EMPIRICAL STUDY OF MACROBIM AND CONCEPTUAL ESTIMATION

A Thesis

by

ANAND DHANRAJ GAJBHIYE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2010

Major Subject: Construction Management

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Approved by:

Chair of Committee,   Julian Kang
Committee Members,   Ivan Mutis
                         Wei Yan
Head of Department,   Joe Horlen

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ABSTRACT

Empirical Study of MacroBIM and Conceptual Estimation.

(May 2010)

Anand Dhanraj Gajbhiye, B.E., University of Mumbai

Chair of Advisory Committee: Dr. Julian Kang

Building Information Modeling (BIM) has set up a mark in the construction industry over a decade. In order to gain benefit of BIM in estimating the project cost at the early stage of construction with the limited data available, a new concept of MacroBIM has been introduced in the industry. However, limited amount of research has been implemented to determine how MacroBIM has been accepted in the construction industry. Most research was focused on the accuracy of the conceptual estimation.

This research attempted to determine the effectiveness of MacroBIM process applied at early stages of construction for conceptual cost estimation. Experts from the discipline of architecture, contractor and owners were interviewed and their professional opinions on MacroBIM were analyzed using grounded theory.

The results show that, compared to the traditional conceptual estimating process, MacroBIM is an effective method for 1) saving labor hours, 2) conveying assumptions with the help of its visualization capabilities, 3) enhancing the collaboration among the project participants, and 4) evaluating multiple design scenarios. However, fear of using

MacroBIM and trust in its outcome existed among some contractors, architects, and owners because this technology has not matured yet. Moreover, the need of interoperability between the MacroBIM tools and MicroBIM tools, such as Revit, has also surfaced in the study.

DEDICATION

To my mom, dad and brother.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Julian Kang, and my committee members, Dr. Ivan Mutis and Dr. Wei Yan, for their guidance and support throughout the course of this research.

Thanks also go to my friends and colleagues and the department faculty and staff for making my time at Texas A&M University a great experience. I also want to extend my gratitude to Beck Technology, which provided the list of their clients and projects, and to all the architects, contractors and owners who were willing to participate in the study. In addition, I also want to thank Brent Pilgrim for his invaluable time, help and support in this study. Also, I would like to thank Prof. Debra Ellis for her support and being such a wonderful person.

Finally, thanks to my mother and father for their encouragement and also to all of my friends, especially Shailendra Jondhale, without whom this research would not have been accomplished.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

1.1 Challenges to Contractors,

Wishes to Use BIM at the Early Stage of Design/Construction and MacroBIM

"The purpose of conceptual estimate is to determine whether a building of a given size, quality level, and desired program requirements can be built within a given cost and time budget" (Eastman, et al. 2008). They are generally evaluated at the early stage during the conceptual or pre-design phase much before the development of design drawings, plans and specifications. "This type of estimate is used by all key people involved in the building process: by the owner or his consultant during the feasibility study, by the designer to evaluate possible design alternatives and by the contractors for bidding and budgeting" (Karshenas 1984).

Conceptual Estimation is a powerful tool in the AEC industry so as to gain an insight of the cost of project, even when very limited data is available. It helps them to analyze the design of the building as per the cost so as to keep the project in the budget of the owner. The ability to influence the cost of construction in any project is best possible at the initial stage during the conceptual planning and feasibility studies.

In the Mac Leamy curve shown in Figure 1, Chuck Eastman explained this fact graphically. The graph of the ability to influence cost is exponential versus the cost of

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This thesis follows the style of *Journal of Construction Engineering and Management.*

construction. For this reason, conceptual estimation has been of real importance for the

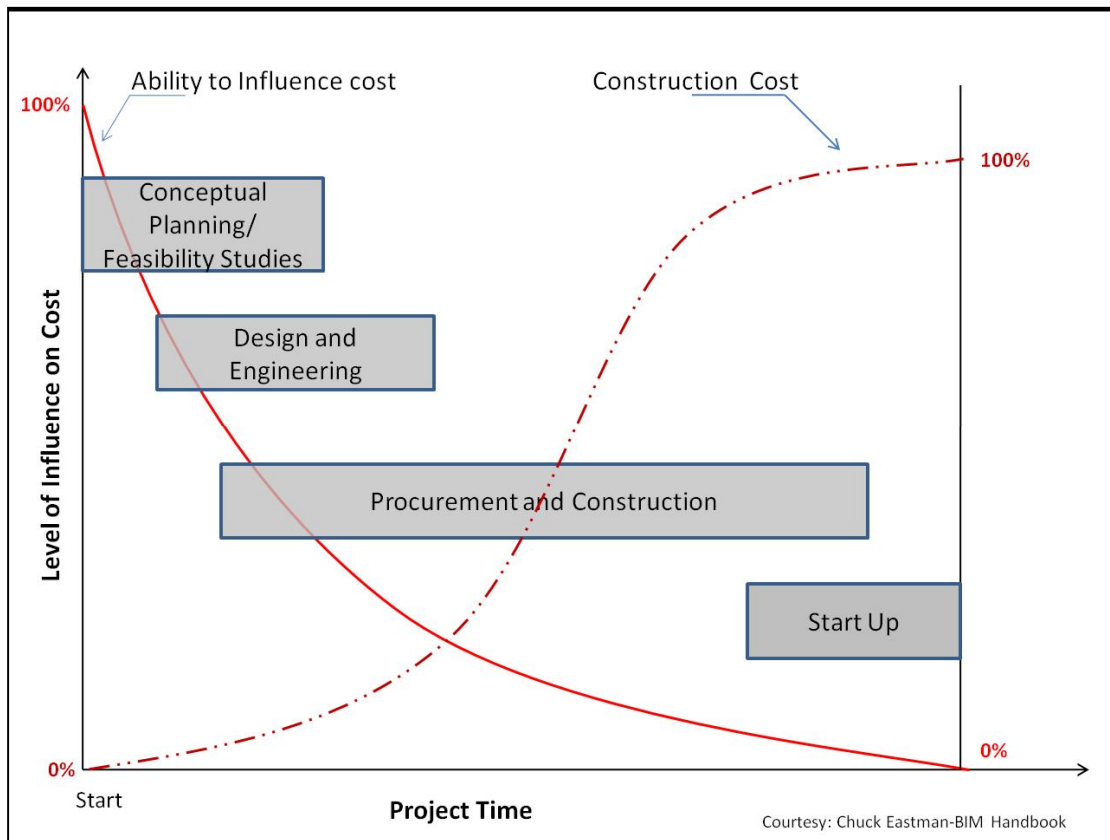three main actors of the construction industry, i.e. designer, owner and contractor.

Figure 1: Mac Leamy Curve (Courtesy: Chuck Eastman-BIM Handbook: A Guide to Building Information Modeling)

BIM

Contractor wishes to utilize BIM at the early stage of construction to support

their process of conceptual estimation (Kraus, et. al. 2007). The tools they used to create

a 3D model at the conceptual stage are Sketch UP[1], Form-Z[2], etc. for the visualization of their concept and Google Earth[3] so as to do the site analysis. However, the 3D model created in these software does not contain any information in them since they do not define any object types, such as area space, floors, etc. It is just the physical appearance of the objects in virtual three dimensional spaces (Ciscon, 2009). They need a tool for quantity extraction and cost estimation at the conceptual stage when the data is very limited. (Eastman, et al. 2008)

Some of the software which has set up a mark in the arena of Building Information technology are Autodesk's Revit[4], Graphisoft's ArchiCAD[5], Bentley Building[6], Tekla Structures[7] etc. These BIM software is helpful in the development of the design of the building and producing better coordinated construction documents. Some of these software may have the capability to create conceptual designs in their 3D environment. However, they do not help in finding out whether the building can be built within the given cost and time budget (Khemlani 2008)[8]. All the benefits of cost estimation from these software can be utilize once the designs are accomplished. At the early stage of construction, when the data is limited and conceptual cost of the design intent is required to make decisions, these software are less helpful. "Software

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[1] Google's Sketch Up http://sketchup.google.com/
[2] AutoDesSys's Form-Z http://www.formz.com/products/formz.html
[3] Google Earth http://earth.google.com/
[4] Revit http://usa.autodesk.com/adsk/servlet/pc/index?id=3781831&siteID=123112
[5] ArchiCAD http://www.graphisoft.com/
[6] Bentley Building http://www.bentley.com/en-US/Products/Bentley+Architecture/
[7] Tekla Structures http://www.tekla.com/us/Pages/Default.aspx
[8] From Beck's perspective, these solutions dealt with "micro models" that provide value primarily in design development and the production of better coordinated construction documents. All the downstream benefits such as cost estimating and construction scheduling come only later, after the BIM development has been done using these solutions. They do not help to answer the most fundamental question early on in the process, namely "Should I build this project?"

applications that develop preliminary building models and costing estimates may not necessarily be the same tools used to support the design development and documentation processes that follow (more typically thought of as *BIM*)" (Sabol 2008).

Hence, it can be said that the available BIM software, or rather to say *Micro BIM* useful at the conceptual and planning stage so as create conceptual designs. These solutions cannot serve the purpose of conceptual estimation done at the early stage of construction when the data is very limited.

Moreover, until the start of the year 2009, most of the BIM software lack the capability of schematic modeling which is the need at the early design stage. In the early design/construction stage, the contractor used to receive limited information from the architect in the form of 2D sketches, narratives, and images. Even if the contractors wish for translating this information into a 3D BIM model prevalent, they were not being able to do so, because of the incapability of the BIM software in the arena of schematic modeling.

To this limitation of BIM, Autodesk has released their new version of Revit 2010[9]. It has the capability to create *conceptual design model* in Revit, which is a BIM solution for designers. Also, in late 2008, Bentley released their new version called Bentley V8i[10], which has the capability of creating conceptual designs. However, from the contractors and owners point of view, these software still lacks the capability to create a *conceptual cost model*. We can get the quantities in terms of area and volume for the *conceptual design model* created, but the process of pricing the cost of

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[9] Autodesk's Revit 2010 http://usa.autodesk.com/adsk/servlet/pc/index?id=3781831&siteID=123112
[10] Bentley's Bentley Architecture V8i http://www.bentley.com/en-US/Products/Bentley+Architecture/

construction still remains manual. Also, Revit does not have a current cost database and does not account for location, type, size of building and function of spaces. These factors form the basis of conceptual estimation. Thus, we believe it provides the contribution only towards the conceptual design of the project and contribute very less towards planning and feasibility studies in terms of cost.

Macro BIM

Macro BIM is the process of creating a three dimensional virtual representation of a building in which large amount of information can be stored and utilized for planning and feasibility studies at the early stage of construction. It is a BIM solution at the conceptual stage, when the data is very limited, generally in the form of rough sketches and narratives. It provides a platform to convert that limited data into rich images and 3D models so as to assist AEC in visualizing the building and providing conceptual estimate in milieu.

Why MacroBIM?

Conceptual Design

"Conceptual design typically includes resolution of siting, building orientation and massing, satisfaction of the building program, addressing sustainability and energy issues, construction and possibly operating costs and sometimes issues requiring design innovation" (Eastman, et al. 2008). The purpose is to assist the owner in the decision making process by providing them the analysis of innovative design along with the construction cost & operating cost associated with that design.

Conceptual Estimate

At the early stage, the parameters required for the conceptual cost estimate are area and volume. These parameters are then multiplied with the unit cost/ft^2 or unit cost/ft^3 – whichever is applicable – for each type of assembly and line item. These unit costs are generally derived from the sources like supplier of construction cost information (RS Means Square Foot Cost[11], Marshall & Swift Cost Data[12]), historical database, or from past experience. Later, the cost that left is multiplied with the gross floor area to get the total cost of that floor. Depending upon the type of structure and given specifications, adjustment is made to unit cost of each assembly and line item before multiplying to the gross floor area.

Schematic Modeling

Unlike in the detailed design phase where information integrated detailed objects are required, schematic modeling includes development of blocks and cells which are less detailed. To serve the purpose of schematic modeling, tools like Sketch UP are very useful for the use of conceptual design at the early stage. Currently, tools like Sketch Up being exploited by the industry for the conceptual design at the early stage. It provides the 3D model with views and images of the virtual building, assisting the owner to better comprehend the design. It also provides a platform of common interpretation of the conceptual design for the other entire project participant.

Unfortunately, tools like Sketch Up does not define object types such as area of each type of spaces, quality level of material, location of building, etc (Eastman, et al.

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[11] RS Means cost data http://rsmeans.reedconstructiondata.com/
[12] Marshall & Swift cost data http://www.marshallswift.com/

2008). In other words, the objects created in these tools lack the "I" (information) of BIM. These are *building models* or *conceptual design models*, rather than building information models. AEC need a tool so as to extract the quantities out of their schematic model which they can use to create and analyze the conceptual cost estimate of the building.

