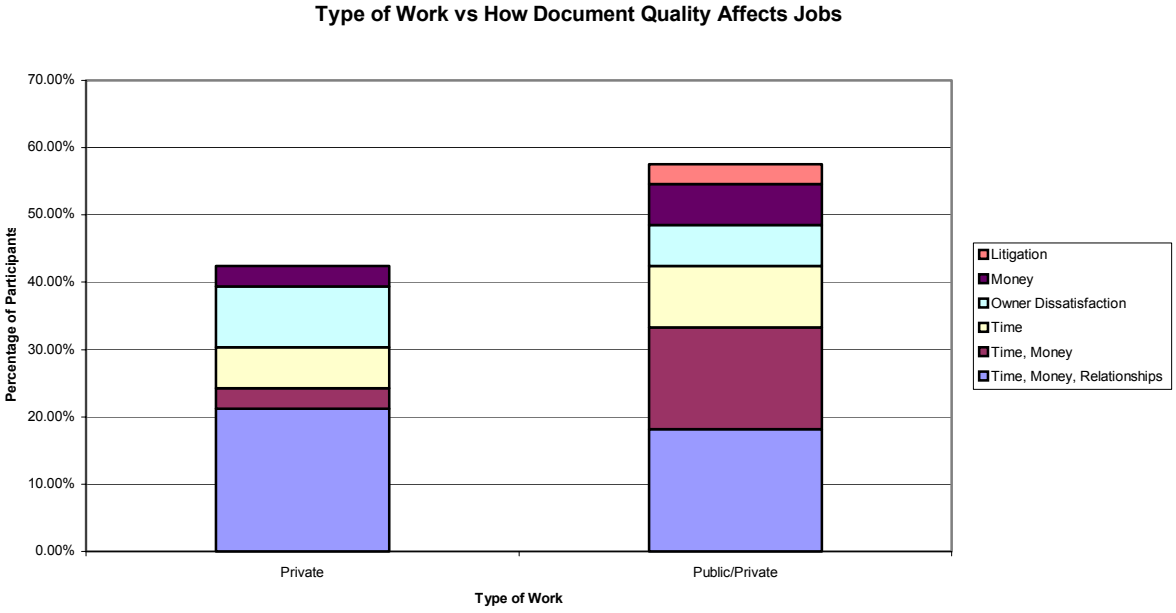

Figure 66: Type of Work vs How Document Quality Affects Jobs

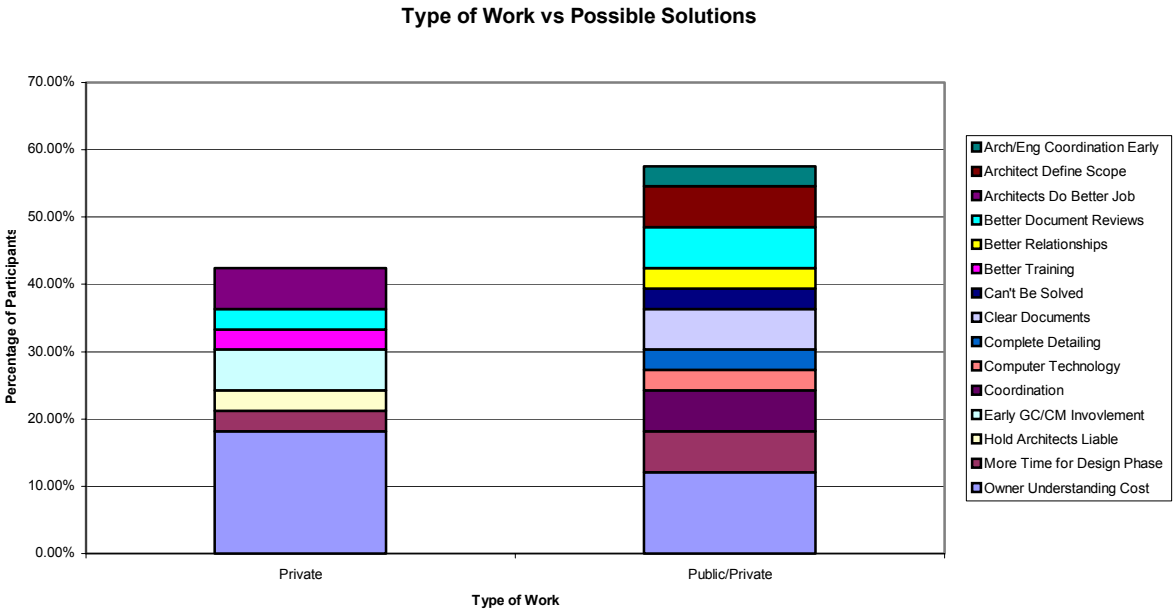

Figure 67: Type of Work vs Possible Solutions

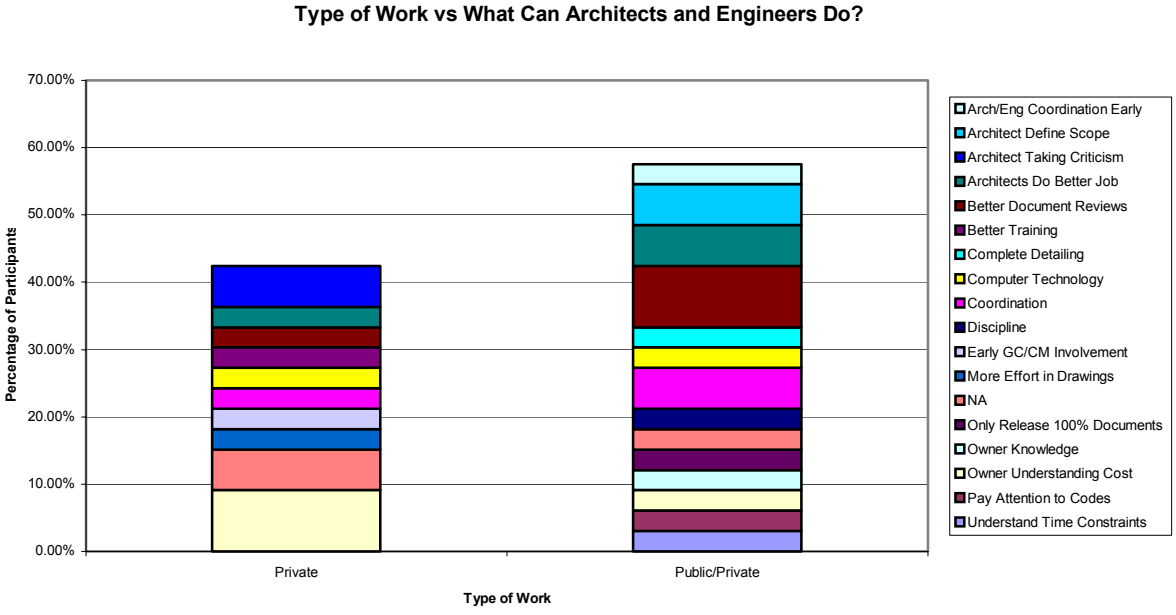

Figure 68: Type of Work vs What Can Architects and Engineers Do?

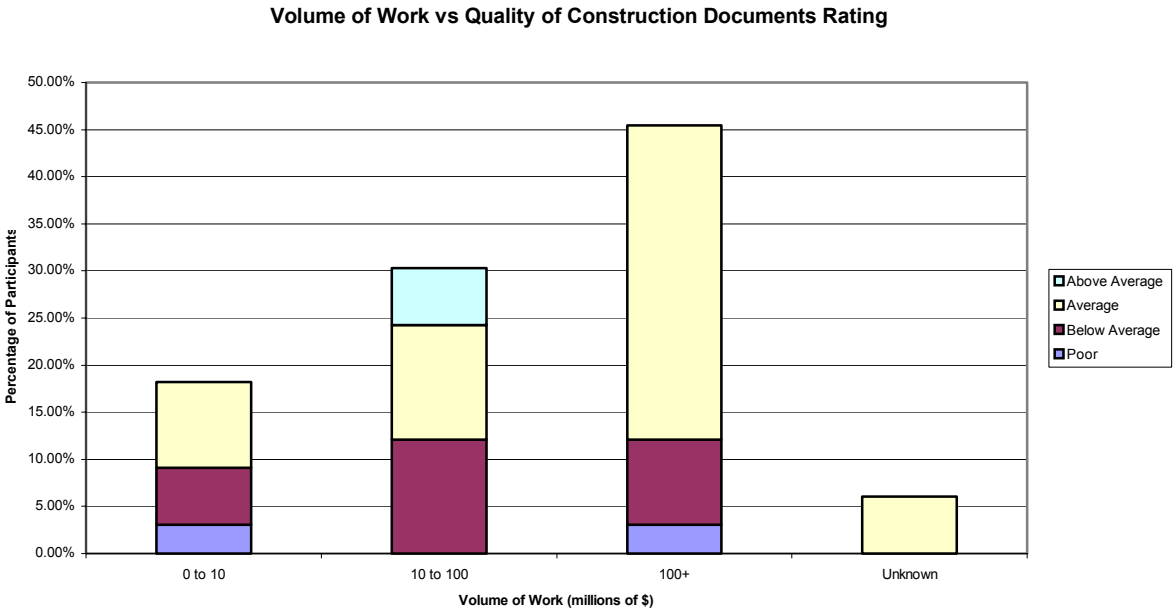

Figure 69: Volume of Work vs Quality of Construction Documents Rating

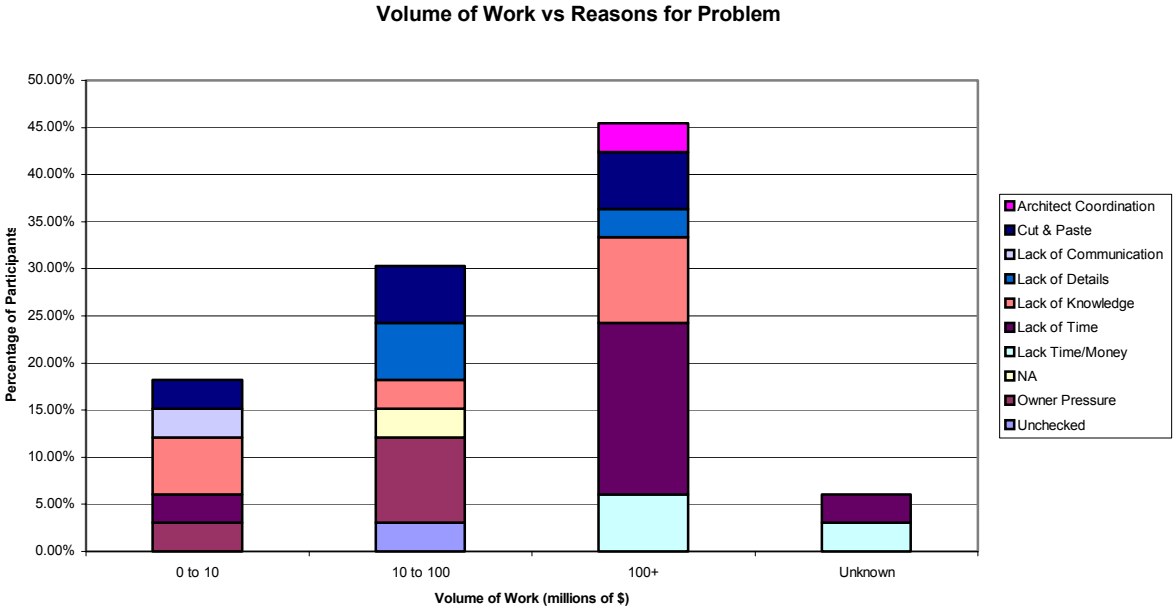

Figure 70: Volume of Work vs Reasons for Problem

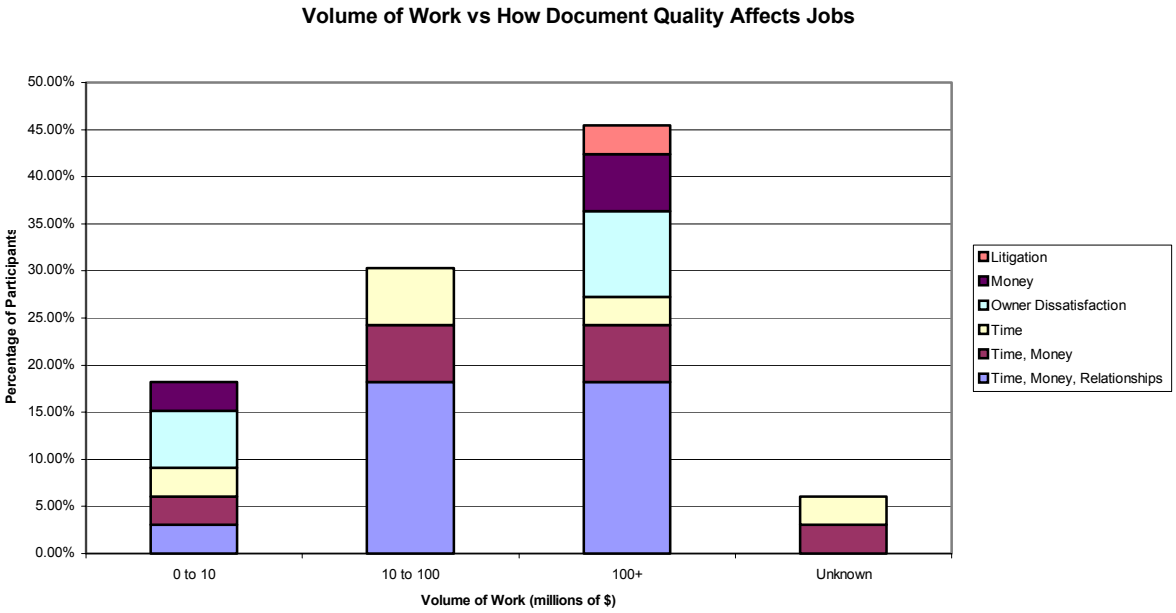

Figure 71: Volume of Work vs How Document Quality Affects Jobs

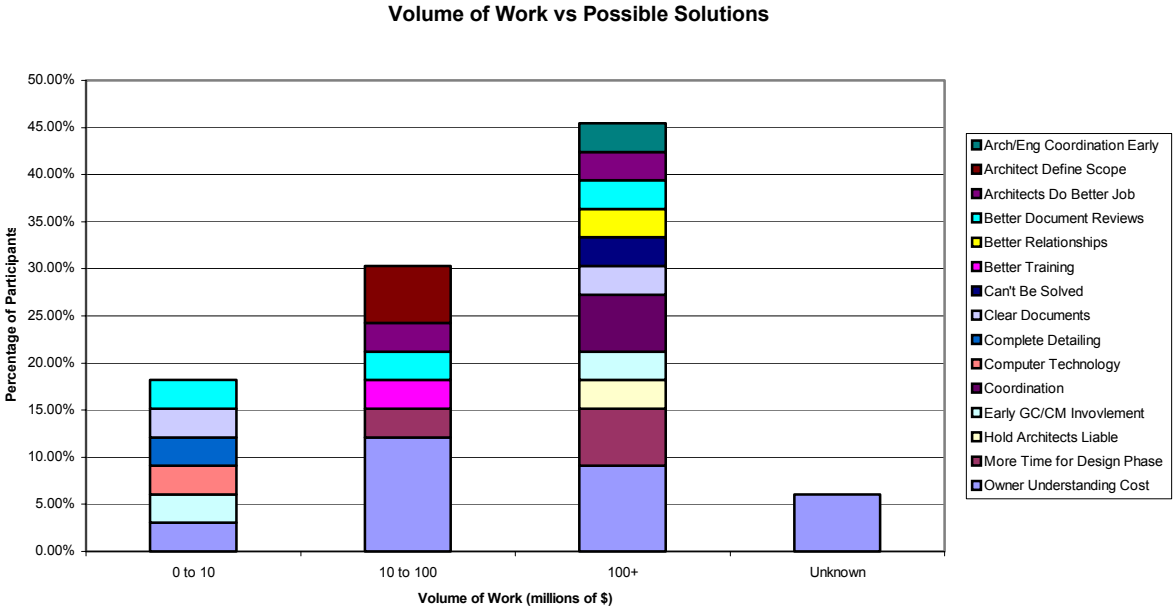

Figure 72: Volume of Work vs Possible Solutions

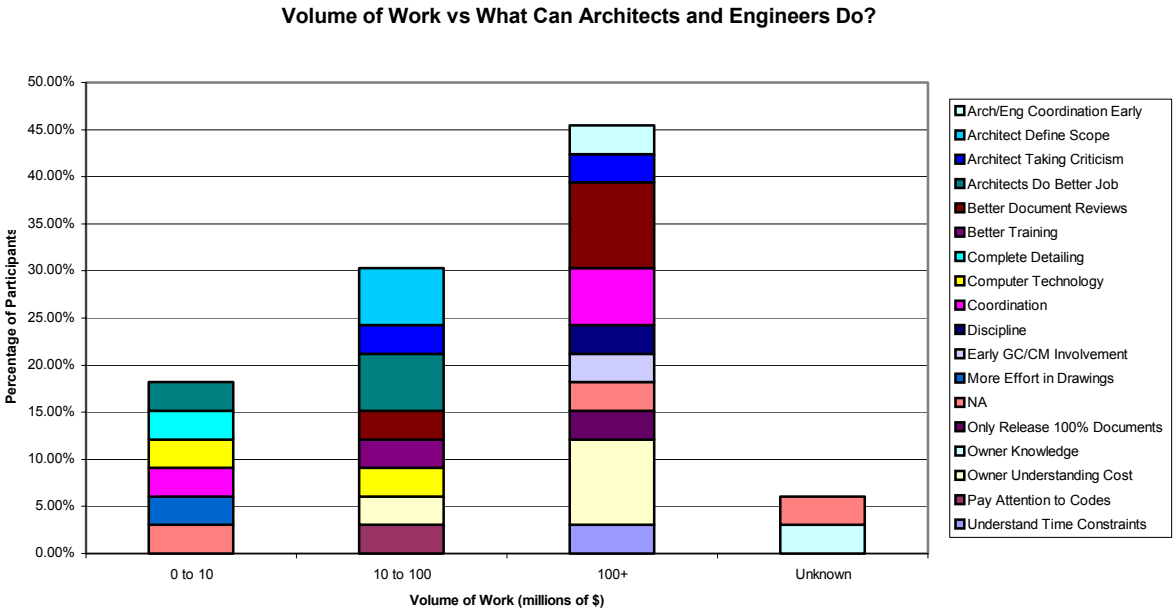

Figure 73: Volume of Work vs What Can Architects and Engineers Do?

Appendix H – Profile Analysis

Architect Tables: Experience

Experience		
0-5	4	9.09%
5-15	11	25.00%
15+	28	63.64%
NA	1	2.27%

Question 6: In your opinion, how skilled are the engineers that create the drawings for your company?

Totals:	
Untrained	2.27%
Not Skilled	4.55%
Varies	31.82%
Skilled	18.18%
Very Skilled	36.36%
NA	6.82%

Untrained		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	2.27%	4.55%
5-15	2.27%	9.09%	100.00%		
15+	0.00%	0.00%	0.00%		
NA	0.00%	0.00%	0.00%		

Not Skilled		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	1.79%	3.57%
5-15	0.00%	0.00%	0.00%		
15+	4.55%	7.14%	100.00%		
NA	0.00%	0.00%	0.00%		

Varies		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	7.14%	24.76%	18.76%
5-15	11.36%	45.45%	35.71%		
15+	18.18%	28.57%	57.14%		
NA	0.00%	0.00%	0.00%		

Skilled		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	9.90%	11.51%
5-15	4.55%	18.18%	25.00%		
15+	13.64%	21.43%	75.00%		
NA	0.00%	0.00%	0.00%		

Very Skilled		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	4.55%	50.00%	12.50%	29.14%	21.53%
5-15	6.82%	27.27%	18.75%		
15+	25.00%	39.29%	68.75%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	33.33%	32.14%	46.57%
5-15	0.00%	0.00%	0.00%		
15+	2.27%	3.57%	33.33%		
NA	2.27%	100.00%	33.33%		

Question 7: What type of review process (if any) does your company, or you personally, use?

Totals:	
Limited	11.36%
Milestone Review	13.64%
QA/QC	22.73%
Several Person	43.18%
NA	9.09%

Limited		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	5.84%	7.07%
5-15	2.27%	9.09%	20.00%		
15+	9.09%	14.29%	80.00%		
NA	0.00%	0.00%	0.00%		

Milestone Review		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	8.12%	9.51%
5-15	4.55%	18.18%	33.33%		
15+	9.09%	14.29%	66.67%		
NA	0.00%	0.00%	0.00%		

QA/QC		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	10.00%	17.05%	11.81%
5-15	4.55%	18.18%	20.00%		
15+	15.91%	25.00%	70.00%		
NA	0.00%	0.00%	0.00%		

Several Person Review		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	4.55%	50.00%	10.53%	35.96%	24.81%
5-15	13.64%	54.55%	31.58%		
15+	25.00%	39.29%	57.89%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	25.00%	33.04%	45.86%
5-15	0.00%	0.00%	0.00%		
15+	4.55%	7.14%	50.00%		
NA	2.27%	100.00%	25.00%		

Question 8a: Is Enough Time Allowed to Complete Accurate Documents?

Totals:	
Yes	34.09%
No	9.09%
Sometimes	54.55%
NA	2.27%

Yes		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	17.53%	21.22%
5-15	6.82%	27.27%	20.00%		
15+	27.27%	42.86%	80.00%		
NA	0.00%	0.00%	0.00%		

No		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	25.00%	10.31%	10.55%
5-15	2.27%	9.09%	25.00%		
15+	4.55%	7.14%	50.00%		
NA	0.00%	0.00%	0.00%		

Sometimes		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	6.82%	75.00%	12.50%	47.16%	33.06%
5-15	15.91%	63.64%	29.17%		
15+	31.82%	50.00%	58.33%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	25.00%	50.00%
5-15	0.00%	0.00%	0.00%		
15+	0.00%	0.00%	0.00%		
NA	2.27%	100.00%	100.00%		

Question 8b: Are Items Omitted?

Totals:	
Yes	45.45%
No	9.09%
Not Sure	6.82%
NA	38.64%

Yes		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	4.55%	50.00%	10.00%	34.09%	23.62%
5-15	9.09%	36.36%	20.00%		
15+	31.82%	50.00%	70.00%		
NA	0.00%	0.00%	0.00%		

No		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	4.95%	5.76%
5-15	2.27%	9.09%	25.00%		
15+	6.82%	10.71%	75.00%		
NA	0.00%	0.00%	0.00%		

Not Sure		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	33.33%	8.04%	11.80%
5-15	0.00%	0.00%	0.00%		
15+	4.55%	7.14%	66.67%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	5.88%	52.92%	33.82%
5-15	13.64%	54.55%	35.29%		
15+	20.45%	32.14%	52.94%		
NA	2.27%	100.00%	5.88%		

Question 8c: Percentage of Time Enough Time is Allowed

Totals:	
10-20	2.27%
20-30	9.09%
30-40	4.55%
40-50	2.27%
50-60	6.82%
60-70	9.09%
70-80	11.36%
80-90	9.09%
90-100	
NA	45.45%

10-20		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	0.89%	1.79%
5-15	0.00%	0.00%	0.00%		
15+	2.27%	3.57%	100.00%		
NA	0.00%	0.00%	0.00%		

20-30		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	25.00%	8.93%	11.85%
5-15	0.00%	0.00%	0.00%		
15+	6.82%	10.71%	75.00%		
NA	0.00%	0.00%	0.00%		

30-40		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	4.55%	9.09%
5-15	4.55%	18.18%	100.00%		
15+	0.00%	0.00%	0.00%		
NA	0.00%	0.00%	0.00%		

40-50		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	2.27%	4.55%
5-15	2.27%	9.09%	100.00%		
15+	0.00%	0.00%	0.00%		
NA	0.00%	0.00%	0.00%		

50-60		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	33.33%	9.42%	11.04%
5-15	2.27%	9.09%	33.33%		
15+	2.27%	3.57%	33.33%		
NA	0.00%	0.00%	0.00%		

60-70		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	3.57%	7.14%
5-15	0.00%	0.00%	0.00%		
15+	9.09%	14.29%	100.00%		
NA	0.00%	0.00%	0.00%		

70-80		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	5.84%	7.07%
5-15	2.27%	9.09%	20.00%		
15+	9.09%	14.29%	80.00%		
NA	0.00%	0.00%	0.00%		

80-90		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	4.95%	5.76%
5-15	2.27%	9.09%	25.00%		
15+	6.82%	10.71%	75.00%		
NA	0.00%	0.00%	0.00%		

90-100	Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	0.00%
5-15	0.00%	0.00%		
15+	0.00%	0.00%		
NA	0.00%	0.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	4.55%	50.00%	10.00%	59.58%	27.11%
5-15	11.36%	45.45%	25.00%		
15+	27.27%	42.86%	60.00%		
NA	2.27%	100.00%	5.00%		

Question 9: Are there any particular aspects of design that are difficult to communicate to owners and contractors in the construction documents?

Totals:	
Communication (ALL)	9.09%
Communication Client	15.91%
Complex Geometries	20.45%
Coordination	11.36%
Details	11.36%
Details (Use 3-D)	11.36%
Final Product	2.27%
Standards	2.27%
NA	15.91%

Communication (ALL)		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	4.95%	5.76%
5-15	2.27%	9.09%	25.00%		
15+	6.82%	10.71%	75.00%		
NA	0.00%	0.00%	0.00%		

Communication Client		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	10.39%	13.12%
5-15	6.82%	27.27%	42.86%		
15+	9.09%	14.29%	57.14%		
NA	0.00%	0.00%	0.00%		

Complex Geometries		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	10.80%	12.77%
5-15	4.55%	18.18%	22.22%		
15+	15.91%	25.00%	77.78%		
NA	0.00%	0.00%	0.00%		

Coordination		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	5.84%	7.07%
5-15	2.27%	9.09%	20.00%		
15+	9.09%	14.29%	80.00%		
NA	0.00%	0.00%	0.00%		

Details		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	7.22%	8.88%
5-15	4.55%	18.18%	40.00%		
15+	6.82%	10.71%	60.00%		
NA	0.00%	0.00%	0.00%		

Details (Use 3-D)		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	7.22%	8.88%
5-15	4.55%	18.18%	40.00%		
15+	6.82%	10.71%	60.00%		
NA	0.00%	0.00%	0.00%		

Final Product		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	0.89%	1.79%
5-15	0.00%	0.00%	0.00%		
15+	2.27%	3.57%	100.00%		
NA	0.00%	0.00%	0.00%		

Standards		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	100.00%	6.25%	12.50%
5-15	0.00%	0.00%	0.00%		
15+	0.00%	0.00%	0.00%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	6.82%	75.00%	42.86%	46.43%	48.71%
5-15	0.00%	0.00%	0.00%		
15+	6.82%	10.71%	42.86%		
NA	2.27%	100.00%	14.29%		

Question 10: Could the architects or GC/CM help in any way to improve efforts to provide quality construction documents?

Totals:	
Communication	13.64%
Coordination	6.82%
Educated Owners	2.27%
Early GC/CM Involvement	25.00%
Improved Documentation	9.09%
None	15.91%
Stick to Constructability	9.09%
Understand Time Constraints	9.09%
NA	9.09%

Communication		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	16.67%	12.09%	10.43%
5-15	2.27%	9.09%	16.67%		
15+	9.09%	14.29%	66.67%		
NA	0.00%	0.00%	0.00%		

Coordination		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	33.33%	9.42%	11.04%
5-15	2.27%	9.09%	33.33%		
15+	2.27%	3.57%	33.33%		
NA	0.00%	0.00%	0.00%		

Educated Owners		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	0.89%	1.79%
5-15	0.00%	0.00%	0.00%		
15+	2.27%	3.57%	100.00%		
NA	0.00%	0.00%	0.00%		

Early GC/CM Involvement		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	15.34%	18.31%
5-15	9.09%	36.36%	36.36%		
15+	15.91%	25.00%	63.64%		
NA	0.00%	0.00%	0.00%		

Improved Documentation		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	6.33%	8.59%
5-15	4.55%	18.18%	50.00%		
15+	4.55%	7.14%	50.00%		
NA	0.00%	0.00%	0.00%		

None		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	7.63%	10.15%
5-15	2.27%	9.09%	14.29%		
15+	13.64%	21.43%	85.71%		
NA	0.00%	0.00%	0.00%		

Stick to Constructability		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	4.95%	5.76%
5-15	2.27%	9.09%	25.00%		
15+	6.82%	10.71%	75.00%		
NA	0.00%	0.00%	0.00%		

Understand Time Constraints		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	25.00%	10.31%	10.55%
5-15	2.27%	9.09%	25.00%		
15+	4.55%	7.14%	50.00%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	2.27%	25.00%	25.00%	33.04%	45.86%
5-15	0.00%	0.00%	0.00%		
15+	4.55%	7.14%	50.00%		
NA	2.27%	100.00%	25.00%		

Architect Tables: Type of Work

Type of Work		
Private	6	13.64%
Public	4	9.09%
Public/Private	33	75.00%
NA	1	2.27%

Question 6: In your opinion, how skilled are the engineers that create the drawings for your company?

	Totals:
Untrained	2.27%
Not Skilled	4.55%
Varies	31.82%
Skilled	18.18%
Very Skilled	36.36%
NA	6.82%

Untrained		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	2.27%	16.67%	100.00%	4.17%	8.33%
Public	0.00%	0.00%	0.00%		
Public/Private	0.00%	0.00%	0.00%		
NA	0.00%	0.00%	0.00%		

Not Skilled		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	1.52%	3.03%
Public	0.00%	0.00%	0.00%		
Public/Private	4.55%	6.06%	100.00%		
NA	0.00%	0.00%	0.00%		

Varies		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	4.55%	33.33%	14.29%	17.42%	20.16%
Public	0.00%	0.00%	0.00%		
Public/Private	27.27%	36.36%	85.71%		
NA	0.00%	0.00%	0.00%		

Skilled		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	17.05%	23.58%
Public	4.55%	50.00%	25.00%		
Public/Private	13.64%	18.18%	75.00%		
NA	0.00%	0.00%	0.00%		

Very Skilled		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.82%	50.00%	18.75%	33.33%	23.57%
Public	4.55%	50.00%	12.50%		
Public/Private	25.00%	33.33%	68.75%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	26.52%	49.07%
Public	0.00%	0.00%	0.00%		
Public/Private	4.55%	6.06%	66.67%		
NA	2.27%	100.00%	33.33%		

Question 7: What type of review process (if any) does your company, or you personally, use?