Macro BIM

"Macro BIM" or "Macro Building Information Modeling" is the word own by Beck Technology, who is the developer of DProfiler, a tool that can be used for the project budgeting and for the conceptual planning and feasibility studies (Beck Technology n.d.). "DProfiler is based on a parametric modeling platform acquired from Parametric Technologies Corporation (PTC) in the middle 1990s, after PTC decided not to enter the AEC market. DProfiler is an application based on a platform called DESTINI that has evolved from the PTC - acquired software." (Eastman, et al. 2008). It is integrated with RS means[13] square foot cost database and creates conceptual cost estimate in a different tab as the concept is being modeled in its 3D environment.

In general, Macro BIM can be defined as a *building information modeling process at the early stage of design/construction with the limited data available, that not only gives the physical appearance of the object in a 3D virtual environment, but also carries a potential to embed the information into those objects, and that information can*

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[13] http://rsmeans.reedconstructiondata.com/
RS Means is a cost book publication that provides the cost data for the construction projects. It is generally referred as a guide for the purpose of cost estimation in the construction industry.

be utilize to carry out conceptual cost estimation, project budgeting, site analysis,

multiple design scenarios, and for planning and feasibility studies.

Even though the word "MacroBIM" is owned by Beck Technology, yet it can be generically applied to the BIM processes which serve the purpose of conceptual design and conceptual cost estimate by utilizing building information modeling at the early stage of construction. MacroBIM process involves the creation of the conceptual design model, conceptual cost model, analysis of the cost and design in a 3D virtual environment, and performing the tasks like multiple design scenarios, site analysis so as to find the problems upfront and fix them instead of facing them at the later stages of construction phase.

Identifying Macro BIM Tools

Broadly, AEC Integration Laboratory[14] in Georgia Institute of Technology divided and gauged the "*Preliminary Architectural Sketch Design* tools into several processes or categories such as Sketching, Space Layout and Programming, Object Modeling, Design Analysis, Cost Estimation, Material Library, User Interface & Rendering, Extensibility & Interoperability, and finally Usability" (AEC Integration Lab Georgia Tech 2009). The tools that they have mentioned to perform the above processes are Facility Composer[15], Trelligence Affinity, FormZ, SketchUP, Ecotect[16], Green Building Studio[17], IES Virtual Environment[18], and DProfiler.

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[14] http://aec.arch.gatech.edu/
AEC Integration lab has been directed by Chuck Eastman in Georgia Institute of Technology. They have been dedicatedly involved in the investigation of issues related to BIM.
[15] US Army Engineer Research and Development Center
http://www.erdc.usace.army.mil/pls/erdcpub/WWW_WELCOME.NAVIGATION_PAGE?tmp_next_page =46970

However, speaking about specification of the BIM tools at the preliminary stage, FormZ and SketchUP cannot be regarded as BIM tool. Rather they can be called as BM tools, since its main purpose is to sketch the model at ease at the conceptual stage and hence they can create a building model showing the geometry and form very rapidly. But they do not have the "I" of BIM, which is information integrated into that form and geometry. Green Building Studio, IES-Virtual Environment, and Ecotect are very good software and very well known for their energy analysis and design analysis techniques, even at the early stage of construction. However, they not generally considered as ideal and recommended software for the other preliminary processes, esp. for MacroBIM processes such as conceptual design modeling, conceptual cost modeling, etc.

Moreover, US Army Engineer Research and Development Center, an R&D center of US Army Corps of Engineers (USACE) has developed software called Facility Composer. "*Facility Composer* is a suite of criteria/requirement-based facility modeling tools that integrate customer-specific criteria with a life-cycle facility model and commercial tools." (US Army ERDC Website).

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[16] Ecotect http://ecotect.com/

[17] Green Building Studio https://www.greenbuildingstudio.com/
[18] IES Virtual Environment www.**ies**ve.com/

Facility Composer is a criterion based modeling tool and supports the conceptual design modeling. As of 11th February 2009, USACE was doing the pilot study on the software before releasing it to the market and very little information about this tool is available to this date. Thus, it will not be appropriate to comment about this software and its capability to do MacroBIM at this point of time.

Hence, there will be some limitations on the tools that should be included in the MacroBIM process. Not every tool that can be utilized at the preliminary sketching can be called as MacroBIM tool. As per our knowledge to this date about the existing preliminary CAD tools and definition of MacroBIM, we identify some of the tools that can be called as MacroBIM tools, and can be used to accomplish the Macro BIM processes. Those tools are DProfiler[19], Onuma Planning System (OPS)[20], Vico Suite[21], and Trelligence Affinity[22].

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[19] Beck Technology http://www.beck-technology.com/
[20] Onuma Planning System http://onuma.com/
[21] Vico Software http://www.vicosoftware.com/
[22] Trelligence Affinity http://www.trelligence.com/

1.2 Literature Review

A significant amount of research has been done in order to find out a fast and accurate method to achieve the cost estimation at the early stage of construction. Some of the literature reviews mentioned below focuses on the researchers' investigation towards finding a methodology in order to enhance the accuracy of the conceptual cost estimation.

In 1999, Akintoye and Fitzgerald did an investigation about the cost estimating practices in UK. They perform the survey of 200 firms in UK with the response rate of 42%. The tangible parameters they measured were uses of cost estimating, techniques of cost estimating, and causes of inaccurate cost estimates. Their study reveals that "the major causes of inaccuracy in cost estimating continue to be the lack of practical knowledge of the construction process by those responsible for the estimating function, insufficient time to prepare cost estimates, poor tender documentation and wide variability of subcontractors' prices." (Akintoye and Fitzgerald 2000)

In 1984, Saeed Karshenas developed a formula for the conceptual cost which is a function of floor area and the height of the building. In his study, he used the historical cost database provided by ENR for the multistory steel framed office buildings. According to him, since the costs books provides the cost based on just the gross floor area of the building, it results into the variabilities in the estimated costs. Since his cost function included a parameter for height as well, it gives more accurate cost as compared

to the costs books. (Karshenas, Predesign Cost Estimating Method for Multistory Buildings 1984)

Alfredo Serpell mentioned that the value of the conceptual cost estimate lies on the application of expertise and experience. He proposed the methodology of knowledge based assessment of the conceptual cost estimate in order to assess the expected accuracy and reliability of conceptual estimate. In his study, he created an *accuracy causal model* based on the factors affecting the accuracy of conceptual estimate. Those factors were scope quality, information quality, uncertainty level, estimator performance and quality of estimating procedure. He proceeded with the development of *qualitative accuracy assessment methodology* where the expected accuracy range can be computed by experienced estimators through their knowledge and expertise. (Serpell 2004)

Wen-Der Yu noticed that for the similar or analogizing projects, it is conceived that the quantities for a construction project remain unchanged as the same work is performed by the same workforce under the same conditions. Cost of the work constitute of quantities and unit price. Even though the quantities remain the same for the similar projects, the unit prices vary as per the time, economic conditions and site locations. To solve this problem, he developed a new conceptual cost estimating method called PIREM (Principal item Ratios Estimating Method), in which similar quantities for similar projects can be utilized while the updated unit prices are considered from the market surveys for the pricing. This method is a combination of different estimating method (i.e. parametric estimation, range estimation and cost significant model) with advanced mapping techniques. He tested the PIREM approach on two case studies and

found out that the highest range of error in the worst scenario falls between 10-20% (Yu 2008).

Jrade and Alkass formulated a framework that allows the user to develop preliminary and parametric cost estimates simultaneously while visualizing the drawings virtually in 3D over the web. First he created preliminary and parametric cost database in Microsoft Access. Later he developed a hierarchy database of the components in AutoCAD that require for the schematic design of the building at the early stage. He developed a module using AutoCAD's Visual basic for Application in order to link the AutoCAD components database with the Access cost database in such a way that changes in the AutoCAD drawings will reflect in the cost estimate produced in Access. The 3D AutoCAD model (.dwg) is then translated to 3D Studio Max and from there to Virtual Reality (.wrl) format. Finally, the model is then uploaded to the web using Java scripts and Virtual Reality browser. (Jrade and Alkass 2002)

Bazjanac in 2005 explained the procedure of data import from an IFC compatible BIM for cost estimating and energy performance estimating at the early stage of construction. It portrayed the goals that can be accomplished at the schematic design stage with different software currently available in the market. It talked about how the AEC industry will be affected with the use of IFC compatible BIM in North America. It discussed a workable framework in order to exploit the IFC compatible BIM with the different available software with a wish of putting the anticipation into reality.

In 2007, Saeed Karshendas developed a framework for the purpose of computerized cost estimation at the early stage using BIM. The focus of this research was towards the

benefit of the designers. In his study, he created a data access module which takes the building design information from Revit Database (by exporting it to ODBC) and installation & material cost information from Microsoft Access database in order to generate the cost estimate. He used the Microsoft Excel as the user interface to view the cost estimate as the output. With the use of this system, designers will be able to analyze their impact of decisions on the building cost resulting into the production of cost effective designs. (Bazjanac 2005)

In 2009, Mary-Alice Avila in her thesis investigated the difference between the application and effectiveness of construction industry's traditional practices versus BIM at the early stage of construction with the help of case study at Cal Poly State University. She documented variations in the assumptions and decisions made by the team members for the exterior enclosure of the building project under study. Later, she interviewed some of the construction industry professional and software vendors who are utilizing BIM at the early stage in order to investigate how those variations could have been eliminated if would have used BIM. She provided Cal Poly State University with the recommendations on how to maintain the information about a project by utilizing BIM and thus minimize the assumption gap. (Avila 2009)

1.3 Motivation

MacroBIM states to provide BIM solutions by overcoming the common problems in the process of conceptual designing and conceptual cost estimating at the early stage of the construction with the limited data available. However, very less contractors, owners and designers use it in real time. It is not a generally and readily acceptable process in the AEC industry and workflow.

The possible reason is the risks they might feel associated with the workability of the new process/software.

There is a need of an analysis so as to find out how effective Macro BIM process is at the early stage of construction. This can be done in best possible way by analyzing the experience of the experts in the industry, who are currently exploiting the MacroBIM process at the early stage of construction in their projects.

1.4 Objective

To find out the effectiveness of MacroBIM at the early stage of construction as compared to traditional estimating process by analyzing the experiences of experts in construction industry.

CHAPTER II

SCOPE OF RESEARCH

2.1 Limitations

In this study, we have limited our scope of research with respect to the following:

1. The software/tool, to this date, which supports Macro BIM process are DProfiler, Vico Constructor, Trelligence Affinity, and Onuma Planning System (OPS). Since, it is not feasible for this study to test the effectiveness of every software/tool within the provided span of time; we are limiting it to only Dprofiler, developed by Beck Technology.

2. The cost estimating practices is regarded for the Building Works only and not for the Civil Engineering works.

2.2 Assumptions

The assumptions that were made in the course of this research study are explained below:

1. We are assuming that the Macro BIM includes the processes regarding project budgeting, which primarily includes conceptual design modeling and conceptual cost modeling. It does not include the other preliminary processes such as energy analysis. Hence, we are considering tools like Ecotect, Green Building Studio and Integrated Environmental Solutions-Virtual Environment (IES) as preliminary tools but not considering under the definition of Macro BIM.

2. We are assuming that detail engineering is not required during the conceptual design. Hence, engineers are not included in the study.

3. Architects who are interviewed do not use DProfiler for the modeling purpose. Rather, they provide the information to the contractor in terms of sketches, narratives and images. Contractors who are interviewed retrieve data from the information given by the Architect or Client and use DProfiler for the cost modeling.

4. Owners or developers who are being interviewed do not use DProfiler to create their internal conceptual cost estimates.

2.3 Hypothesis

The hypothesis of the research is:

1. In comparison to traditional estimating process, the process of Macro Building Information Modeling or MacroBIM is effective in providing the visualization of the concept.

2. In comparison to traditional estimating process, the process of Macro Building Information Modeling or MacroBIM is effective in providing the conceptual cost estimate with the limited data available.

3. In comparison to traditional estimating process, the process of Macro Building Information Modeling or MacroBIM is effective in reducing the labor hours

4. In comparison to traditional estimating process, the process of Macro Building Information Modeling or MacroBIM is effective in conveying the assumptions and for doing what if scenarios.

2.4 Definitions

Following is the definition of the terms that are used in this manuscript:

- Effectiveness:

Capacity of D-profiler to produce contractors desired outcome while doing

estimation.

- Traditional estimating process:

  o Conceptual Estimation - done manually or with timberline - using RS Means

  Square Foot[23] cost data, Marshall-Swift[24] cost data, custom cost data or historical

  cost data (For ex. Design Cost Data-DCD).

  o Unit cost per square feet for each type of assembly and line item is derived from

  the above source and then multiplied with the gross floor area.

  o Depending upon the type of structure and given specifications, adjustment is

  made to unit cost of each assembly and line item before multiplying to the gross

  floor area.

- Macro BIM:

It can be defined as a building information modeling process at the early stage of

construction, that not only gives the physical appearance of the object in a 3D virtual

environment, but also carries a potential to embed the information into those objects,

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[23] RS Means http://rsmeans.reedconstructiondata.com/
RS Means is a cost book publication that provides the cost data for the construction projects. It is generally referred as a guide for the purpose of cost estimation in the construction industry.
[24] Marshall & Swift http://www.marshallswift.com/
It is a cost book publication that provides the cost data for the construction projects. It is generally referred as a guide for the purpose of conceptual cost estimation in the construction industry.

and that information can be utilize to carry out conceptual cost estimation, project budgeting, site analysis, multiple design scenarios, and for planning and feasibility studies.

- Standard Building Types:

  The cost database populated in RS Means that is divided in the assemblies for different building types and integrated in DProfiler.

- Custom Cost Database:

  It is defined as the cost database (in $/square feet) created by the contractors as per their market segment for the purpose of conceptual cost estimation at the early stage of construction.

- Conceptual Design Model:

  A conceptual design of a building created in a software that can be visualized and manipulated in three dimensions.

- Conceptual Cost Model:

  A conceptual design model that has the construction cost attached to it.

- AEC: Architect, Engineers and Contractors.

- Cost Modeler:

  It is defined as the estimators performing the conceptual estimation at the early stage of construction utilizing MacroBIM with the help of application like DProfiler.

CHAPTER III

RESEARCH PROTOCOL

3.1 Micro Analysis

Wishes of Contractors

The discussion with the academia and some general contractors during the pre-research stage led us to identify their wishes they would like to see with BIM in the process of conceptual planning and feasibility studies. Those wishes can be categorize into six categories as follows:

1. Put information in their concept model. Model needs to infer that info and tie cost to it in order to provide cost estimate

2. Less labor hours

3. Get the visualization of their concepts

4. Do what if scenarios pain free

5. Convey assumptions within project participant hassle free

6. Convey estimate within project team in such a way so that they understand the concept as well as the estimate after looking at it resulting better collaboration

Conceptual Ordering

"It certainly is necessary to do the detailed type of analysis at the beginning of a research project to discover the categories (with their properties and dimensions) and to uncover the relationships among the concepts." (Strauss and Corbin 1998). Based up on

the Micro-Analysis, the following categories can be conceptualized so as to find out what is going on in the industry with MacroBIM.

1. Labor Hours

2. Assumption

3. Visualization

4. Collaboration

5. Multiple Design Scenario

6. Problems

The description of the reality under each of this category from the experts in the construction industry who are utilizing Macro BIM will produce knowledge. That knowledge will tell us how effective MacroBIM process is at the early stage of construction, to what capacity MacroBIM is fulfilling their wishes, what are the challenges they are facing with this processes and what are their wishes they would like to see in future associated with this process.

CHAPTER IV

METHODOLOGY

4.1 Qualitative Study: Grounded Theory

We choose the nature of this study to be qualitative. The reason is, very little is known about the topic of MacroBIM amongst the researcher and amongst the construction industry professional. Thus, we have used the methodology called Grounded Theory developed by Glaser and Strauss in 1967 (Glaser and Strauss 1967). As per the grounded theory methodology, we have interviewed experts in the construction industry so as to produce new knowledge about the effectiveness of MacroBIM. We have gauged their experience in the domain of MacroBIM under the categories which has been identified during Micro-Analysis.

"GT is a process by which researcher generates theory that is grounded in the data. The data is collected from interviews, observations, videos, etc. which are then analyze by a coding procedure to illuminate patterns or "concepts that are building blocks of theory" (Strauss and Corbin 1998). "Grounded Theory is a systematic generation of theory from data that contains both inductive and deductive thinking." (Glaser and Strauss 1967) "It is the practice of developing theories that emerge from observing a group. Theories are grounded in the group's observable experiences, but researchers add their own insight into why those experiences exist." (Colorado State University)

"GT is a behavioral research. It does not aim for the "truth" but to conceptualize what's going on by using empirical data." (Glaser and Strauss 1967)

However, the intent of utilizing this method is not to develop a theory about MacroBIM. Very few numbers of experts has gain significant experience in the domain of MacroBIM. The intent of using this methodology was to successfully accomplish logical data collection for the study by interviewing experts and present the results in a justifiable manner for the readers. In order to analyze the data, we have used indexing method. The results are showing the patterns of the experiences of the experts with the researchers' insight.

Since the focus of research is on MacroBIM and our analysis is based on D-Profiler which is one of the many Macro BIM tools, we included Beck Technology[25], in our research study much before the data collection process started. Beck Technology has been very courteous to provide us with the data in order to accomplish the study. They provided us the list of their clients who are utilizing DProfiler as a MacroBIM tool and list of the project in which they were involved during the MacroBIM process.

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[25] Beck Technology http://www.beck-technology.com/

4.2 Data Collection Method

Data

Population of Interest

Contractors, Architects, and Owners in Texas who have been using DProfiler at the early design/construction phase of their building construction projects.

Sample

The method of sampling we used in this study is called Theoretical Sampling. Our goal was to sample 10 expert professionals each from contractor, architect and owner's firm. We contacted the Beck Technology at their head quarters in Dallas so as to provide their list of clients who are currently using DProfiler. We received the pool of population in two formats from them as explained below in Pool 1 and Pool 2:

Pool 1

This pool of data consists of the list of 11 projects in which DProfiler has been used in order to do the conceptual planning and to calculate the conceptual cost. The contractor, architect and owner are then identified who were involved in the respective project. The list of projects used in the study is shown in the Table 1 below.

In these projects, the DProfiler modelers were from Beck Technology. They offered the services to the contractors working on that project by creating the design model and cost estimation using DProfiler. They worked in collaboration with the cost estimators of Contractors and Cost Consultants to bear the end result of conceptual cost estimate.

Table 1: Name and Type of Project for Data Collection in Pool 1

No	Name of the Project	Type of Project	Phase
1	Texas Army National Guard AFRC/JVMF	DBB	Schematic Design Estimate Check, Design Development Estimate Check
2	Mary Shields Hospital	GMP	Conceptual Design/Budgeting
3	UTA Bldg	DBB	Conceptual Design/Budgeting
4	Palladium Rosedale	DB	Conceptual Design/Budgeting
5	Carpenter Recreation Center	CS	Schematic Design Estimate & Design Development Estimate
6	Harbor side Senior Care Facility	-	Conceptual Design/Budgeting
7	BBJV Texas Air National Guard Joint Reserve Addition	GMP	Design Development – Establishment of GMP
8	SAMMC AFDTL	-	Feasibility Study
9	GSA - Leland Bldg	DB	Phasing Studies/Conceptual Design/Budgeting
10	2100 M. Street	-	Phasing Study
11	FWISD Paschal Elementary School	CS	Scope To Budget Design Estimate Check/Conceptual Design Estimate Check/ Design Development Estimate Check

Pool 2

This pool consists of 5 contractors who are using Dprofiler for conceptual estimation. In this pool, contractors have been carrying out both the phases of MacroBIM, i.e. conceptual design modeling and conceptual cost modeling by themselves. They have their own DProfiler cost modelers and cost estimators.

Research Screening

The expert professionals representing the architect, owner and contractor are then screened so as to meet the following criteria as shown in the Table 2 below:

Table 2: Experts' Criteria

Contractor	Architect	Owner
• AEC industry experience of 5 years • Experience of 5-12 months with DProfiler • Academic Qualification: BS in Construction or similar • Designation in company: Cost Estimator/Project Manager and a DProfiler Modeler	• Should be working under the direction of a Texas registered Architect • Academic Qualification: Bachelor in Architecture. • Designation in company: Project Designer/Project Manager	• Designation: Contracting Officer • Minimum 5 years of experience handling construction projects for the Owner.

4.3 Data Collection

As per the sampling method discussed above, we formed three groups of experts. After the research screening, the experts group of contractor and cost consultant consisted of 11experts, the experts group of architect consisted of 14 architects and the experts group of owner consisted of 4 owners. These numbers of experts are from both the pools, i.e. Pool 1 and Pool 2. This can be graphically illustrated in the Figure 2 below:
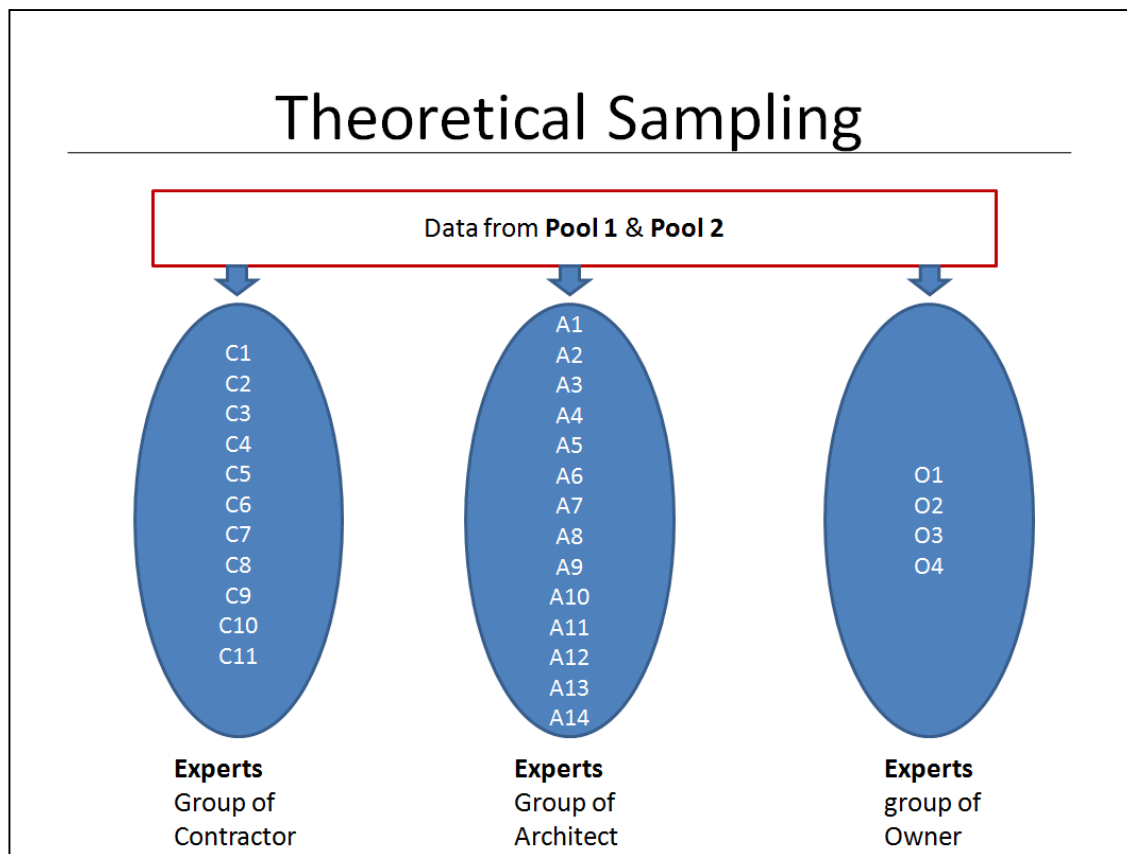
Figure 2: Theoretical Sampling of Expert Groups in each discipline

In this study, we collected the data by interviewing people in the construction industry. The method we selected to sample the subjects for interview so as to collect the data is called theoretical sampling. This method of sampling is generally used in the research whose objective is to develop a grounded theory by interviewing people.

Theoretical Sampling

To determine the sample size in a qualitative study is difficult. We speculated and targeted to have at least 5 participants in each group so as to generate new knowledge and get the theoretical saturation. The number of interviews can be 10 or 20 or 30 or even more in each group of contractors, owners and architects, until the theoretical saturation occurs.

The theoretical saturation occurs when:

- No new or relevant data seem to emerge regarding a given phenomena (in our case, MacroBIM)

- Enough in-depth data that can illuminate patterns, concepts, categories, properties and dimensions of the given phenomena is generated.

- The relationships among given phenomena are well established and validated. (Strauss and Corbin, 1998, p.212)

There is no set number for when theoretical saturation will occur. (Glaser and Strauss 1967) (Strauss and Corbin 1998)

In the method of theoretical sampling, the people who are being interviewed are professionals, or rather to say, *Experts"* in the industry. "By using theoretical sampling and targeting the most knowledgeable participants, one can increase the quality of the

data gathered in each interview" (Thomson 2007). "In other words, the greater the amount of usable and rich data a researcher is able to gather from a single participant, fewer participants will be required" (Moorse 2000).

Is the Sample Size Workable?

In our case, the targeted sample size was 5 participants in each group. S. Bruce Thomson put their effort on a research so as to find out the range of sample size required in a qualitative research, especially in case of interview for developing grounded theory. He went through 50 research papers in which interview has been done and found out that the range of sample size varies 5 to 93. Assuming that the MacroBIM is a recent and new emerging process and have limited use so far in the industry, it can be said that there is a possibility of occurring of theoretical saturation with 5 participants in one group. Hence, we can say that 5 participant in each group is a workable sample size (Thomson 2007).

The response rate we received from Pool 1 is shown in the Table 3 below:

Table 3: Statistics of the Pool Data 1

Discipline	Approached	Responded	Interviewed	Response rate
Architects	14	10	4	71.43%
Contractors	5	3	1	60%
Owners	4	3	2	75%

The response rate we received from Pool 2 is shown in the Table 4 below:

Table 4: Statistics of the Pool Data 2

Discipline	Approached	Responded	Interviewed	Response rate
Contractors	4	3	2	75%
Cost Consultants	2	2	2	100%

We had in total 10 architects, 6 contractors, 3 Owners and 2 Cost Consultants. We achieved the theoretical saturation with 4 architects, and 3 contractors and 2 cost consultants. In total, we took 11 interviews including 2 owners.