Totals:	
Limited	11.36%
Milestone Review	13.64%
QA/QC	22.73%
Several Person	43.18%
NA	9.09%

Limited		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	4.55%	33.33%	40.00%	10.61%	15.75%
Public	0.00%	0.00%	0.00%		
Public/Private	6.82%	9.09%	60.00%		
NA	0.00%	0.00%	0.00%		

Milestone Review		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	2.27%	16.67%	16.67%	7.95%	9.21%
Public	0.00%	0.00%	0.00%		
Public/Private	11.36%	15.15%	83.33%		
NA	0.00%	0.00%	0.00%		

QA/QC		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	13.07%	15.12%
Public	2.27%	25.00%	10.00%		
Public/Private	20.45%	27.27%	90.00%		
NA	0.00%	0.00%	0.00%		

Several Person Review		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.82%	50.00%	15.79%	41.10%	31.20%
Public	6.82%	75.00%	15.79%		
Public/Private	29.55%	39.39%	68.42%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	27.27%	48.67%
Public	0.00%	0.00%	0.00%		
Public/Private	6.82%	9.09%	75.00%		
NA	2.27%	100.00%	25.00%		

Question 8a: Is Enough Time Allowed to Complete Accurate Documents?

Totals:	
Yes	34.09%
No	9.09%
Sometimes	54.55%
NA	2.27%

Yes		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.82%	50.00%	20.00%	43.56%	42.81%
Public	9.09%	100.00%	26.67%		
Public/Private	18.18%	24.24%	53.33%		
NA	0.00%	0.00%	0.00%		

No		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	2.27%	16.67%	25.00%	6.44%	8.05%
Public	0.00%	0.00%	0.00%		
Public/Private	6.82%	9.09%	75.00%		
NA	0.00%	0.00%	0.00%		

Sometimes		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	4.55%	33.33%	8.33%	25.00%	31.91%
Public	0.00%	0.00%	0.00%		
Public/Private	50.00%	66.67%	91.67%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	25.00%	50.00%
Public	0.00%	0.00%	0.00%		
Public/Private	0.00%	0.00%	0.00%		
NA	2.27%	100.00%	100.00%		

Question 8b: Are Items Omitted?

Totals:	
Yes	45.45%
No	9.09%
Not Sure	6.82%
NA	38.64%

Yes		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	9.09%	66.67%	20.00%	28.79%	34.06%
Public	0.00%	0.00%	0.00%		
Public/Private	36.36%	48.48%	80.00%		
NA	0.00%	0.00%	0.00%		

No		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	3.03%	6.06%
Public	0.00%	0.00%	0.00%		
Public/Private	9.09%	12.12%	100.00%		
NA	0.00%	0.00%	0.00%		

Not Sure		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	2.27%	4.55%
Public	0.00%	0.00%	0.00%		
Public/Private	6.82%	9.09%	100.00%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	4.55%	33.33%	11.76%	65.91%	39.38%
Public	9.09%	100.00%	23.53%		
Public/Private	22.73%	30.30%	58.82%		
NA	2.27%	100.00%	5.88%		

Question 8c: Percentage of Time Enough Time is Allowed

Totals:	
10-20	2.27%
20-30	9.09%
30-40	4.55%
40-50	2.27%
50-60	6.82%
60-70	9.09%
70-80	11.36%
80-90	9.09%
90-100	
NA	45.45%

10-20		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	0.76%	1.52%
Public	0.00%	0.00%	0.00%		
Public/Private	2.27%	3.03%	100.00%		
NA	0.00%	0.00%	0.00%		

20-30		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	3.03%	6.06%
Public	0.00%	0.00%	0.00%		
Public/Private	9.09%	12.12%	100.00%		
NA	0.00%	0.00%	0.00%		

30-40		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	7.01%	12.08%
Public	2.27%	25.00%	50.00%		
Public/Private	2.27%	3.03%	50.00%		
NA	0.00%	0.00%	0.00%		

40-50		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	0.76%	1.52%
Public	0.00%	0.00%	0.00%		
Public/Private	2.27%	3.03%	100.00%		
NA	0.00%	0.00%	0.00%		

50-60		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	2.27%	4.55%
Public	0.00%	0.00%	0.00%		
Public/Private	6.82%	9.09%	100.00%		
NA	0.00%	0.00%	0.00%		

60-70		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	3.03%	6.06%
Public	0.00%	0.00%	0.00%		
Public/Private	9.09%	12.12%	100.00%		
NA	0.00%	0.00%	0.00%		

70-80		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	14.77%	23.87%
Public	4.55%	50.00%	40.00%		
Public/Private	6.82%	9.09%	60.00%		
NA	0.00%	0.00%	0.00%		

80-90		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	3.03%	6.06%
Public	0.00%	0.00%	0.00%		
Public/Private	9.09%	12.12%	100.00%		
NA	0.00%	0.00%	0.00%		

90-100		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private		0.00%	0.00%	0.00%	0.00%
Public		0.00%	0.00%		
Public/Private		0.00%	0.00%		
NA		0.00%	0.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	9.09%	66.67%	20.00%	69.51%	26.25%
Public	6.82%	75.00%	15.00%		
Public/Private	27.27%	36.36%	60.00%		
NA	2.27%	100.00%	5.00%		

Question 9: Are there any particular aspects of design that are difficult to communicate to owners and contractors in the construction documents?

Totals:	
Communication (ALL)	9.09%
Communication Client	15.91%
Complex Geometries	20.45%
Coordination	11.36%
Details	11.36%
Details (Use 3-D)	11.36%
Final Product	2.27%
Standards	2.27%
NA	15.91%

Communication (ALL)		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	2.27%	16.67%	25.00%	11.93%	11.11%
Public	2.27%	25.00%	25.00%		
Public/Private	4.55%	6.06%	50.00%		
NA	0.00%	0.00%	0.00%		

Communication Client		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	2.27%	16.67%	14.29%	19.70%	21.39%
Public	4.55%	50.00%	28.57%		
Public/Private	9.09%	12.12%	57.14%		
NA	0.00%	0.00%	0.00%		

Complex Geometries		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	12.31%	14.22%
Public	2.27%	25.00%	11.11%		
Public/Private	18.18%	24.24%	88.89%		
NA	0.00%	0.00%	0.00%		

Coordination		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	3.79%	7.58%
Public	0.00%	0.00%	0.00%		
Public/Private	11.36%	15.15%	100.00%		
NA	0.00%	0.00%	0.00%		

Details		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	2.27%	16.67%	20.00%	12.69%	10.67%
Public	2.27%	25.00%	20.00%		
Public/Private	6.82%	9.09%	60.00%		
NA	0.00%	0.00%	0.00%		

Details (Use 3-D)		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	9.28%	11.94%
Public	2.27%	25.00%	20.00%		
Public/Private	9.09%	12.12%	80.00%		
NA	0.00%	0.00%	0.00%		

Final Product		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	2.27%	16.67%	100.00%	4.17%	8.33%
Public	0.00%	0.00%	0.00%		
Public/Private	0.00%	0.00%	0.00%		
NA	0.00%	0.00%	0.00%		

Standards		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	0.76%	1.52%
Public	0.00%	0.00%	0.00%		
Public/Private	2.27%	3.03%	100.00%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	29.55%	47.75%
Public	0.00%	0.00%	0.00%		
Public/Private	13.64%	18.18%	85.71%		
NA	2.27%	100.00%	14.29%		

Question 10: Could the architects or GC/CM help in any way to improve efforts to provide quality construction documents?

Totals:	
Communication	13.64%
Coordination	6.82%
Educated Owners	2.27%
Early GC/CM Involvement	25.00%
Improved Documentation	9.09%
None	15.91%
Stick to Constructability	9.09%
Understand Time Constraints	9.09%
NA	9.09%

Communication		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	10.04%	12.27%
Public	2.27%	25.00%	16.67%		
Public/Private	11.36%	15.15%	83.33%		
NA	0.00%	0.00%	0.00%		

Coordination		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	2.27%	4.55%
Public	0.00%	0.00%	0.00%		
Public/Private	6.82%	9.09%	100.00%		
NA	0.00%	0.00%	0.00%		

Educated Owners		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	6.25%	12.50%
Public	2.27%	25.00%	100.00%		
Public/Private	0.00%	0.00%	0.00%		
NA	0.00%	0.00%	0.00%		

Early GC/CM Involvement		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	13.83%	16.11%
Public	2.27%	25.00%	9.09%		
Public/Private	22.73%	30.30%	90.91%		
NA	0.00%	0.00%	0.00%		

Improved Documentation		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	2.27%	16.67%	25.00%	6.44%	8.05%
Public	0.00%	0.00%	0.00%		
Public/Private	6.82%	9.09%	75.00%		
NA	0.00%	0.00%	0.00%		

None		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	2.27%	16.67%	14.29%	25.19%	33.90%
Public	6.82%	75.00%	42.86%		
Public/Private	6.82%	9.09%	42.86%		
NA	0.00%	0.00%	0.00%		

Stick to Constructability		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	4.55%	33.33%	50.00%	9.85%	15.92%
Public	0.00%	0.00%	0.00%		
Public/Private	4.55%	6.06%	50.00%		
NA	0.00%	0.00%	0.00%		

Understand Time Constraints		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	3.03%	6.06%
Public	0.00%	0.00%	0.00%		
Public/Private	9.09%	12.12%	100.00%		
NA	0.00%	0.00%	0.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	27.27%	48.67%
Public	0.00%	0.00%	0.00%		
Public/Private	6.82%	9.09%	75.00%		
NA	2.27%	100.00%	25.00%		

Architect Tables: Volume

Volume		
0 to 10	18	40.91%
10 to 100	9	20.45%
100+	3	6.82%
NA	1	2.27%
Unknown	13	29.55%

Question 6: In your opinion, how skilled are the engineers that create the drawings for your company?

Totals:	
Untrained	2.27%
Not Skilled	4.55%
Varies	31.82%
Skilled	18.18%
Very Skilled	36.36%
NA	6.82%

Untrained		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	2.27%	5.56%	100.00%	1.11%	2.48%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Not Skilled		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	100.00%	2.22%	4.97%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Varies		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	13.64%	33.33%	42.86%	26.15%	14.66%
10 to 100	6.82%	33.33%	21.43%		
100+	2.27%	33.33%	7.14%		
NA	0.00%	0.00%	0.00%		
Unknown	9.09%	30.77%	28.57%		

Skilled		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	25.00%		
10 to 100	4.55%	22.22%	25.00%		
100+	2.27%	33.33%	12.50%	17.95%	12.75%
NA	0.00%	0.00%	0.00%		
Unknown	6.82%	23.08%	37.50%		

Very Skilled		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	15.91%	38.89%	43.75%		
10 to 100	9.09%	44.44%	25.00%		
100+	0.00%	0.00%	0.00%	24.36%	22.36%
NA	0.00%	0.00%	0.00%		
Unknown	11.36%	38.46%	31.25%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	2.27%	33.33%	33.33%	28.21%	42.40%
NA	2.27%	100.00%	33.33%		
Unknown	2.27%	7.69%	33.33%		

Question 7: What type of review process (if any) does your company, or you personally, use?

Totals:	
Limited	11.36%
Milestone Review	13.64%
QA/QC	22.73%
Several Person	43.18%
NA	9.09%

Limited		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	40.00%		
10 to 100	2.27%	11.11%	20.00%		
100+	2.27%	33.33%	20.00%	12.65%	12.42%
NA	0.00%	0.00%	0.00%		
Unknown	2.27%	7.69%	20.00%		

Milestone Review		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	6.82%	16.67%	50.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	2.27%	33.33%	16.67%	13.08%	13.88%
NA	0.00%	0.00%	0.00%		
Unknown	4.55%	15.38%	33.33%		

QA/QC		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	20.00%		
10 to 100	11.36%	55.56%	50.00%		
100+	0.00%	0.00%	0.00%	17.95%	23.08%
NA	0.00%	0.00%	0.00%		
Unknown	6.82%	23.08%	30.00%		

Several Person Review		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	22.73%	55.56%	52.63%		
10 to 100	6.82%	33.33%	15.79%		
100+	0.00%	0.00%	0.00%	27.01%	25.89%
NA	0.00%	0.00%	0.00%		
Unknown	13.64%	46.15%	31.58%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	2.27%	5.56%	25.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	2.27%	33.33%	25.00%	29.32%	41.54%
NA	2.27%	100.00%	25.00%		
Unknown	2.27%	7.69%	25.00%		

Question 8a: Is Enough Time Allowed to Complete Accurate Documents?

Totals:	
Yes	34.09%
No	9.09%
Sometimes	54.55%
NA	2.27%

Yes		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	6.82%	16.67%	20.00%		
10 to 100	9.09%	44.44%	26.67%		
100+	0.00%	0.00%	0.00%	24.53%	27.53%
NA	0.00%	0.00%	0.00%		
Unknown	18.18%	61.54%	53.33%		

No		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	6.82%	16.67%	75.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	2.27%	33.33%	25.00%	10.00%	14.91%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Sometimes		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	27.27%	66.67%	50.00%		
10 to 100	11.36%	55.56%	20.83%		
100+	4.55%	66.67%	8.33%	45.47%	27.91%
NA	0.00%	0.00%	0.00%		
Unknown	11.36%	38.46%	20.83%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%	20.00%	44.72%
NA	2.27%	100.00%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Question 8b: Are Items Omitted?

Totals:	
Yes	45.45%
No	9.09%
Not Sure	6.82%
NA	38.64%

Yes		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	25.00%	61.11%	55.00%		
10 to 100	6.82%	33.33%	15.00%		
100+	4.55%	66.67%	10.00%	38.38%	26.80%
NA	0.00%	0.00%	0.00%		
Unknown	9.09%	30.77%	20.00%		

No		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	50.00%		
10 to 100	4.55%	22.22%	50.00%		
100+	0.00%	0.00%	0.00%	6.67%	9.94%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Not Sure		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	2.27%	5.56%	33.33%		
10 to 100	4.55%	22.22%	66.67%		
100+	0.00%	0.00%	0.00%	5.56%	9.62%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	9.09%	22.22%	23.53%		
10 to 100	4.55%	22.22%	11.76%		
100+	2.27%	33.33%	5.88%	49.40%	34.24%
NA	2.27%	100.00%	5.88%		
Unknown	20.45%	69.23%	52.94%		

Question 8c: Percentage of Time Enough Time is Allowed

Totals:	
10-20	2.27%
20-30	9.09%
30-40	4.55%
40-50	2.27%
50-60	6.82%
60-70	9.09%
70-80	11.36%
80-90	9.09%
90-100	
NA	45.45%

10-20		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	2.27%	5.56%	100.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%	1.11%	2.48%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

20-30		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	2.27%	5.56%	25.00%		
10 to 100	2.27%	11.11%	25.00%		
100+	2.27%	33.33%	25.00%	11.54%	12.83%
NA	0.00%	0.00%	0.00%		
Unknown	2.27%	7.69%	25.00%		

30-40		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	2.27%	5.56%	50.00%		
10 to 100	2.27%	11.11%	50.00%		
100+	0.00%	0.00%	0.00%	3.33%	4.97%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

40-50		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	2.27%	5.56%	100.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%	1.11%	2.48%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

50-60		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	2.27%	5.56%	33.33%		
10 to 100	2.27%	11.11%	33.33%		
100+	0.00%	0.00%	0.00%	4.87%	4.87%
NA	0.00%	0.00%	0.00%		
Unknown	2.27%	7.69%	33.33%		

60-70		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	50.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	2.27%	33.33%	25.00%	10.43%	13.69%
NA	0.00%	0.00%	0.00%		
Unknown	2.27%	7.69%	25.00%		

70-80		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	40.00%		
10 to 100	4.55%	22.22%	40.00%		
100+	0.00%	0.00%	0.00%	8.21%	9.22%
NA	0.00%	0.00%	0.00%		
Unknown	2.27%	7.69%	20.00%		

80-90		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	6.82%	16.67%	75.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%	4.87%	7.39%
NA	0.00%	0.00%	0.00%		
Unknown	2.27%	7.69%	25.00%		

90-100		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10		0.00%	0.00%		
10 to 100		0.00%	0.00%		
100+		0.00%	0.00%	0.00%	0.00%
NA		0.00%	0.00%		
Unknown		0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	13.64%	33.33%	30.00%		
10 to 100	9.09%	44.44%	20.00%		
100+	2.27%	33.33%	5.00%	54.53%	27.91%
NA	2.27%	100.00%	5.00%		
Unknown	18.18%	61.54%	40.00%		

Question 9: Are there any particular aspects of design that are difficult to communicate to owners and contractors in the construction documents?

Totals:	
Communication (ALL)	9.09%
Communication Client	15.91%
Complex Geometries	20.45%
Coordination	11.36%
Details	11.36%
Details (Use 3-D)	11.36%
Final Product	2.27%
Standards	2.27%
NA	15.91%

Communication (ALL)		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	50.00%		
10 to 100	4.55%	22.22%	50.00%		
100+	0.00%	0.00%	0.00%	6.67%	9.94%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Communication Client		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	28.57%		
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%	9.91%	16.67%
NA	0.00%	0.00%	0.00%		
Unknown	11.36%	38.46%	71.43%		

Complex Geometries		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	11.36%	27.78%	55.56%		
10 to 100	0.00%	0.00%	0.00%		
100+	4.55%	66.67%	22.22%	21.97%	27.57%
NA	0.00%	0.00%	0.00%		
Unknown	4.55%	15.38%	22.22%		

Coordination		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	40.00%		
10 to 100	4.55%	22.22%	40.00%		
100+	0.00%	0.00%	0.00%	8.21%	9.22%
NA	0.00%	0.00%	0.00%		
Unknown	2.27%	7.69%	20.00%		

Details		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	6.82%	16.67%	60.00%		
10 to 100	2.27%	11.11%	20.00%		
100+	0.00%	0.00%	0.00%	7.09%	7.22%
NA	0.00%	0.00%	0.00%		
Unknown	2.27%	7.69%	20.00%		

Details (Use 3-D)		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	9.09%	22.22%	80.00%		
10 to 100	2.27%	11.11%	20.00%		
100+	0.00%	0.00%	0.00%	6.67%	9.94%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Final Product		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%		
10 to 100	2.27%	11.11%	100.00%		
100+	0.00%	0.00%	0.00%	2.22%	4.97%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Standards		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%		
10 to 100	2.27%	11.11%	100.00%		
100+	0.00%	0.00%	0.00%	2.22%	4.97%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%		
10 to 100	2.27%	11.11%	14.29%		
100+	2.27%	33.33%	14.29%	35.04%	38.86%
NA	2.27%	100.00%	14.29%		
Unknown	9.09%	30.77%	57.14%		

Question 10: Could the architects or GC/CM help in any way to improve efforts to provide quality construction documents?

Totals:	
Communication	13.64%
Coordination	6.82%
Educated Owners	2.27%
Early GC/CM Involvement	25.00%
Improved Documentation	9.09%
None	15.91%
Stick to Constructability	9.09%
Understand Time Constraints	9.09%
NA	9.09%

Communication		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	2.27%	5.56%	16.67%		
10 to 100	2.27%	11.11%	16.67%		
100+	0.00%	0.00%	0.00%	9.49%	12.76%
NA	0.00%	0.00%	0.00%		
Unknown	9.09%	30.77%	66.67%		

Coordination		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	66.67%		
10 to 100	2.27%	11.11%	33.33%		
100+	0.00%	0.00%	0.00%	4.44%	6.09%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Educated Owners		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%		
10 to 100	2.27%	11.11%	100.00%		
100+	0.00%	0.00%	0.00%	2.22%	4.97%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Early GC/CM Involvement		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	11.36%	27.78%	45.45%		
10 to 100	4.55%	22.22%	18.18%		
100+	0.00%	0.00%	0.00%	16.15%	15.06%
NA	0.00%	0.00%	0.00%		
Unknown	9.09%	30.77%	36.36%		

Improved Documentation		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	6.82%	16.67%	75.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	2.27%	33.33%	25.00%	10.00%	14.91%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

None		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	9.09%	22.22%	57.14%		
10 to 100	2.27%	11.11%	14.29%		
100+	0.00%	0.00%	0.00%	9.74%	9.74%
NA	0.00%	0.00%	0.00%		
Unknown	4.55%	15.38%	28.57%		

Stick to Constructability		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	2.27%	5.56%	25.00%		
10 to 100	2.27%	11.11%	25.00%		
100+	0.00%	0.00%	0.00%	6.41%	6.81%
NA	0.00%	0.00%	0.00%		
Unknown	4.55%	15.38%	50.00%		

Understand Time Constraints		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	4.55%	11.11%	50.00%		
10 to 100	4.55%	22.22%	50.00%		
100+	0.00%	0.00%	0.00%	6.67%	9.94%
NA	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%		
10 to 100	0.00%	0.00%	0.00%		
100+	4.55%	66.67%	50.00%	34.87%	45.89%
NA	2.27%	100.00%	25.00%		
Unknown	2.27%	7.69%	25.00%		

Engineer Tables: Experience

Experience		
0-5	2	3.39%
5-15	14	23.73%
15+	43	72.88%

Question 5: In your opinion, how skilled are the engineers that create the drawings for your company?

Totals:	
Untrained	3.39%
Varies	25.42%
Skilled	23.73%
Very Skilled	40.68%
NA	6.78%

Untrained		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	50.00%		
5-15	0.00%	0.00%	0.00%	17.44%	28.22%
15+	1.69%	2.33%	50.00%		

Varies		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	3.39%	14.29%	13.33%	14.84%	15.12%
15+	22.03%	30.23%	86.67%		

Skilled		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	6.78%	28.57%	28.57%	17.28%	15.20%
15+	16.95%	23.26%	71.43%		

Very Skilled		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	10.17%	42.86%	25.00%	28.24%	24.46%
15+	30.51%	41.86%	75.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	25.00%		
5-15	3.39%	14.29%	50.00%	22.20%	24.80%
15+	1.69%	2.33%	25.00%		

Question 6a: Is Enough Time Allowed to Complete Accurate Documents?

Totals:	
Yes	38.98%
No	3.39%
Sometimes	57.63%

Yes		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	4.35%		
5-15	6.78%	28.57%	17.39%	40.14%	10.82%
15+	30.51%	41.86%	78.26%		

No		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.55%	2.69%
15+	3.39%	4.65%	100.00%		

Sometimes		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	2.94%		
5-15	16.95%	71.43%	29.41%	58.31%	11.50%
15+	38.98%	53.49%	67.65%		

Question 6b: Are Items Omitted?

Totals:	
Yes	28.81%
No	28.81%
Not Sure	5.08%
NA	37.29%

Yes		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	5.88%		
5-15	6.78%	28.57%	23.53%	35.49%	12.57%
15+	20.34%	27.91%	70.59%		

No		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	8.47%	35.71%	29.41%	21.21%	18.78%
15+	20.34%	27.91%	70.59%		

Not Sure		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	33.33%	3.93%	3.63%
15+	3.39%	4.65%	66.67%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	4.55%		
5-15	6.78%	28.57%	18.18%	39.37%	10.72%
15+	28.81%	39.53%	77.27%		

Question 6c: Percentage of Time Enough Time is Allowed

Totals:	
10-20	5.08%
20-30	
30-40	6.78%
40-50	1.69%
50-60	10.17%
60-70	10.17%
70-80	10.17%
80-90	11.86%
90-100	3.39%
NA	40.68%

10-20		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	3.39%	14.29%	66.67%	5.54%	7.67%
15+	1.69%	2.33%	33.33%		

20-30		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5		0.00%	0.00%		
5-15		0.00%	0.00%	0.00%	0.00%
15+		0.00%	0.00%		

30-40		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	3.10%	5.37%
15+	6.78%	9.30%	100.00%		

40-50		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

50-60		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	16.67%	6.26%	5.86%
15+	8.47%	11.63%	83.33%		

60-70		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	3.39%	14.29%	33.33%	7.86%	7.25%
15+	6.78%	9.30%	66.67%		

70-80		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	5.08%	21.43%	50.00%	9.47%	10.93%
15+	5.08%	6.98%	50.00%		

80-90		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	14.29%		
5-15	3.39%	14.29%	28.57%	24.53%	22.20%
15+	6.78%	9.30%	57.14%		

90-100		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.55%	2.69%
15+	3.39%	4.65%	100.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	4.17%		
5-15	6.78%	28.57%	16.67%	40.92%	11.08%
15+	32.20%	44.19%	79.17%		

Question 7: What type of review process (if any) does your company, or you personally, use?

	Totals:
Individual	3.39%
Limited	5.08%
Milestone Review	10.17%
QA/QC	42.37%
Several Person	33.90%
Value Eng	1.69%
NA	3.39%

Individual		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	50.00%	3.16%	3.64%
15+	1.69%	2.33%	50.00%		

Limited		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	33.33%	3.93%	3.63%
15+	3.39%	4.65%	66.67%		

Milestone Review		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	16.67%	6.26%	5.86%
15+	8.47%	11.63%	83.33%		

QA/QC		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	8.47%	35.71%	20.00%	27.41%	24.34%
15+	33.90%	46.51%	80.00%		

Several Person Review		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	5.00%		
5-15	8.47%	35.71%	25.00%	39.42%	9.29%
15+	23.73%	32.56%	70.00%		

Value Engineering		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	50.00%		
5-15	1.69%	7.14%	50.00%	19.05%	27.04%
15+	0.00%	0.00%	0.00%		

Question 8: Are there any particular aspects of design that are difficult to communicate to owners and contractors in the construction documents?

Totals:	
Communication (ALL)	5.08%
Communication Client	15.25%
Construction Staging	1.69%
Coordination	6.78%
Cost versus Quality	1.69%
Design Intent	1.69%
Details	20.34%
Equipment	1.69%
Isometrics	1.69%
New Technologies	1.69%
None	13.56%
Permitting	1.69%
Risk	1.69%
Specifications	6.78%
Standards	1.69%
Unforeseen Conditions	6.78%
Utilities	1.69%
NA	8.47%

Communication (ALL)		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	2.33%	4.03%
5-15	0.00%	0.00%	0.00%		
15+	5.08%	6.98%	100.00%		

Communication Client		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	8.58%	9.39%
5-15	1.69%	7.14%	11.11%		
15+	13.56%	18.60%	88.89%		

Construction Staging		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	0.78%	1.34%
5-15	0.00%	0.00%	0.00%		
15+	1.69%	2.33%	100.00%		

Coordination		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	3.10%	5.37%
5-15	0.00%	0.00%	0.00%		
15+	6.78%	9.30%	100.00%		

Cost versus Quality		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	100.00%	2.38%	4.12%
15+	0.00%	0.00%	0.00%		

Design Intent		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	100.00%	2.38%	4.12%
15+	0.00%	0.00%	0.00%		

Details		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	6.78%	28.57%	33.33%	15.73%	14.50%
15+	13.56%	18.60%	66.67%		

Equipment		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

Isometrics		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

New Technologies		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

None		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	5.08%	21.43%	37.50%	11.02%	10.73%
15+	8.47%	11.63%	62.50%		

Permitting		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	100.00%	2.38%	4.12%
15+	0.00%	0.00%	0.00%		

Risk		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

Specifications		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	3.10%	5.37%
15+	6.78%	9.30%	100.00%		

Standards		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

Unforeseen Conditions		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	25.00%		
5-15	0.00%	0.00%	0.00%	18.99%	27.08%
15+	5.08%	6.98%	75.00%		

Utilities		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	100.00%	2.38%	4.12%
15+	0.00%	0.00%	0.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	20.00%		
5-15	3.39%	14.29%	40.00%	22.98%	23.89%
15+	3.39%	4.65%	40.00%		

Question 9: Could the architects or GC/CM help in any way to improve efforts to provide quality construction documents?

Totals:	
Communication	15.25%
Coordination	10.17%
Cost versus Quality	1.69%
Create Quality Programs	1.69%
Early Eng Involvement	1.69%
Early GC/CM Involvement	15.25%
Fewer Claims	1.69%
Improved Documentation	1.69%
Money	1.69%
None	1.69%
Timely Constructability Reviews	20.34%
Timely Responses	1.69%
Understand Time Constraints	6.78%
Understand Various Trades	1.69%
NA	16.95%

Communication		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	15.01%	18.53%
5-15	8.47%	35.71%	55.56%		
15+	6.78%	9.30%	44.44%		

Coordination		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	6.26%	5.86%
5-15	1.69%	7.14%	16.67%		
15+	8.47%	11.63%	83.33%		

Cost versus Quality		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	0.78%	1.34%
5-15	0.00%	0.00%	0.00%		
15+	1.69%	2.33%	100.00%		

Create Quality Programs		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	0.78%	1.34%
5-15	0.00%	0.00%	0.00%		
15+	1.69%	2.33%	100.00%		

Early Engineer Involvement		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	0.78%	1.34%
5-15	0.00%	0.00%	0.00%		
15+	1.69%	2.33%	100.00%		

Early GC/CM Involvement		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	5.08%	21.43%	33.33%	11.79%	10.88%
15+	10.17%	13.95%	66.67%		

Fewer Claims		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

Improved Documentation		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

Money		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

None		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	0.78%	1.34%
15+	1.69%	2.33%	100.00%		

Timely Constructability Reviews		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	5.08%	21.43%	25.00%	14.12%	12.23%
15+	15.25%	20.93%	75.00%		

Timely Responses		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	100.00%		
5-15	0.00%	0.00%	0.00%	16.67%	28.87%
15+	0.00%	0.00%	0.00%		

Understand Time Constraints		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	25.00%	4.71%	4.08%
15+	5.08%	6.98%	75.00%		

Understand Various Trades		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	1.69%	7.14%	100.00%	2.38%	4.12%
15+	0.00%	0.00%	0.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	1.69%	50.00%	10.00%		
5-15	0.00%	0.00%	0.00%	23.64%	25.11%
15+	15.25%	20.93%	90.00%		

Engineer Tables: Type of Work

Type of Work		
Private	6	10.17%
Public	9	15.25%
Public/Private	44	74.58%

Question 5: In your opinion, how skilled are the engineers that create the drawings for your company?