For the owners, only 4 people were approached and out of them only two were interviewed. The reason is because, very less owners who were involved in the MacroBIM project were considered as experts. The reason might be because of this new technology has not been popular enough to be acquainted with many owners. However, the responses can be considered as legitimate from the Owners perspective.

Questionnaire Design

We have set up the questionnaire for the interview based on 6 categories that emerged after getting the Micro Analysis done (discussed under the chapter Research Protocol). These categories are defined as:

1. Labor Hours

2. Assumption

3. Visualization

4. Collaboration

5. Multiple Design Scenario

6. Problems

The questionnaire included 10 to 11 questions each for the architect, owner and for the contractor. The interview was semi-structured, where along with the questions in the questionnaire, supplementary questions to the interviewee were asked as they emerged during the interview. All the questions were open ended questions were interviewee has been asked to share their experiences with the DProfiler. All the 11 interviews lasted for 60-90 minutes.

Please find the Interview questionnaire at the appendix A, appendix B and appendix C.

CHAPTER V

RESULTS

As a qualitative method of analysis, we have used indexing method in order to decode the data we gathered by interviews. "In speaking about qualitative analysis, we are referring not to the quantifying of qualitative data but rather to a non mathematical process of interpretation, carried out for the purpose of discovering concepts and relationships in raw data and then organizing these into a theoretical explanatory scheme." (Strauss and Corbin 1998).

The results are broken down into three domains, Contractors Perspective, Architects Perspective and Owners Perspective about MacroBIM. The results in each domain show the theoretical explanation of the experiences of experts with an insight of the researchers.

5.1 Contractors' Perspective

Labor Hours

With RS Means

DProfiler can be of help in saving the labor hours for the tasks of conceptual estimation when it is used along with RS Means[26]. DProfiler basically comes along with RS Means and it has all the standard building types built into its cost database. If any contractor is using RS Means, and if it is using those standard building types to work on their projects, then it saves a significant amount of time as compared to a traditional estimating process.

Without RS Means

However, if the contractor is creating a custom cost model that is unique where it cannot use the standard building types provided by RSMeans, then it takes the same amount of time as it would take in a traditional estimation process. This is because the contractor will have to start from scratch and the process will be the same as it would be with some other estimating application. Potential time savings might exists in quantification tasks. However, for projects that becomes repetitive or have similar properties, once the contractor has created the building type database, it can expedite their process and save time in estimation.

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[26] RS Means http://rsmeans.reedconstructiondata.com/
RS Means is a cost book publication that provides the cost data for the construction projects. It is generally referred as a guide for the purpose of cost estimation in the construction industry.

All of the experts in the contractors group said that they prefer to use their own custom database and that the RS Means database that comes along with the DProfiler is rarely used. Contractors mentioned that creating the custom cost database for an individual company is time consuming. It eventually turns out to be more work at the start. But once a company has created a custom cost database for the repetitive and similar building types of projects, they can experience time savings in the estimation process as compared to traditional estimating process. One of the contractor said that, "*the work we do, with our poor market, and how technical building they are, we elected to not use RS Means and we use and create our own custom database, so that turns out to be a lot of work but at the end of the day, I think it's the only way to work for us*".

Another contractor said, "*D- Profiler helps us save lot of time in doing the budget because we had good mathematical models of buildings that would give us cost of the building which was very accurate. And I would say D-Profiler increases our accuracy somewhat but it also because there is reason why it increases the accuracy because we are more aware of what all is going on with the building, we are modeling more visually than mathematically.*" Thus, it again highlights the fact that, in order to save time and labor, a contractor needs to have good mathematical models for cost estimating. For a good mathematical model, the contractor needs to have significant experience in their market sector, so that they can understand the construction process and should be able to take into account all the cost that goes into construction of that type of building.

Additionally, the amount of experience of the individual DProfiler modeler also affects the savings in labor hours using MacroBIM. Someone with the experience of 2-3

years on DProfiler will probably save greater time as compared to the one with the experience of 6 months.

Assumptions and Visualization

Effectiveness

All the 3 contractors and the cost consultant agreed that the effectiveness of DProfiler in conveying the assumptions is greater than compared to the traditional estimating process of conceptual cost estimation. Everyone agreed that it is an effective presentation and communication tool which helps to convey the information that is present in the conceptual estimate. Questions such as, "What is in the estimate?","How did the estimators quantify items in the estimate?", and "What elements has the estimators not included in the estimates?" can be effectively conveyed with the help of DProfiler.

The reason for its effective communication of the assumptions to other project participants is the visualization capabilities of MacroBIM. Some owners are not building savvy, unless they are developers who have managed multiple building construction projects. When working during the conceptual stage of design, the cost estimators have very limited amount of information on which to base their cost estimate. Thus in that process, they are required to make assumptions and base their estimate on those assumptions and prepare the qualification reports as the basis of their estimates.

Non technical building owners who are not familiar with the process seldom perceive the importance of the assumptions and may not understand the significance of the qualifications made by the contractors during the early stage of design. They may not

take the time to read through the clarifications or qualifications and take the time to understand what assumptions contractor has based its estimates.

The visualization capability of DProfiler helps the Owner to clearly understand and comprehend those assumptions. It creates a platform to communicate the technical cost information in a manner more friendly to the Owner or Architect and in doing so they get a clearer cost-insight of the cost of a project. The challenge of reading through the clarifications to understand the estimate as well as the assumptions can be eliminated.

Cost Insight

Two out of three estimators and the cost consultant agreed that they have gained an insight into the cost of the project that they would not have otherwise by using traditional estimating process. One of the cost estimators said, "*We might be doing a conceptual estimate from a sketch of a floor plan and front elevation when we have to build a model and we have to do the other three sides of the building, lot of times we find things we might not have assumed otherwise. And you find that stuff particularly when you are working in 3 dimensions. Even if you are provided with all the four elevation, when we build the model we find that the places where they are not coordinated, co-ordination is not there and we have to solve the stuff to get it working in three dimensions that relates the costs.*"

The other contractor said, "*Our mathematical cost models may be very good but they may not depict something to us about the building. Let's say an item in the building that requires extra finish that you might not put in there otherwise. By modeling you*

would be able to put a cost to that extra finish. There might be places you can save

money. So we can say no need to do this and can then raise questions then."

One cost estimator disagreed with this previous argument saying that as a cost estimator, they have pretty good understanding and expertise in quantifying the things that goes into a building regardless whether or not they use MacroBIM or traditional estimating process. They have a pretty good idea of what things are going to cost.

Level of Detail

It has found out that the 3D model in DProfiler should be kept simple and generic. If one tries to create a very detailed model in DProfiler, it becomes very cumbersome for them to deal with. The main purpose of DProfiler is to attach the cost to the elements that are being drawn in the 3D environment and give a Macro overview of the project.

At the early stage of design/construction, contractors are more likely to talk in terms of cost/SF rather than detailed cost such as cost per metal studs. They are not keen into detail in order to make sure they have got every detail element in their model. The simpler the model, the effective it is. The contractor should make sure that they create a schematic 3D model of the building where they have accounted for all of the components. For example, rather than drawing details of window mullions in a storefront, they can draw a large area of glass, void of details and associate cost with it.

Architects perceive that the DProfiler cost model is very vague, inarticulate, less precise and not as detailed as compared to their own design model. The purpose for which the Architect draws a 3D model and Contractor draws a 3D model is intentionally

different. The architect is interested in conveying the physical appearance of the building to the Owner, focusing on aesthetic values, forms and function, while the contractor is interested in conveying the cost associate with the construction work required to create the building. DProfiler has enabled the contractor to convey through a 3D model what they have visualized and considered in their conceptual estimate.

Constructability Analysis

The 3D visualization capability of MacroBIM stimulates the contractor's potential ability to do the constructability analysis for a given building project. During budgeting, a contractor needs to think about the constructability and the feasibility of the proposed building project. One contractor said, "*Some issues can come out very early when you model in 3D that would not come out if you did not model it.*" Thus, in essence, by visualization of the building at the early stage, they tend to find out the things that may not work in reality. It allows them to convey such challenges to the Owner like lost revenue or additional cost they may have to incur to cover their revenue. Sometimes, there could be potential additional cost in other part of the building that wouldn't have been recognized without creating a model.

Some of the examples have been shared by the contractors regarding the constructability issues they have recognized which they wouldn't have without using MacroBIM."*I have had buildings that were offset and hit storefront that was almost behind the wall. Those things you would not see in just an elevation but when you do the model you realize that oh this is going behind this building.*" "*Well the architect had a sketch where he actually did the stairs. He had stairs backward on his floor plan so that*

they landed in between the floors outside the building." "One of the doors would have been half way between the floors and it was below grade so door was opening on dirt. It looks good on plan view but it did not work in the model. He did not predict the door in the elevation he had it on the plan. Door belonged in the plan view, it did not work on the elevation so early in the process I could realize that it was not constructible. They had to fix before they could do any detailed drawings."

Finding out these constructability issues at the very early stage of design, not only saves money for the owner, but also eliminates the possibility of any delay to the project. Things like this can be detrimental to the budget at the later phases of the project especially when the architect is preparing the detailed drawings.

Feasibility Analysis

Contractors shared their experiences doing feasibility analysis for building projects with DProfiler. According to them, it is an effective tool that provides contractors visualization capacity to perform the feasibility studies. For example, if a door is appearing below grade in elevations, it makes the contractor to think on the feasibility platform of what would it will cost to raise the building 4 feet up. There may be height restrictions on the building that a contractor would like to think about.

DProfiler does not help in solving those feasibility issues, but it helps to visualize them. It helps the contractor to get a visual picture and helps them to understand what is going on in the project in terms of constructability, and what steps they might would have to take in terms of feasibility.

It is not the primary job of the architects to consider constructability of the project in a technical sense. At conceptual design, an architect is focused on developing an architectural concept that responds to the design program. At this early stage, the architects may only have provided the contractor with a plan and an elevation and may not have had time to generate the other three elevations. In this scenario, there will be some cost associated with the undeveloped information. It is the contractor's job to "fill in the blanks" in order to create a complete cost estimate that represents a fully designed project. DProfiler helps the contractor to think about those costs and helps them to understand how different buildings interchange with each other despite the fact that the information may not yet exist from the design team.

Moreover, usually Architect lays down the Owners idea of constructing a building with a given budget on a sketch and later creates renderings or 3D models. It can come up with a rendering or 3D model at the very early stage, which may not be feasible to do since it will not fit into the budget of the owner. However, owner will still like the fact, that he will be able to get all those things constructed in reality as per shown by the Architect.

Once the contractor come up with initial first couple of estimates, it brings out the reality what is feasible to construct according to the owners budget and how it will look like which in turn may become the reason of unhappiness for the Owners . With MacroBIM, contractors were able to reduce that gap and tighten those initial first couple of estimate. With the help of its visualization capabilities, they were able to do the

feasibility analysis at the early stage and give the owner that confidence that its budget is very less likely to burst in future.

The cost consultant said, "*We had the preliminary budget that most of the time may be within 30%. With BIM, we were able to tighten in that down to probably 5-8% realistically at the conceptual stage, keeping in mind that if you utilize best practices the one to the market, keeping our cost model updated, our pricing updated. So the advantage is to the owner and to the contractor. For the owner, you come in and you say I secure $50M for this building what can I get. Well, we were there again within 5-8% and so midway between the design, you are not going back and changing the designs of the building and going back to the bank and get the money. Owners never want to do that.*"

From the Owners point of view, visualization gives them the comfort when they see the 3D model. Contractor is putting a number in front of owner confirming them that the contractor has included all the things that the Owner wanted them to consider. One of the contractor said, "*We are not low balling, we are not going to come back and say, 'Oh no! All these designs that you are adding are not included!' It gives them that comfort level, which is really nice and makes them want to work more with us which is good*."

Presentation Tool

With the introduction of MacroBIM process and its tools, software like DProfiler had been previously just regarded as a good presentation tool. The initial purpose of the contractor using DProfiler was just for presentation, particularly since it

caught the attention of Owners. Indeed, in this study every contractor agreed that it's a good presentation tool. However, its benefit is not just limited to the presentation. Now, the MacroBIM process has been further developed and it is being utilized in many other preconstruction processes such as constructability analysis, feasibility analysis, etc. Yet, speaking about the effectiveness of MacroBIM, DProfiler is found out to be more effective in presenting the estimate information as compared to the traditional estimating process.

The sophistication level of Owners vary widely depending upon their experience or involvement in the construction industry and may not fully understand the complexities of a particular building project. As a result, justification of certain construction cost not represented by the design documents can be more easily communicated to the owner through the 3D model from DProfiler. With MacroBIM being used for the initial estimate development, the ability for the contractor to sit down with Owner and explain everything that goes into the estimate has been greatly enhanced with the use of 3D model. They can present it to the Owner and can clearly present and justify the cost of each element that goes into the building.