Totals:	
Untrained	3.39%
Varies	25.42%
Skilled	23.73%
Very Skilled	40.68%
NA	6.78%

Untrained		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	1.69%	11.11%	50.00%	4.46%	5.87%
Public/Private	1.69%	2.27%	50.00%		

Varies		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.78%	66.67%	26.67%		
Public	3.39%	22.22%	13.33%	36.45%	26.19%
Public/Private	15.25%	20.45%	60.00%		

Skilled		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	3.39%	22.22%	14.29%	16.50%	14.51%
Public/Private	20.34%	27.27%	85.71%		

Very Skilled		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.39%	33.33%	8.33%		
Public	6.78%	44.44%	16.67%	39.56%	5.68%
Public/Private	30.51%	40.91%	75.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	3.03%	5.25%
Public/Private	6.78%	9.09%	100.00%		

Question 6a: Is Enough Time Allowed to Complete Accurate Documents?

Totals:	
Yes	38.98%
No	3.39%
Sometimes	57.63%

Yes		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	5.08%	50.00%	13.04%		
Public	5.08%	33.33%	13.04%	40.66%	8.52%
Public/Private	28.81%	38.64%	73.91%		

No		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	1.69%	11.11%	50.00%	4.46%	5.87%
Public/Private	1.69%	2.27%	50.00%		

Sometimes		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	5.08%	50.00%	8.82%		
Public	8.47%	55.56%	14.71%	54.88%	4.58%
Public/Private	44.07%	59.09%	76.47%		

Question 6b: Are Items Omitted?

Totals:	
Yes	28.81%
No	28.81%
Not Sure	5.08%
NA	37.29%

Yes		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	5.88%		
Public	8.47%	55.56%	29.41%	32.41%	20.48%
Public/Private	18.64%	25.00%	64.71%		

No		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.39%	33.33%	11.76%		
Public	3.39%	22.22%	11.76%	28.37%	5.65%
Public/Private	22.03%	29.55%	76.47%		

Not Sure		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	33.33%		
Public	0.00%	0.00%	0.00%	7.07%	8.62%
Public/Private	3.39%	4.55%	66.67%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.39%	33.33%	9.09%		
Public	3.39%	22.22%	9.09%	32.15%	9.40%
Public/Private	30.51%	40.91%	81.82%		

Question 6c: Percentage of Time Enough Time is Allowed

Totals:	
10-20	5.08%
20-30	
30-40	6.78%
40-50	1.69%
50-60	10.17%
60-70	10.17%
70-80	10.17%
80-90	11.86%
90-100	3.39%
NA	40.68%

10-20		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	33.33%		
Public	1.69%	11.11%	33.33%	10.02%	7.26%
Public/Private	1.69%	2.27%	33.33%		

20-30		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private		0.00%	0.00%		
Public		0.00%	0.00%	0.00%	0.00%
Public/Private		0.00%	0.00%		

30-40		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	3.03%	5.25%
Public/Private	6.78%	9.09%	100.00%		

40-50		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

50-60		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	16.67%		
Public	1.69%	11.11%	16.67%	12.29%	3.92%
Public/Private	6.78%	9.09%	66.67%		

60-70		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	1.69%	11.11%	16.67%	7.49%	6.49%
Public/Private	8.47%	11.36%	83.33%		

70-80		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	16.67%		
Public	3.39%	22.22%	33.33%	15.24%	7.80%
Public/Private	5.08%	6.82%	50.00%		

80-90		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	5.30%	9.19%
Public/Private	11.86%	15.91%	100.00%		

90-100		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	1.52%	2.62%
Public/Private	3.39%	4.55%	100.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	5.08%	50.00%	12.50%		
Public	6.78%	44.44%	16.67%	44.36%	5.68%
Public/Private	28.81%	38.64%	70.83%		

Question 7: What type of review process (if any) does your company, or you personally, use?

Totals:	
Individual	3.39%
Limited	5.08%
Milestone Review	10.17%
QA/QC	42.37%
Several Person	33.90%
Value Eng	1.69%
NA	3.39%

Individual		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	1.52%	2.62%
Public	0.00%	0.00%	0.00%		
Public/Private	3.39%	4.55%	100.00%		

Limited		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	33.33%	12.96%	11.56%
Public	3.39%	22.22%	66.67%		
Public/Private	0.00%	0.00%	0.00%		

Milestone Review		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	16.67%	12.29%	3.92%
Public	1.69%	11.11%	16.67%		
Public/Private	6.78%	9.09%	66.67%		

QA/QC		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.78%	66.67%	16.00%	49.92%	14.79%
Public	6.78%	44.44%	16.00%		
Public/Private	28.81%	38.64%	68.00%		

Several Person Review		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	21.04%	20.48%
Public	3.39%	22.22%	10.00%		
Public/Private	30.51%	40.91%	90.00%		

Value Engineering		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	0.76%	1.31%
Public	0.00%	0.00%	0.00%		
Public/Private	1.69%	2.27%	100.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	1.52%	2.62%
Public	0.00%	0.00%	0.00%		
Public/Private	3.39%	4.55%	100.00%		

Question 8: Are there any particular aspects of design that are difficult to communicate to owners and contractors in the construction documents?

Totals:	
Communication (ALL)	5.08%
Communication Client	15.25%
Construction Staging	1.69%
Coordination	6.78%
Cost versus Quality	1.69%
Design Intent	1.69%
Details	20.34%
Equipment	1.69%
Isometrics	1.69%
New Technologies	1.69%
None	13.56%
Permitting	1.69%
Risk	1.69%
Specifications	6.78%
Standards	1.69%
Unforeseen Conditions	6.78%
Utilities	1.69%
NA	8.47%

Communication (ALL)		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	5.22%	5.59%
Public	1.69%	11.11%	33.33%		
Public/Private	3.39%	4.55%	66.67%		

Communication Client		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	5.08%	50.00%	33.33%	24.16%	22.38%
Public	1.69%	11.11%	11.11%		
Public/Private	8.47%	11.36%	55.56%		

Construction Staging		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	3.70%	6.42%
Public	1.69%	11.11%	100.00%		
Public/Private	0.00%	0.00%	0.00%		

Coordination		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	1.69%	11.11%	25.00%	5.98%	5.60%
Public/Private	5.08%	6.82%	75.00%		

Cost versus Quality		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

Design Intent		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

Details		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	8.33%		
Public	3.39%	22.22%	16.67%	19.78%	2.84%
Public/Private	15.25%	20.45%	75.00%		

Equipment		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

Isometrics		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

New Technologies		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

None		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	12.50%		
Public	0.00%	0.00%	0.00%	10.86%	9.41%
Public/Private	11.86%	15.91%	87.50%		

Permitting		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

Risk		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

Specifications		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	25.00%		
Public	1.69%	11.11%	25.00%	10.77%	6.07%
Public/Private	3.39%	4.55%	50.00%		

Standards		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

Unforeseen Conditions		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	1.69%	11.11%	25.00%	5.98%	5.60%
Public/Private	5.08%	6.82%	75.00%		

Utilities		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	1.69%	11.11%	20.00%	6.73%	5.92%
Public/Private	6.78%	9.09%	80.00%		

Question 9: Could the architects or GC/CM help in any way to improve efforts to provide quality construction documents?

Totals:	
Communication	15.25%
Coordination	10.17%
Cost versus Quality	1.69%
Create Quality Programs	1.69%
Early Eng Involvement	1.69%
Early GC/CM Involvement	15.25%
Fewer Claims	1.69%
Improved Documentation	1.69%
Money	1.69%
None	1.69%
Timely Constructability Reviews	20.34%
Timely Responses	1.69%
Understand Time Constraints	6.78%
Understand Various Trades	1.69%
NA	16.95%

Communication		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	6.82%	11.81%
Public	0.00%	0.00%	0.00%		
Public/Private	15.25%	20.45%	100.00%		

Coordination		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	16.67%	12.29%	3.92%
Public	1.69%	11.11%	16.67%		
Public/Private	6.78%	9.09%	66.67%		

Cost versus Quality		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	0.76%	1.31%
Public	0.00%	0.00%	0.00%		
Public/Private	1.69%	2.27%	100.00%		

Create Quality Programs		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	0.76%	1.31%
Public	0.00%	0.00%	0.00%		
Public/Private	1.69%	2.27%	100.00%		

Early Engineer Involvement		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	0.76%	1.31%
Public	0.00%	0.00%	0.00%		
Public/Private	1.69%	2.27%	100.00%		

Early GC/CM Involvement		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	11.11%		
Public	3.39%	22.22%	22.22%	17.51%	4.35%
Public/Private	10.17%	13.64%	66.67%		

Fewer Claims		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	1.69%	11.11%	100.00%	3.70%	6.42%
Public/Private	0.00%	0.00%	0.00%		

Improved Documentation		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

Money		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

None		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	1.69%	16.67%	100.00%		
Public	0.00%	0.00%	0.00%	5.56%	9.62%
Public/Private	0.00%	0.00%	0.00%		

Timely Constructability Reviews		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	5.08%	50.00%	25.00%		
Public	5.08%	33.33%	25.00%	32.32%	18.20%
Public/Private	10.17%	13.64%	50.00%		

Timely Responses		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	0.76%	1.31%
Public/Private	1.69%	2.27%	100.00%		

Understand Time Constraints		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public	0.00%	0.00%	0.00%	3.03%	5.25%
Public/Private	6.78%	9.09%	100.00%		

Understand Various Trades		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	0.76%	1.31%
Public	0.00%	0.00%	0.00%		
Public/Private	1.69%	2.27%	100.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	13.47%	11.84%
Public	3.39%	22.22%	20.00%		
Public/Private	13.56%	18.18%	80.00%		

Engineer Tables: Volume

Volume		
0 to 10	18	30.51%
10 to 100	22	37.29%
100+	14	23.73%
Unknown	5	8.47%

Question 5: In your opinion, how skilled are the engineers that create the drawings for your company?

Totals:	
Untrained	3.39%
Varies	25.42%
Skilled	23.73%
Very Skilled	40.68%
NA	6.78%

Untrained		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	50.00%	2.53%	2.94%
10 to 100	1.69%	4.55%	50.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Varies		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	8.47%	27.78%	33.33%	22.82%	12.41%
10 to 100	13.56%	36.36%	53.33%		
100+	1.69%	7.14%	6.67%		
Unknown	1.69%	20.00%	6.67%		

Skilled		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	5.08%	16.67%	21.43%	19.91%	15.39%
10 to 100	10.17%	27.27%	42.86%		
100+	8.47%	35.71%	35.71%		
Unknown	0.00%	0.00%	0.00%		

Very Skilled		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	11.86%	38.89%	29.17%	48.39%	21.56%
10 to 100	11.86%	31.82%	29.17%		
100+	10.17%	42.86%	25.00%		
Unknown	6.78%	80.00%	16.67%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	50.00%	6.35%	7.45%
10 to 100	0.00%	0.00%	0.00%		
100+	3.39%	14.29%	50.00%		
Unknown	0.00%	0.00%	0.00%		

Question 6a: Is Enough Time Allowed to Complete Accurate Documents?

Totals:	
Yes	38.98%
No	3.39%
Sometimes	57.63%

Yes		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	10.17%	33.33%	26.09%	43.14%	11.92%
10 to 100	13.56%	36.36%	34.78%		
100+	10.17%	42.86%	26.09%		
Unknown	5.08%	60.00%	13.04%		

No		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	2.27%	4.55%
10 to 100	3.39%	9.09%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Sometimes		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	20.34%	66.67%	35.29%	54.59%	11.03%
10 to 100	20.34%	54.55%	35.29%		
100+	13.56%	57.14%	23.53%		
Unknown	3.39%	40.00%	5.88%		

Question 6b: Are Items Omitted?

Totals:	
Yes	28.81%
No	28.81%
Not Sure	5.08%
NA	37.29%

Yes		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	10.17%	33.33%	35.29%	27.29%	5.52%
10 to 100	10.17%	27.27%	35.29%		
100+	6.78%	28.57%	23.53%		
Unknown	1.69%	20.00%	5.88%		

No		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	8.47%	27.78%	29.41%	28.34%	10.20%
10 to 100	8.47%	22.73%	29.41%		
100+	10.17%	42.86%	35.29%		
Unknown	1.69%	20.00%	5.88%		

Not Sure		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	33.33%	3.66%	4.47%
10 to 100	3.39%	9.09%	66.67%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	10.17%	33.33%	27.27%	40.70%	13.83%
10 to 100	15.25%	40.91%	40.91%		
100+	6.78%	28.57%	18.18%		
Unknown	5.08%	60.00%	13.64%		

Question 6c: Percentage of Time Enough Time is Allowed

Totals:	
10-20	5.08%
20-30	
30-40	6.78%
40-50	1.69%
50-60	10.17%
60-70	10.17%
70-80	10.17%
80-90	11.86%
90-100	3.39%
NA	40.68%

10-20		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	66.67%	7.78%	9.69%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	1.69%	20.00%	33.33%		

20-30		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10		0.00%	0.00%	0.00%	0.00%
10 to 100		0.00%	0.00%		
100+		0.00%	0.00%		
Unknown		0.00%	0.00%		

30-40		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	50.00%	5.70%	4.66%
10 to 100	1.69%	4.55%	25.00%		
100+	1.69%	7.14%	25.00%		
Unknown	0.00%	0.00%	0.00%		

40-50		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.79%	3.57%
10 to 100	0.00%	0.00%	0.00%		
100+	1.69%	7.14%	100.00%		
Unknown	0.00%	0.00%	0.00%		

50-60		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	16.67%	7.72%	7.62%
10 to 100	6.78%	18.18%	66.67%		
100+	1.69%	7.14%	16.67%		
Unknown	0.00%	0.00%	0.00%		

60-70		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	33.33%	7.97%	5.95%
10 to 100	5.08%	13.64%	50.00%		
100+	1.69%	7.14%	16.67%		
Unknown	0.00%	0.00%	0.00%		

70-80		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	5.08%	16.67%	50.00%	8.23%	6.85%
10 to 100	3.39%	9.09%	33.33%		
100+	1.69%	7.14%	16.67%		
Unknown	0.00%	0.00%	0.00%		

80-90		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	28.57%	14.27%	7.93%
10 to 100	1.69%	4.55%	14.29%		
100+	5.08%	21.43%	42.86%		
Unknown	1.69%	20.00%	14.29%		

90-100		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	50.00%	2.53%	2.94%
10 to 100	1.69%	4.55%	50.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	8.47%	27.78%	20.83%	44.02%	13.20%
10 to 100	16.95%	45.45%	41.67%		
100+	10.17%	42.86%	25.00%		
Unknown	5.08%	60.00%	12.50%		

Question 7: What type of review process (if any) does your company, or you personally, use?

Totals:	
Individual	3.39%
Limited	5.08%
Milestone Review	10.17%
QA/QC	42.37%
Several Person	33.90%
Value Eng	1.69%
NA	3.39%

Individual		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	50.00%	6.39%	9.44%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	1.69%	20.00%	50.00%		

Limited		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	33.33%	3.66%	4.47%
10 to 100	3.39%	9.09%	66.67%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Milestone Review		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	15.19%	17.45%
10 to 100	5.08%	13.64%	50.00%		
100+	1.69%	7.14%	16.67%		
Unknown	3.39%	40.00%	33.33%		

QA/QC		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	11.86%	38.89%	28.00%	43.10%	9.49%
10 to 100	13.56%	36.36%	32.00%		
100+	13.56%	57.14%	32.00%		
Unknown	3.39%	40.00%	8.00%		

Several Person Review		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	11.86%	38.89%	35.00%	27.74%	18.55%
10 to 100	13.56%	36.36%	40.00%		
100+	8.47%	35.71%	25.00%		
Unknown	0.00%	0.00%	0.00%		

Value Engineering		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.14%	2.27%
10 to 100	1.69%	4.55%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	100.00%	2.78%	5.56%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Question 8: Are there any particular aspects of design that are difficult to communicate to owners and contractors in the construction documents?

Totals:	
Communication (ALL)	5.08%
Communication Client	15.25%
Construction Staging	1.69%
Coordination	6.78%
Cost versus Quality	1.69%
Design Intent	1.69%
Details	20.34%
Equipment	1.69%
Isometrics	1.69%
New Technologies	1.69%
None	13.56%
Permitting	1.69%
Risk	1.69%
Specifications	6.78%
Standards	1.69%
Unforeseen Conditions	6.78%
Utilities	1.69%
NA	8.47%

Communication (ALL)		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	33.33%	4.31%	3.07%
10 to 100	1.69%	4.55%	33.33%		
100+	1.69%	7.14%	33.33%		
Unknown	0.00%	0.00%	0.00%		

Communication Client		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	22.22%	15.25%	7.33%
10 to 100	8.47%	22.73%	55.56%		
100+	1.69%	7.14%	11.11%		
Unknown	1.69%	20.00%	11.11%		

Construction Staging		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.79%	3.57%
10 to 100	0.00%	0.00%	0.00%		
100+	1.69%	7.14%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Coordination		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	25.00%	5.45%	3.91%
10 to 100	3.39%	9.09%	50.00%		
100+	1.69%	7.14%	25.00%		
Unknown	0.00%	0.00%	0.00%		

Cost versus Quality		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	100.00%	1.39%	2.78%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Design Intent		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.79%	3.57%
10 to 100	0.00%	0.00%	0.00%		
100+	1.69%	7.14%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Details		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	5.08%	16.67%	25.00%	20.85%	5.32%
10 to 100	6.78%	18.18%	33.33%		
100+	6.78%	28.57%	33.33%		
Unknown	1.69%	20.00%	8.33%		

Equipment		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	100.00%	1.39%	2.78%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Isometrics		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.14%	2.27%
10 to 100	1.69%	4.55%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

New Technologies		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.79%	3.57%
10 to 100	0.00%	0.00%	0.00%		
100+	1.69%	7.14%	100.00%		
Unknown	0.00%	0.00%	0.00%		

None		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	25.00%	14.11%	6.02%
10 to 100	6.78%	18.18%	50.00%		
100+	1.69%	7.14%	12.50%		
Unknown	1.69%	20.00%	12.50%		

Permitting		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	100.00%	1.39%	2.78%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Risk		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.79%	3.57%
10 to 100	0.00%	0.00%	0.00%		
100+	1.69%	7.14%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Specifications		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	5.08%	16.67%	75.00%	5.30%	7.87%
10 to 100	1.69%	4.55%	25.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Standards		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.14%	2.27%
10 to 100	1.69%	4.55%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Unforeseen Conditions		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	25.00%	9.31%	7.21%
10 to 100	1.69%	4.55%	25.00%		
100+	1.69%	7.14%	25.00%		
Unknown	1.69%	20.00%	25.00%		

Utilities		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.14%	2.27%
10 to 100	1.69%	4.55%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	40.00%	10.70%	6.76%
10 to 100	1.69%	4.55%	20.00%		
100+	1.69%	7.14%	20.00%		
Unknown	1.69%	20.00%	20.00%		

Question 9: Could the architects or GC/CM help in any way to improve efforts to provide quality
construction documents?

Totals:	
Communication	15.25%
Coordination	10.17%
Cost versus Quality	1.69%
Create Quality Programs	1.69%
Early Eng Involvement	1.69%
Early GC/CM Involvement	15.25%
Fewer Claims	1.69%
Improved Documentation	1.69%
Money	1.69%
None	1.69%
Timely Constructability Reviews	20.34%
Timely Responses	1.69%
Understand Time Constraints	6.78%
Understand Various Trades	1.69%
NA	16.95%

Communication		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	22.22%	16.54%	4.96%
10 to 100	5.08%	13.64%	33.33%		
100+	5.08%	21.43%	33.33%		
Unknown	1.69%	20.00%	11.11%		

Coordination		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	33.33%	7.97%	5.95%
10 to 100	5.08%	13.64%	50.00%		
100+	1.69%	7.14%	16.67%		
Unknown	0.00%	0.00%	0.00%		

Cost versus Quality		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	100.00%	1.39%	2.78%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Create Quality Programs		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.14%	2.27%
10 to 100	1.69%	4.55%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Early Engineer Involvement		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.14%	2.27%
10 to 100	1.69%	4.55%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Early GC/CM Involvement		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	22.22%	16.54%	4.96%
10 to 100	5.08%	13.64%	33.33%		
100+	5.08%	21.43%	33.33%		
Unknown	1.69%	20.00%	11.11%		

Fewer Claims		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.79%	3.57%
10 to 100	0.00%	0.00%	0.00%		
100+	1.69%	7.14%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Improved Documentation		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	100.00%	1.39%	2.78%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Money		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	5.00%	10.00%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	1.69%	20.00%	100.00%		

None		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	100.00%	1.39%	2.78%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Timely Constructability Reviews		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	16.67%	23.17%	13.22%
10 to 100	10.17%	27.27%	50.00%		
100+	3.39%	14.29%	16.67%		
Unknown	3.39%	40.00%	16.67%		

Timely Responses		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	100.00%	1.39%	2.78%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Understand Time Constraints		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.39%	11.11%	50.00%	5.05%	5.89%
10 to 100	3.39%	9.09%	50.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Understand Various Trades		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	1.69%	5.56%	100.00%	1.39%	2.78%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	5.08%	16.67%	30.00%	14.72%	11.74%
10 to 100	5.08%	13.64%	30.00%		
100+	6.78%	28.57%	40.00%		
Unknown	0.00%	0.00%	0.00%		

General Contractor Tables: Experience

Experience		
0-5	9	27.27%
5-15	6	18.18%
15+	18	54.55%

Question 5: On average, how would you rate the quality of construction documents your company receives?

Totals:	
Poor	6.06%
Below Average	27.27%
Average	60.61%
Above Average	6.06%
Excellent	

Poor		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	3.70%	6.42%
15+	6.06%	11.11%	100.00%		

Below Average		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	6.06%	22.22%	22.22%		
5-15	6.06%	33.33%	22.22%	27.78%	5.56%
15+	15.15%	27.78%	55.56%		

Average		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	21.21%	77.78%	35.00%		
5-15	12.12%	66.67%	20.00%	64.81%	13.98%
15+	27.27%	50.00%	45.00%		

Above Average		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	3.70%	6.42%
15+	6.06%	11.11%	100.00%		

Excellent		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5		0.00%	0.00%		
5-15		0.00%	0.00%	0.00%	0.00%
15+		0.00%	0.00%		

Question 7: What do you attribute this problem to?

Totals:	
Architect Coordination	3.03%
Cut & Paste	15.15%
Lack of Communication	3.03%
Lack of Details	9.09%
Lack of Knowledge	18.18%
Lack of Time	24.24%
Lack Time/Money	9.09%
Owner Pressure	12.12%
Unchecked	3.03%
NA	3.03%

Architect Coordination		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	100.00%	3.70%	6.42%
5-15	0.00%	0.00%	0.00%		
15+	0.00%	0.00%	0.00%		

Cut & Paste		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	20.00%	11.11%	11.11%
5-15	0.00%	0.00%	0.00%		
15+	12.12%	22.22%	80.00%		

Lack of Communication		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	1.85%	3.21%
5-15	0.00%	0.00%	0.00%		
15+	3.03%	5.56%	100.00%		

Lack of Details		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	6.06%	22.22%	66.67%	9.26%	11.56%
5-15	0.00%	0.00%	0.00%		
15+	3.03%	5.56%	33.33%		

Lack of Knowledge		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%	18.52%	16.97%
5-15	6.06%	33.33%	33.33%		
15+	12.12%	22.22%	66.67%		

Lack of Time		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	9.09%	33.33%	37.50%	27.78%	9.62%
5-15	6.06%	33.33%	25.00%		
15+	9.09%	16.67%	37.50%		

Lack Time/Money		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	33.33%		
5-15	3.03%	16.67%	33.33%	11.11%	5.56%
15+	3.03%	5.56%	33.33%		

Owner Pressure		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	3.03%	16.67%	25.00%	11.11%	9.62%
15+	9.09%	16.67%	75.00%		

Unchecked		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	100.00%		
5-15	0.00%	0.00%	0.00%	3.70%	6.42%
15+	0.00%	0.00%	0.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Question 8: How does the quality of construction documents affect your job?

Totals:	
Litigation	3.03%
Money	9.09%
Owner Dissatisfaction	15.15%
Time	15.15%
Time, Money	18.18%
Time, Money, Relationships	39.39%

Litigation		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Money		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	33.33%		
5-15	0.00%	0.00%	0.00%	7.41%	6.42%
15+	6.06%	11.11%	66.67%		

Owner Dissatisfaction		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	20.00%		
5-15	3.03%	16.67%	20.00%	14.81%	3.21%
15+	9.09%	16.67%	60.00%		

Time		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	20.00%		
5-15	3.03%	16.67%	20.00%	14.81%	3.21%
15+	9.09%	16.67%	60.00%		

Time, Money		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	9.09%	33.33%	50.00%		
5-15	3.03%	16.67%	16.67%	20.37%	11.56%
15+	6.06%	11.11%	33.33%		

Time, Money, Relationships		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	9.09%	33.33%	23.08%		
5-15	9.09%	50.00%	23.08%	40.74%	8.49%
15+	21.21%	38.89%	53.85%		

Question 9: How do you see this problem being solved?

Totals:	
Arch/Eng Coordination Early	3.03%
Architect Define Scope	6.06%
Architects Do Better Job	6.06%
Better Document Reviews	9.09%
Better Relationships	3.03%
Better Training	3.03%
Can't Be Solved	3.03%
Clear Documents	6.06%
Complete Detailing	3.03%
Computer Technology	3.03%
Coordination	6.06%
Early GC/CM Involvement	6.06%
Hold Architects Liable	3.03%
More Time for Design Phase	9.09%
Owner Understanding Cost	30.30%

Arch/Eng Coordination Early		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Architect Define Scope		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	50.00%		
5-15	3.03%	16.67%	50.00%	9.26%	8.49%
15+	0.00%	0.00%	0.00%		

Architects Do Better Job		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	3.70%	6.42%
15+	6.06%	11.11%	100.00%		

Better Document Reviews		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	33.33%		
5-15	6.06%	33.33%	66.67%	14.81%	16.97%
15+	0.00%	0.00%	0.00%		

Better Relationships		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	3.03%	16.67%	100.00%	5.56%	9.62%
15+	0.00%	0.00%	0.00%		

Better Training		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Can't Be Solved		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	100.00%		
5-15	0.00%	0.00%	0.00%	3.70%	6.42%
15+	0.00%	0.00%	0.00%		

Clear Documents		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	3.70%	6.42%
15+	6.06%	11.11%	100.00%		

Complete Detailing		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Computer Technology		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Coordination		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	6.06%	22.22%	100.00%		
5-15	0.00%	0.00%	0.00%	7.41%	12.83%
15+	0.00%	0.00%	0.00%		

Early GC/CM Involvement		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	50.00%		
5-15	0.00%	0.00%	0.00%	5.56%	5.56%
15+	3.03%	5.56%	50.00%		

Hold Architects Liable		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	3.03%	16.67%	100.00%	5.56%	9.62%
15+	0.00%	0.00%	0.00%		

More Time for Design Phase		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	33.33%		
5-15	0.00%	0.00%	0.00%	7.41%	6.42%
15+	6.06%	11.11%	66.67%		

Owner Understanding Cost		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	6.06%	22.22%	20.00%		
5-15	3.03%	16.67%	10.00%	25.93%	11.56%
15+	21.21%	38.89%	70.00%		

Question 10: Could the architects and engineers help in any way to improve efforts to provide quality construction documents?

Totals:	
Arch/Eng Coordination Early	3.03%
Architect Define Scope	6.06%
Architect Taking Criticism	6.06%
Architects Do Better Job	9.09%
Better Document Reviews	12.12%
Better Training	3.03%
Complete Detailing	3.03%
Computer Technology	6.06%
Coordination	9.09%
Discipline	3.03%
Early GC/CM Involvement	3.03%
More Effort in Drawings	3.03%
Owner Knowledge	3.03%
Owner Understanding Cost	12.12%
Pay Attention to Codes	3.03%
Understand Time Constraints	3.03%
NA	9.09%

Arch/Eng Coordination Early		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Architect Define Scope		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	50.00%		
5-15	3.03%	16.67%	50.00%	9.26%	8.49%
15+	0.00%	0.00%	0.00%		

Architect Taking Criticism		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	3.03%	16.67%	50.00%	7.41%	8.49%
15+	3.03%	5.56%	50.00%		

Architects Do Better Job		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	33.33%		
5-15	0.00%	0.00%	0.00%	7.41%	6.42%
15+	6.06%	11.11%	66.67%		

Better Document Reviews		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	6.06%	33.33%	50.00%	14.81%	16.97%
15+	6.06%	11.11%	50.00%		

Better Training		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Complete Detailing		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Computer Technology		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	3.70%	6.42%
15+	6.06%	11.11%	100.00%		

Coordination		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	6.06%	22.22%	66.67%		
5-15	3.03%	16.67%	33.33%	12.96%	11.56%
15+	0.00%	0.00%	0.00%		

Discipline		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Early GC/CM Invovlement		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

More Effort in Drawings		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

Owner Knowledge		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	100.00%		
5-15	0.00%	0.00%	0.00%	3.70%	6.42%
15+	0.00%	0.00%	0.00%		

Owner Understanding Cost		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	9.09%	33.33%	75.00%		
5-15	0.00%	0.00%	0.00%	12.96%	17.86%
15+	3.03%	5.56%	25.00%		

Pay Attention to Codes		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	3.03%	11.11%	100.00%		
5-15	0.00%	0.00%	0.00%	3.70%	6.42%
15+	0.00%	0.00%	0.00%		

Understand Time Constraints		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	0.00%	0.00%	0.00%	1.85%	3.21%
15+	3.03%	5.56%	100.00%		

NA		Percentage/Experience	%/Total	Mean	Standard Deviation
0-5	0.00%	0.00%	0.00%		
5-15	3.03%	16.67%	33.33%	9.26%	8.49%
15+	6.06%	11.11%	66.67%		

General Contractor Tables: Type of Work

Type of Work		
Private	14	42.42%
Public	0	0.00%
Public/Private	19	57.58%

Question 5: On average, how would you rate the quality of construction documents your company receives?

Totals:	
Poor	6.06%
Below Average	27.27%
Average	60.61%
Above Average	6.06%
Excellent	

Poor		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				5.26%	7.44%
Public/Private	6.06%	10.53%	100.00%		

Below Average		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	12.12%	28.57%	44.44%		
Public				27.44%	1.59%
Public/Private	15.15%	26.32%	55.56%		

Average		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	24.24%	57.14%	40.00%		
Public				60.15%	4.25%
Public/Private	36.36%	63.16%	60.00%		

Above Average		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.06%	14.29%	100.00%		
Public				7.14%	10.10%
Public/Private	0.00%	0.00%	0.00%		

Excellent		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private		0.00%	0.00%		
Public				0.00%	0.00%
Public/Private		0.00%	0.00%		

Question 7: What do you attribute this problem to?

Totals:	
Architect Coordination	3.03%
Cut & Paste	15.15%
Lack of Communication	3.03%
Lack of Details	9.09%
Lack of Knowledge	18.18%
Lack of Time	24.24%
Lack Time/Money	9.09%
Owner Pressure	12.12%
Unchecked	3.03%
NA	3.03%

Architect Coordination		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

Cut & Paste		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.06%	14.29%	40.00%		
Public				15.04%	1.06%
Public/Private	9.09%	15.79%	60.00%		

Lack of Communication		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

Lack of Details		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.06%	14.29%	66.67%		
Public				9.77%	6.38%
Public/Private	3.03%	5.26%	33.33%		

Lack of Knowledge		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	15.15%	35.71%	83.33%		
Public				20.49%	21.53%
Public/Private	3.03%	5.26%	16.67%		

Lack of Time		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	5.26%	12.50%		
Public				21.05%	22.33%
Public/Private	21.21%	36.84%	87.50%		

Lack Time/Money		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				7.89%	11.16%
Public/Private	9.09%	15.79%	100.00%		

Owner Pressure		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	9.09%	21.43%	75.00%		
Public				13.35%	11.43%
Public/Private	3.03%	5.26%	25.00%		

Unchecked		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	100.00%		
Public				3.57%	5.05%
Public/Private	0.00%	0.00%	0.00%		

Question 8: How does the quality of construction documents affect your job?

Totals:	
Litigation	3.03%
Money	9.09%
Owner Dissatisfaction	15.15%
Time	15.15%
Time, Money	18.18%
Time, Money, Relationships	39.39%

Litigation		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	2.63%	3.72%
Public					
Public/Private	3.03%	5.26%	100.00%		

Money		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	33.33%	8.83%	2.39%
Public					
Public/Private	6.06%	10.53%	66.67%		

Owner Dissatisfaction		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	9.09%	21.43%	60.00%	15.98%	7.71%
Public					
Public/Private	6.06%	10.53%	40.00%		

Time		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.06%	14.29%	40.00%	15.04%	1.06%
Public					
Public/Private	9.09%	15.79%	60.00%		

Time, Money		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	16.67%	16.73%	13.56%
Public					
Public/Private	15.15%	26.32%	83.33%		

Time, Money, Relationships		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	21.21%	50.00%	53.85%	40.79%	13.03%
Public					
Public/Private	18.18%	31.58%	46.15%		

Question 9: How do you see this problem being solved?

Totals:	
Arch/Eng Coordination Early	3.03%
Architect Define Scope	6.06%
Architects Do Better Job	6.06%
Better Document Reviews	9.09%
Better Relationships	3.03%
Better Training	3.03%
Can't Be Solved	3.03%
Clear Documents	6.06%
Complete Detailing	3.03%
Computer Technology	3.03%
Coordination	6.06%
Early GC/CM Involvement	6.06%
Hold Architects Liable	3.03%
More Time for Design Phase	9.09%
Owner Understanding Cost	30.30%

Arch/Eng Coordination Early		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	2.63%	3.72%
Public					
Public/Private	3.03%	5.26%	100.00%		

Architect Define Scope		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	5.26%	7.44%
Public					
Public/Private	6.06%	10.53%	100.00%		

Architects Do Better Job		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.06%	14.29%	100.00%	7.14%	10.10%
Public					
Public/Private	0.00%	0.00%	0.00%		

Better Document Reviews		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	33.33%	8.83%	2.39%
Public					
Public/Private	6.06%	10.53%	66.67%		

Better Relationships		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	2.63%	3.72%
Public					
Public/Private	3.03%	5.26%	100.00%		

Better Training		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	100.00%		
Public				3.57%	5.05%
Public/Private	0.00%	0.00%	0.00%		

Can't Be Solved		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

Clear Documents		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				5.26%	7.44%
Public/Private	6.06%	10.53%	100.00%		

Complete Detailing		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

Computer Technology		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

Coordination		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				5.26%	7.44%
Public/Private	6.06%	10.53%	100.00%		

Early GC/CM Involvement		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.06%	14.29%	100.00%		
Public				7.14%	10.10%
Public/Private	0.00%	0.00%	0.00%		

Hold Architects Liable		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	100.00%		
Public				3.57%	5.05%
Public/Private	0.00%	0.00%	0.00%		

More Time for Design Phase		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	33.33%	8.83%	2.39%
Public					
Public/Private	6.06%	10.53%	66.67%		

Owner Understanding Cost		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	18.18%	42.86%	60.00%	31.95%	15.42%
Public					
Public/Private	12.12%	21.05%	40.00%		

Question 10: Could the architects and engineers help in any way to improve efforts to provide quality construction documents?

Totals:	
Arch/Eng Coordination Early	3.03%
Architect Define Scope	6.06%
Architect Taking Criticism	6.06%
Architects Do Better Job	9.09%
Better Document Reviews	12.12%
Better Training	3.03%
Complete Detailing	3.03%
Computer Technology	6.06%
Coordination	9.09%
Discipline	3.03%
Early GC/CM Involvement	3.03%
More Effort in Drawings	3.03%
Owner Knowledge	3.03%
Owner Understanding Cost	12.12%
Pay Attention to Codes	3.03%
Understand Time Constraints	3.03%
NA	9.09%

Arch/Eng Coordination Early		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	2.63%	3.72%
Public					
Public/Private	3.03%	5.26%	100.00%		

Architect Define Scope		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%	5.26%	7.44%
Public					
Public/Private	6.06%	10.53%	100.00%		

Architect Taking Criticism		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.06%	14.29%	100.00%		
Public				7.14%	10.10%
Public/Private	0.00%	0.00%	0.00%		

Architects Do Better Job		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	33.33%		
Public				8.83%	2.39%
Public/Private	6.06%	10.53%	66.67%		

Better Document Reviews		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	25.00%		
Public				11.47%	6.11%
Public/Private	9.09%	15.79%	75.00%		

Better Training		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	100.00%		
Public				3.57%	5.05%
Public/Private	0.00%	0.00%	0.00%		

Complete Detailing		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

Computer Technology		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	50.00%		
Public				6.20%	1.33%
Public/Private	3.03%	5.26%	50.00%		

Coordination		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	33.33%		
Public				8.83%	2.39%
Public/Private	6.06%	10.53%	66.67%		

Discipline		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

Early GC/CM Involvement		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	100.00%		
Public				3.57%	5.05%
Public/Private	0.00%	0.00%	0.00%		

More Effort in Drawings		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	3.03%	7.14%	100.00%		
Public				3.57%	5.05%
Public/Private	0.00%	0.00%	0.00%		

Owner Knowledge		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

Owner Understanding Cost		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	9.09%	21.43%	75.00%		
Public				13.35%	11.43%
Public/Private	3.03%	5.26%	25.00%		

Pay Attention to Codes		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

Understand Time Constraints		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	0.00%	0.00%	0.00%		
Public				2.63%	3.72%
Public/Private	3.03%	5.26%	100.00%		

NA		Percentage/Type of Work	%/Total	Mean	Standard Deviation
Private	6.06%	14.29%	66.67%		
Public				9.77%	6.38%
Public/Private	3.03%	5.26%	33.33%		

General Contractor Tables: Volume

Volume		
0 to 10	6	18.18%
10 to 100	10	30.30%
100+	15	45.45%
Unknown	2	6.06%

Question 5: On average, how would you rate the quality of construction documents your company receives?

Totals:	
Poor	6.06%
Below Average	27.27%
Average	60.61%
Above Average	6.06%
Excellent	

Poor		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	50.00%	5.83%	7.88%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	50.00%		
Unknown	0.00%	0.00%	0.00%		

Below Average		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	6.06%	33.33%	22.22%	23.33%	17.64%
10 to 100	12.12%	40.00%	44.44%		
100+	9.09%	20.00%	33.33%		
Unknown	0.00%	0.00%	0.00%		

Average		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	9.09%	50.00%	15.00%	65.83%	26.72%
10 to 100	12.12%	40.00%	20.00%		
100+	33.33%	73.33%	55.00%		
Unknown	6.06%	100.00%	10.00%		

Above Average		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	5.00%	10.00%
10 to 100	6.06%	20.00%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Excellent	Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	0.00%
10 to 100	0.00%	0.00%		
100+	0.00%	0.00%		
Unknown	0.00%	0.00%		

Question 7: What do you attribute this problem to?

Totals:	
Architect Coordination	3.03%
Cut & Paste	15.15%
Lack of Communication	3.03%
Lack of Details	9.09%
Lack of Knowledge	18.18%
Lack of Time	24.24%
Lack Time/Money	9.09%
Owner Pressure	12.12%
Unchecked	3.03%
NA	3.03%

Architect Coordination		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.67%	3.33%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Cut & Paste		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	20.00%	12.50%	8.77%
10 to 100	6.06%	20.00%	40.00%		
100+	6.06%	13.33%	40.00%		
Unknown	0.00%	0.00%	0.00%		

Lack of Communication		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	100.00%	4.17%	8.33%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Lack of Details		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	6.67%	9.43%
10 to 100	6.06%	20.00%	66.67%		
100+	3.03%	6.67%	33.33%		
Unknown	0.00%	0.00%	0.00%		

Lack of Knowledge		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	6.06%	33.33%	33.33%	15.83%	14.24%
10 to 100	3.03%	10.00%	16.67%		
100+	9.09%	20.00%	50.00%		
Unknown	0.00%	0.00%	0.00%		

Lack of Time		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	12.50%	15.83%	17.51%
10 to 100	0.00%	0.00%	0.00%		
100+	18.18%	40.00%	75.00%		
Unknown	3.03%	6.67%	12.50%		

Lack Time/Money		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	5.00%	6.38%
10 to 100	0.00%	0.00%	0.00%		
100+	6.06%	13.33%	66.67%		
Unknown	3.03%	6.67%	33.33%		

Owner Pressure		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	25.00%	11.67%	14.53%
10 to 100	9.09%	30.00%	75.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Unchecked		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	2.50%	5.00%
10 to 100	3.03%	10.00%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	2.50%	5.00%
10 to 100	3.03%	10.00%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Question 8: How does the quality of construction documents affect your job?

Totals:	
Litigation	3.03%
Money	9.09%
Owner Dissatisfaction	15.15%
Time	15.15%
Time, Money	18.18%
Time, Money, Relationships	39.39%

Litigation		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.67%	3.33%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Money		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	33.33%	7.50%	8.77%
10 to 100	0.00%	0.00%	0.00%		
100+	6.06%	13.33%	66.67%		
Unknown	0.00%	0.00%	0.00%		

Owner Dissatisfaction		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	6.06%	33.33%	40.00%	13.33%	16.33%
10 to 100	0.00%	0.00%	0.00%		
100+	9.09%	20.00%	60.00%		
Unknown	0.00%	0.00%	0.00%		

Time		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	20.00%	23.33%	18.66%
10 to 100	6.06%	20.00%	40.00%		
100+	3.03%	6.67%	20.00%		
Unknown	3.03%	50.00%	20.00%		

Time, Money		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	16.67%	25.00%	16.89%
10 to 100	6.06%	20.00%	33.33%		
100+	6.06%	13.33%	33.33%		
Unknown	3.03%	50.00%	16.67%		

Time, Money, Relationships		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	10.00%	7.69%	27.50%	27.54%
10 to 100	18.18%	60.00%	46.15%		
100+	18.18%	40.00%	46.15%		
Unknown	0.00%	0.00%	0.00%		

Question 9: How do you see this problem being solved?

Totals:	
Arch/Eng Coordination Early	3.03%
Architect Define Scope	6.06%
Architects Do Better Job	6.06%
Better Document Reviews	9.09%
Better Relationships	3.03%
Better Training	3.03%
Can't Be Solved	3.03%
Clear Documents	6.06%
Complete Detailing	3.03%
Computer Technology	3.03%
Coordination	6.06%
Early GC/CM Involvement	6.06%
Hold Architects Liable	3.03%
More Time for Design Phase	9.09%
Owner Understanding Cost	30.30%

Arch/Eng Coordination Early		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.67%	3.33%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Architect Define Scope		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	5.00%	10.00%
10 to 100	6.06%	20.00%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Architects Do Better Job		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	4.17%	5.00%
10 to 100	3.03%	10.00%	50.00%		
100+	3.03%	6.67%	50.00%		
Unknown	0.00%	0.00%	0.00%		

Better Document Reviews		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	33.33%	8.33%	6.94%
10 to 100	3.03%	10.00%	33.33%		
100+	3.03%	6.67%	33.33%		
Unknown	0.00%	0.00%	0.00%		

Better Relationships		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.67%	3.33%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Better Training		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	2.50%	5.00%
10 to 100	3.03%	10.00%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Can't Be Solved		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.67%	3.33%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Clear Documents		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	50.00%	5.83%	7.88%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	50.00%		
Unknown	0.00%	0.00%	0.00%		

Complete Detailing		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	100.00%	4.17%	8.33%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Computer Technology		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	100.00%	4.17%	8.33%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Coordination		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	3.33%	6.67%
10 to 100	0.00%	0.00%	0.00%		
100+	6.06%	13.33%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Early GC/CM Involvement		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	50.00%	5.83%	7.88%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	50.00%		
Unknown	0.00%	0.00%	0.00%		

Hold Architects Liable		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.67%	3.33%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	100.00%		
Unknown	0.00%	0.00%	0.00%		

More Time for Design Phase		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	5.83%	6.87%
10 to 100	3.03%	10.00%	33.33%		
100+	6.06%	13.33%	66.67%		
Unknown	0.00%	0.00%	0.00%		

Owner Understanding Cost		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	10.00%	44.17%	38.62%
10 to 100	12.12%	40.00%	40.00%		
100+	9.09%	20.00%	30.00%		
Unknown	6.06%	100.00%	20.00%		

Question 10: Could the architects and engineers help in any way to improve efforts to provide quality construction documents?

Totals:	
Arch/Eng Coordination Early	3.03%
Architect Define Scope	6.06%
Architect Taking Criticism	6.06%
Architects Do Better Job	9.09%
Better Document Reviews	12.12%
Better Training	3.03%
Complete Detailing	3.03%
Computer Technology	6.06%
Coordination	9.09%
Discipline	3.03%
Early GC/CM Involvement	3.03%
More Effort in Drawings	3.03%
Owner Knowledge	3.03%
Owner Understanding Cost	12.12%
Pay Attention to Codes	3.03%
Understand Time Constraints	3.03%
NA	9.09%

Arch/Eng Coordination Early		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.67%	3.33%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Architect Define Scope		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	5.00%	10.00%
10 to 100	6.06%	20.00%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Architect Taking Criticism		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	4.17%	5.00%
10 to 100	3.03%	10.00%	50.00%		
100+	3.03%	6.67%	50.00%		
Unknown	0.00%	0.00%	0.00%		

Architects Do Better Job		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	33.33%	9.17%	10.67%
10 to 100	6.06%	20.00%	66.67%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Better Document Reviews		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	7.50%	9.57%
10 to 100	3.03%	10.00%	25.00%		
100+	9.09%	20.00%	75.00%		
Unknown	0.00%	0.00%	0.00%		

Better Training		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	2.50%	5.00%
10 to 100	3.03%	10.00%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Complete Detailing		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	100.00%	4.17%	8.33%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Computer Technology		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	50.00%	6.67%	8.16%
10 to 100	3.03%	10.00%	50.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Coordination		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	33.33%	7.50%	8.77%
10 to 100	0.00%	0.00%	0.00%		
100+	6.06%	13.33%	66.67%		
Unknown	0.00%	0.00%	0.00%		

Discipline		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.67%	3.33%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	100.00%		
Unknown	0.00%	0.00%	0.00%		

Early GC/CM Involvement		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.67%	3.33%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	100.00%		
Unknown	0.00%	0.00%	0.00%		

More Effort in Drawings		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	100.00%	4.17%	8.33%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Owner Knowledge		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	12.50%	25.00%
10 to 100	0.00%	0.00%	0.00%		
100+	0.00%	0.00%	0.00%		
Unknown	3.03%	50.00%	100.00%		

Owner Understanding Cost		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	7.50%	9.57%
10 to 100	3.03%	10.00%	25.00%		
100+	9.09%	20.00%	75.00%		
Unknown	0.00%	0.00%	0.00%		

Pay Attention to Codes		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	2.50%	5.00%
10 to 100	3.03%	10.00%	100.00%		
100+	0.00%	0.00%	0.00%		
Unknown	0.00%	0.00%	0.00%		

Understand Time Constraints		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	0.00%	0.00%	0.00%	1.67%	3.33%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	100.00%		
Unknown	0.00%	0.00%	0.00%		

NA		Percentage/Volume	%/Total	Mean	Standard Deviation
0 to 10	3.03%	16.67%	33.33%	18.33%	22.19%
10 to 100	0.00%	0.00%	0.00%		
100+	3.03%	6.67%	33.33%		
Unknown	3.03%	50.00%	33.33%		

Appendix I – Survey Responses not Specifically Discussed

Computer and New Technologies

One participant discussed the use of computer technology. He stated the following: "3D objects need to be designed using 3D tools. Any other method is an artifact of limited technology. However, real cost benefit analysis needs to show that 3D CAD results in better design with [fewer] errors and produced faster. Efforts then need to be made to communicate this to clients so that they demand this from the architectural community. Also contractors and engineers need to be aware that if someone is using a real 3D tool, their quotes can be more accurate and timely. Cost overruns on various projects should be tracked. This type of hard data, well communicated, will pressure the AEC community to implement 3D design" (Survey).

One participant discussed how new technologies affect a project's cost. There is an additional cost to train the client and contractor in understanding and utilizing these technologies.

Details, Using 3-D

Many participants discussed different details that could be difficult to portray on the construction documents. A list of some of the responses is provided below:

- flashing, sub slab drainage, insulation, fire stopping, demolition, millwork vs. manufactured casework, windows vs. storefront vs. curtain wall, location of slab-on-grade control joints, location of other material control and expansion joints.
- underground site work
- hard details (or wall sections etc.)

(Survey)

Another category used in the survey was Details (Use 3-D). This means that the details are hard to communicate and technology such as 3-D CAD could be used to help solve this problem. Architects feel that details such as connections can be illustrated better using 3-D technology. Another architect discussed realizing a "sense of space" using Revit (Survey).

Other architects discuss how it is difficult for clients to understand sizes of rooms or elevations in two dimensions. They feel that it is easier for everyone to understand if they are presented in three dimensions.

Time, Money, Relationships

The general contractors were asked the question "How does the quality of construction documents affect your job?" Many responded to the question in different combinations of time, money, and relationships. Most said that the duration of a project is increased due to insufficient construction documents. The cost of the project is also increased. And finally, inaccurate construction documents can create adverse relationships between all of the parties involved.

Understanding Various Trades

One engineer felt that if the GC/CMs and architects understood the engineers it could help the problems with the quality of construction documents. He feels that they do not understand the engineers at all, especially on small projects (Survey).

Miscellaneous Items with No Explanations

There were a few responses that were simply one-word answers that did not fit into any of the other categories. For the question, "Are there any particular aspects

of design that are difficult to communicate to owners and contractors in the construction documents?" one person responded with Cost Versus Quality. Another person responded with Final Product. One response to the question "Could the architects or GC/CM help in any way to improve efforts to provide quality construction documents?" was Fewer Claims. An answer of Discipline was provided for the question "What can architects and engineers do to improve the quality of construction documents?" As stated, previously, these answers were not accompanied by any explanations.

Appendix J – Survey Responses

Architect Responses

	1
Question 1	Construction Administrator
Question 2	20+
Question 3	Private development, interior design
Question 4	don't know
Question 5	none
Question 6	very skilled
Question 7	we have several senior persons review sets of drawings for completeness
Question 8a	yes
Question 8b	NA
Question 8c	NA
Question 9	yes; it is useful to sit down with clients and walk them through the design intent
Question 10	they already do as part of the process
	2
Question 1	Job Captain
Question 2	0-5
Question 3	full service
Question 4	34.5 mil
Question 5	production
Question 6	very skilled
Question 7	They are reviewed by myself, the Project Architect and the project Manger.
Question 8aa	sometimes
Question 8b	not_sure
Question 8c	NA
Question 9	
Question 10	The engineers could cordinate better among themselves. i.e. If the same engineering company is doing the Fire Protection, Electrical, Lighting and HVAC - they could cordinate the drawings. In most cases it is up to the architect or CM to cordinate when there is a conflict with a light and diffisuer or diffisuer and sprinler.
	3
Question 1	PM
Question 2	15-20
Question 3	full service
Question 4	33 mil
Question 5	PM
Question 6	The Architects in our company are very skilled.
Question 7	in house quality control review
Question 8a	sometimes
Question 8b	yes
Question 8c	20-30
Question 9	Certain details or connections can sometimes be better illustrated in 3D zia computer modeling or physical modeling.
Question 10	Just keep communication open. Contractors should also preview shop drawings prior to sending them to the architect

	4
Question 1	PM, Proj Arch
Question 2	15-20
Question 3	Architecture, interiors, urban design. All types of architecture except single family residential.
Question 4	don't know
Question 5	Setting direction for CD organization and content, managing production team, reviewing for quality control, redlining sets, coordination with specifications.
Question 6	Although skill levels vary across the staff, in general our staff is highly skilled.
Question 7	review by project manager and QA review by designated person in firm not associated with the project.
Question 8a	yes
Question 8b	NA
Question 8c	NA
Question 9	None that are particularly difficult as long as enogh views, details and sections are provided. the only exception to this is the occasional use of highly complex, non-orthogonal, or curvilinear geometries.
Question 10	GC/CM involvement in a project is most beneficial if they are brought in before Design Development is concluded. Their biggest advantage to the CD production is in providing cost estimates and constructability reviews.
	5
Question 1	Senior Proj Leader
Question 2	20+
Question 3	Architecture and interior design. Complete scope of services, both disciplines. Almost all building / project types, except hospital buildings
Question 4	30-35 mil
Question 5	Project manager: responsible for overseeing all drawing production and specification writing
Question 6	varies widely from fair to excellent
Question 7	Internal review (using dedicated inhouse QA Architect)at end of each phase of project, including construction cost estimate prepared / updated by third party. Client review / sign-off at end of each phase, plus 50% CD review. Peer review at submission of permit drawings. Value Engineering in conjunction with CM
Question 8a	sometimes
Question 8b	no
Question 8c	NA
Question 9	Coordination of engineer's / consultants' work with that of Architect and each other !!!! Your choices permitted in items 8a 8b, and 8c are too limiting / simplistic. Items are not intentionally omitted; typically, any time shortfall occurs in the amount of time remaining to coordinate the work of the engineering disciplines with each other and with that of the Architect. The amount of time required varies according to the complexity of the project / building type.
Question 10	Yes: coordinate all MEPF disciplines before releasing to Architect; coordinate their work with that of the Architect. Engineers: be more pro-active in dealing with Architect, rather than waiting for Architect to send completed drawings. GC/CM: Be more realistic in early / conceptual stages of project estimating, so that design intent can be fully realized, rather than having a disappointing VE phase which leaves everyone disappointed / frustrated, and out of time for good CD's...
	6
Question 1	Senior PM

Question 2	20+
Question 3	We are a full service Architectural firm with in-house Mechanical and Electrical Engineers, Civil Engineering staff and Interior Design Department.
Question 4	50-100 mil
Question 5	Architectural schematic, preliminary, design development and construction document production in pencil sketch and hard-line drawings fed to CADD department for final drawings.
Question 6	Architects and Engineers are professionals, some having CADD experience and proficiency and some not. Most drawings which leave our office are produced by our CADD department.
Question 7	We have a QC (Quality Control) process which works well to coordinate our work and that of in-house and outside consultants. Most projects go throught this process. Some, because of tight scheduling and deadlines, are not put through the process. This can take as long as a week on some projects. Schedules usually include necessary time for QC.
Question 8a	yes
Question 8b	not_sure
Question 8c	70-80
Question 9	Knowing the particular materials and the skills of the craftsmen that are available makes a difference. Quality of finishes is difficult, making the specifications become the dominant source of guidance.
Question 10	Bringing a GC or CM on board as a part of the design/constructin team early can make it easier to select a construction type and finishes consistent with the pallet of materials and skills available. Feedback during construction and and after construction give-and-take critique with the contractor and subcontractors can provide valuable information useful for future projects.
	7
Question 1	PM
Question 2	10-15
Question 3	Private work mostly. Golf clubhouses, condo developments, educational
Question 4	1.4 mil
Question 5	Complete oversite of the process from inception to completion. Also help on the production end as required
Question 6	Our consulting engineers are routinly above average in there actual document production. It seems that as they have limited need to know, they can concentrate on thier task and give a decent document as output. Our in house staff is less satisfying however. I am new here and my main task is to improve the CD product. Our staff is a mix of computer people and designers, with no one having any real training in document production.
Question 7	Inhouse reviews consist of peer to peer review of the drawings at least once a month. This is a small office and we are able to do it with some regularity. It would be a huge issue at a larger firm. A "clean" set of eyes can quickley point out errors/ommissions/deficiencies as well as outstanding work.
Question 8a	sometimes
Question 8b	yes
Question 8c	30-40
Question 9	Sense of space. New 3-d parametrict software (Revit) seems to be one way to address this. We will see.
Question 10	Hard to tell. They have a profit motive where we have an Architectural motive.

	8
Question 1	Arch/PM
Question 2	20+
Question 3	Full service firm, specializing in educational facilities
Question 4	millions
Question 5	Coordinate the work of staff in different disciplines, and do some drafting myself.
Question 6	Very skilled (in-house engineers)
Question 7	Peer review of documents by staff not involved in actual design of project
Question 8a	sometimes
Question 8b	yes
Question 8c	60-70
Question 9	
Question 10	they could, but often don't
	9
Question 1	PM
Question 2	15-20
Question 3	public, higher education, corporate, science and technology, private schools, healthcare.
Question 4	don't know
Question 5	Responsible for oversight of production team.
Question 6	We have a range of skills, and try to create teams that are well-balanced.
Question 7	We use a Redi-check process for reviewing documents at each phase of production (i.e. Design Development, and two or three times during Construction Documents).
Question 8a	yes
Question 8b	NA
Question 8c	NA
Question 9	The coordination between different disciplines (arch, struct, MEP) is challanging. That's where most errors occur.
Question 10	We typically work with GC on projects that are put out to bid, so their input is somewhat after-the-fact. Projects that utilize a construction manager, in my opinion, result in a better product at a better price.
	10
Question 1	Senior Assoc/Proj Arch
Question 2	20+
Question 3	Educational building ; public schools,college building
Question 4	80 mil
Question 5	supervision
Question 6	above average
Question 7	Project Architect holds weekly meetings with consultants to review progress.
Question 8a	yes
Question 8b	NA
Question 8c	NA
Question 9	The final product.
Question 10	no
	11
Question 1	PM
Question 2	20+
Question 3	Full service architectural office, architecture, planning, graphics, landscape architecture, interior design. Our main focus is on healthcare and research buildings.
Question 4	

Question 5	I direct a team of architects in the production of construction documents. I setup the project and oversee the execution of the process.
Question 6	The skill level of our architects vary from person to person. Depending of the experience level of the individual, we have architects at every skill level.
Question 7	We review the project as a team (self checking) and we review the project with a third party such as a group of individuals in the firm that have no relationship to the project.
Question 8a	sometimes
Question 8b	yes
Question 8c	50-60
Question 9	Owners and contractors need to understand that we typically need time to complete construction documents without distractions. Changes to the construction documents are very disruptive. It would be better to hold off changing the construction documents until all all documents are finished. This may seem strange but it allows everyone to stay focused.
Question 10	Same response as question above.
	12
Question 1	Arch
Question 2	10-15
Question 3	Architectural services for the public and private education markets, religious markets, and residential markets.
Question 4	7-10 mil
Question 5	Construction document production (drafting) and job captain level coordination of architectural and consultant drawings and specs.
Question 6	If you are referring to our consultants, they are skilled in their respective disciplines, and display routine/basic drafting competence. In our office, we have both "advanced" draftspeople along with those of average skill. We do try to provide in-house training and support, as well as professional training.
Question 7	We try to have in-house review periods of the documents, performed by someone not on the project team. There is also a Quality Control committee, who documents "lessons learned" from past projects, and creates a reference for current jobs to further enhance document quality.
Question 8a	sometimes
Question 8b	yes
Question 8c	40-50
Question 9	Generally speaking, no, if adequate detailing is performed. However, coordination between the architecure and the other design disciplines is often incomplete and/or poorly documented, resulting in construction difficulties.
Question 10	If they were to limit themselves to "constructability" issues and not attempt to redesign the building, and perform timely, comprehensive document review, that would be a welcome contribution.
	13
Question 1	Proj Arch/Manager
Question 2	15-20
Question 3	Private, commercial, retail, biotech, residential, educational
Question 4	5 mil
Question 5	Supervise and oversee the transfer of design development drawings & sketches into CD's.
Question 6	very skilled
Question 7	very inept, haphazard
Question 8a	no

Question 8b	yes
Question 8c	NA
Question 9	details
Question 10	Not particularly, what input is needed is readily available.
	14
Question 1	Production/Technical Manager
Question 2	10-15
Question 3	Public, Architecture, primarily educational facilities
Question 4	2 mil
Question 5	I am in charge of quality control, technical standards, the document process, etc. (office wide)
Question 6	Very highly skilled
Question 7	Internal periodic peer reviews, as well as day-to-day review by highly specialized personell overseeing the technical content of the construction documents.
Question 8a	yes
Question 8b	NA
Question 8c	NA
Question 9	No, if enough effort is made in the documentation to the contractor, and good client management/client education
Question 10	Possibly, especcially in documentation of Phasing the Construction
	15
Question 1	Proj Arch
Question 2	10-15
Question 3	Full range of architectural services
Question 4	10 mil
Question 5	Drafting, Quality Control
Question 6	Varies considerably but generally I would say they typically lie between "moderate" to "highly" skilled.
Question 7	Project manager gives a not-quite-thorough review of the set of architectural drawings and specifications between one and three times over the course of CD's. MEP consultants drawings receive only a cursory review at each major phase. We'll usually only have one (maybe two) meetings with the engineers per phase regarding coordination.
Question 8a	no
Question 8b	yes
Question 8c	NA
Question 9	Flashing at doors, windows. Phasing requirements. Ownership of "gray areas" in public bid projects (e.g. flashing, sub slab drainage, insulation, firestopping, demolition, millwork vs. manufactured casework, windows vs. storefront vs. curtainwall, location of slab-on-grade control joints, location of other material control and expansion joints.
Question 10	They need to thoroughly coordinate they're drawings with the architectural to be certain what they want to do fits in walls or ceilings as proposed by the architect. If they are going to run shafts through closets, the architect needs to be clearly advised of these conflicts as early as possible.
	16
Question 1	Interior Arch/PM
Question 2	5-10
Question 3	private architecture and interiors, full service large and small scale projects.
Question 4	
Question 5	Drawing and production of documents. Checking of Documents

Question 6	They are of varying abilities, some are very capable and require little supervision. Other groups require much more time reviewing drawings and demanding that work be done. The projects that I work on are typically small and some of the engineering firms do not want to give these projects their proper attention.
Question 7	Our company has a project mananger to review drawings during the drawing process and an in house reviewer that reviews projects prior to milestone deadlines.
Question 8a	yes
Question 8b	NA
Question 8c	NA
Question 9	I think that the most difficult thing to convey to owners is why things they don't see cost so much. They don't tend to realize what needs to happen on the technical side of things and most often will look to the achitect for explainations of these items rather than seeking out the engineering team. If the owner is a large developer, this is typically much less of a problem because they have staff that are trained in construction.
Question 10	Early in the process comments from the GC are very helpful because their comments can be incoroporated into the drawing set. Normally their input is very helpful at this phase. I find working with the engineers, it is important to ask them to explain to you how items work and why they are needed so that you can understand the impact on the architectural side. Asking questions like, does this have water in it? are helpful to know where to place items.
	17
Question 1	Dir of Const Admin
Question 2	15-20
Question 3	We are an Architectural firm doing business in the public and private sectors. Our services include those traditonally offered by an Architectural firm, studies, master planning, design, construction administration.
Question 4	3.5 mil
Question 5	I assist in the preparation of specifications based on the experiences the firm has had on previous projects, mainly in Divisions 1,2,3,6,9,10.
Question 6	Our firm has been praised for the quality of its drawings. The staff in very capable, both in design and in the production (CAD) of the drawings. We include numerous details (sometimes too many!)that assist the Contractor's in bidding and constructing the work.
Question 7	The Contract Documents are reviewed on a continual basis. As plans, details and specifications are fleshed out, they are reviewed as milestones are reached: Programming, Schematics, Design Development and Construction Documents. The specifications are reviewed on a parallel track, incorporating the materials specific to the project and edited as required for public or private construction.
Question 8a	sometimes
Question 8b	no
Question 8c	80-90
Question 9	The single most problematic part of the documents to fully understand, from the Owner's and Contractor's point of view is the underground sitework. Obviously, no one was xray vision, so we rely on the results from test borings, test pits, ground penetrating radar, etc. to get a mental picture of what lies underground, yet this does not always translate well to two dimensions, especially for the people who didn't do the actual design.