Collaboration

Effectiveness

All the contractors and the cost consultant agreed that MacroBIM is an effective communication tool as compared to traditional estimating process and provides better opportunities to collaborate with the team and with the project participant. One of the contractor said, "*We produce an estimate regardless of the system we are using.*

DProfiler allows us to quickly and more effectively communicate what we were basing our estimate on." The information shared among the project participants is transparent and clearer as compared to the traditional estimating process. The issues that are found during the pricing are being shared and presented in 3D, so the Owners and the Architects gets a better understanding of the project and get more comfortable with the numbers presented to them. It enables the collaborative time to be more efficient if the contractor uses DProfiler. In addition, MacroBIM can be most beneficial if the contractor has a good relationship with the project participants. It helps them to fine tune their collaborative process.

Beyond Early Stage

MacroBIM can be more exploited further after the conceptual design phase, in order to work with the design teams and with the operations team. At the conceptual phase, MacroBIM can be used with the business development and with operations to get an understanding of the building at a more thorough level as the teams go through negotiation. During budgeting, some contractors are using MacroBIM for keeping the process in motion. For example, they will use DProfiler parallel to the design development process. As they make changes in the design development, they model those changes in the DProfiler model. They continue to maintain their model until the construction documents are completed and the project goes out for bid. By doing so, information in the model remains dynamic, live and up-to-date and can be communicated very easily amongst the project participants.

Multiple Design Scenario

Effectiveness

The effectiveness of MacroBIM in analyzing the multiple design scenarios for a building project depends upon the nature of those scenarios. As per the contractors, it is efficient in terms of time while analyzing the cost for different kinds of skin or different number of stories for a building. However, it's not as fast for analyzing the cost for different elements at the interior of the building, or analyzing the cost for different footprints. In order to make those changes, contractors need to start creating the model from the beginning. While not as fast, this process is still more efficient than the traditional estimating process.

The purpose of evaluating multiple design scenarios is to determine the most effective design solution that fits into the budget of the owner. With the help of MacroBIM, contractors model the building cost wise and thus it influences the design of the building. In a sense, teams can develop the best scenario even before the Architect is getting into the design phase and the Architect will know beforehand what options he has to design the building so as to stay within the budget.

One of the contractor said, "*We can do the analysis and hand over the analysis to the client and to the design team and say that, 'look we know what program you want and we know what is the size of the building like the square footage of it. Now that you have high restriction on the dollars and we have zero idea what you want your building to look like. Here is the same program, so if it's an 80,000 square foot office or hospital, these are the programs per floor we model it with different configurations. And 3 out of*

4 configurations comes out to be +/- 5-10$/sq.ft. while the fourth one comes out to be +30$/sq.ft. we can give that synopsis to the design team and can say, 'look if you can keep the design somewhere between these three shapes of the building, we can get there. But if you gonna draw this way, we gonna kill the budget. So, don't waste your time because you gonna waste all the resources, and it will be an ugly experience."

DProfiler can be best utilized for multiple design scenarios when the contractor has zero information or very little information because they have the most flexibility to influence the conceptual design at that time. If they already have a schematic conceptual design, then DProfiler may be good for constructability analysis and feasibility analysis, however, it will limit its power for analyzing different design scenarios for the cost effectiveness of the building and coming up with the best design scenario.

Site Analysis and Sustainability

It depends upon the contractor's expertise and technical skills to see how well he can utilize the system to perform the tasks of site analysis and sustainability studies utilizing MacroBIM at the conceptual stage. MacroBIM can be effective to analyze the different cost associated with different site layout. If the process is collaborative amongst the architect, owner and contractor, it can eliminate the need for the architect to redraw all the layouts and get the approvals. Different site layouts can be analyzed as per the Owners need versus the cost associated with each layout very quickly.

It also helps them to see how well the building fits into the surrounding areas and surrounding parameters after putting the model on Google Earth. With the available program requirements from the owner, the 3D cost model can be created and uploaded

on the virtual site and can be analyzed to see if the building can fit the site as per the owners program requirements and still be in the budget.

From the sustainability standpoint, the contractors said that MacroBIM may have the potential in studying the cost effectiveness in terms of lowering the energy cost in the building, if they considering for gaining a LEED point. If the achievement of the LEED point is not having any cost impact as it would be predicted, then the design team will get a heads-up at the early stage itself for not going in those directions and thus will save their extra work.

However, MacroBIM is not being utilized for its sustainability capabilities by everyone yet. The possible reasons are as follows:

1. The lack of technical skills and awareness amongst the contractors to use those tools of MacroBIM for sustainability analysis.

2. The lack of need for doing the sustainability analysis on the projects on which contractors have been working on using MacroBIM at the early stage of construction.

3. The varying and undocumented cost of different LEED levels and Sustainability requirements.

Supplementary Results

Exporting from DProfiler to Revit (MacroBIM to MicroBIM)

All the contractors and cost consultant said that they don't find any need of exporting the DProfiler model into Revit and provide it to the Architect for proceeding ahead with the design development. According to contractors, the Architects do not wish

to use their DProfiler model, since it is more conceptually modeled, while appear very generic and less detailed.

One of the contractors wished if DProfiler could provide a conceptual design/cost model which will have all the parameters similar to a Revit conceptual design model. In this way, they will be able to utilize the model created in DProfiler in the design development phase utilizing Revit.

Challenges

RS Means

When DProfiler was first introduced into the construction industry, it was delivered with the integration of RS Means cost database. That is one of the reasons why its value is not being appreciated in the market initially. Contractors seldom tend to rely on the cost given by the RS Means. The reason is:

a) Every estimating department performs the conceptual cost estimation differently at the early stage of construction. They tend to rely on their own cost that comes out of construction experience for the trades at the early stage as compared to the costs given by the RS Means.

b) RS Means does not have a moderate level of cost information. It has either very detail level of information that is suitable for the hard bid jobs or it have very generic level of cost information with $/sq.ft.

c) Contractors need to see inside so as to understand how the cost is being calculated in order to achieve that comfortable level with RS Means. As per the

experts, it is very hard for them to look inside and see how things are being calculated in reality and where the cost is associating.

Thus, in order to use MacroBIM, every expert is developing their own custom cost database or *Macro-database*.

In a sense, there are two types of database, Macro database and Micro database. While at the early stage of construction and using MacroBIM, the experts tends to use *Macro-database* so as to get the cost where they have very limited information available to deal with the entire building. Detailed line items in thousands of numbers are not working at that time. They wish to have the database smaller and more manageable.

On the other hand, while at the detail design stage, when they have enough information about the building program, they tend to use *Micro-database*, so as to get into every detail of the building and build the cost estimate.

Custom Cost Database

Earlier when DProfiler launched into the market and contractors bought their licenses, they were trying to build their own custom database**.** Creating a custom cost database so as to work with that software has been very tedious job, since it was not user-friendly and needed the understanding of programming for altering the software as per the concern needs.

To assist in this effort, Beck Technology came up with the new tools which allow the user to create their own custom database. However, building a custom database along with the building types and testing them before actually putting those database into practice is time investing. Roughly, it needs entire 20 to 25 days in whole to come up

with a database along with multiple building types. Nevertheless, once the database is created, one can save a lot of time in the tasks of cost estimation at the early stage. Also, once the contractor created a database for one building type, then he can go ahead using that building type for similar kind of projects.

Thus, for a contractor, who has repetitive jobs, they can use the system efficiently without creating a full-blown database. One of the experts said, "*The challenge is when a project arrives for which the contractor does not have a custom database already built. In that situation, there may be some extra labor creating an estimate; however, it won't be regarded as extra work, but perhaps it's the same work as it would take in creating an estimate in Timberline. The only thing we are not being able to take advantage of is open DProfiler and model a standard building type. But once you create the estimate, you can apply that to just about any model for that type of building program*".

In addition, it depends on the people how efficiently they can spend time in developing those databases and keep on updating it as per the latest market trend.

Thus the biggest challenge is to the contractors to invest the time so as to develop a working cost database. It needs a combination of good understanding of estimation portion and the good understanding of the how the model goes together with the estimating portion.

Fear and Trust

It has been found out that, fear and trust when using new technology are two of the challenges MacroBIM is currently facing in the construction industry. Some

contractors are not comfortable with the number generated by the DProfiler. When they prepare the model, they are reluctant to trust the application and the numbers created by it. As a result of this fear, sometimes they double check the estimate and even actually have an estimator to build the cost estimate manually to overcome the fear. This serves as a cross check it and also so they are not completely relying on the cost provided by DProfiler.

This issue of fear and trust with MacroBIM is raised partially, because of the struggle users are going through in order to create a database that works similar to their current platform. The issue is also partially due to the familiarity and workability of the new software tool and hence some experts ultimately manipulate DProfiler to change the way it calculates to better conform to their comfort level.

The best way to overcome this fear and develop trust in the application in order to gain value from it is, create an own custom database including the line items for the standard type of projects a company does and test them on projects.

Maturity

Some companies are utilizing the help of professionals in Beck Technology to obtain their services on modeling and estimating with DProfiler. There are some companies who are also offering their modeling and cost estimating services to other companies to come up with a budget.

This signifies that this technology has not matured enough yet among the user bases. Contractors or cost consultants are interested in using the MacroBIM on their

building projects, but because of the lack of expertise and technical skills, they approach these companies to get the MacroBIM services.

This may be because DProfiler is a unique MacroBIM tool that can be utilized in the MacroBIM processes. There are not many tools that had been in the industry and offered similar functionality like DProfiler. In order to overcome this, Beck Technology has been providing the in-house training to their clients. The training is very intensive and in-depth.

Many senior cost estimators are older and have been in the industry for several decades. The ability to get the insight of the construction cost comes along with this extensive experience. Often people in this category do not like having to learn new software and attend long tenuous trainings. It's very difficult to persuade old estimators to learn new software. As a result, there will be a challenge to move people on board, give them the experience and training on the specifics of the application.

Also, they cannot put a person of young age solely in charge of estimating a project with DProfiler. They might be good at the technical skills, but they seldom have the experience necessary to adequately create the cost estimate. Hence, the best practice is to put a person of young age who is acquainted with the MacroBIM processes and skilled with the MacroBIM tools along with a well experienced cost estimator or estimating manager. This way, there might be the possibility of reducing the number of cost estimators that will be required in a team to just one or two cost estimators and an estimating manager.

Site Tools

Two out of three contractors and the cost consultant expressed that one of the challenge they are facing with the DProfiler is with the site tools. The site tools available in DProfiler are in 2D and allow them to perform the tasks like creating the site, landscape and setbacks. However, it lacks the capability to perform tasks like cut and fill, creating retaining walls and angle parking, and other site related tasks required for conceptual planning and cost estimation at the early stage of construction. They are wishing to have the site tools in 3D as opposed to just 2D, so that they can perform those tasks as well.

After talking with the project manager of Beck Technology, they said that they were aware of the challenges faced by the contractors regarding the Site tools. At their company, they are developing a new module for Site, which will allow users to look at the site in 3D and perform the tasks like cut and fill, etc. To this date when the study was underway, the new module was not yet launched. Beck Technology is anticipating to launch the new module by Summer of 2010.

5.2 Architects' Perspective

Value of DProfiler for Architects

All four Architects agreed that if contractors used DProfiler to create 3D model for the conceptual planning and feasibility studies, they see the value for the Architects. That value lies in the visualization capabilities of DProfiler and the conceptual cost model created in DProfiler. Architects are very visual. They are able to see the building in 3D and check various components to see the cost attached to that component rather than reading pages of a spreadsheet to understand it.

Also, the value depends on the expert or the personnel who is creating the cost estimate. It depends on his expertise how well he knows the DProfiler and how well he can make use of it.

Visualization and Assumptions

Better Understanding

It's sometimes difficult for the Architects to comprehend the numbers that are in the spreadsheet provided by the cost estimator. In order to present those estimates to their clients, they need to have a better understanding of the origin of the numbers. When the contractors have been provided with the 3D images, they are better able to see the building holistically. As a result, they are better able to gain an insight on the cost and could see from where those costs are being originated. It also helps in raising the confidence level of the Architects and their clients that everything is included in the estimate what is documented in the design intent.

Communication Tool

The architects that participated in the study believe that DP is a communication tool with which, Contractors are able to convey convincingly that they understand the design intent created by the architect. Previously, the cost estimator attempted to review the estimate with the architects by reviewing the numbers in the spreadsheet , but without the aid of visualization. That need to demonstrate comprehension of design intent to the Architect has been greatly enhanced because of the visualization capabilities of DProfiler.

Effectiveness

All four Architects agreed that MacroBIM is effective in conveying the estimator's assumptions as compared to traditional estimating process if they are looking at the 3D model or looking at the 3D images. Contractors sometimes make assumptions that may not go along with the program requirements of the building and may effectively change the scope of work. By visually looking at the model, it helps them to see the assumptions that are made by the contractor. Hence, Architects can then advise the contractor to make the necessary changes to their assumptions so as to be in the budget. It also gives a confidence to the Architects by seeing that Contractor has understood the intent of the Architect and both of them are on the same page.