Question 10	Our experience is that a General Contractor can assist with specific questions (how would you build this, what product worked best on that) as well as cost estimates. On large public projects, it is difficult for a Contractor to spend the amount of time necessary to estimate a large project due to the time and cost involved. Sometimes the Contractor is compensated. Design-Build work is different. In this type of project, it is expected that the Contractor and Archtect work together during design and budgeting. A Construction Manager is helpful if brought into the project during the design phase, to offer input on experiences from other jobs. Coming to the party late often causes problems due to the changing of horses mid-stream.
	18
Question 1	Proj Arch
Question 2	15-20
Question 3	Institutional, Commercial, Retail, Hotel, Office and Mixed-use buildings
Question 4	10 mil
Question 5	I oversee production of drawings, I review drawings prepared with CAD, I design and detail using CAD. I am currently performing construction administration for two of the projects that I oversaw.
Question 6	We are architects and we work to continually improve the quality of the work that we produce. There is always room for improvement, but the quality of our documents is very good. I haven't checked this in a long time, but typically our errors and omissions rate is well below the 5% which is industry standard.
Question 7	Individual drafters are responsible for checking thier own work for graphical errors. Job Captains and Project Architects do ongoing review and redlining at regular intervals. At major milestones during the project progress sets are submitted for owner review or pricing and ultimately for issuance to the contractor for bidding or execution. Typically the week before any of these sets is published a progress set including the work of our consultants (Civil Engineering, Structural, Mechanical, Electrical and Plumbing and Fire Protection) and a formal review of the set is performed by one of the senior technical architects.
Question 8a	sometimes
Question 8b	yes
Question 8c	80-90
Question 9	Complex geometry is often a challenge to convey in the form of traditional drawings: plans, sections, and elevations. We have used CAD to generate building Axonometric drawings to aid in the understanding of complex building forms. These drawings were developed as presentation tools and then adapted as illustrative drawings for the contractor.
Question 10	Common standards for electronic information is rare but helpful to coordinate information with contractors, particularly on complex projects involving existing conditions that is often not fully surveyed until construction begins.
	19
Question 1	PM
Question 2	10-15
Question 3	Custom Residential, full service Architecture
Question 4	4 mil
Question 5	prepare drawings from schematic thru working construction documents
Question 6	Typically very skilled, and if not are supervised.
Question 7	Red line process, with pin ups as well as passing over to principal
Question 8a	sometimes
Question 8b	NA

Question 8c	70-80
Question 9	spacial relationships, stairs, fireplaces
Question 10	Perhaps if you had a GC from the inception of a project you could have a give and take of what the GC is comfortable with and avoid getting into situations where the GC is unclear how to complete a task
	20
Question 1	Intern Arch
Question 2	0-5
Question 3	Full Service - Architecture and Engineering (MEP and Site/Civil)
Question 4	don't know
Question 5	Drawing, Checking, Coordinating
Question 6	very skilled
Question 7	A "quality control" process that uses a staff member outisde of the project team to review a project's status at significant design intervals (SD, DD, CD)
Question 8a	sometimes
Question 8b	yes
Question 8c	20-30
Question 9	
Question 10	More thorough communication at frequent intervals to track the changes in the design process. Acceptance and realization of change as a natural process, rather than resisting modifications.
	21
Question 1	Job Captain
Question 2	0-5
Question 3	Full Service Architecture and Interiors
Question 4	11 mil
Question 5	I manage the production of cds for 1-2 jobs at a time, meaning I oversee others' work as well as actively produce drawings myself.
Question 6	Some are better than others, what's the scale? You get what you pay for. Or, you get what your client pays for.
Question 7	Ongoing review of cd's by job captain and/or project manager. One final review of drawings by senior associate, maybe.
Question 8a	sometimes
Question 8b	yes
Question 8c	50-60
Question 9	Standard of quality workmanship that is expected.
Question 10	I don't think so. Architecture, generally, is not some mysterious practice of the symbiosis of math and art. Although, that would be nice, wouldn't it? Instead, today, without slave labor, architecture is driven by the proverbial bottom line. In addition, more often than not, the line for acrchitecture IS at the bottom of the budget list. Architecture doesn't matter to some. The resonant beauty of architecture is that it can make life beautiful and healthy in very subtle ways. Owners that don't see this underbudget their architectural budgets. However, it's not a straight up money issue. It's a time issue. Time is money. Great architects can do great things with little money. Great architects can't always do great things with all the money in the world if they don't have time on their side. Time is non-negotiable. I think, for the most part, quality left out of construction docuements is af unction of limited time alotted to complete them. I see this as falling under the responsibility umbrella of the owners. Owners who want seamless, high quality workmanship have to budget time for it.

	However, the GC/CM CAN help the CD effort if enough time is alotted, by the owner, for them to review the drawings and specs in preparation of a two-way dialogue with the architects.
	22
Question 1	Construction Administrator
Question 2	15-20
Question 3	Building Architecture, Private; Interior Design, Private; Full Service, Private
Question 4	30-40 mil
Question 5	Generate them as job captain(team leader), Review them prior to issuing(checker), and administer the construction related work, ie, observe the work, answer questions, review submittals, review applications for payment, etc.
Question 6	THe architects are very skilled that problem comes from having the wrong people on the wrong task, or peole who need training going it alone.
Question 7	We have a formal review process which is required by our insurer, but has no teeth and has become totally ineffectual.
Question 8a	yes
Question 8b	yes
Question 8c	70-80
Question 9	Owners tend to underestimate the need to document the sonditions generated where tow building systems collide or come together. It' at these points tthe architests skill is neeeded to create an attractive or at least consistent, resolution of the condition. GC's assume that everything can be resolved into building systems, this springs from their cost estimating excersise. There are some conditions which by design require special consideration. They generally don't get it.
Question 10	CM are an entirely different role than GC. But the Owners don;t seem to know that from a CM they should expect money back if the building system can be swapped to a lower cost alternative. A GC does not have the otion of swapping building systems and therfore won't be inclined to give back cost.
	23
Question 1	Contract Documents Manager
Question 2	20+
Question 3	Primarily publically funded projects. Project type is program management, and architecture, for residential.
Question 4	NA
Question 5	Oversight of all specifications and project manuals, training in spec writing, writing of some project specifications, writing office master specifications, oversight of product research.
Question 6	The engineering skills are acceptable for the project types and fees. We would not use an engineer again if their skills weren't acceptable.
Question 7	No formalized process, though one is being developed. Each project manager reviews the documents for their projects. I review all specifications.
Question 8a	yes
Question 8b	NA
Question 8c	NA

Question 9	In my experience at other firms, any type of complexity in design, whether architectural or MEP, is difficult to convey. Since architectural fees are fixed (along with the budget for production), there is a limit to what can be put on the drawings. The problem is that architects fail to plan for the most important elements that need to be included in the drawings to insure project success. Thus, a lot of time is spent detailing ordinary construction, which contractors and tradesman know well, and the hard details are ignored - in part because the production is done by less experienced staff who have no idea how to do the hard details. But, its the hard details (or wall sections etc.) that are most important to be illustrated.
Question 10	Engineers need to be more creative in response to architects' stated needs, and to help architects understand their designs. GC/CM's are only useful if the project is using a design build process so they are involved from the start. Their best contribution would be to help with "buildability" of designs - what works and whats too complicated or expensive. The individual most able to help with improved quality is the owner. It is their money, their building, and ultimately they can control the process better by setting the right goals at the start. They must: 1) pay the architect sufficient fees so that the design can be properly worked out; 2) be very involved so that they know the problems and difficulties of the design and construction process, and contribute constructively; 3) be realistic about what their budgets can provide in the way of a finished building (especially public clients who usually have about 80% of what they need to build their desired building.)
	24
Question 1	Principal
Question 2	20+
Question 3	Residential Architectural services for new homes, additions, renovations, two family housing, historical restoration for older homes.
Question 4	$300,000
Question 5	Supervising role
Question 6	On residential projects of this scope, I do my own engineering. When I have worked with engineers, I find that I have to do coordination to make a consistant package.
Question 7	
Question 8a	sometimes
Question 8b	not_sure
Question 8c	10-20
Question 9	When the project is complex or the scope includes a rich palatte of interior materials, details, and cabinets, then the drawings required to adequately describe these is often underestimated by owners and contractors. Otherwise, projects with unusual roof geometry and multible levels require more complex framing plans and/or sections.
Question 10	On projects of larger scope than we do, having the contractors part of the team effort is helpful. The engineers are part of the process, introduced at Design Development.
	25
Question 1	Architect
Question 2	20+
Question 3	Commercial, Elderly Housing, Health Care, Jails/Prisons, Homes
Question 4	don't know
Question 5	I produce them

Question 6	The engineering is fine. The quality and completeness of their drawings leaves a lot to be desired. Insufficient time is available to coordinate their work to the architectural. In most cases the engineers draw VERY schematically and with little concern for if their design is "buildable". Additionally, they spend little time in the field assisting the contractor and making sure the work is installed correctly.
Question 7	Not much, usually reviews during document production by the Project Architect. Little after that except for changes required to obtain permit. Very little time for review as a unique process seperate from the other tasks. Experience in a particular type of building eases the time pressure on reviews because you can "checklist" the project as you proceed and this is about the same as "mini-reviews".
Question 8a	sometimes
Question 8b	NA
Question 8c	80-90
Question 9	Owners: The process is very complicated. It is difficult to produce "perfect" documents even if you have sufficient time. Time pressure to complete directly reduces the quality of the output. Contractors: The process of documentation has become very performace orientated. This can be difficult for inexperienced bidders. The bidders really need to take sufficient time to review the bid documents.
Question 10	I don't think so! Generally, in my experience, GC's/CM's do not have any ideas until you draw something and then they have 3 ways to do it differently than what you drew. Getting the GC/CM involved too early increases the difficulty of producing good documents within the Owner's design budget. It also puts undue pressure on the design document schedule. Engineers need to see their work as something that is built, not just designed. Many can work out problems in the field, however this is always costly to the Owner.
	26
Question 1	Senior Staff Architect
Question 2	15-20
Question 3	Design, engineering and construction or BioMEdical and BioTechnological processing facilities throughout the US and Europe.
Question 4	10 mil
Question 5	Construction Documents are used not only to construct the facility but as the basis for the Validation of the facility that must be completed, highly documented and issued to the FDA as the basis for the licensing of the facility.
Question 6	The engineers are highly skilled as the design requirements are extremely complicated and are extremely important to the safe operation of the facility.
Question 7	On all projects, coordination meetings are held at various stages of the design process, from Schematic Design, Design Development and finally through preliminary and final bidding phases, contract document production, and prior to relaese for construction.
Question 8a	sometimes
Question 8b	yes
Question 8c	60-70
Question 9	Trying to present a three dimensional environment to the client is sometime difficult with two dimensiuonal drawings. Most clients cannot understand the sizes of rooms shown on a drawing and be able to relate that to reality.
Question 10	Yes, allow the necessary tim eto complete detailed and accurate drawigns that are WELL coordinated with the other trades. Most of the time final details for instalaltion are left to the contractor installing the system or component without having prior information of the proposed installation to review and comment on for improvement.

	27
Question 1	PM
Question 2	10-15
Question 3	We are a full-service architectural firm specializing in healthcare. We offer our clients a full-range of services from planning and development to construction (under a design-build model). We usually design our own interiors, but also work with interior design firms at our client's request. Along with the healthcare spectrum (everything from complete hospitals to Medical Office Buildings), we design senior living projects that range along the continuum of care (independent housing, assisted living, continuing care communities, skilled nursing, etc).
Question 4	5-10 mil
Question 5	I supervise the production of construction documents on my projects (redline, review, coordinate) and frequently edit/coordinate the specifications and project manuals. I also perform other quality controls on an office-wide basis (internal 3rd party reviews, revising construction document standards, etc).
Question 6	They range all over the place. We tend to develop strong working relationships with highly skilled engineers (it's a little scary to not trust your engineers on a hospital project....). We work with the same companies over and over again, so I have a fairly high opinion of our standard engineers. Occasionally, our clients request that we use "their" preferred engineers on projects; sometimes that's been OK and other times we've had to replace them (with our favorites).
Question 7	We are a large enough firm (3 separate offices) that we usually perform our reviews in-house. A project manager who knows nothing about the project will review it at several points during the design process (usually upon completion of Design Development and once or twice during the construction documents phase). We issue the drawings for Owner review at 90%, so that we can incorporate their comments prior to releasing for bid or construction.
Question 8a	sometimes
Question 8b	NA
Question 8c	80-90
Question 9	Ideally, by the time we've reached the construction documents phase, the design process is almost finished. We may be working on details or finishes that require design input, but the big moves are finished. It is difficult throughout the process to communicate ideas - but that's part of the challenge! We find that people are singularly unable to understand plans and elevations, so we try to use 3D modelling to convey information (sometimes tough to do on a small project because of cost). Once we have reached the CD phase, it gets easier because clients can see the materials (samples) and understand the details.
Question 10	As a design-build firm, we believe so! Our experience has been that getting the GC/CM involved early in the process helps everybody. They can make suggestions about everything from phasing to estimating to material selections.
	28
Question 1	Job Captain
Question 2	10-15
Question 3	Commercial and Residential Architecture and Interior Design and Building Envelope consulting.
Question 4	4.3 mil
Question 5	Oversight of drafter, Detail development and document coordination

Question 6	They are skilled but as to their attention to document quaqlity that is not a priority to them. You have to constantly ask for their drawings to be revised because of incacuracies of graphic problems.
Question 7	We have all project reviewed by a independent reviewer and principal prior to being published.
Question 8a	sometimes
Question 8b	yes
Question 8c	50-60
Question 9	I think design internt to contractors. To owner it would be making sure they understand the documents and what has been designed. You will find out during construction that a particular part of the project differed from their expectation because they did not understand the documents. No matter how well you draw it, if they can't visualize it you won't know it not what they want until it is built. They will say yes that is it on the documents when they really aren't sure.
Question 10	For the engineers it would be helpful if they did their own internal reviews and were criticle of their drawing quality before submitting it to the Architect.
	29
Question 1	PM
Question 2	10-15
Question 3	architecture, primarily institutional (college, healthcare, etc)
Question 4	40-70 mil
Question 5	supervisory, management
Question 6	we do not directly emply engineers. the ones that we hire as firms to consult on our project are generally skilled but produce usually below- average drawings
Question 7	we do informal QC reviews
Question 8a	sometimes
Question 8b	no
Question 8c	30-40
Question 9	phasing, lifesafety, anything to do with renovation issues- existing conditions araea nightmare due ot everyone's expectations of perfection
Question 10	the contractors could report any issues found during bidding instead of waiting until construction starts. engineers could coordinate their work much better
	30
Question 1	PM
Question 2	5-10
Question 3	Full Service Custom Residential Architecture
Question 4	don't know
Question 5	I produce construction documents on a daily basis. I make sure that everyone is adhearing to our graphic standards. I also help to estimate the total number of hours required to complete a set of CD's.
Question 6	Generally, very skilled
Question 7	All drawings are reviewed either by the senior project manager, or the principal.
Question 8a	yes
Question 8b	NA
Question 8c	NA
Question 9	Complex 3d dimensional relationships are the most difficult. Complexe floor to floor relationships can be difficult, but with enough sections they can generally be communicated.

Question 10	If the structural engineers understood complex 3d relationshsips in the building, and the 3d implications of their designs it would help. When you have a relationship with a GC you can have better success through their familiarity with your documents. This could lend some credence to efforts like the National CAD Standard.
	31
Question 1	Architect
Question 2	15-20
Question 3	Architecture
Question 4	10 mil
Question 5	I produce them and /or oversee their production.
Question 6	I believe they are highly skilled
Question 7	We use a peer review process when the project is approximately 95% complete.
Question 8a	yes
Question 8b	no
Question 8c	NA
Question 9	There is not neccessarily one aspect that is more difficuly than others. The main challenge is getting the contractors to fully read the drawings and sepcifications.
Question 10	No
	32
Question 1	CADD Manager
Question 2	15-20
Question 3	full service design-build delivery system including Civil infrastructure, real estate, financing, etc.
Question 4	700 mil
Question 5	Management/Development of CAD systems.
Question 6	Skilled in engineering, less than skilled in graphically positioning elements on a plottable sheet for aesthetic display.
Question 7	Redi-check type of system integrated via VBA with excel.
Question 8a	sometimes
Question 8b	yes
Question 8c	20-30
Question 9	Volumes, space, curvilinear shapes and constructs.
Question 10	We are the GC/CM as well!
	33
Question 1	Proj Arch
Question 2	15-20
Question 3	Education facilities K-12
Question 4	12 mil
Question 5	Develop basis for production, direct necessary personnel, in production, coordination of outside consultants, direct drawing.
Question 6	As Architects, 8 on a scale of 10; as CAD users, 6 on a scale of 10
Question 7	In house QA/QC performed by Senior personnel not associated with the project
Question 8a	yes
Question 8b	NA
Question 8c	NA
Question 9	Owners: Difficulty in reading plans and elevations, difficulty in presenting 3 dimensional information. Contractors: The process of laying out the horizontal dimensions of a complex grid; communicating the complexities of code constraints, clearly showing quantities of materials .
Question 10	Yes, by providing input on constructability.

	34
Question 1	Principal
Question 2	15-20
Question 3	Full service, primarily churches
Question 4	1 mil
Question 5	Sketh detail design, Review, Approval
Question 6	Staff Education is a priority in the firm. We have some junior staff with low skills on hire, but we challenge them to learn and take them to the site as often as possible. Most staff come up to an intermediate level over 2-3 projects - if they do not, or don't want to learn, they have no place in our organization. Intermediates are encouraged to keep learning and move to the senior level and ultimately to partnership. Short answer - appropriately skilled.
Question 7	We try to ensure two full reviews by senior staff on check sets of the construction documents before the client sees them.
Question 8a	sometimes
Question 8b	yes
Question 8c	60-70
Question 9	The benefits of Quality and the need to work together as a team - minimizing adversarial relations over the project.
Question 10	Flagging details and issues early enough to allow reasonable time to look for alternates or other solutions.
	35
Question 1	Senior Architect
Question 2	15-20
Question 3	Full service
Question 4	1 bil
Question 5	I am a Registerd Architect proficient on CAD, I generate design on CAD, with Client input, and stay on the project through Preliminary Documents. My CAD generated files are being expanded into Contract Documents by myself and /or others.
Question 6	They are skilled in paper drawings, not skilled in CAD drawings.
Question 7	Documents are being reviewed on paper.
Question 8a	sometimes
Question 8b	yes
Question 8c	60-70
Question 9	The vertical dimension of the building, so called "vertical integration".
Question 10	Yes, by demanding deliverables as a single building model, and do the design review costing on the model.
	36
Question 1	Senior Application Engineer, Autodesk Inc.
Question 2	0-5
Question 3	Architectural Software Development
Question 4	800 mil
Question 5	Integration of standards into the software.
Question 6	NA
Question 7	NA
Question 8a	no
Question 8b	NA
Question 8c	NA
Question 9	
Question 10	

	37
Question 1	Senior Technical Architect
Question 2	20+
Question 3	Public, private, buildings, interiors, full service
Question 4	2 mil
Question 5	Quality Control
Question 6	not skilled at creating drawings on cad.
Question 7	periodic quality control checks.
Question 8a	no
Question 8b	yes
Question 8c	20-30
Question 9	volumes and actual sizes of finished spaces.
Question 10	Yes. Better constructability reviews.
	38
Question 1	Partner
Question 2	15-20
Question 3	Private architecture and interior architecture/design
Question 4	250,000
Question 5	Oversight primarily with some production
Question 6	Well skilled in the production of drawings. Less skilled in the interpretation of those or the drawings of others.
Question 7	All construction drawings are reviewed by one or both of the two partners.
Question 8a	sometimes
Question 8b	yes
Question 8c	70-80
Question 9	Spatial elements are difficult for both. To aid with that we use a modeling drafting program as well as physical models of buildings and/or spaces.
Question 10	We find that a team construction effort improves the quality of documents. Gaps are recognized and filled both before and during construction. The difficult part is establishing the team process. Often times contractors, subcontractors, engineers and architects become too focused on and defensive of thier part of the overall construction. Our goal is always a successful project for the client where everyone profits.
	39
Question 1	
Question 2	
Question 3	
Question 4	
Question 5	
Question 6	
Question 7	
Question 8a	
Question 8b	
Question 8c	
Question 9	
Question 10	
	40
Question 1	Architect
Question 2	15-20
Question 3	Building architecture, Interior design
Question 4	don't know

Question 5	manage teams, prepare specifications, organize drawings set
Question 6	very
Question 7	internal QA review process at various stages of project
Question 8a	sometimes
Question 8b	yes
Question 8c	70-80
Question 9	the basic assumption behind the idea or the situation. ie the location of this partition is based on trying to not have the door swing be in front of a elevator opening.
Question 10	lucky to work with GC/CM that are interested in the process. we often meet to review the rational behind the design so no one is in a vacumn about the intended goals
	41
Question 1	Spec Writer
Question 2	20+
Question 3	Architectural specification writing
Question 4	don't know
Question 5	we are not a direct consultant. we provide a specification service to architects and engineers
Question 6	drawings are not usually the problem. coordination between the drawings and the specs and accurate specs are usually the problem.
Question 7	
Question 8a	yes
Question 8b	NA
Question 8c	NA
Question 9	if you are considering drawings only, there are lots of things that drawings do not convey. specs are an essential part of the contract documents.
Question 10	in design-bid-build the GC is not involved in the production of construction documents.
	42
Question 1	Architect
Question 2	20+
Question 3	Architecture
Question 4	1 mil
Question 5	Architect
Question 6	Very little
Question 7	Internal
Question 8a	yes
Question 8b	yes
Question 8c	NA
Question 9	3-d view of details
Question 10	NO
	43
Question 1	Architect
Question 2	20+
Question 3	Full service
Question 4	don't know
Question 5	Project Manager / Project Architect
Question 6	On a scale of 1 to 5, somewhere around a 4.x
Question 7	Use of an in-house third-party not directly involved with the production of contract documents for a particular project
Question 8a	yes
Question 8b	NA

Question 8c	NA
Question 9	
Question 10	Of course, especially contractors. Any feedback regarding problems of clarity or inconsistency during the bidding or construction phases are invaluable in producing more accurate documents for subsequent projects

	44
Question 1	Architect
Question 2	05-10
Question 3	Full Service
Question 4	1 mil
Question 5	Creation, editing and coordination
Question 6	Very skilled
Question 7	We have document checks at every stage of the design process. We also utilize in-house second party checking (fresh eye).
Question 8a	sometimes
Question 8b	NA
Question 8c	NA
Question 9	It all depends on the owner's or contractor's knowledge of construction. Some are very versed, where others are not. In the commercial side of architecture, it is very rare to find an owner or contractor who doesn't understand a drawing. However, in residential architecture, many clients can't understand a drawing.
Question 10	To really answer this question, you must go back to questions 8a-8c. Time is the most dominant aspect of this profession. More time is always beneficial. The more time you have, the more time you have to coordinate a project. Not having enough time to coordinate is perhaps the most common reason for erroneous construction documents.

Engineer Responses

	1
Question 1	PM
Question 2	20+
Question 3	Structural, general construction
Question 4	25 mil
Question 5	Not bad they is certainly room for improvement
Question 6a	no
Question 6b	not_sure
Question 6c	NA
Question 7	Value Engineering
Question 8	Isometrics
Question 9	Yes if they do a better job

	2
Question 1	Steven L. Bernstein
Question 2	20+
Question 3	Mostly Private civil and landscape and surveying.
Question 4	6 mil
Question 5	Good to excellent
Question 6a	yes
Question 6b	NA

Question 6c	NA
Question 7	We have an in house QA/QC process where a senior level engineer reviews planss and specifications.
Question 8	We try not to tell the Owner too much regarding civil, site issues because in most part what we provide is required by Zoning Boards and Planning Boards, Board of Healt, Conservation Commissions. Most of the time the only variable is the typr of curbing and amounts of landscaping.
Question 9	Varies per GC/CM, we usually have full copperation.
	3
Question 1	Vice President- Director of Transportation Design Division
Question 2	20+
Question 3	My division does mostly public work. Most of my career, with another company, was in the public sector. For 38 years, I worked for a major consulting firm. Since my retirement, I work part time at my current company.
Question 4	4 mil
Question 5	They are skilled to do the assigned work. If they weren't, we would not use them.
Question 6a	sometimes
Question 6b	no
Question 6c	10-20
Question 7	I think that the questions in 6a,6b,6c are missing an essential element. The package will always be complete. The initial bid package may not be complete. However, addendas will follow to complete the scope of the project. Thus, when bids are received, they should be based on a complete package. We have a QA/QC program that applies to our delivereables. Part of the process requires reviews by senior managers who have not had a role in the development of the product. In my other firm, we used the concept of "two sets of eyes". All packages were done and checked by two different individuals.
Question 8	Specifications are probably the most difficult. The tendency is to use standard models that may not fit the particular project in total, and thus are not fully coordinated with the drawings. Traditionally, designers tend to spend more time on calculations, drawings and less on specifications.
Question 9	Yes. My view is that the more people review a set, bringing their experience and bias, will improve any set of documents. Based on my own research and experience, the most significant improvements can be achieved by having constructability reviews done by construction professionals. Studies have shown that the savings could be as high as 5 times the cost of the reviews. The review would be similar to what a contractor would do in preparing a bid. In public works, typically, a GC is not on board until after the bids are taken. The review has to be of the bid package. In private sector work, a GC could be on board prior to completion of all the design packages. You may want to focus your research to a specific segment of the the industry , ie buildings, infrastructure, public,private,design/bid/build,design/build, etc. rather than a broad generalization of a varied and complex industry with many ways of delivering a construction project.
	4
Question 1	Senior VP
Question 2	20+
Question 3	Mostly municipal client base including individual Towns as well as infrastructure agencies including MWRA, BWSC, MDC, etc. Our projects involve a wide array of civil and environmental work (with values from a few thousand to several million), most of which we do in-house, with assistance from subconsultants in specialty fields.
Question 4	29 mil

Question 5	Need to be more educated with the software that is used! Need also be educated regarding the standards normally practiced by plan production staff!
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	Drawings that are created are reviewed by the plan production supervisor for format, accuracy of presentation, content and adequacy with the historic standards of the Client. Prior to going to bid, drawings are reviewed by the project manager or engineer, although not to the extent sometimes that they should be reviewed! Regarding the above time criteria, there is often not enough time budgeted to conduct thorough (and objective) reviews by qualified staff.
Question 8	Sometimes clients will ask for details that are not always necessary to construct a project. In some cases, the details limit any creative options that could be done during construction to meet the intent of the project and save the Client money! [Contractors will often propose modifications to the design (bidding documents) that will result in meeting the functional intent of the work, at a lower cost to the Contractor. Sometimes these savings get passed on to the Owner/client!]
Question 9	This is done on design-build type projects. On conventional design/bid projects, it may help for the designers to discuss and understand methods of construction with knowledgeable contractors to better design and illustrate the work with a minimum of details. In some cases though, contractors particpating in design collaboarative efforts may be precluded from bidding the work, as they could have an advantage over other prospective bidders!
	5
Question 1	Senior VP
Question 2	20+
Question 3	Public and private civil engineering site design and highway design and landscape archicture.
Question 4	13.5 mil
Question 5	Highly experienced
Question 6a	sometimes
Question 6b	no
Question 6c	30-40
Question 7	All projects are reviewed by department head for QA?QC prior to submission to client.
Question 8	The intent of environmental permitting conditions and the possibility of changes in a public agency standard.
Question 9	A GC/CM with extensive field experience can be helpful in spotting potential constructability issues and in value engineering.
	6
Question 1	PM
Question 2	5-10
Question 3	private & public civil engineering and landsurveying services.
Question 4	4-5 mil
Question 5	Good. Most civil design is basically the same once you've done a few projects. The damage lies in assuming a projects simplicity or a young designers capabilities. A cautious approach to a new project is key. Identify all the issues before deciding on the appropiate design path.
Question 6a	yes
Question 6b	NA
Question 6c	NA

Question 7	QA/QC programs involves the following: 1. Kickoff meeting with "Chief civil Engineer" to identify potential design problems and solutions. 2. A checklist and review by professional engineer not involved in said project before each submission. "Second Pair of Eyes" Policy.
Question 8	Boston permitting schedules and personalities. A project success often depends on timely permitting. Timely permitting typically requires that the site design be 95-100% complete by the end of design development (when Architects/MEPs are at 50-75% done) City review time can take days to months depending on agencies backlog and political pressure or non-pressure project has.
Question 9	Better communication. There are projects with too much communication and the civil engineer is copied every piece of coorsepondence and invited to every meeting (this drives up design costs). Then, there are projects where I never meet the design team and only get feedback/schedules, etc. when I asked or when the deadlines are imminent. The solution falls somewhere in the middle.
	7
Question 1	Proj Designer
Question 2	5-10
Question 3	We are a civil/survey company specializing in Site development both public and private sectors.
Question 4	2-5 mil
Question 5	Highly skilled
Question 6a	sometimes
Question 6b	yes
Question 6c	80-90
Question 7	We have design engineers who do most of the design and drafting then the project manager checks the work throughout the design process. Frequent project meetings are used as quality control. Finally before a document goes out it is checked by an Engineer not involved in the project for a final quality control check.
Question 8	Not particularly in general, it's very project specific. Some projects are very technical in one area making it difficult to convey accurately exactly what we are trying to accomplish. For example a project may have a very involved drainage system and sometimes the plans can get very cluttered with information making it hard to convey accurately the way the drainage system should work.
Question 9	The more involved the architect is during the design process the better the documents tend to be. Frequent coordination with the Architects is imperative to construction documents being accurate. Architects tend to make changes sometimes without letting the Engineer know until we either notice the change or the Contractor calls about discrepancies in the plans.
	8
Question 1	Chief Bridge Engineer
Question 2	20+
Question 3	public, private, mechanical, electrical, landscaping, civil, environmental, structural, almost all disciplines of civil engineering.
Question 4	300 mil
Question 5	Very skilled
Question 6a	sometimes
Question 6b	no
Question 6c	40-50
Question 7	We have a full QC procedure
Question 8	Repair work and unforeseen conditions

Question 9	Yes. We typically consult with fabricator, manufacturers, and trade associaations with regard to material and design issues. Also, we consult with contractors with regard to special construction elements.
	9
Question 1	Senior Project Director
Question 2	15-20
Question 3	Public and Private civil and transportation projects
Question 4	12 mil
Question 5	The range from very skilled to a low level of skill.
Question 6a	sometimes
Question 6b	yes
Question 6c	70-80
Question 7	We have peer reviews by staff who where not directly involved in hte design. A selerate set of eyes on each project.
Question 8	Fine details
Question 9	Tell us what works and what doesn't. Provide feedback on what makes a good set of drawings and what doesn't.
	10
Question 1	Project Engineer
Question 2	5-10
Question 3	civil public and private
Question 4	100 mil
Question 5	pretty skilled
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	review by project managers
Question 8	
Question 9	any feed back from them is always helpful
	11
Question 1	Senior Civil Engineer I
Question 2	15-20
Question 3	Civil and environmental engineering services
Question 4	20 mil
Question 5	The engineers who create drawings for the company have different qualifications and possess different skill levels. The individuals generally range from co-op engineers to engineers that have a significant number of years of experience with more than one professional engineering registration. Some of the engineers have AutoCad experience, some do not.
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	Our company employs a strict quality assurance/quality control process before contract documents are finalized for their intended use.
Question 8	No. This should not be an issue if the contract documents have been prepared accurately.
Question 9	Possibly. It would depend on the nature of the proposed construction work, and if the project deals with subject matter that is outside of the engineer's area of expertise.
	12
Question 1	Senior Staff Engineer

Question 2	15-20
Question 3	Structrual engineering, both public and private.
Question 4	20 mil
Question 5	Mostly drafters create our drawings. We have some drafter/engineers that create drawings. The skill level varies from 2 years to over 25 years worth of experience.
Question 6a	sometimes
Question 6b	no
Question 6c	50-60
Question 7	Drawings, reports, and letters are always reviewed by another engineer, unless the documents are clearly marked "DRAFT".
Question 8	No construction document will cover every possible detail on the project. On existing buildings, there are unforseen conditions. On new buildings, bid documents are issued without every single item designed. Questions will be raised during construction, and it takes time and therefore money to answer the questions.
Question 9	Remember that taking time to properly coordinate the construction doucments will save time in the long run.
	13
Question 1	Principal Structural Engineer
Question 2	10-15
Question 3	Private, structural engineering
Question 4	65000
Question 5	Myself -- moderately to very skilled
Question 6a	sometimes
Question 6b	no
Question 6c	10-20
Question 7	As a sole proprietor, on complex work, I may ask a colleague to have a second set of eyes review, but it will only be a very short, not very detailed review - only to catch glaring information. I am always aware of this issue and make sure I am double checking all of my work.
Question 8	Yes. The details are the most difficult as well as pecular construction processes.
Question 9	Yes. Having a GC on board at the design level will simplify what details are selected. Not in a design/build delivery system, but as a consultant as to how this contractor would be able to build this particular item.
	14
Question 1	Vice President
Question 2	20+
Question 3	Architecture and engineering for private clients and state and federal governments. We cover the following disciplines: Architecture, Structural Engineering, Civil Engineering, Mechanical/HVAC Engineering, Electrical Engineering, Plumbing and Fire Protection Engineering, Environmental Engineering
Question 4	9.3 mil
Question 5	We have a broad and well-balanced range of experience, from 2 years to 35 years
Question 6a	yes
Question 6b	no
Question 6c	NA

Question 7	We have a Total Quality Management Plan that specifies our QA/QC procedures. This includes an independent review of all work products (mostly drawings and specifications) by a senior engineer not involved in their production before any submittals are made to the client. We also perform a conceptual design review at about the 15% complete stage where a senior engineer reviews the concepts being developed to be sure the design team is headed in the right direction. Additionally, all design calculatsions are checked by an independent engineer.
Question 8	Usually, the design (i.e. layout of beams and columns, etc.) are straightforward. The toughest part is conveying contractual requirements, including schedule constraints, owner-specified requirements, "filed sub-bid" requirements (a peculiar Massachusetts state law requirement for getting independent bids from subcontractors for certain items), etc. It is also important to be sure that the drawings and all of the individual specification requirements are consistent and well-coordinated with each other.
Question 9	The prime consultant, usually the architect, can help by sequencing the work in a logical order. Often, in a rushed project architecture, which should precede everything else, is being done concurrently.
	15
Question 1	Senior VP
Question 2	20+
Question 3	My company performs private, public, civil site, water and wastewater design and hazardous waste assessments as well as landfill work.
Question 4	55 mil
Question 5	My company consists of a wide range of experts with varied years of experience from 0 to 30 years experience bringing to the table the ability to prepare design plans and specifications that meet today's industry standards.
Question 6a	sometimes
Question 6b	yes
Question 6c	60-70
Question 7	My company has a requirement for all studies and design projects to go thru a technical review prior to delivery. Typically this review will be conducted at various junctures throughtout the study and design process such as: 30%, 60%, 95% depending on the size of the project and the potential risk associated with the project. The review team is identified at the beginning of the project and are made part of the project kickoff meeting to ensure their understanding of the goals of the project.
Question 8	In Massachusetts the most complicated part of preparing plans and specifications for publically bid projects is the filed sub-bid requirement. If the plans and specifications are not prepared well and coordination checks are not in place you can run the risk of the general contractor and the filed sub bidder having conflicts with who is responsible for what. Also in Massachusetts publically bid projects funded by the state require that each item specified have a minimum of three vendors who can meet the requirements of the bid. This can be very difficult at times to keep up to date with vendors currently in business. Sometimes the client would like to specify their favorite vendor so we are challenged to write the spec such that the client can get what they want and still meet the bidding laws.
Question 9	Due to the nature of the bidding environment unless the GC is part of a design/build/operate team they typically do not get involved in the project until the project is bid out and the design is complete. When working on new innovative projects typically we pole contractors on their means and methods to understand what updates are occuring in the industry and to assist us in refining our plans and specs.

	16
Question 1	Asst Chief Engineer
Question 2	15-20
Question 3	Public road and bridge planning, design, construction and maintenance.
Question 4	???
Question 5	Very skilled. We generally employ (directly or through contracts) the most skilled persons in the transportation industry.
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	Formal reviews are required at various stages of the design process. A particular project would generally go through at least 3 formal reviews prior to construction; some projects go through many more reviews, depending on their complexity. Experts in each particular discipline (bridge design, traffic signal design, drainage design, etc.) are responsible for reviewing material that they are familiar with. Written comments are generated at each review phase. The entire design process, including review submission requirements, are documented in our Highway Design Manual. All designers are required to follow this process.
Question 8	Generally, no. We feel that if our design manuals are followed properly, then the construction documents will be adequate. The greatest problems usually occur when "unknowns" or latent conditions are discovered during construction. There are also occasional errors made by designers that cause problems during construction. But in general, our design process results in clear construction documents that produce fair bids and accurate construction projects.
Question 9	We believe that some sort of constuctibility review during the design process could result in higher quality construction documents. We are currently constrained by law from completing our projects in a design/build fashion, with the designer and contractor working together. Designs and contract documents must be completed first, and all construction contracts must be awarded to the lowest qualified bidder for each job. Thus, it is not possible for us to use the GC as a reviewer for work that he/she will eventually bid on. We may, however, use other persons with knowledge of construction processes to review design work.
	17
Question 1	Marketing Manager
Question 2	0-5
Question 3	Reprographics
Question 4	1 mil
Question 5	
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	
Question 8	
Question 9	From the standpoint of the reprographics house, we can not vouch for the quality of a document in relation to the project. Our main concern is receiving the documents in a timely fashion so that we can distribute them to the subcontractors. However, based on the amount of addendums we see come through our shop on the average project, we could make the assumption that most projects have addendums due to unforseen problems on the job site or within the original design.

	18
Question 1	PM
Question 2	20+
Question 3	Water and wastewater consulting primarily for large municiplaities and water/sewer authorities
Question 4	2 bil +
Question 5	Highly skilled and specialized
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	All our projects go through a formal QA/QC process
Question 8	It is difficult to properly allocate risk items between the engineer, owner and contractor.
Question 9	It is often helpful to have constructability reviews from a General Contractor
	19
Question 1	Officer-in-charge
Question 2	20+
Question 3	geotechnical engineering on public infrastructure and private buildings and site development projects
Question 4	80 mil
Question 5	Our drawings are created by a team of an engineer and CAD operators. They are skilled in what they do and have QA/QC provided on each and every project by the Officer-in-charge of the project
Question 6a	sometimes
Question 6b	NA
Question 6c	90-100
Question 7	Project teams are headed by project managers who are overseen from a QA/QC perspective by an Officer-in-charge. On large, complex projects, occasionally technical peer review teams are organized to review several aspects of a project which sometimes include construction documents.
Question 8	The potential underground risk associated with differing site conditions is particulary difficult to communicate and depends heavily on how educated owners are on managing risk associated with the ground.
Question 9	Yes. Constructibility reviews of projects are helpful in improving the quality of construction documents and beneficial in educating owners on the realities of managing underground risk.
	20
Question 1	Senior PM
Question 2	15-20
Question 3	We do design and construction of all disiplines (architectural, mech, elect, structural). We are a private non-profit institution that self performs our design and manages all construction with in house project managers.
Question 4	45 mil
Question 5	Our in-house designers are very skilled. At times (for large projects or disciplines that we do not have on staff) we contract with outside firms for services. The majority of the engineers we deal with are very skilled.
Question 6a	sometimes
Question 6b	yes
Question 6c	50-60

Question 7	We try to implement a type of QA/QC review in which the design team and project managers meet prior to a project being bid to review the documents in an attempt at providing complete documents. Many times our documents will go to bidders without finish schedules for interior work. When this happens, we carry allowances for various items that are not finalized.
Question 8	Mostly it is the owners specific requirements related to the institution in which the work is to be performed. A good contractor typically has the skill to interpret construction documents.
Question 9	I think that having the entire team (ie. designers, construction manaagers and GC) on board during the design process is a means to providing a quality set of documents. Unfortunately, this does not happen often. The team building the project may be able to provide input regarding means and methods that the design team is not familar with, saving money and time on the project.
	21
Question 1	Principal
Question 2	20+
Question 3	structural and geotechnical design of buildings
Question 4	1.8 mil
Question 5	with appropriate supervision that are very competent
Question 6a	sometimes
Question 6b	NA
Question 6c	30-40
Question 7	independent review by Principal or Project Manager notworking on that particular project
Question 8	not on our projects ususally
Question 9	Dimension responsiblity- Dimension drawings and establish grid at beginning of project and keep design team informed of revisions. Docuement and inform of us changes on updated electronic progress drawings.
	22
Question 1	VP
Question 2	20+
Question 3	Public transportation projects (roadways, tunnels, bridges, railroads)
Question 4	300 mil
Question 5	very skilled
Question 6a	sometimes
Question 6b	yes
Question 6c	70-80
Question 7	QA/QC reviews in additionto detailed checking
Question 8	Construction staging, sequencing
Question 9	Yes -- by asserting less claims
	23
Question 1	Supervising Engineer
Question 2	20+
Question 3	Mechanical, electrical, plumbing, fire protection and elevator consulting engineering
Question 4	3.5 mil
Question 5	They are considered to be the best in the business
Question 6a	sometimes
Question 6b	yes
Question 6c	30-40
Question 7	All projects are checked by an engineer who was not involved in the project.
Question 8	The intended operation for the equipment that was specified and installed.

Question 9	Allow the proper amount of time for our work to be executed which generally means we need time after the architect is complete with their work.
	24
Question 1	Chief Engineer
Question 2	20+
Question 3	Transportation, Land Development and Environmental Services for a variety of public and private clients. My work involves working with the Land Engineering group, a group of 65 contained within the Land Development Section a group of approximately 110 in size.
Question 4	80 mil
Question 5	All varies with experience level. We try to structure teams which combine staff with 4 to 8 years of experience with those with lesser years experience. With that type of structure the documents are in solid shape before they undergo the final independent QC review.
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	Each project undergoes an independent QA/QC review by one of three senior staff members each having over 25 years of experience prior to the documents being issued for permitting (Site Plan, Zoning Board of Appeals, Subdivision, Board of Health etc) or issued for construction.
Question 8	The simple answer is to ask the design engineer(s) in the review is what is in their head in the design intent CLEARLY depicted on the documents. There is no reason that all issues can be clearly depicted
Question 9	I feel many architects (sorry to generalize) do not provide sufficient time for proper coordination to be completed between the MEP and site/civil engineer.
	25
Question 1	President
Question 2	20+
Question 3	Mechanical design for public & private clients
Question 4	$850,000
Question 5	In order to produce biddable, constructable documents, especially for the public sector, the engineers need to be highly skilled.
Question 6a	sometimes
Question 6b	no
Question 6c	50-60
Question 7	I attempt to perform a complete QA/QC review of all documents that have my stamp on them (virtually everything we do). I try to accomplish this at or near the end of the design process, before going to bid, in order to prevent any errors or omissions from appearing on or in the documents.
Question 8	There shouldn't be if you are are skilled at what you do. If proper communication doesn't exist between the Owner & the Engineer when the project is being designed, then the Owner will not be happy with the results; if proper communication doesn't exist between the Engineer & the contractor (through the bid documents), the systems will not meet the design intent, and nobody is happy. If the engineer knows what questions to ask the Owner during the design, and can effectively communicate these ideas on the bid documents to the Contractor, things usually will go smoothly, and everyone gets what they want.

Question 9	Absolutely. Communication is a key, and so is timely exchange of information. The design team must be on the same page regarding satisfying the Owners requirements and expectations, while remaining in budget. If time constraints for the design period weren't as tight as they typically get to be, the design of the building structure & shell could be finialized before the infrastructure (HVAC, plumbing, fire protection, electrical) were completed, so that space for chases, equipment, etc. could be worked out, and adequate time would be available to complete the design. Too often, the building and the spaces inside evolve right up to the time the design goes out to bid. If Owners and the design team worked together in this area, the quality of construction documents would improve.
	26
Question 1	Principal, Manager of MEP
Question 2	20+
Question 3	Commercial, Industrial, Institutional, Retail
Question 4	12 mil
Question 5	very
Question 6a	sometimes
Question 6b	no
Question 6c	80-90
Question 7	Quality reviews at the begining, middle and end of the project.
Question 8	The necessity and interaction of the multitude of conflicting requirements including technical, cost, user and builder preferences
Question 9	Architects could make the design process more inclusive to inform the engineer early about the goals stated and unstated of the project. Get the engineer involved early to conceptualize the project and the approach and the compromises.
	27
Question 1	Senior Engineer
Question 2	5-10
Question 3	We design Intelligent Transportation Systems for municipalities such as State of New York, Washington, DC, and Detroit, MI. Additionally, our company performs many traffic studies and roadway improvements for private companies such as Home Depot.
Question 4	don't know
Question 5	Our engineers are very skilled at the engineering behind the drawings we create. Since most of our clients are municipalities who have multiple consultants working for them, they have a pretty formal standards policy to follow when preparing plans and specification packages.
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	Most of our packages go through a 30%, 65%, 95%, and final submittal process before they are approved by the client to be bid upon by a contractor. At each stage of completion, we request that the client review for accuracy, completeness, and quality. Of course, prior to any submittal, we have an internal review of the drawings and specifications performed by our senior project managers who typically have 20 years of experience in the field.
Question 8	The most difficult aspect of the design to communicate is the visualization of the end product. As engineers we are trained to look at two dimensional representations of a top view, side view, and front view and picture it in three dimension in our head. Our clients don't have this advantage.

Question 9	There should be more oversight and reviews by a contractor because they are the sargeant in the field. However, because of the bid process this would be seen as an unfair advantage. Currently, none of our clients have a medium to pay for an independent review by an unbiased contractor.
	28
Question 1	Director, IT
Question 2	20+
Question 3	70% public - environmental, transportation, site dev., and general civil.
Question 4	40 mil
Question 5	Moderately skilled - younger ones are more focused on technology (software skills) than they are on drawing organization, aesthetics, content, and other quality issues.
Question 6a	sometimes
Question 6b	yes
Question 6c	50-60
Question 7	Drawings are supposed to be checked by the Project Engr. and signed off. All too often this is skipped to meet deadlines, or they are only checked to be sure nothing major is missing.
Question 8	Unfortuneately, what needs to be communicated to the owner is significantly different than what the contractor needs to know. The owner would rather see rendered 3D models, so they can visualize the finished facility. The contractor needs to know dimensions and material quantities so they can bid and construct the facility. Most constr. docs. are much better suited for contractors than owners. But models built for visualization by the owner are of almost no use when producing 2D constr. dwgs.
Question 9	There have been several initiatives to develop and promote an industry-wide standard (Natl. CAD Std. (NCS) for one) - but they are rarely mandated and engrs. always find reasons for creating dwgs. with their own in-house standard. This complicates coordination with other engineers, with review agencies, and with contractors. Widespread acceptance won't happen until either the 2 major CAD developers implement a NCS interface, until public agencies mandate (and enforce) NCS use, or both.
	29
Question 1	Senior CAD Administrator
Question 2	10-15
Question 3	Civil and Structural Engineering
Question 4	60 mil
Question 5	6 out of a possible 10. We hire good entry level techs, but we are not recognizing the full potential of the technology that we are using.
Question 6a	sometimes
Question 6b	no
Question 6c	70-80
Question 7	Depending on the client we may have serveral internal reviews on any one project. At a minimum we have at least one internal in-house review, before the project is delevered.
Question 8	Can not think of any one aspect that is more or less difficult than another.
Question 9	Improved communication
	30
Question 1	PM
Question 2	5-10
Question 3	Mechanical, Electrical, Plumbing Design. The breakdown of work is typically 75%-Municipal 25% Private
Question 4	6 mil
Question 5	Very good techinical knowledge with adequate CAD ability

Question 6a	sometimes
Question 6b	yes
Question 6c	70-80
Question 7	Use a peer process to let senior level staff review the projects that are presented by the younger engineers resposible for design
Question 8	Cost versus quality
Question 9	Provide adequate time to incorporate changes
	31
Question 1	Traffic Engineering Manager
Question 2	15-20
Question 3	95% public works, civil engineering. I prepare and supervise electrical and signal plans for street and highway improvements.
Question 4	40 mil
Question 5	Tend to be ex-agency employees, very skilled. We also hire the college graduates, but prefer a 2-3 years of experience in design engineering.
Question 6a	no
Question 6b	yes
Question 6c	NA
Question 7	The review process is not a separate process, its not independant, client's review our work, then we respond to their comments. We should have an independant review before it goes to the client, but often this is not the case. The flow of information frequently does not stop until the "Print" button is clicked. I think your research is interesting.
Question 8	Not sure how to answer at this point.
Question 9	We have constructibility reviews for some projects, and value engineering on others.
	32
Question 1	Executive Vice President
Question 2	20+
Question 3	Approximately 50% of our work is in the public sector. We design MEP/FP and minor structural systems for buidings.
Question 4	2 mil
Question 5	The engineers are very skilled and average more than 35 years experience
Question 6a	sometimes
Question 6b	yes
Question 6c	60-70
Question 7	Chief engineers for each trade review and check the construction documents prior to issue. The principal in charge then does a cursory review with the project manager.
Question 8	In public work (filed sub-bid) coordination between the sub trades is difficult. On private project the General Contractor is held responsible. On public projects the level of detail required in the construction documents to adequately cover inter-trade coordination is excessive.
Question 9	For public projects only if the filed sub bid laws were changed.
	33
Question 1	Lead CAD technician
Question 2	20+
Question 3	Structural, Civil, Fire and enviromental
Question 4	don't know
Question 5	Average to Good
Question 6a	sometimes
Question 6b	no

Question 6c	80-90
Question 7	Quality assurance system
Question 8	
Question 9	Better communication and reduction of design variations late in the project
	34
Question 1	PM
Question 2	20+
Question 3	Full service architectural/engineering services including water, wastewater, hazardous waste, solid waste, etc. for public, private, and federal clients
Question 4	600 mil
Question 5	Very satisfactory....a team effort of young to senior engineers with regular design checks and QA.
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	Typically: 30%/60%/90%
Question 8	Occasionally the use of new technologies as part of a remediation project will require bench scale testing prior to full scale implementation. The cost of this effort and schedule require educating the client and contractor to the design approach. Constructibility reviews are of assistance. Regulatory changes during construction are also difficult. This is particularly true for multi-year construction projects.
Question 9	During construction, regular (monthly or every other week) technical issues meetings are helpful to collaborate ideas and address issues in a timely manner. Construction details can be worked out if unclear. For future projects, the field information (aka design changes) needs to be conveyed back to the home office or wherever the design originated.
	35
Question 1	Director of Structural Engineering
Question 2	20+
Question 3	We do a wide range of transportation and building-related projects. In transportation, we do highway, traffic, bridge, rail, and airport design, as well as transportation planning and environmental permitting. We do site design and landscape architecture for developments and individual building sites. For buildings, we also provide architectural, mechanical, electrical, and structural design services. We also do provide a variety of telecommunications ervices including design for cell tower sites, to roof-mounted antennas, fiber optic cable installation, etc. Our clients are from both the private and public sectors, with the public sector being larger.
Question 4	180 mil
Question 5	There is a wide range from highly skilled to new graduates. The key is who is responsible for the work, namely the project managers and department heads, who are responsible for ensuring the proper QA/QC procedures are followed before any set of documents leave the office. Since the majority of our work is repeat business, I believe that reflects well on the skill of the engineers doing the work and that the necessary checking is done prior to submittal to the client.
Question 6a	yes
Question 6b	no
Question 6c	NA

Question 7	There is a formal QA/QC manual for the company. The actual implementation depends on the specific project. In my department, which performs primarily bridge design, all calculations receive a direct check by a second engineer. In some cases, such as for the Massachusetts Highway Department, two independent sets of calculations are required. For the contract plans, the design engineer performs a check of the plans after the CAD operator prepares the plans. A senior engineer, sometimes it is the project manager or department head, performs an independent review after the design engineer has checked the plans.
Question 8	An area of confusion often can be temporary work, such as temporary support of excavation, or other temporary bracing. If the actual design of the temporary elements is left up to the contractor, then it is critical that the design requirements for those temporary elements be clearly spelled out on the drawings or in the specifications. Also, if the design was based on a particular sequence of construction, the documents must clearly relate that information, because otherwise the contractor will not know.
Question 9	I do not deal with many GC/CM situations. Our typical process for bridge work with a public agency is that we do the design, it is reviewed by the client, and then put out for bid. The low bidder gets the job, which doesn't always mean the most qualified contractor. Therefore, it is critical that our documents be a clear and free from error as possible to reduce the possibility of extra work claims during construction. The very nature of the low bid process means that it is very likely the contractor may have underbid some item and will look for any means to additional money during construction, either from claims of extra work or the work not being clearly spelled out in the documents.
	36
Question 1	Senior PM
Question 2	15-20
Question 3	geotechnical, environmental, geocivil, remediation, hydrogeo, laboratory (geo and enviro), air quality, asbestos and lead services, etc... for both public and private clients
Question 4	73.6 mil
Question 5	They're skills are suited to our needs
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	We have a very good system of checks in place. A PM reviews the documents, gives them to a PIC for review, and gets input from a consultant reviewer prior to issuing documents. This is part of our loss prevention program that we have had for many years.
Question 8	Sometimes, it is difficult for owners, architects and contractors to realize that spending extra money up front during the investigation phase of a project has the potential to save a lot of money later. There is pressure to do designs for less money. The Architect may feel he is saving the Owner's money by not spending additional money up front, however, in many cases, the extra money is needed to properly address the risks on a job.
Question 9	Keep the initial design team involved throughout initial design, final design and construction instead of getting low bids on design and construction phases of the work. There needs to be consistency throughout a project to make it successful and to limit risk to the Owner. The firms involved during design need to see that the work is performed in accordance with the design and that the actual subsurface conditions are consistent with the subsurface conditions assumed during design.
	37
Question 1	PM
Question 2	10-15

Question 3	Public, private, civil, structural, telecommunications, environmental, site development, transportation planning and design, water/wastewater design, design build work
Question 4	25-30 mil
Question 5	Very skilled, on a scale of 1-10 I would say 8.
Question 6a	sometimes
Question 6b	no
Question 6c	60-70
Question 7	Company has a QA/QC process which includes a constructability review as well as a peer project review process. Personally I conduct QA/QC design and constructability reviews at 50% design, 75% design and 90% design and 100% submittal for stormwater system design, sewer rehabilitation design and water rehabilitation design in dense urban streets usually laden with numerous utilities.
Question 8	The complexity of the potential utility impacts due to insufficient or unreliable record plan information provided by utility companies.
Question 9	We include proposed test pit and design verification language and work in the contract documents in order for the contractor and CM to verify the proposed design within the complex areas. Test pits offer additional information regarding utility locations, duct bank configurations, elevations and manhole sizes not usually depicted on plans or evident from field inspection. We also include vacuum excavation in teh design phase to help obtain specific information on existing utilities and their locations to better depict these conduits on the design plans and to help design around potential conflicts to help minimize potential costly construction claims.
	38
Question 1	President
Question 2	15-20
Question 3	Civil and Structural Engineering for both public and private sectors. Construction Inspections also.
Question 4	<100000
Question 5	Ver good.
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	I personally review all calculations, drawings and specifications before sending them out to the clients.
Question 8	Both owners and contractors have a tendency to criticize a design (in the name of cost savings!).
Question 9	Yes. But that will only happen when their is a balance between Cost Reduction and Quality. In present days, Cost Reduction is the main driving force.
	39
Question 1	Senior Structural Engineer
Question 2	10-15
Question 3	My company performs a very large variety of work for both public and private clients. Our experience varies widely and includes surface transportation, air transportation, facilities, environmental, hazardous waste and heavy industry related work.
Question 4	2.3 bil
Question 5	
Question 6a	sometimes
Question 6b	no
Question 6c	80-90

Question 7	The company has a formal QA/QC process which all projects, regardless of size, must follow. This process is tailored to the type of project, but typically includes Design Coordination Reviews, Detailed Checks and Independent Technical Reviews to ensure the completeness of contract documents.
Question 8	No
Question 9	At times, yes. GC could give input on the constructability of design aspects, although, oftentimes the input tends towards cost saving measures instead of alternate construction practices without sacrificing quality. I personally do not have extensive experience on projects where an architect is involved.
	40
Question 1	Northeast Region Operations Manager
Question 2	15-20
Question 3	We are a full service engineering firm providing all types of engineering services.
Question 4	4.5 bil
Question 5	Our engineers are very competent, but each level of engineer in the organization requires oversight by the next higher level to ensure quality control.
Question 6a	sometimes
Question 6b	no
Question 6c	60-70
Question 7	Our firm has a formal QA/QC process which requires a complete review of the documents by a reviewer before the documents are sealed for construction.
Question 8	I personally have found that most Error and Ommission problems during construction result from changes to the design documents at the end of the design process. In this situation, it is sometimes difficult to properly evaluate the impact of a change to other parts of the design. I also believe that the ability to quickly modify designs on CAD has impacted the design process. Owners and clients are more likely to ask for major changes to the design during the 90% review process which increases the probability of errors and ommissions.
Question 9	The current structure of the construction industry rewards contractors that find errors or ommissions during the bid process. They are able to weight their bids to win contracts, knowing that they will claim extra work for the unclear documents. I do not blame the contractors for this situation. The construction bidding process is flawed and it is difficult for reputable contractors to success in this business climate.
	41
Question 1	Senior Associate
Question 2	20+
Question 3	Civil/Structural Engineering - Public & Private Clients
Question 4	25 mil
Question 5	The engineers who actually produce the CADD drawings are generally the younger engineers who do not have many years of experience (1-7 years. However they are supervised by very qualified engineers.
Question 6a	sometimes
Question 6b	yes
Question 6c	60-70
Question 7	We have a quality assurance/quality control plan that has several steps. 1. All drawings and calculations are independently checked and signed off. 2. After step one, a separate quality control review is done by another independent senior person. This is not a detail check, but rather a big picture check to make sure that nothing gross is missed.