Design Influence

Architects believe that DProfiler has the potential to influence the design of the building in terms of size, shape and skins of the building. They are able to think about

the value engineering options more easily since they have the 3D cost model in front of them.

Collaboration

The projects for which the Architects have been interviewed are the ones in which DProfiler has been used for budgeting in the traditional Design Bid Build or Competitive Sealed Proposal type projects. They were preparing the budget of the project, so that they can issue the construction documents to the Contractors.

In doing so, they were utilizing the help of a third party cost consultant to provide them with the cost estimate. In addition, the third party cost consultant tends to utilize the service of Beck Technology for modeling and creating the estimate. This may be because the MacroBIM has not been matured yet in the industry.

In this case, there has not been any establishment of direct relationship with the Architects and Beck Technology so as to get the benefits of DProfiler and raising the collaboration level.

However, the Architects interviewed for this study indicated, that in CM@Risk or in design-build type of projects, they can see the value for architects to collaborate with contracting team. One of the Architects said, "*It changes my relationship with him. Because usually, you think of a cost estimator as an accountant, where he is sitting with his spreadsheet and numbers. And now he also became a part of the design team. Because he just did not gave a full bucket of numbers which I did not understand, but he also gave me images which I did understand. So, it changed the way how I looked at him. He became more valuable to me.*"

Multiple Design Options

In the design-bid-build type projects, DProfiler cannot be utilized for analyzing the cost for multiple design options. The reason for this is related to timeline associated with design-bid-build contract vehicles. In the design-bid-build environment Architects have already prepared the schematic designs for the building before engaging the cost consultant or cost estimator to create a cost estimate for budgeting. Additionally, architects may not be familiar with the MacroBIM process and its ability to analyze the cost for multiple design options. Therefore, the cost consultant lacks the opportunity to analyze the cost against different designs.

However, in design-build or CM@Risk projects, architects and contractors work together collaboratively, earlier in the design cycle. Thus, DProfiler can be used to analyze the costs for different design options and come up with the best design to fit into the Owners budget.

Site Analysis and Sustainability

No Architect had enough experience to comment on the capabilities performing sustainability analysis with the application. Two architects indicated that sustainability was not required on their projects in which cost estimator used DProfiler. On the other hand, one architect was not aware of the sustainability capabilities of DProfiler.

One Architect indicated that they are doing the sustainability analysis in their own architecture model itself. Hence, they do not require for any analysis to be done by the cost estimator in DProfiler.

Two out of four architects said that performing site analysis in DProfiler is more effective as compared to traditional estimating process. Since it is visual and cost is attached to the 3D model, they were able to see how different buildings interacted with each other and with the site. Moreover, the other two architects were not yet exposed to the capabilities of DProfiler in doing the site analysis.

Challenges

Interoperability

Three out of four Architects wished that they could integrate DProfiler with their own BIM software like Revit or Microsoft Station. Architects feel that rather than designing the whole building in Revit and then giving it to cost estimator for pricing, it would be better to get the cost estimate hand in hand with the design.

Moreover, Architects feel that it leads to communication challenges. Cost estimators are making their own DProfiler model and not making the use of Architect's model. Thus in doing that, there is a probability that they might miss some of the elements or add some redundant elements. Also, it leads to the duplication of work, which can be reduced if there is a way to translate the Architects model into DProfiler. Perhaps, it depends upon the ability of the person, how efficiently he can create the model.

Two out of four Architects said that they wish there was a way to export the DProfiler model into Revit. They wish to use the same DProfiler cost model to create the construction documents and designs using software like Revit. If the model they are creating at the design development phase is the same model that has been created earlier

for conceptual cost estimation and for pursuing other MacroBIM processes, it gives the Architect a better level of comfort.

Fear and Trust

Architects and Contractors or Cost estimators create two different models. It has been found out that some Architects hesitate to trust the model created by contractors or cost estimators in DProfiler. The reason is the visual representation or level of detail presented in the cost model. The model that is being created in DProfiler is often visually conceptualized (generalized) and much less detailed as compared to the Architects 2D drawings or their 3D conceptual model created in other applications. Thus, it raises the concern in Architects since it does not look similar to their model. They need to engage with the contractors to make sure that they are covering the full design intent.

In order to overcome this fear, they wish:

1) To have a platform where they can give their conceptual design model to contractors and contractors can use that model for creating the cost estimation using DProfiler without having the need of creating a separate model. If Architects and Contractors use the same model, there will be no reason of fear amongst the Architects.

OR

2) If there is a way for Architects to tap into the contractors DProfiler model, so that they can navigate through the model by themselves.

Second cause of fear in some Architects is the fact that younger estimators are working on the MacroBIM software as the cost modelers. There is concern about the level of expertise required in conceptual cost estimation and the level of expertise by younger cost modelers. They wish to see a modeler who is expert in technology working together with an experienced professional who is an expert in cost and know how the construction process goes at the early stage. In this way, the experienced professional can guide the cost modeler whenever that expertise is needed. Architects want to see the experienced cost estimators getting on board with the technology in order to have a good estimate and to obtain comfort in that estimate.

User Accessibility

Some Architects said that, even though they received the images, they are still going through the estimation report manually to check if the contractors has missed anything or added additional elements. When the Contractor shows them the model and the cost attached to each elements in the model, they comprehend the assumptions more clearly and understands the estimate more thoroughly. Thus, they feel it will be more beneficial for them if they could tap in to the contractors cost model directly.

Architects wish to obtain the DProfiler model so that they could navigate through the model, see directly the elements contractor has put in as compared to the contractor showing them the model in a meeting. Currently, there is no way they can look at the cost model directly. Because even if they received the model, they could not open it since they do not have the license. Moreover, they do not wish to buy the license since no Architect wish to use DProfiler on their own.

When asked, all the Architects said that they do not wish to use DProfiler by themselves, since it is a cost estimating tool and not a design tool. Hence, like Autodesk Design Review[27] or Navisworks[28], there should be a way where Architects cannot make changes in the contractor's DProfiler model, but can see it and navigate through it to see the information embedded in it.

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[27] Autodesk Design Review http://usa.autodesk.com/adsk/servlet/pc/index?siteID=123112&id=4086277
[28] Autodesk Navisworks http://usa.autodesk.com/adsk/servlet/pc/index?siteID=123112&id=10571060

5.3 Owners' Perspective

Value of DProfiler for Owners

In our interviews with the Owners, it was found out that DProfiler can be of tremendous value for specialty building projects regardless of whether the Owner is construction savvy or not. For those specialty projects which are unique and not repetitive, Owners may not be able to comprehend and able to visualize the building or understand some of its elements from the drawings. In this case, the contractor can create a 3D conceptual design model for the owner in order to help him visualize it. Moreover, the contractor can embed the cost of construction into the model creating a 3D conceptual cost model, making the cost estimate visual for the Owner so that he gets a better understanding of it.

If the Owner is a developer and construction savvy and the job is repetitive in their service lines, then they have good understanding of the specifications, and different parameters of the building type. They already seem to have a baseline of the building, in terms of cost, its physical appearance and other parameters. They are able to manipulate those parameters very easily, since they have been doing those types of projects every time. In that case, Owners do not feel there is any significant value of MacroBIM since the only thing that is different for them in a new project is the square footage and the offerings of the site.

On the other hand, if the Owner is not construction savvy, then MacroBIM can be valuable to them for any kind of projects. Owners feel that it will help the general

contractors to sell themselves. One of the owners said, "We are not specifically saying that we require to do it, but I will say that in those RFP's when we are putting a scorecard together for multiple GC's who are proposing on our project, they get favorable consideration, if they have got the BIM modeling in there. That can get you the job, that can lose you the job, depend on you do or you don't do."

Assumptions and Visualization

Constructability Analysis

Owners agreed that DProfiler helps in reducing the overall risks in a project. With the help of visualization capabilities of DProfiler, they are able to see the constructability issues beforehand. DProfiler provided them a platform to look at the building from the constructability standpoint.

Owners do not wish either Architect or Contractor to provide them just the physical appearance of the building and an independent number for the whole building and for different trades that goes with that physical appearance. They expect from the project participants to perform the constructability analysis for different trades, find the conflicts and discrepancy between different trades. Owners feel that, DProfiler provides that platform for the Architects and Owners to perform those analyses and is effective as compared to traditional estimating process.

Better Understanding

Owners agreed that since the contractor provided 3D model and images portrayed by DProfiler instead of just numbers, it helped them to gain a better understanding of the cost of the project. They are not just looking at the physical

appearance of the building, but can also look at the construction cost associated with that rendering and can understand cost wise each element of that rendering.

Traditionally, the architect creates a rendering for the proposed building so as to help Owner understand what are those numbers in the cost estimate represents. They tend to scrutinize the estimate report presented by the Architects and inquire about the expensive line items. Owners feel that with the help of 3D conceptual cost model, they can see where the cost is going and thus it is more justifiable to them.

Collaboration

Owners agreed that since contractor used MacroBIM on this project, Architects and themselves had provided better opportunities to collaborate with the team. As per the owners' experiences, they said that Architects were able to understand the meaning behind the numbers provided by the contractor more proficiently as compared to traditional estimating process. Moreover, they were able to convey that meaning of those numbers more confidently.

Architects and Contractor had an analogous interpretation of the cost estimates and thus it helped them to communicate the progress of the project smoothly and at a quicker pace.

In any project, Owners biggest concern has been the cost and time. Owners mentioned that contractor has the technical skills to comprehend the constructability of the designs while the architects are dexterous in creating good-looking designs with their creativity. In a design-build scenario, DProfiler provides a cost-wise collaborative platform, where the contractor can work along with the Architect and quickly find the

construction cost of the designs produced by him. Thus, Owners are being provided with the cost efficient designs while saving the time by integrating design-build and MacroBIM process.

Multiple Design Scenarios

Owners agreed that DProfiler is an effective tool in comparing the cost of two different designs and has been able to distinguish the changes quickly and clearly as oppose to an individual having to make that comparison by himself.

Owners feel that DProfiler has the capability to convey the reason for the cost differentiation based on respective parameters amongst two different designs.

Challenges

Fear and Trust

"*WYSIWYG*" is a computing term that means what you see is what you get. This means that the content that is appearing during the creation of a model in a system is analogous to the final output in the field. Owners feel that cost estimators should look at the drawings or model from the constructability stand point and understand the inherent components that are behind those drawings or model, required during the construction process. They feel that estimators should not just rely on the numbers that are appearing on the screen and coming out of the systems. Owners fear that with the advent of new systems, estimators should not lose that constructability insight while pricing.

Similar to Architects, the second cause of the fear in some Owners is the fact that young estimators are working on the MacroBIM software since older people are less technological savvy. They seldom trust expertise of young professionals in conceptual

cost estimation and their understanding of the construction process. They wish to see a modeler who is expert in technology working together with an experienced professional who is an expert in cost and know how the construction process goes at the early stage. In this way, the experienced professional can suggest the technology expert whenever he is going wrong. Architects want to see the experience getting on board with the technology in order to have a good estimate and to obtain comfort in that estimate.

Wishes

Licensing

 Owners feel that one of the reason Contractors are not willing to take advantage of the MacroBIM process is the cost of acquiring the license of the system. They feel that licensing of new system is sometime very expensive for the contractors. They wish that the vendors should provide some offers in licensing to the contractors so that it will prove less expensive if they buy for all of their estimators.

Interoperability

Owners feel that there are some interoperability issues between the software used by the Architect and Contractor. There should be bilateral transition amongst the model in such a way that Contractor should be able to make use of the Architects design model as oppose to create their own new model in DProfiler.

They wish that if those interoperability issues are solved, they can save the repetitive work done by the GC in creating a new model in DProfiler and thus can save time, making the process more collaborative.

Garbage In - Garbage Out

Owners feel that contractor should keep their cost database updated according to the market rates. They wish that contractor should assign a professional who is expert in MacroBIM and well understand the system in order to manipulate the cost database as per the market trends. In doing so, contractors will be able to offer them the accurate costs resulting into less conflicts at the later stages.

CHAPTER VI

CONCLUSIONS AND FUTURE WORK

6.1 Conclusions

The objective of the research was to find out the effectiveness of MacroBIM process at the early stage of construction. We utilized grounded theory to accomplish our objective and interviewed 3 contractors, 2 cost consultants, 4 architects and 2 owners who have been using DProfiler for MacroBIM process.

The focus of this study was not towards finding out the accuracy of MacroBIM in performing conceptual cost estimation. Future research can create a focus in finding out the efficiency of MacroBIM in terms of accuracy in cost estimates as compared to traditional estimating process.

Labor Hours

All 11 experts interviewed agreed that MacroBIM was an effective process as compared to traditional estimating process in saving the labor hour for conceptual estimation. If a custom cost database has to be created, MacroBIM takes almost the same amount of time as it would take in traditional estimating process. However, the same custom cost database can be used later for the similar type of projects, and it may help in saving time.