Question 8	Limitations of construction are very often sources of contractor claims. These are sometimes difficult to communicate. Another general problem is coordination of multi-discipline projects between design disciplines (architects, engineers, landscape architects, etc.)
Question 9	Yes. Much more time needs to be spent coordinating disciplines. It is a constant source of contractor claims.
	42
Question 1	Senior PM
Question 2	15-20
Question 3	The firm is a nationwide corporation that contracts with allentities and in many disciplines. Locally, we serve both public and private clients, primarily in the fields of Tansporation and Environmental services.
Question 4	1 bil
Question 5	Average
Question 6a	sometimes
Question 6b	yes
Question 6c	NA
Question 7	THe firm has a formal review process in place for detailed checking by a peer, and independent technical reviews by senoir professionals.
Question 8	Generally problems occur when there are linkages to other adjacent or overlapping contracts - integrating milestones and providing sufficient work zones, etc.
Question 9	Perhaps
	43
Question 1	Chief Engineer
Question 2	20+
Question 3	Mostly public work involving transportation, including highways, bridges, and transit.
Question 4	6.5 mil
Question 5	There are varying levels of skills within our company. Many engineers are very adept at creating drawings while others primarily focus on the development of design calculations. Overall we find the ones that can do both are most useful to our office. We are also very fortunate that we have some senior level drafters that can work with little supervision in the development of drawings.
Question 6a	sometimes
Question 6b	yes
Question 6c	70-80
Question 7	When time allows we generally conduct indepentent technical reviews of the drawings, followed by a Quality Assurance review by one of the senior staff or managers. In many instances, we conduct reviews by other offices in the organization. This gives us the best oppportunity to catch any errors that might exist. At time when such reviews are not allowed due to time constraints, we normally perform such reviews after the product has been submitted. If errors are detected, we inform the client as they are discovered.
Question 8	Not really. Sometimes it is difficult to show complex detailing in 2 dimensional views as is typically done, but this usually requires that multiple views be included or additional detailing of smaller components be provided. Unfortunately, you can't always include all details that you'd like, so it's important to include the ones that are needed. We typically do not include methods to be used by the contractor for construction because each contractor has its own equipment and methods. This is left to the contractor to decide.
Question 9	It's important to have a GC/CM that is willing to work cooperatively with the designer and vice versa. It's inevitable that items will be missed or misinterpreted. Once the various parties react defensively, progress can be slowed to a crawl.

	44
Question 1	Supervising Engineer
Question 2	10-15
Question 3	Municipal, industrial, and Federal clients Full service (Civil, Environmental, Mechanical process, HVAC, Electrical, Instrumentation)**suggest reviewing our website for specifics: www.mwhglobal.com
Question 4	750 mil - 1 bil
Question 5	Our engineers are technically competent.
Question 6a	sometimes
Question 6b	yes
Question 6c	50-60
Question 7	We adhere to very strict QA/QC procedures with several stages of internal and external project team reviews. We typically start with corporate standards and revise them to suit specific project needs. Reliance on staff with appropriate experience (i.e. years and product based) is critical to success.
Question 8	Design intent is rarely transferred. This often leads to misconceptions by the construction contractor and subsequently requires the expenditure of excessive effort by the engineer to help the contractor understand this intent. There is usually an adverse cost/schedule impact that the contractor may be forced to assume since it may differ from his implementation plan that he mentally understood during bidding.
Question 9	While the use of more industry standardized documents might prove helpful, owners and engineers will always be looking to improve the quality of construction products delivered. Quality documents tend to be those that have been proven through the successful implementation during construction; however, they are still going to be subject to interpretation by the various members of the construction and engineering teams. It is important to understand the existing roles/relationships that exist with owners in the marketplace(i.e. General Contractors, Construction Managers, Architects, Engineers, Filed-SubBidders, design builders, etc. all have discrete roles in the process and while each is capable of positively/negatively impacting the overall outcome of the construction project not all parties can impact document quality.).
	45
Question 1	Principal Engineer
Question 2	15-20
Question 3	Consulting services: water and wastewater planning, design and construction, water resources, stormwater management, ododr control, program management
Question 4	500-800 mil
Question 5	Our designer's have the necessary skills to create drawings under the direct supervision of the project manager and project enggineer.
Question 6a	sometimes
Question 6b	yes
Question 6c	80-90
Question 7	The company has standard QA/QC procedures for review of drawings and specifications at each stage of development, i.e., predesign, 50%-75% complete, 100% complete and bidding.
Question 8	As long as appropriate details are provided that clearly indicate the designer's intent, then communication between owners and contractors is generally good. When important details are omitted, change orders from the contractor usually occur.
Question 9	General discussions and review of major design components with a general contractor and specialty contractors during the early stages of a design can help identify potential issues.

	46
Question 1	Standards Engineer
Question 2	20+
Question 3	Environmental (water, wastewater, etc.), multitrade construction lasting several years in construction
Question 4	650 mil
Question 5	very highly skilled
Question 6a	sometimes
Question 6b	no
Question 6c	30-40
Question 7	Each of our operating units has its own process, but generally each one has a skilled person not involved in the project checking the work in detail.
Question 8	Lack of perfection! Both owners and contractors seem to think our designs should be perfect in every nuance and detail, and when they are not, the owner or contractor think we should fix the problem for them.
Question 9	In the Design/Bid/Build sequence for governmental work, the GC and CM are typically not known until after design is finished. The architect is generally on the design team, and can contribute most by being a team player. After creating the highest quality construction documents we can for what we are paid in design, we switch our concern for the quality of the finished facility. During the construction process, the GC/CM/architect (and the owner) can help most by taking the attitude that each must allow some give and take for the betterment of the project. We all do this and achieve a win/win/win/win project.
	47
Question 1	Project Manager
Question 2	15-20
Question 3	Public amd Private, Transportation, Architecture, Structural
Question 4	500 mil
Question 5	Very. I have recently written an artiche in Concrete International Nov 2002 on this topic called "Don't Blame the Computer." I would be happy to send you a copy.
Question 6a	yes
Question 6b	no
Question 6c	NA
Question 7	Every design and drawing is independentry checked, initialed and dated by a second engineer. An independent review is usually done at the end for major projects.
Question 8	Levels of risk invloved with varius forms of construction.
Question 9	yes
	48
Question 1	President
Question 2	20+
Question 3	Structural Engineering for Public and Private clients, architects, developers and Consulting Firms.
Question 4	200,000
Question 5	Very skilled - As only employee and a P.E. I prepare the drawings myself.
Question 6a	yes
Question 6b	NA
Question 6c	90-100
Question 7	Depending on the size of the project I will sometimes ask an independent Engineer to review my work.
Question 8	Detail specs are the hardest. It's hard to get the Contractor's to look at them carefully.

Question 9	N/A
	49
Question 1	Principal
Question 2	15-20
Question 3	civil, structural, electrical, transportation, CM, survey, landscape architecture
Question 4	not public
Question 5	ver skilled
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	qa/qc by independent senior professionals at various stages of design completion and oversight by independent professionals throughout the entire design process.
Question 8	no
Question 9	question 6 seems to be a key question or the crux of your inquiry. i think that your inclination in this regard is a bit flawed. engineers are by nature very thorough and ethical professionals, due in large part to their intense training/education and the high level of life safety responsibility they posses with most projects. therefore, your survey should not be based in time but rather in money. it is not lack of time that influences lower quality but the competitive nature of the business environment between owners and consultants that influences quality the most. selection of designers is in many public cases based on quality and not price. however, this practice is mainly a theoretical one where the large majority of owners strive to select by quality but in reality end up deferring to price. this automatically leads without fail to pressure on the successful firm (in this argument, the low bidder) to perform all the work that the client requested for the smallest ppossible fee. in many cases, the competitive nature of business forces some firms to take on projects for prices where they compromise their ability to break even on the job. this of course does eventually reflect itself in time, however, in this discussion, the detraction is not originating in time but is originating in money. i have heard very theorectical discussions (translation, those not taken seriously) where from an ideal perspective, it would be best for public infrastructure projects to be designed in full by the owner (the government) in an environment where cost was not the primary motivating factor. this is not to say that design in this scenario should be set free to cost as much as it wants, but it means that it would not be as closely linked to the final designed product. in this case, the primary motivating factor would return to its righful place, that of public safety, longevity, and cost effectiveness in construction (smart designs). in practice, this idea would also need a shift of mentality to succeed because even an agency that designs its own products would need to have a backbone that does not use cost as its benchmark. a case in point might be NASA although i am not sure about this. you are welcome to contact me to discuss these ideas further. if you want to use this material, however, you will need to quote me and reference my name in your document. i would be happy to help you develop the ideas more fully. this could also be a risky proposition since this concept is a dramatic departure from how things are presently done and may not be embraced by all as a good idea.
	50
Question 1	Principal
Question 2	20+
Question 3	Structural Engineering for building structures. Mostly institutional buildings for hospitals and universities, with some commercial office and residential mixed in.
Question 4	30 mil

Question 5	Our drawings are generally created by professional drafters, with some help from engineers trained in CAD as we approach deadlines. The drafters have varying degrees of skill based on their level of experience. The engineers often are good at using the software, but we need to teach them our presentation standards, such as line weights, layers used for various items, etc. The combination of professional drafters with time-critical help from engineers is working well.
Question 6a	sometimes
Question 6b	not_sure
Question 6c	50-60
Question 7	We have planned drawing reviews at various project stages. In the final days approaching a deadline, changes and additions are verified by the engineers working on the job and the project manager.
Question 8	None that are new or unmanageable. The biggest issues that cause delays or change orders are related to coordination with the architect and the other engineering consultants. We rarely miss scope items, and our own work is most often internally consistent. If the project schedule is too tight, which happens frequently, the coordination suffers.
Question 9	If architects could allow the final stages of the Construction Document Phase of a project to be devoted to production of details and coordination, then Contract Documents would be improved. Too often design changes are still occuring as the drawings are going out the door, so coordination can not occur.
	51
Question 1	New England Transportation Manager
Question 2	20+
Question 3	All. We work for Federal, State and Municipal governments, as well as a broad array of private sector clients (industry, commercial, and institutional). Our primary areas are Civil (in all forms), Structural, Environmental, Architectural, Landscape Architecture and so on.
Question 4	1.3 bil
Question 5	
Question 6a	yes
Question 6b	NA
Question 6c	80-90
Question 7	Teams do ongong reviews / checks over the course of design development. We also do formal Design Reviews of projects at milestones / product delivery times. These are done by independent eyes.
Question 8	As far as Owners, there is a need for them to support adequate design budgets/fees. Also that they Qualification Based Selection when they select their consultant team.
Question 9	Yes in certain cases. We have folks skilled in CM in the firm. These folks are available to review and provide input on the more complex projects
	52
Question 1	CAD Designer
Question 2	0-5
Question 3	Public/Private, Civil Site and Roadway design Survey
Question 4	4 mil
Question 5	Fairly Skilled, They're very good engineers, but not the best draftsmen.
Question 6a	sometimes
Question 6b	yes
Question 6c	80-90
Question 7	CAD Design, Project Manager, and Chief Engineer all review documents

Question 8	Sometimes the existing conditions are very crucial to the design, and field verification is necessary
Question 9	Yes, CG/CM could provide field verification in a timely fashion.
	53
Question 1	Project Manager
Question 2	10-15
Question 3	Geotecnhical consulting firm
Question 4	3 mil
Question 5	N/A
Question 6a	sometimes
Question 6b	no
Question 6c	60-70
Question 7	I am not sure I understand this question. Are you referring to in-house review of documents before they are sent to a client or the final plans and specifications. Assuming final plans and specifications, we prefer to review the final deisgn and construction documents to assess if our design intent has been properly interpreted and included.
Question 8	
Question 9	If GC/CM and architects understood geotechnical engineers' roll in design and construction, they could certaintly improve the quality of construction related documents. However, this is generally not the case. This is particullarly true on small projects.
	54
Question 1	Project Manager
Question 2	05-10
Question 3	Public and Private Structural Engineering Consulting.
Question 4	don't know
Question 5	The drawings are physically created by draftspersons (cad operators). The engineeris design and mark-up the information to be presented in the drawings. In my opinion the staff of the company is highly competent in the preparation of contract documents considering the time and money limitations that exist relative to the preparation of the documents.
Question 6a	sometimes
Question 6b	yes
Question 6c	10-20
Question 7	CASE has a recommended list of items that must be presented in the structural contract documents. There is no specific company review, but each engineer and production manager has their own review process. In the last year we have been working to create a list of minimum nessesary information that must be presented on the documents and who can provide that information, for example the engineers must design the beam, but the production department can determine the pitching of the steel for drainage.

Question 8	Structural steel buildings are usually easily understood, and there is a clear shop-drawing process where the engineer has time verify that the design intent has been followed by the steel detailer. The concrete portions of buildings seem to be mis-interpreted slightly more but again the shop drawing process will indicate if the detailer understands the design intent. Masonry and wood construction seem to have the most problems because shop drawings are not common and the masons and carpenters are usually set in their ways and they tend to ignore or not coprehend special requirements that have been included in the documents. The extensive testing requirements that have been added to the MA building code have facilitated more time in the field for the engineer of record to verify that the work is being performed in accordance with the orginal design intent.
Question 9	GC/CM that are brought in early in the design process and take the process seriously can make suggestions as to cost and constructability issues that can speed the design and detailing of a project. Architects need to bring the engineers into design mix earlier because many times the architect has created a nice looking building but they have not planned for the structure or left any space for structure. The structure and architecture of a building must go hand-in-hand but this is forgotten on the east coast because structure is eventually hidden in the final building and environmental impacts such as earthquakes are not as critical to the building design as they are in areas like California. Architectural changes during the design process impact the quality of the construction documents since the changes are made without informing the engineer or without sufficient time to redesign for the changes which leads to addendums after the project has gone to bid that appear to be the engieers fault but are really due to the architect changing their mind.
	55
Question 1	Senior Engineer
Question 2	10-15
Question 3	public, private civil and landscaping
Question 4	24 mil
Question 5	Very
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	Senior Technical Review by a committee of senior professional engineers
Question 8	sometimes piping and sepcific details of special items
Question 9	better communication prior to the design phase
	56
Question 1	Vice President
Question 2	20+
Question 3	Geotechnical Engineering for both public and private sector, and Environmental Remediation for the private sector.
Question 4	76 mil
Question 5	We have graphic specialists who are well versed with CAD. They are not engineers. Typically we create only geotechnical related drawings. Engineers oversee the development of the drawings by our graphic specialists.
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	Our engineers will review drawings as necessary and give markups to our graphics people to make the revcisions. Some of our engineers can make the revisions themselves. An officer of the company will review the final work product before it is sent to the client.
Question 8	Nothing comes to mind.

Question 9	N/A
	57
Question 1	Director of Transportation Eng
Question 2	20+
Question 3	Public and private sector work including Environmental Engineering, Environmental Sciences, Transportation Engineering and Planning, Rail and Transit, Civil, Structural, Commercial and Industrial Site Planning and Engineering..etc..(full range of services)
Question 4	90 mil
Question 5	Very highly skilled, We have recruited and retained only the best.
Question 6a	yes
Question 6b	NA
Question 6c	NA
Question 7	Daily checking of work by supervisors and periodic QA and QC reviews in accordance with corporate policy.
Question 8	Geotechnical and foundation conditions are the most difficult.
Question 9	Quality does not happen by chance. Quality only happens when a firm has a deliberate and dedicated quality program. Mandated.
	58
Question 1	President
Question 2	10-15
Question 3	95% Private work - 5% Public work HVAC, Plumbing, Electrical and Fire Protection Engineering Building Design and Code Consulting
Question 4	5.5 mil
Question 5	Skilled to very skilled
Question 6a	sometimes
Question 6b	not_sure
Question 6c	70-80
Question 7	We have a quality control program however sometimes there is not enough time to do full additional reviews.
Question 8	Not really
Question 9	Yes, we get our drawing from the architect and the advent of CADD allows them to change theit drawings quickly so it is just to tempting for them to keep changing them up until the due date which causes a lot of problems for us because of we routinely get new (changed)drawings the day before the job is due we do not have enough time to complete the necessary changes. This causes out engineers to work overtime to get the jobs done on a regular basis and cost us a lot of money. Also there are many different cadd software packages out there and sometimes we spend a lot of time (money) converting the files into a form that we can use them.
	59
Question 1	Senior VP
Question 2	20+
Question 3	90% public, 10% private. Civil/site, water/wastewater, solid wastes, hazardous wastes, GIS, landscape architecture, structural, roads and bridges, mechanical
Question 4	20 mil
Question 5	Skills vary with experience. Our biggest challenge is for the most skilled to have enough time to check the work of the lesser skilled engineers who do the most work on the projects.
Question 6a	yes
Question 6b	NA
Question 6c	NA

Question 7	We have two types of review - 1. Project managers and licensed PE's are supposed to review all documents thoroughly before they are delivered to the client for review. 2. We have an independent technical review that is supposed to be performed for biddability and constructability by senior firm personnel not directly involved on the project
Question 8	The designs we do are fairly straightforward and almost always able to be understood by owners and contractors.
Question 9	Yes, by pointing out any design aspects that present problems during construction

General Contractor Responses

	1
Question 1	PM
Question 2	5-10
Question 3	approximately 60% private and 40% public. Our type of work ranges from new buildings (schools, churches, manufacturing facilities), to additions/renovations (dormitories, libraries), to historical restorations (brick/stone facade towers, exterior wood and masonry structures)
Question 4	80 mil
Question 5	below average
Question 6	Most of my project experience has been in the restoration/renovation side. The two biggest problem with documents on these types of projects are the lack of verification of existing conditions and the coordination of the new systems and designs being added within or to the exisitng structure.
Question 7	I think the problem can be attributed to the pressure on design and end use. It appears that Owners put pressure on the Architects and engineers to prepare documents that show the final project and are not as concerned with the "dirty" investigative work that is the existing structure.
Question 8	Poor drawings or drawings that lack significant coordination and existing conditions investigations affect all of the above. Unexpected changes directly correlate to additional time and additional money. Depending on the expectations of the design and owner team, these two issues can create tension and possibly deteriorate relationships. The general contractor sees the relationships deteriorate from both sides.
Question 9	in public work - getting away from the hard bid process and including general contracor's in the preconstructoin process. An interesting case to review may be with the Massachusetts State College Building Authority (MSCBA). They are developing projects with preconstruction included in the scope. They are including processes typically used in private client work in public work. We have just been awarded a project using this process and are beginning the preconstruction review with the Architect. This should minimize change orders and construction defficencies that,as I mentioned above, affect cost and schedule.
Question 10	see above
	2
Question 1	PM
Question 2	0-5
Question 3	PUBLIC, PRIVATE, SITEWORK, CARPENTRY, MASONRY
Question 4	80 mil
Question 5	average

Question 6	SINCE WE DEAL WITH MANY ARCHITECTS, THE QUALITY OF DOCUMENTS VARIES GREATLY. MANY ISSUES ARE RELATED TO MISSED SCOPE AND NOT INCORRECT INFO
Question 7	NOT ENOUGH TIME SPENT BY THE ARCHITECT ON ENSURING COMPLETE DOCUMENTS
Question 8	AFFECTS QUALITY OF JOB, TIME SPENT ON CHANGE ORDERS, TIME SPENT CORRECTING THE PROBLEM, AND THE COST TO COMPLETE THE WORK.
Question 9	ARCHITECT SHOULD SPEND MORE TIME ENSURING THE PROPER SCOPE IS COVERED AND THE OWNER SHOULD ENGAGE THE CONTRACTOR EALIER IN THE PROCESS.
Question 10	see above
	3
Question 1	PM
Question 2	5-10
Question 3	all of the above
Question 4	unknown
Question 5	average
Question 6	the documents we receive range in quality. most are poor.
Question 7	no one wants to spend a lot of money on design. sometimes lack of time to design a project.
Question 8	poor documents lead to numerous rfi's to the architect - this wastes time producing more documents but is needed to clarify the scope
Question 9	the clients need to realize the importance of having detailed documents (and pay for them) and architects need to be more thorough.
Question 10	architects are usually the cause of the problem, so yes.
	4
Question 1	PE
Question 2	0-5
Question 3	Public, Private and Self-Perform Concrete, Masonry, Carpentry
Question 4	70 mil
Question 5	average
Question 6	Documents vary from project to project depending on the Architect and whether they are public or private jobs.
Question 7	Lack of detail and forthought in the drawings, and lack of thoroughness in the specifications. Many times the specifications are very general and are even used from project to project including items that are not on the project the specifications are written for.
Question 8	It can waste time and money waiting for Architects to issue sketches or provide more information becuase it was absent from the original documents. Obviously unforseen conditions will occur, but some of them could be prevented.
Question 9	People need to put a decent amount of pride into their jobs instead of going through the motions. Lack of experience and attention to detail can cause problems that, if a careful review was completed prior to issuing the documents, could have been avoided.
Question 10	Pay attention to code requirements for the project, don't over or under design.
	5
Question 1	PM
Question 2	0-5
Question 3	General contracting for private construction focusing in design build and negotiated contract work. Work in education, manufacturing, and elder care areas.

Question 4	150 mil
Question 5	below average
Question 6	In terms of construction documents, I would assume you mean contract drawings, sketches, specifications, etc. In terms of these documents, the drawings and sketches tend to have conflicts in several areas, lack sufficient detail, and are poorly drawn in terms of perspective. Specifications tend to be vague, ambiguous, and conflicting both amongst other areas of specifications and the drawings.
Question 7	Industry-wide there are problems with this issue do to comepetative (low-ball) pricing. In order to be awarded the design for a project, architectectural firms are forced to cut corners to minimize project time. This often causes problems for everyone on the project. Another issue is the fact that the people preparing drawings and specifications (or any construction documents for that matter) often do not work on the projects throughout their lifetime. Because of this, they do not understand the issues such as constructability and coordination. Finally, liability is also a problem. Designers, engineers and architects are worried about liability and this often affects the quality of the documents.
Question 8	In terms of time and money, the low quality of construction documents affects all parties involved in the project. Ambiguities and discrepencies cause conflcit between parties, which causes loss of time, which causes loss of money both on the manpower to solve the problem and the schedule delays the problem causes. In terms of relationships, these issues strain all people involved.
Question 9	I don't. Documents seem to be getting continually worse, especially from larger firms who control a larger share of the market. Untill owners realize this problem and are willing to put more money in up front to designers and architects to assure better documents, the problem will not be solved. Owner's may not be fully aware of this problem or the causes, so getting them to change their ways (i.e. awarding design and construction to the lowest bidder or smoothest talked) will be a slow process.
Question 10	YES! They can inform owners that the more money spent on better documents, extended design time, and focus on details and coordination of drawings and specification will yield a better project with fewer changes and issues during construction. Also, an architectural firm should be responsible for the quality of their documents. If there was a way to track the discrepencies throughout a project and hold the architect responsible, this would change things for certain. However, this is also unlikely since the most widely used contracts are written by the AIA, and they would most likely never include any clauses that make architects directly liable for the documents. Unfortunatley the contracts take responsibility in terms of documentation away from the architects and place it on others.

	6
Question 1	CM
Question 2	15-20
Question 3	Private Residential custom homes $3 - $15 million range
Question 4	25 mil
Question 5	below average

Question 6	Architects ask us to give solid bids to plans which are mostly incomplete. They then ask us to correct all of their mistakes in the field and then we have to explain to the homeowner why we're over budget without pointing the finger at the architect In the 20 years we've been in business, we have recieved maybe one set of complete and really detailed set of plans that were even close to correct in the field. we are one of the top two builders in New england for fine residentila homes, so if what we're getting is poor i wonder what the rest gets!?
Question 7	Lack of knowledge and lack of commitment to fulfilling the promise mady by fine artists (architects) who don't have the committment to doing the job right!
Question 8	totally and completely. It seriously affects the bottom line of every job.
Question 9	Architects need to re-think their true role in the industry. Builders are paid to put things together, not decipher plans that don't work and not to make design decisons because the architect who was supposed to be on the job site had too much going on and sent a lacky intern who doesn't have a clue! The almighty dollar has caught hold! The customer ultimately ends up losing! Don't get me wrong, we need achitects, but we need them to perform their job completely.
Question 10	Yes, every....yes, every set of plans should have to be engineered before the job begins...this would virtually eliminate most problems in the field.
	7
Question 1	CM
Question 2	20+
Question 3	Private Work, ie.. Restaurants, Hotels, schools, renovations, alterations etc..
Question 4	15-20 mil
Question 5	below average
Question 6	Having been in the industry for over 20 years, I have seen the level of Construction Documents(plans & specs.) decline.It is few and far between when we see a well prepared set og construction documents.
Question 7	Wether it is the low fees, the compressed schedules, or the the use of computer generated documents, I am not sure. Many designers seem to provide documents with only a minimal amount of documentation. Many private projects have plans issued withour accompaning specifications.
Question 8	If drawings do not accuratly depict what is to be constructed, questions will arise during the construction. This takes time, delays the schedule, and ultimatly adds cost to the project. Also, an unclear or incomplete set of contract documents cause subcontractors to add contingencies which inflate the cost. Finger pointing occurs and relationships deteriorate. Lawyers are happy as they have a steady stream of work.
Question 9	Very difficult. A well coordinated intern program for designers to work for contractors(and vice versa) would help. But owners typically want the lowest cost and this usually drives the process.
Question 10	Since they produce the construction documents-sure! There is really no standards as to what is considered a good set except that they are good if no addenda is necessary.
	8
Question 1	PM
Question 2	0-5
Question 3	GC for public, private, we do self perform with carpenters, laborers, equipment operators, and masons, we also do design build jobs and some CM jobs.
Question 4	80 mil
Question 5	below average

Question 6	I am involved mostly in public school construction so the documents I see are often poor to below average. The drawings and the specifications do not agree, the documents and the field conditions do not agree, and sometimes owner and the architect do not agree.
Question 7	The attempt to push all responsibility to the GC, the architects experience, and the owner deadlines for state money drive the documents further towards poor. The deadlines put the architects in situations where they are rushed to complete or produce documents. The architects in general I feel are getting worse, it is becoming a cut and paste world with no thought behind the documents and no licenced architect drawing them. More often than not the people creating the documents have litte experience, no liscene / stamp, no field experience. The architect is trying to hold the GC responsibility for everything, sometime including performing their job. They do this by putting work in our specification that really is part of there contract obligation such as design coordination.
Question 8	The worse the documents are directly causes more delays in the schedule, more cost to the owner, and more relationship problems.
Question 9	More time must be spent in the design phase at the begining. "7 P's - Proper pre planning prevents piss poor performance" This may cost added money upfront but will save money and time in the end for all, including the architect.
Question 10	Yes, but first they need to realize how much time and money they waste because the documents are poor in solving problems. It takes twice as long and costs twice as much to fix a problem, instead spend only 1/2 the money up front to do it right. This will eventually payoff propelling the architects and engineers to the top of there field and getting new work based on reputation.
	9
Question 1	CM
Question 2	20+
Question 3	High end custom residential
Question 4	3.5-4.5 mil
Question 5	poor
Question 6	In the majority of cases drawings are not internally consistent, specifications are not complete and in conflict with the drawings. Also, only about 1/3 of architects issue meeting notes. The projects are delyed while questions are answered, and as most of the problems are relating to finish details, client satisfaction suffers due to apparrent lag in schedule and repeated requests for additional funds, which gives the client a "nibbled to death" feeling.
Question 7	The lack of sufficient hours put into the project, especially when doing out of the ordinary projects, when seemingly minor deviations from standard details can lead to major revisions of systems.
Question 8	The hidden costs are unrecoverable, and client dissatifaction occurs at the completion of the project, when it remains the final impression.
Question 9	More complete detailing earlier on in the project. Typically questions are answered at the drop dead hour, and often solutions mean other work (done previously thinking a typical solution would be chosen) needs to be redone.
Question 10	The cost of detailing will be incurred sooner or later. Better sooner than later.
	10
Question 1	CM
Question 2	20+
Question 3	Private
Question 4	300 mil

Question 5	average
Question 6	Architects could make the design process more inclusive to inform the engineer early about the goals stated and unstated of the project. Get the engineer involved early to conceptualize the project and the approach and the compromises.
Question 7	Pencils - I believe that younger people are to reliant on CAD to develop details without simply sketching out some details to see if it makes sense.
Question 8	All of the above, poor details reflect additional changes and costs to a project, which places CM's on one side and the Arch, whose aligned with the owner on the other side. They design a marginal set of documents and then have the final say on our payments and change orders.
Question 9	I would love to say additional time, but I really think it is experience and focus to giving the client a better product. Improvement of listening skills would be very helpful.
Question 10	Collaborative alignment with a CM/GC early, so form and function can be achieved. Budgeting along the way can save a lot of time.
	11
Question 1	Other
Question 2	20+
Question 3	public fixed price work, public filed sub bid GC work, Public design build work, Private commercial construction, negotiated competetive procurement.
Question 4	160 mil
Question 5	poor
Question 6	On public fixed price work the drawings are generally poorly coordinated between the Architectural and the structural drawings. The shop drawing process seems to be a design function more than a documention function
Question 7	The use of Owners representatives to administer contracts on public school projects have raised the level of conflict on these projects as the Owners today seek to have scope and ommission problems paid for by the designers or the contractors as long as it is not the change order contingency. The drawings today seem to be a cut and paste function of the CAD opperator as opposed to a design function
Question 8	It shows up first in margin erosion then contract disputes and too often in litigation.
Question 9	Owners need to have the tools and experiance to have the statuatory ability to select designers and contractors on quality and experiance. The indusrty needs to be self regulating which is a function of adequate margins to do the job right and rewards for the organizations that serve their clients well. The use of alternative delivery systems such as negotiated competetive procurement and design build offer benefits that the Federal government has taken advantage of.
Question 10	discipline
	12
Question 1	PM
Question 2	5-10
Question 3	Private (instutional, residential, commercial, etc...)
Question 4	8-10 mil
Question 5	average

Question 6	In residential. Drawings have accuracy towards design intent, but lack true coordination of building systems. Physical performance of the architecture falls far behind the visual,tactile. Also we are experiencing alot of designing over the owners budget. This makes everyones lives difficult. As far as computers. I think a residential job can be drawn by hand and be a better construction set. Representation on the computer tends to be too percise beyond the tollerances of residential. (sorry for spelling)Instutional: the range of quality is large. The specifications tend to not relate directly to the drawing sets, for obviouse reasons.
Question 7	Experience and care.
Question 8	Time is money and rework is three times as bad
Question 9	Better editing and review. List only the critical dimensions to hold. Design in a system of slack.
Question 10	Yes, you have to think coordination when designing and how the work is executed. Some trades have far dirrerent tollerances to work with. When ever two trades come ito contact this is a critical intersection and requires lots of preplanning and coordination.
	13
Question 1	Other
Question 2	20+
Question 3	Private Remodeling
Question 4	600,000
Question 5	average
Question 6	Some project plans are very sketchy leaving us to fill in the details with the homeowner. Others are very detailed but most details change during construction.
Question 7	Changing plans in midstream, owners not being abel to visualize what the architect proposed.
Question 8	Lots of change orders which alway cost us money no matter how much we charge.
Question 9	Contractor input during the design stage, full size models (ie cardboard walls, etc.) during the building process, and an open plan that allows easy changes. Design/build firm have this ability.
Question 10	
	14
Question 1	CM
Question 2	20+
Question 3	Building private sector , institutional , healthcare , technical
Question 4	300 mil
Question 5	average
Question 6	level of knowledge of how project must be built , coordination , and time spent is lacking
Question 7	architects abdicated their role years ago , fees are down , and level of atention is missing
Question 8	affects the owner quality , and cost . we as industry need to address ther owner on these issues .
Question 9	back to basics , working together ansd puttting the time that is needed or doing design build more where thewre is closer cooperation
Question 10	YES
	15
Question 1	Other
Question 2	15-20

Question 3	Architectural, Civil and Engineering models, both physical and virtual involving landscape, terrain, planning, exterior and interior residential and commercial. See www.lgmmodel.com
Question 4	500,000
Question 5	below average
Question 6	There are numerous and frequent inconsistencies in documents. Elements that show up in one plan are not consistent with other floor level plans and are not consistent with elevations. Elevations are not consistent with each other. Often roof plans are not drawn correctly. If multiple contractors are involved, reference datums are often not consistent and drawing communication among contractors is not consistent.
Question 7	Primarily, 3D objects, structures are being designed and drafted in 2D. Often different people are responsible for different documents. EG, one person is in charge of elevations annother, plans. Often each elevation document is a different CAD file.
Question 8	Maintaining the intent and detail of the architect while attempting to create a real 3D object is a constant conern. The extreme variablity of document/data quality makes quoting very difficult and "good" clients are often penalized as, without prior knowledge, we assume a relatively high level of drawing interpretation will be necessary. Frustration among our people who have to attempt to reconcile drawings is often very high.
Question 9	3d objects need to be designed using 3D tools. Any other method is an artifact of limited technology. However, real cost benefit analysis needs to show that 3D CAD results in better design with less errors and produced faster. Efforts then need to be made to communicate this to clients so that they demand this from the architectural community. Also contractors and engineers need to be aware that if someone is using a real 3D tool, thier quotes can be more accurate and timely. Cost overruns on various projects should be tracked. THis type of hard data, well communicated, will pressure the AEC community to implement 3D design.
Question 10	See discussion above. Design architects need to be held responsible for issuing drawings that have a high level of consistency and accuracy. Perhaps there should be an independent method of rating architectural firms by their peer and by the users of thier documents so that clients can see what trades people think of various architects.
	16
Question 1	CM
Question 2	20+
Question 3	General Contracting: Residential, new and remodel Industrial
Question 4	500,000
Question 5	average
Question 6	Average set of documents: Hope that the architect works close by, so as not to run up phone bill. Owner supplied items, not yet spec'd out. Mechanical is yet to be detailed, with current construction in progress. Dimensions of plan, and actual - differ. There is no such thing as a brief reply to this answer.
Question 7	Lack of communication between the owner, architect, and general contractor. When the information does make it through to the general, it's not always conveyed correctly or in timely fashion to all the affected trades.

Question 8	The more thorough the set of documents, from the initial bid set to the actual construction set, the more efficient the project. I spend my (unpaid)time estimating a set of documents(time away from loved ones.) I get paid if the project becomes ours (I look at it like continuing education - expensive.) Once the project's ours, the pressure gets turned up a few notches. With all the new products out there, it's hard to have the installation details for them all in your head, at least my head. Construction documents are the most important tools for a project.
Question 9	More clear and comprehensive set of documents.
Question 10	Yes. They are the 'bookbinders.' They staple that set of blueprints together a little too fast, I believe. At the end of most projects, I have a file drawer full of spec sheets, change of work orders, and a few spare parts.
	17
Question 1	CM
Question 2	5-10
Question 3	Construction Management on Public and Private Building Construction.
Question 4	2 bil
Question 5	below average
Question 6	I think that overall the general quality of construction documents is below average related to what was delivered years ago. Coordination amongst disciplines is the biggest problems (i.e. structural drawings that don't coordinate with architecturals, etc.)
Question 7	1. Timeframes: The entire construction process proceeds at a breakneck pace. Both architects and cms are forced to deiver their product in unrealistic timetables with limited budgets. It gets back to the old addage with schedule, quality and time. You can't have all three, so if you want it done quickly and cheap, then the quality suffers.
Question 8	It depends on whether we have the time to appropriately review the documents and either buy the missing pieces from subs or respond back to the architect with RFIs and questions. If we are able to catch these issues early, then the only cost is the time and labor spent in doing these reviews. This is paid for by the owner, typically. If we don't have the time, then everything suffers. There is animosity amongst all team members. Subcontractors suffer tremendously because they are often the ones that are left "holding the bag" and paying for these issues. Typically (and I have first hand knowledge) this lands the owner in court with costly claims and litigation. Reputations are often tarnished in these situations, the jobs are almost always delivered late, and the budgets are typically overrun. It is a lose-lose situation.
Question 9	By improving the working relationships between the A/E and CM. Both timeframes and money are getting tighter. There will be no movement in that area. Therefore, the only thing that will improve the process is to have a positive working relationship where each side understands the objectives and problems of the other side and they can work together to solve these problems.
Question 10	What I've found is that A/Es that have a set document quality review process where they have a checklist of items that they go through prior to sending out the documents helps tremendously. Also, allowing the CM some time for constructability analysis and overall document review pays off in the long run. Some A/Es look at this as an attack on their work, when it is merely meant to try to get a set of documents that are buyable and buildable. This saves the owner money and helps to insure that the building will be completed on time.
	18

Question 1	CM
Question 2	20+
Question 3	All private, 80 % academic/instituitional work.
Question 4	80 mil
Question 5	average
Question 6	Quality varies from one firm to another. We typically work with fairly "high-end" architectural firms who are building one-of-a-kind facilites and the quality is generally fair to good. The Construction Documents are often not fully coordinated with respect to the mechanical trades and we have hired a M.E.P. coordinator AND a licensed P.E. to check and recheck documents for errors, ommissions and contradictory or incomplete information. In general, the quality of drawings now - as compared to 10-20 years ago - is not as good as it once was. The pressure on architects to keep fees low has resulted in poorer documents overall and the trend away from construction administration by architects has also hurt the profession.
Question 7	See #6 above.
Question 8	It affects it us in many ways. Delays are the most troublesome. Many architects simply do not understand - or perhaps they don't care - that their incomplete work costs contractors time and money. We are operating under the same restrictive economic climate and are being squeezed by Owner's to do more work for less money in less time. We are also held responsible (and often penalized) for not meeting schedules when the circumstances leading to the delays - defective and incomplete documents - are not within our control. We have trouble getting paid for legitimate change orders. Requests [of architects] for information are often not answered in a timely fashion. This can lead to adversarial releationaships and lawsuits. In short, Bad documentation costs us money and threatens our relationships with both the client and the architect and our hard earned reputation.
Question 9	Architect's need to resist the tempetation to lower their fees to get work. They need to educate Owners about thevalue of complete documents and and properly and thoroughly document their design and carry enough money in their budgets to assign ample staff to do so.
Question 10	See #9 above.
	19
Question 1	CM
Question 2	20+
Question 3	All types of building construction management (public, private)
Question 4	2 bil
Question 5	average
Question 6	Fairly complete by discipline but poor coordination among disciplines (i.e. between architectural and mechanical/electrical)
Question 7	Lack of time allowed by architect for engineer to react to architectural options and lack of expertise within architect's offices on engineering requirements.
Question 8	Requires more RFI's and change orders which costs more and affects time.
Question 9	More active and early coordination between architect and engineer
Question 10	Yes see above
	20
Question 1	PM
Question 2	0-5
Question 3	Private building construction management - colleges, churches, museums, labs, private high schools, corporate fit out, banks, law firms, restaraunts, retail

Question 4	300 mil
Question 5	average
Question 6	Average = 75% complete. Missing architectural details, not properly coordinated - i.e. door schedule may not match the floor plan. Elevations may not show all the misc. specialty items like markerboards, tackboards, fire extinguishers. Structurals may not show support steel at mechanical penetrations for shafts etc. Civil may not show locations for utility connections. Mechanicals and electricals are very poorly coordinated and usually left until construction starts to flush out conflicts.
Question 7	Due to the nature of schedule driven projects and an Owner's willingness to purchase a 100% set of documents, I would say that as a general rule of thumb, construction drawings are more like 75% complete. An Owner should be advised that if they bid a 75% complete set, they should carry a design contingency to account for missed details on the bid set.
Question 8	Highly dependant on the Owner's knowledge of the construction process. An inexperienced Owner may be very confused having spent a substantial amount of money on a design and then awarding a contract to a successful CM bidder that they did not buy the whole project and there will be additional costs. To bring an Owner up to speed on this can be quite a challenge. A poor set of drawings means the Owner will be paying a lot more and possibly not be able to open a project on time. This can be extremely taxing on the team relationship. Because of this it is crucial to be very up front with the entire team at the start and set expectations. Discuss the completeness of the drawings and what this will mean throughout the course of the project. A CM is in a tough position because they will most likely be looking to keep and Owner happy, but not at the expense of the architect because more likely than not, the CM has a certain business interst with the architect as well and may have future projects with them.
Question 9	Bring a CM firm in for preconstruction to work with the design team at a conceptual stage and negotiate the work instead of hard bidding the work. This can only be done if there is a high level of trust between the Owner and CM firm, but if executed properly, the Owner is extremely satisfied with the final product.
Question 10	The simple fact is that in almost every case this is the first time this building is being built and we will encounter certain details that are all but impossible to forecast. In addition design teams are under tight schedules as well and are often trying to work with an Owner to develop a program for the use of the space. If an Owner is slow to deliver answers to an Architects questions, they are forced to make a best guess at what is best for the project. It isn't until much later that these types of 'program changes' are flushed out - and this is usually a more expensive time to correct the problems. The best thing a design team can do is to communicate to an Owner that changes will come up and it is in everyone's best interest to deal with these changes in a fast and effective mannor to keep the project moving forward. They should advise and Owner to set aside a contigency budget for such items.
	21
Question 1	CM
Question 2	20+
Question 3	private, gen contracting work, sitework, concrete, carpentry
Question 4	4-10 mil
Question 5	below average
Question 6	Lacking the detail and thought process that went into drawings in the past
Question 7	inexperience and cost cutting by arch. firms

Question 8	time- it takes us longer to figure out what arch wants, longer to convey that info to job foreman. money- there for it costs us money. relationships- - it detracts from a positive relationship with arch. which is not good for project
Question 9	Owners need to expect to pay for good documents in order to get a good job
Question 10	yes put more time and effort into documents
	22
Question 1	PM
Question 2	20+
Question 3	Private construction - AstraZeneca Research and Development Laboratories.
Question 4	40 mil
Question 5	above average
Question 6	Our Architectural/Engineering team and the Contractor is thoroughly involved with electronic information transfer. Archiving, tracking, easy to read (no handwriting to interpret)drawings. No waiting for land mail. Spend a gfreat deal of time in Outlook (email).
Question 7	This level of work could not really be performed well without state of the art communications. I find that other types of work where less emphasis is placed on speed and accuracy attract contractors ansd designers using more outdated equipment and methods. Perhaps the profit margins do not allow it. Perhaps the personnel are not sufficiently trained.
Question 8	Mostly, the work progresses smoothly and all parties are attuned to flow of work. Once in a while, some detail-oriented person will really dig into the subject matter beyond what is required for a solution and eat up time.
Question 9	A higher level of technical training for the personnel on all teams would be a great help. Also, more work-experienced personnel in the leadership positions.
Question 10	Same aas above for the contractors. Without the training and experience in the background, all the computers equipment will not help.
	23
Question 1	CM
Question 2	20+
Question 3	Large Heavy Civil, Highways, Dams, Airports, Mass Transit
Question 4	550 mil
Question 5	average
Question 6	Most construction Documents come via disk, CD or downloaded from internet. There is a problem with numerous amendments prior to bidding which is an indication of owner revisions to the plans and specs.
Question 7	Hasty assemble of documents and too many shortcuts trying to use "canned" specs or what we often refer to as "Boiler plate"
Question 8	If awarded a contract with incomplete specs, we will attempt to receive payment by change order to recover costs
Question 9	More accurate documents that are job specific.
Question 10	Yes, have review of documents by a licensed P.E. that has a construction background prior to issuing plans and specs for bid.
	24
Question 1	PM
Question 2	0-5
Question 3	We are a construction management and general contracting firm that operates in both the public and private sector.
Question 4	2.4 bil
Question 5	average

Question 6	Most documents that are design, bid, build are not even close to 100% documents. As you analyze them, you start to see many gaps in the process. As a matter of fact, one of the latest competitive bids that we submitted had drawings that were noted as 90%, but were in actuality about 70-75% complete. Very difficult to put in a hard bid on this type of work and keep your risk low. Much of the bid/construction documents are generic as well. There is so much liability in construction that everyone wants to cover their backs. I had one job that was $400,000 just last year. The owner negotiated with the architect and then with us. During the duration of the project, the specification that the Architect used was not accurate and the materials were updated. It turned into a $10,000 change order. This leads to the issue of a need for due diligence on the A/E part.
Question 7	1. Architects fees are being pushed lower and lower by owners, which in turn translates to poorer documents being distributed. This is the main argument in the marketplace from what I see. In general, I think architects believe that they need to take back their role in the construction industry. My opinion is that whether you are an engineer, architect, or CM, your most important role is to listen to clients and find out what their needs and wants are and then design to that. So, in lieu of architects trying to "take back the industry", they should be looking at things from a perspective of how can I create the most value for the owner. 2. Owners need to continue to get away from the design bid build mentality and move into a system whereby the CM/GC is working closely with the Architect and the team in preconstruction to develop high quality documents that reduce the risk of the owner and increase the quality of the project. Some aspects of Mass State is starting to go this route. MSCBA is looking for architect/CM teams that have worked together in the past and have demonstrated quality performance. In lieu of bidding out the job, the MSCBA negotiates based on a lump sum fee and general conditions work. 3. Let's face it, time or the lack of time is also a factor.
Question 8	1. Increases paperwork (i.e. RFI's). 2. Increases the contingency on the project in some cases in order to accomodate for gaps in the drawings. 3. Takes you longer to review, analyze, and price the drawings. 4. Increases subcontractor qualifications and in some cases subcontractor prices cause they have to accomodate for the unknown.
Question 9	1. Early coordination between architect and construction manager. 2. Owner awareness. 3. Collaboration between the AIA/AGC/ASA. You need all parties to be part of the collaboration process if we want to get away from finger pointing, reduce hositility in the industry, improve construction documents, and improve the quality of the process overall. 4. A higher standard of ethics in the industry.
Question 10	See above. Notes: Please do not use my name or company name in your project unless authorization is given. I would be interested in finding out the results of your survey.
	25
Question 1	PM
Question 2	0-5
Question 3	General Contractor/Construction Manager; Private & Public Projects
Question 4	2.2 bil
Question 5	average
Question 6	We have bid projects in which the drawings are incomplete, while we have also bid jobs in which the drawings were in great shape. I depends on the architect/owner.

Question 7	The problem happens when owners force architects to produce construction documents in less time than is needed. Once projects get financing, owners want projects built. Its easy for an owner to go on site and see a project in progress and understand the delays that occur during construction. Its very difficult for an owner to understand how long it takes to complete drawings and specifications when they can't actually see something being built.
Question 8	A job with lower quality construction documents will be alot more expensive for an owner. The general contractor will spend more money in general conditions. When a subcontractor prices a job, they will assume the worst for items not included on the drawings. All specification have an item written that states the contractor will be responsible to meet code. This will cause contractors to take more risk and therefore the owner will pay more money. GC's spend more money on general conditions by sending RFI's and dealing with scheduling issues due to coordination issues on the drawings.
Question 9	I don't believe that it will be solved.
Question 10	They need to be more firm with owners in the begining of the design phase and not rush thru design just to temorarily please the owner.
	26
Question 1	CM
Question 2	05-10
Question 3	Private sector construction management, program management (owner's representative), and facilities management.
Question 4	300 mil
Question 5	average
Question 6	Project dependent. Quality is dictated by experience level of the design team for building type, schedule for completion of project, fee associated with the design contract.
Question 7	Poor understanding of construction phasing, building techniques, and coordination issues from the architect. They tend to be more concerned with creating monuments to themselves than the needs of the client. Their focus is design without consideration of cost, schedule, and any other negative ramifications.
Question 8	Average to poor documents make my job very strenuous to meet the clients expectations. Relationships are usually strained and tensions run high throughout the duration of a project. A cohesive team from the designers, contractors, and owner can never be developed since average to poor documents lead to numerous issues which continually affect and trickle through a project.
Question 9	Owner's need to hold architects liable through penalty and liability clauses.
Question 10	They could listen to what is directed back to them versus taking a stance that their word is final. If people actually practiced the buzz words, such as partnering, there would be improvement.
	27
Question 1	PM
Question 2	05-10
Question 3	Commercial and industrial projects for both public entities and private corporations.
Question 4	2 bil
Question 5	average

Question 6	At the stage of 100% construction documents, the majority of the design is complete however there is innevitable details missing or incomplete which needs to be resolved via RFIs or compensated for in the scope of work. There also seems to be a propensity for "canned" specifications which don't necessarily address the specifics of the job and may even conflict with what is on the drawings.
Question 7	In some cases it is poor coordination and QC with the Architect/Engineer. Most cases though I believe it is just a matter of being pushed to a deadline and not having time to complete the documents.
Question 8	Being also pushed to a deadline to get the documents out to bid and construction started, it really helps us as a GC/CM to have complete documents. We don't need to spend so much time clarifying incomplete items in the scope or writing endless RFIs to the A/E and waiting for a response. It also helps relationship between us and the A/E if we don't have to swamp them with RFIs. Cost wise it is only a problem if we also happen to miss what the A/E missed. That situation could put us in an adversarial relationship with the A/E or even the owner depending on who the A/E works for.
Question 9	I wish I had a good answer for this as I could help make every job go smoother. I think having the staff at the A/E dedicated to the coordination and Q/C process at the end, prior to the documents going out the door - no matter what the deadline. This would benefit them and everyone else down the road greatly. Some A/E's do really do a fine job of this, but it definitely isn't the majority.
Question 10	See above.
	28
Question 1	PE
Question 2	0-5
Question 3	High tech, retail, Universities, Biotechnology,ETC
Question 4	2 bil
Question 5	average
Question 6	Most of the general documents are acceptable however many of the details on the drawings and the specification are either missing, wrong, or conflict with other drawings or trades of work.
Question 7	For many jobs it seems that architectural companies put together a "cookie cutter" spec which do not accurately portray the drawings which have been distributed. Also there is a lack of coordination between all parties in the design team (be it the architectural, structural, mechanical, and electrical) Without this initial coordination the documents do not mesh with each other to form a single design. Instead there are several different designs which must be fitted together via changes in the field in order to achieve the design intent.
Question 8	In the fast pace jobs of the 21st century poor construction documents greatly effect all of the above. if something is designed incorrectly it will have to go back through the design process all the way from the construction manager to the architect and maybe to the engineer. Upon completion of this it will go back through in reverse any everybody tacks on a fee for every change. The end result is a change that has taken 2 weeks to get corrected, cost the owner way to much money, and damaged relation ships between many if not all parties.
Question 9	1. Make sure any changes made on the plans are also changed on the details. 2. The design team MUST coordinate the design documents with all other departments. 3. During the design phase all parties including the construction manager and the owner's rep to have a design review which may help in identifying problematic areas prior to construction.

Question 10	See #9
	29
Question 1	PM
Question 2	0-5
Question 3	all of the above
Question 4	unknown
Question 5	average
Question 6	drawings are almost always poor to average - but those are the same drawings that ohter contractors get.
Question 7	lack of time spent on planning. lack of input from owner
Question 8	more time is spent on design; more time spent on change orders later; can incur more costs due to poor drawigns or can benefit monitarily because the owner has to pay for a lot of change orders; on a fast track job - you loose time due to waiting for rfi's to be answered and getting sk's from architect, etc.
Question 9	unless people put more time into the design phase it won't be solved; most owners don't realize the benefit of spending $$ for a good set of drawings, owners need to be educated more on the building process
Question 10	take the time to explain design/building process to owners; ask questions in the beginning; planning - preplanning. it's all about planning
	30
Question 1	Other
Question 2	15-20
Question 3	Commercial, Institutional and some retail. Most of the work is renovation or tenant fit-up (on the commercial side) Some new build. Projects have ranged from very small to 50 million. Most projects are under 5 million. Much of the work is negotiated and with return clients
Question 4	220 mil
Question 5	average
Question 6	Given the negotiated work we are usually introduced to a project somewhere between conceptual schematic and final design. We review less than complete sets and provide budgets that the architects and owners use to tweek design for the final product. Less than complete drawings are expected. Unlike public work that is based on hard pricing, we tend to see more CM type work and come into the selection process at an earlier stage. I suppose that a hard bid contractor would find what we get as poor quality but hard bid id not the intent. With respect to hard bid drawings, we have gotten used to the quality at a certain level over time. I think to some degree the quality of drawings may be less than it was say 10 years ago.
Question 7	In environments where a certain level is expected yet not met, even at the conceptual budget level poor quality is attributed to a number of things. In my opinion there is less time and resource provided and much of that is due to the amount of money owners are paying for A/E services. This situation has developed over time and in some ways it can also be attributed to how contracts are written today. There is more and more responsibility shouldered by the GC for means and methods, field investigation, minor design intagibles and so on. This is fueled by contract language indirectly and certainly provides some leeway to the owner to produce less than perfect design information via the architect. This is especially the case in the mechanical and electrical reas.

Question 8	Depending on the budget and the type of contract constraints we are under it can have a great impact. In a hard bid environment especially in the public sector poor drawing quality impacts all things related to time, money and relationships, (which are weak at best in the public sector) Changes cost money and if not addressed quickly can cost time, In conceptual budgeting on negotiated work there are certain expectations that the consultants at least meet certain requirements. Gaps are usually filled during conceptual budgeting. If the final documents are inferior it will most likley impact time. In a negotiated project the GC usually has contingencies in place that can handle missing information, albeit the objective is to save money and avoid excess contingency spending. So it can certainly be less economic to have inferior drawings. Time wasted is usually the critical factor.
Question 9	I am not sure if the case can be called a "problem" given the in our negotiated work market we are accustomed to a less than 100% level of completion in drawings. But I feel that in the hard bid market the quality of drawings may be less than what it was 10 years ago. Why? A pattern was set in the past few years due to the amount of work available combined with compressed schedules. It appeared that architects, engineers and contractors were overloaded. A greater amount of responsibility for construction means and methods has been placed on the contractor over the course of time, particularly in the mechanical and electrical trades. This is becoming more evident in contract language that has appeared in the last few years. See above Owners have been able to use that contractual leverage to protect themselves, if permitted, and therefore shoulder less responsibility in the design process. The assumption is that money is saved in design costs.
Question 10	The key factor discussed above are time and money related. I did not discuss the one thing that they can control and that is the quality of the indivudual to do as good a job as possible under the given circumstance. I still feel there are a lot of quality people doing the design out there. I can only expect that architects and engineers provide their best due diligence in the process with the information available. That being said they are occasionally under difficult financial as well as time constraints which are not in their control. Prior to submitting this please call me to discuss the information and if I am going to be quoted in any manner. These are general thoughts that I would like to keep somewhat confidential. I am more than happy to discuss this information further for the purpose of future publication.
	31
Question 1	PM
Question 2	20+
Question 3	Sitework- including earhwork, utilities (water, sewer, drainage, electric), roadway construction, foundation excavation and backfill, etc. Our work is primarily on jobs ranging from 400K upwards of 10M. We ususally perform private commercial work, with an occasional public job. The bulk (80%)of our work is also with repeat clients. We are a union shop contractor based in Worcester.
Question 4	12 mil
Question 5	average

Question 6

Many documents we receive are preliminary in nature, as budget items are often still being worked out. We do not receive many electronic drawings, and never receive Specifications in an electronic format. Our estimating and bidding procedure is the same as it has been for many years. Revsisions are often provided on a sketchy or verbal basis, and quite often a project's overall design is not complete when the sitework package is handed out to begin work.

Question 7

There are several reasons why the documents we receive are mediocre. Most earthwork and site prep specifications are very basic, and are usually 'cut-and-paste' specs from a previous job. I worked for several years in an AE firm, and as a matter of economics, we were reminded not to 're-invent the wheel', that is, do not spend any time trying to refine something which has been already been done successfully. Secondly, sitework clearly is a less glamorous, or certainly a less pressing item for most AE firms. They are working for clients whose focus is often upn the more visble aspects of their projects. Financial constraints and consequently time limitations often result in site specs to be 'canned' items. There is also the factor of revisions due to municipal reviews. Planning Boards, Conservation Commissions, Army Corps permits, State Highway, local DPW agencies all have input on projects, and it often takes quite some time to incorporate all of the equired modifications into Construction documents. There is also a need to provide cost impacts as a result of the changes, and because of that factor, further changes are often affected. As the first sub-contactor on a jobsite, we usually feel the impact of project revisions immediately. Often we are directed to proceed on a very sketchy basis (verbal instruction baesd on the AE's office's understanding of what will be allowed). We often begin projects with the knowledge that major portions of our scope willbe changed, or are just in the process of design. (I can detail a few such projects for you later if you wish.) Only within the few years have we received electronic drawing files. For the last twelve years we have had to manually digitize blueprints in our office, rather than use a CADD file provided by the AE office. The AE's are often reluctant to provide such info, and I am uncertain as to whether they think are protecting proprietary information and that someone might 'steal' their ideas, or are afraid that release of such information might somehow harm them.

Question 8

One could look at our particular situation in two ways- either as aproblem that must be addressed and completed thoroughly before construction starts, or as an opportunity to work with a client and remain viable. We clearly have chosen the latter. We are often able to suggest modifications, or react quickly with revised cost information to allow our clients to make informed decisions. We rely on our experience and our office's ability to turn such information aroud fairly quickly. But last-minute revisions and time pressure on a client to get a project underway do not add up to a license to print money. It would be tempting to try to take advantage of another's urgent needs. But as I noted earlier, most of our work is with repeat clients, so we do take time to nurture those relationships. The best way is to share as much information as quickly and thoroughly as possible, to allow all parties to make informed decisions. No client ever enjoys hearing that he must spend another 250K or that her project is going to take three months longer because of unforeseen conditions. So it is important to stay close with information but not to be so overly obtrusive and demanding that relationships are severed as soon as a project is done.

Question 9

The only way I can see these issues being properly addressed is to allow for more time in investigative, planning, review, budgeting, financing, and sales. And that acnnot happen. Most projects are developed, even unknowingly, on a fast-track method. And there are always revsions to every project. Clients do not want to pay for furtehr investigation, and are willing to gamble on a quickly starting project. AE offices are not paid enough usually nor given enough time to address all of the issues with which they are presented.

Question 10	Absolutely. They should be encouraged to take advantage of current electronic technology, both in transmission of drawings and specs, biut also in requesting information about contemplated revisions.
	32
Question 1	CM
Question 2	20+
Question 3	Company performs full range of sitework including earthwork, utilities,paving, curbing, etc. 95% of projects are for private development with contract values $500K to 15MM
Question 4	30 mil
Question 5	above average
Question 6	In the past few years I believe the quality of design drawings have vastly improved, owing largely from the use of electronic media. One recurring deficiency in documents for sitework is lack of sufficient subsurface investigations, through borings and test pits, and well prepared geotechnical report narratives which provide both the design professionals and contractors the appropriate background, observations and conclusions.Specifications, as they have been forever, are generally "canned", not necessarily tailored to the project at hand, full of engineering disclaimers and attempt to cover in words items that should be detailed on drawings.
Question 7	In the overall design/construction process the Owners generally get what they pay for. Use of less qualified firms at the initial cheaper price, demands for unrealistically low budgets or fees and demands for quicker than posssible turn around all contribute to deficiencies in documents on the design side and budget/time impacts on the construction side. Quality is achieved through compentent people who gain insite into the project objectives and are provided the appropriate compensation and time for implementation.
Question 8	The objective of most professional contractors is to provide a quality project and turn a reasonable profit. Inferior construction documents cause: Loss of field productivity, Loss of management productivity---chasing problems in lieu of the work, Hostile relationship between owner--designer--contractor, Project cost and schedule overruns, Legal fees and protracted disputes, Loss of future businees for designers and contractors
Question 9	Attention to the issues noted in Item 7
Question 10	Better quality management. Provide questionaires to contractors on this subject to solisit feedback and suggestions from the construction community and the owners. This has been used peridocally by som eof the GC/CM firms to gain a better perspective of the subcontractors opinions and recommendations for project implementation. Many architects and enginers are adverse to criticism or advise.
	33
Question 1	CM
Question 2	20+
Question 3	Construction Management - public, private Program Management - public and private General Contracting - public and private
Question 4	1.3 bil
Question 5	below average

Question 6	Lacking coordination between design disciplines, i.e. mechanical - structural-electrical-architectural. Constructibility issues not thought through enough - phasing, site utilization, access for hoisting and cranes. NOt enough time spent on the details of the building , especially the exterior details.
Question 7	Architects fees are lower and that yields less manhours to complete the project and the 85% to 100% details are done during construction. Those details are not the exciting part of an Architect's scope. They would much rather work on creative ideas than buildable details. Less and less architects being educated in how a building is constructed and how their drawings must relate to how it can be constructed rather than leaving it all up to the contractors.
Question 8	Much more staff required to handle all the RFI's and resultant change orders. Lots of schedule extensions required which is more cost to the Owner.
Question 9	Better educated Owners that buy complete coordinated designs from Architects, not just buy low bid fees. Better educated architects that know how buildings are constructed. More involvement of CM's in design phase - add constructibilty and coordination reviews to design phase services and schedule.
Question 10	Yes - a better definition of 100% construction documents. Don't release documents unitl they are 100%.