Assumption and Visualization

Experts interviewed agreed that the visualization capability of MacroBIM helped contractors better convey their assumptions cost estimation to architects and owners as compared to traditional estimating processes. The visualization capability of MacroBIM facilitated effective communication and presentation. It helped architects and owners gain a better understanding of the project cost. It also helped contractors make sure that they comprehended and considered the full design intent.

However, some architects addressed that the model created by contractors using MacroBIM appeared vague and less detailed as compared to their own design model. On the other hand, contractors felt that the MacroBIM cost model should be kept simple and less detailed because it was not a design model and if made very detailed, the model would be cumbersome to handle.

Collaboration

In design-build and CM @ risk type of projects, MacroBIM can provide better opportunities for collaboration at the early stage among architects, contractors, and the owner as compared to traditional estimating process. However, if contractors are not utilizing MacroBIM by themselves and taking the services of the third party, then architects would not see any value in collaboration.

Multiple Design Scenarios

With little information available at the early stage, MacroBIM is an effective tool for evaluating and analyzing multiple design scenarios for design-build and CM@risk type of projects. On the contrary, if architects have already prepared preliminary

sketches during budgeting, then its benefit of analyzing multiple design scenarios cannot be utilized. Moreover, MacroBIM cannot be utilized for evaluating multiple design scenarios during the design-bid-build type of projects.

MacroBIM is an effective tool for performing site analysis as compared to traditional estimating process. However, architects and contractors expressed their wishes to have more site tools in DProfiler which will help them to create the job site in 3-dimension and will help them to perform the tasks related to excavation.

For sustainability studies, MacroBIM is not currently being utilized yet either by contractors or architects.

Challenges

Fear and trust about the workability of MacroBIM is shown by contractors, architects, and owners. For contractors, it is related to custom cost database and advent of new technology which can be overcome as they test the technology on the projects.

Contractors refrain from giving the 3D cost model created by them to the architects. Moreover, architects do not have the DProfiler license, since it is a cost modeling software and not the design software. However, architects wish to look inside the 3D cost model in order to make sure that contractors have completely followed as per the architects 3D design model. In other words, fear of architects is related to the different 3D models that are being created by architects and contractors individually. This fear can be removed by providing architects an access to the contractor's cost models. This access can be provided by creating a model viewer for the architects and owners.

For owners and also for the architects, the fear is related to the young estimators creating the cost models which can be removed by bringing the senior estimators on board along with the young professionals.

It appeared from the investigation that the MacroBIM technology has not been matured enough in the industry. There is a lack of technical skills of MacroBIM among the senior estimators while the young estimators have the lack of experience. As per the owners and cost consultants, focus of training should put on the young estimators and they should engage with the senior estimators for guidance on cost in order to create a conceptual cost model.

Architects and owners feel that there needs to be an interoperable bilateral translation of 3D model between DProfiler and other architectural BIM tools such as Revit. On the other hand, contractor feels that there is no need of translating from MacroBIM to MicroBIM, since Architects do not wish to utilize their cost model for design development.

Reliability of the Research

In this study, we have prepared the questionnaire with an intention that in future, if any researcher carry out the study with either this application or any other application of MacroBIM , they are expected to receive the similar answers.

Validity of the Research

In order to create a justifiable validity of this study, we interviewed experts who are professionals of the construction industry. In order to develop the questionnaire, we used the help of project managers from Beck Technology, who are the developer of DProfiler. However, due to the limitation of the number of DProfiler users in Texas, we were not being able to conduct any pilot study to test the questionnaire.

Moreover, the new knowledge that has emerged about MacroBIM in this study is based on DProfiler which is one of the many MacroBIM tools. Researchers in future may expect to receive different pattern of knowledge if conducted the same study utilizing the same questionnaire with different MacroBIM tools.

6.2 Future Work

Further research can be accomplished in order to find out the effectiveness of other MacroBIM tools such as Vico, Trelligence Affinity, and Onuma Planning System.

Effectiveness of MacroBIM process in different type project delivery systems might vary. Further research can be carried out to find out the effectiveness of MacroBIM in different type of project delivery methods.

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APPENDIX A

INTERVIEW QUESTIONNAIRE-CONTRACTOR

0. General Information

Q1. How did you use to do the conceptual estimation earlier before started using

DProfiler?

1. Labor Hour

Q2. Does DProfiler play any role in saving labor hours in the processes of quantification

and pricing, as compared to what it takes in traditional estimating process? Is there

any other domain in which you think DProfiler saves time as compared to traditional

estimating process?

2. Assumptions

Q3. What do you think about the reports and documentation provided by DProfiler in the

process of estimation at the early stage?

Q4. As compared to traditional estimating process, how was your experience with

DProfiler in conveying the assumptions to the project team and amongst project

participants?

3. Visualization

Q5. What is your opinion about the visualization capabilities of DProfiler at conceptual

stage with limited data?

Q6. By creating a visual model, did you gain any insight into the cost of the project that

you may not have received if you utilized a traditional estimating process?

4. Collaboration

Q7. Do you think that by using DProfiler, the client and the architect provided any

opportunities to collaborate with your team working on this project?

Q8. In the future, given the opportunity, would you see value in collaborating with your

team using Macro BIM.

5. Multiple Design Scenarios

Q9. What is your opinion about the capability of DProfiler for doing multiple design

scenarios, sustainable design and site analysis?

6. Problems

Q10. What are the problems you feel currently with DProfiler and what are your

wishes that you would like to see happening with DProfiler in future?

Q11. Is there anything that I have not asked and you would like to say?

APPENDIX B

INTERVIEW QUESTIONNAIRE-ARCHITECT

1. **Labor Hours**

   1. If contractor uses DProfiler to create 3D model for the conceptual planning and feasibility studies, do you see any value coming for the Architect? If yes, what are those values?

2. **Assumptions**

   2. Did you find the reports and documentation that provided by contractor using DProfiler any helpful?

   3. Did you find DProfiler helpful in clearly translating the assumptions within the project participants?

3. **Visualization**

   4. Since contractor provided 3D model and images portrayed by DProfiler instead of just numbers, did it help you to gain a better understanding of the cost of the project? Did it influence your design?

4. **Collaboration**

   5. Do you think that since contractor used DProfiler on this project, you (as an architect) had provided better opportunities to collaborate with the team of contractor?

   6. In the future, given the opportunity, would you see value in collaborating with the team using Macro BIM.

5.   **Multiple Design Options**

7. How was your experience with DProfiler in practicing sustainable design and doing site analysis at the conceptual stage?

8. *Did you use DProfiler for the tasks like space planning and preparing floor plans and cresting multiple design options?* How was your experience with DProfiler in performing the tasks like space planning, preparing floor plans, and cresting multiple design options for the project?

6. Problems

9. What are the problems you feel currently with DProfiler and wishes you have that you would like to see happening with DProfiler in future?

10. Is there anything else that you would like to say which I did not ask?

APPENDIX C

INTERVIEW QUESTIONNAIRE-OWNER

1. **Labor Hours**

   1. If contractor uses DProfiler to create 3D model for the conceptual planning and feasibility studies, do you see any value coming for the Owner? If yes, what are those values?

2. **Assumptions**

   2. Did you find the reports and documentation which provided by contractor using DProfiler any helpful?

   3. Does DProfiler helps in reducing the overall risks of a project?

3. **Visualization**

   4. Since contractor provided 3D model and images portrayed by DProfiler instead of just numbers, did it help you to gain a better understanding of the cost of the project?

4. **Collaboration**

   5. Do you think that since contractor used DProfiler on this project, you (as an Owner) and the architect had provided any opportunities to collaborate with the team?

   6. In the future, given the opportunity, would you see value in collaborating with the team using Macro BIM.

5. **Multiple Design Scenario**

   7. Have you been provided multiple design scenarios for this project? Can you explain, to what capacity multiple design scenario has been helpful to you

6. **Problems**

8. What are the problems you feel currently with DProfiler and wishes you have that you would like to see happening with DProfiler in future?

9. Is there anything else that you would like to say which I did not ask?

APPENDIX D

INTERVIEW TRANSCRIPT-CONTRACTOR

CONTRACTOR #1

Interviewer: How did you use to do the conceptual estimation earlier before started using DProfiler?

Interviewee: We used excel, rely on our historical cost database created from the historical cost we capture along the way. And of course, tapping on to the sub contractors we worked with for unit cost information and things like that.

Interviewer: Yes, like by using the software like Timberline or MC square, and obviously taking the numbers from the subs since they have the latest cost information.

Interviewee: Yes, and moreover, it's always like you take the information and you give it what it says whether it's a written narrative, or a phone conversation, or a floor plan. We take that and elaborate on that sketch and kind of draw out what it is worth thinking so that we can communicate with the client. Sometimes it is hand drawn, sometimes it is using sketch up, once in a while with Revit. We piece that together to an estimate to tell the story.

Interviewer: Does DProfiler play any role in saving labor hours in the processes of quantification and pricing, as compared to what it takes in standard procedure?

Interviewee: Ya, I would say yes. It does. I mean it still got the…In the perfect world, the DProfiler is up and running like you wanted to and you have all your standard building types built, modeled something within one of those std building types, then absolutely it saves time. If you are creating something that is for custom and you can't really use the building types, then you have the modeler and have to create the estimate from the scratch, probably saves a little bit of time. It depends on how versed you are in the system I guess.

It's the same process if you have to start from the scratch and do the costing, then it's the same process using timberline and some other methods of sketching

Interviewer: Exactly, like for example if there is a standard building that usually go for office building types with different cladding and stuff like that, then it is easy. But, Lets say if it is a structured parking garage with two floors of retail and above that 2 floors of parking and again above that 5 floors of office space. Then for these types of complex structure, does it take more labor hours or what?

Interviewee: No, I wouldn't say more at all. You use the system quite a bit and then you are familiar with how it works. Out of the box it comes with based on RS Means and it got all the building types RS Means has all populated into it. If you are able to think out of the box and you know the system and you model it based on RS Means, I say it will save your time everyday every time.

But the work we do, with our poor market, and how technical building they are, we elected to not use RS Means and we use and create our own custom database, so that turns out to be a lot of work but at the end of the day, I think it's the only way to work for us.

Interviewer: What do you think about the reports and documentation provided by DProfiler in the process of estimation at the early stage?

Interviewee: It's weaker than we were wanted to be. It's definitely improved. When we got our first license and we tried to use it and it wasn't producing what we truly needed. I would model something and then take the information and create in excel. It dint sort the way I wanted to sort actually, but it's absolutely improved. It came a long way than I thought. We have some trouble, since we create our own custom database, and when we do that we are pushing the limits on reporting based on the way we build and sort estimates.

Interviewer: As compared to standard procedure, how was your experience with DProfiler in conveying the assumptions to the project team and amongst project participants?

Interviewee: I think it helps, it does help. Because our standard procedure is to create----No estimate goes out the door without the basis of the estimate documents to go with. You estimated it and you have some qualifications in there, inclusions, exclusions, but the basis of estimate is are our narratives what exactly what it is we are assuming. I thought good that we builders can communicate everything, seems crystal clear and narrative to us. You give it to the user group that are owners who are not building savvy and its kinda greek language to them sometimes. Clearly, they do not understand everything we are writing. So, DProfiler really helps to tell the story with the visual. I think that's the power of DProfiler. You have the estimate and you have that visual and you can see exactly what we are assuming. And of course the idea that it is live, as we change the model, it changes the estimate.

Interviewer: Earlier you said, the reports were not the way you wanted. So, is it like in timberline, when we do our estimate and whenever we wanted to prepare the report in pdf or excel or whatever format, we can sort our estimate according to group or phase and WBS, stuff like that. Did you mean these things when you mentioned that it is not the way we wanted?

Interviewee: As far as the reporting goes, we build and sort our reports by system as it is in CSI format. And as we are building our custom database, the reports are running off----we are just struggling to get the database built such that the report shows exactly how we wanted it to be. We are running into some limitations that it just wouldn't work. Beck Tech were listening to us that we couldn't do what we wanted to do, so they come up with couple of next enhancements.

Interviewer: What is your opinion about the visualization capabilities of DProfiler at conceptual stage with limited data?

Interviewee: Oh! I think it's great. That's why it makes the system powerful. In my opinion, you don't use DProfiler, if you are already have a schematic design. You use it when you have zero information, very little information, because then you have the most flexibility to influence the design. And we do not use it to influence every ginger belly of the design, we use it to influence the shape, size, footprint, layout, that kind of stuff. A U-shape building, in a killer budget is more effective than a rectangle or something similar to rectangle, does that make sense! To get the method which is cost effective, take the same program that we get for a building, ROI in 3 years for 4 different drastically different shapes, sizes, and show which building types will---if we know the budget---show which building types will get us to the budget and which building types gonna blow our budget. And based on the footprint ratio or the number of floors to footprint ratio can do the cost per square foot.

Interviewer: Basically, we are talking about the multiple design scenarios, if you have a U-shape building versus a rectangular shape, how better it is fitting in our budget and stuff like that and we can do the multiple design scenario like virtually and visually watching it how the building will look like, right?

Interviewee: Right, so we can do the analysis and hand over the analysis to the client and to the design team and say that, 'look we know what program you want and we know what is the size of the building like the square footage of it. Now that you have high restriction on the dollars and we have zero idea what you want your building to look like. Here is the same program, so if it's a 80,000 square foot office or hospital, these are the programs per floor we model it with different configurations. And 3 out of 4

configurations comes out to be +/- 5-10$/sq.ft while the fourth one comes out to be +30$/sq.ft. we can give that synopsis to the design team and can say, 'look if you can keep the design somewhere between these three shapes of the building, we can get there. But if you gonna draw this way, we gonna kill the budget. So, don't waste your time because you gonna waste all the resources, and it will be an ugly experience.

Interviewer: Well, it does influence the design, right!

Interviewee: Absolutely.

Interviewer: By creating a visual model, did you gain any insight into the cost of the project that you may not have received if you utilized a traditional estimating process?

Interviewee: I don't think so. I would like to say, that we preconstruction department do a good job for accounting for the all the systems that go on to the building, whether we do it with DP or by traditional ways. I think more than anything that helps us communicate--as we have talked earlier—communicate all our assumptions to the owner and to the design team and allows us to quickly analyze different scenarios for the same building program so that can get the feedback on cost.

Interviewer: So basically, communication, analyzing the different cost and presentation to the owner these are the three power of DProfiler you can say, right?

Interviewee: Definitely. For sure. But I don't think it has given us any "Ahaa!" moment. You know, we would have left something out as we not using it in DProfiler.

Interviewer: Do you think that by using DProfiler, the client and the architect provided any opportunities to collaborate with your team working on the project?

Interviewee: Yes. It's a communication tool. So we produce an estimate regardless of the system we are using. DP allows us to quickly and more effectively communicate what we were basing our estimate on. So, it does helps in the collaboration.

Interviewer: Since we are talking about collaboration, I am wondering how do you present your estimate or your model to the architects or to the owners?

Interviewee: With a projector on a wall.

Interviewer: And they are like, sitting in their office and watch the model thru video conference?

Interviewee: Ya, If the project is in the same town, then we will get together in the same room and will play with the model together. If we are different parts of the country, then obviously you can do the same thing over the web.

Interviewer: In the future, given the opportunity, would you see value in collaborating with your team using Macro BIM.

Interviewee: Yes, absolutely. So, far we are self developing on our database. But absolutely we planned to use it in the near future.

Interviewer: What is your opinion about the capability of DProfiler for doing multiple design scenarios, sustainable design and site analysis?

Interviewee: I cant say. I haven't used that too much for sustainable design. For site analysis, we have absolutely interviewed for a project, and in the pre-submittal meeting the owner set up there to this room of contractors and designers and said, "We don't think the site is big enough to fit the program that we

wanted and here is the program that we wanted…" They gave us the size of the building, "…we think its gonna create a odd shape building because of the site parameters. We gonna pay extra because we have weird shape site with influence from the neighboring facilities…" We took that information and came back to the office, and modeled it in DP and we found out that the site was plenty big to fit a normal shape building. We work out the cost because of the shape of the site, and went to the interview with confidence and with DP, we showed them, hey we created this estimate, possibly can fit your budget and the building can look like this, a normal shape building for the program you wanted to go into the building. That absolutely helped us to communicate our knowledge, our expertise for that particular building on that site.

Interviewer: I believe creating the database goes along with your estimation as the project comes. Like if you have a project for office building or a structured parking garage or recreation center, so according to that, you keep in developing your own estimating database, you have not yet created the whole databse of all the 44 building types or something they have, right?

Interviewee: we have essentially ditched the RS Means completely and we have worked on the custom DPR database and we got the 4 building types. Some project comes up with------anything in there----- without the database already built, there is a little bit of extra labor involve in creating an estimate within DProfiler to model that we built but its not any extra work in creating same estimate in timberline. It's the only thing we are not being able to take advantage of is open DP, and model a standard building type. That's the only piece we are not fully take advantage of. But once you cerate the estimate, you can apply that to just about any model for that type of building program. The modeling building can be done in 15 minutes and the estimate takes a little bit of parts and process to put together.

Interviewer: What are the problems you feel currently with DProfiler and what are your wishes that you would like to see happening with DProfiler in future?

Interviewee: The struggle that we are having that how the system reads the database. There are some things inherent in the designs that don't work hand in hand with the way we build and sort database for our estimate. So, we are still struggling a little bit with that. We were working really close with Bech-Tech, and communication is constantly about what problems are coming up and they are extremely responsive and been able to work around or keep it for the future enhancement. That's our biggest stumbling blocks but its not by any means keeping us away from using the system.

Interviewer: So**,** its like the way the software has prepared…you mentioned that because of the design, you are not being able to properly synchronize the database with your model, so….

Interviewee: We have a certain way across our company, like we have an agreement on how we wanna sort our estimate and present our estimate. We don't wanna this that on one project a team is using DP and present the information in one way and once you get on to schematic design, you ditched DP and start working with Innovaya or QTO or Revit and present the data in an entirely different way. There is not continuity here. So, we are not gonna change how we sort things. We need to make DP work for us. It how the reports and the system looks for the stuff in the database, where it is hidden and how it is sorted in. Its not a show stopper, its just a struggle.

The topic is MacroBIM. And that's what the DProfiler does. The macro type overview. Its like a macro look at the project. Its not keen into detail and make sure you got every window. In my experience, the simpler the model, the more effective it is. You wanna make sure you have your building and accounted for all your components, but you talk in big buckets of money, not cost per metal studs that goes into the building.

As close to the model that is having a skin, just put the bungy material out there and say its 40% glass, 30% CMU and 30% whatever. And that's what my estimate was based on. We used a target value design, where we model it, we creat bucket of money and we tell the designers, this is what you have to deal with, this is what you have to design to, your exterior skin has to fit into this bucket. If it doesn't, then

something else whether be your interior finishes or your mechanical systems, that bucket gonna get smaller, and still mug it into the exterior skin bucket.

So, we don't want DP to be based on Timberline database. Because Timberline database we self perform drywall, concrete, doors and demo. You can imagine, our timberline database has 1000 of line items big. We don't want that much information in DP database. We created unwanted headache. So, we are keeping the database of DP, more manageable, more smaller, because it is more of a macro look of it, because you do not have any information. You have very limited information and you are looking at the entire system. So, yes, in essence, we will always have two database, one macro database for DP, and one timberline database for micro level where we have 1000 of line items and can create such estimate out of it. The idea is when we use DP at the very beginning, it influence the design and us to make sure that we are not going over budget, and as the design progresses, we move over to micro type tools, where the designs are being created and we can put our estimated together in more detailed format.

That's the big struggle, I should say. When we present DP to other DPR folks across the nation, and we explained we don't wanna tie to timberline database, people who don't know how to use DP, they don't understand why it has to be----For those who are familiar with DP and know DP, they are on the same page that we wanted.

Interviewer: So, to my understanding this technology MacroBIM has not yet matured yet enough

Interviewee: Yeah, I agree with that. It's the only system of its kind, unless there is something come up recently and there is so much training. A lot of people when they see it, they think its more of a marketing tool than actual an estimating tool and I think that's an another struggle. We estimors…some kind of prima donna, we think that there is no one anybody else who can create the estimate the way we do and this tool can make us work out of job. I dont know what people think, I think it's a very useful tool if it is being used in a right way.

Interviewer: Marketing tool, what do you mean by that?

Interviewee: I got some comments in the past from some people came from different origin and said that it's a great tool for the presentation purposes. They are right, it is good for presentation purposes. They don't have the understanding of how the system works and who knows how much it is true behind the comment. People are less likely to trust. They just aren't trying to willing to trust that the estimate that comes out the model are right. This is just because they have never used the system.

Interviewer: So, basically fear and trust are the two things that revolves around the MacroBIM.

Interviewee: Absolutely. Absolutely.

Interviewer: And you said that you used another tools to go ahead with your estimation when you get the design development drawings, lets say like 70% or 100% drawings and you used different tools for doing the MicroBIM, like detailing the BIM model. So is there any channel you found to transport your MacroBIM model to MicroBIM model

Interviewee: No. Essentially, you have your MacroBIM model and the estimate. Once the owner or the design team gets into the schematic design phase, they are building the model at that point. We are not designers, we are builders. DP were explained to the design team what the estimate is based on, we used DP to do that and what they can and cant do to keep us in budget or not. Then they design the building and then they give us the model at that phase and we use that model and we then create the estimate based on that model. We use our MicroBIM tools that we have for the estimating or the pre-construction process for rest of the job.

Interviewer: You give the designers the DP model or the images that comes out of the DP model?

Interviewee: As I said, we are doing it live and together. We are more than happy to give the model. But none of them gonna buy licenses at the end and will be willing to use DP and you cant import DP model into anything else. All we can do is give them pictures

Interviewer: To my understanding, Beck Technology has come up with a tool called DP viewer, where we can view the model. I am not pretty sure if that tool require DP installed on the machine so as to run/utilize that tool.

Interviewee: Oh! Great.

Interviewer: Any other problems you feel going on with DP?

Interviewee: Not really a problem, its just a work in progress. It's a new software. Its not uncommon to build a model and the estimate and then find out that something is not working correctly, that needs to be fix, whether the type of markup they are calculating. I mean humans built it, so its not really a problem that is just a reality. Every software face it when it is created.

Interviewer: do you have any wishes that you would like to see in future?

Interviewee: I wish there is a path to walk around the reporting challenges. I know they have answered a lot of those. I haven't tried my hands on the site module yet. I would love to get my hands on that and give it a shot, that would be pretty powerful.

Interviewer: How do you estimate the quantities of earthwork now to get the cut and fill cost and cost of other things related to earthwork?

Interviewee: What you mean that you have a project that has a building and a site and you know you have underground utilities things like that needs to be accounted for but there is no way to get it drawn?

Interviewer: Exactly

Interviewee: You can do it in couple of ways, you can always draw-----(lost the term, type of tool for drawing in DP)----you can draw second mass to it, but your reports are all screwed up. Draw a mass and can assign a value to it. Or you can just identify what is it you gonna have it, you know 800 LF of 6" water line and 4" sewer line, and you can plug those in with the estimate numbers, you don't actually have to model them. If its really very early and you don't know anything about the site, you can just plug in lump sum cost per acre. In general, you don't know all that stuff when we are using DP, because it is still in the essence stage of the design. We really dint had any roadblock when it comes to that.

Interviewer: Is there any thing else that I have not asked and you would like to say?

Interviewee: I think it's a wonderful tool. I think we definitely gonna start using it company wide. We get some challenges, but software is not a problem. The true key is to get the people on board and give it to is and give them the experience **.** Having build an estimate and an model, you start to get an comfort level with it.

Interviewer: In DPR, how many people are using DP?

Interviewee: There are not many users. I am the only pre-con guy that I know who uses the DP. There is another guy in the office and he is an engineer and he knows the system better than I do and he uses it. He helped in creating the database. Two folks in our Sacramento office, playing around with it as well. But, I don't know how much they have used it. We presented to some of the National pre-con group and we just putting in forward.

Interviewer: Yeah, I understand, that whenever a new software comes, there is a little bit of hesitation by folks esp. the older folks. Most of the estimators in the office are above 50 and its very hard to persuade them to learn new software. I saw people having a hard time with Timberline itself. So, I can understand people will might have hard time understanding the nuts and bolts of the DP. So, fear and trust is there along with the hesitation to learn the new soft skills.

Interviewee: I agree. I agree

CONTRACTOR #2

Question 1:

We had pretty talented conceptual estimator, who used to do it with whatever sketch or drawing he had, historic knowledge, and his brain.

Did he use any specific tools to do so or just rely on his experience?

It depended on how much information we got, and what level of conceptual it was, whether we got plans or not, or whether it was just sketch, but probably in excel spreadsheet just to lay the numbers in and other than that just the hand tools.

Gist of the project and Role:

In GSA Leland building, all we did is we created a cost model for us. So it was not an estimating effort from our company. That was just a cost model, purely built just for us. They provided me with the estimation information and line items and the cost information.

So, were you some sort of CMA?

Yes. They are putting together a design build RFP, so they are creating a budget at RFP.

Question 2:

Not at the moment. I think it will. That is the reason we are putting energy into it. The challenge is that you got to put so much into costing database and so much effort and time into texting, it takes a while and you need to do bunch of that before you start seeing real efficiency benefit. So we are in that and we are doing that. But right now, the biggest challenge is getting the cost database to actually work in the way we estimate and to create trust in the estimating side. So that they believe it's telling them. So, we need to get our database build and then get enough accurate estimates out of it in order to that to be true.

Question 3:

They are OK. They could have been better in terms of customizing reports. Having said that, I think they have improved some of that, but, I have not used the updated stuff yet in terms of customizable report. So, that might be an outdated statement, I just haven't tried it out.

Interviewer: You mean to say that, the flexibility we have in Timberline to make the reports in group, assembly and phases, that's what you are talking about?

Interviewee: Ya…and Hmmm…May be even more…the look of it…You know just the aesthetic and the appearance of the document. The information that DProfiler puts out is good, but I could have used lot more flexibility in how to pull that information and put it in the kind of information I want to make and pull in a way that I wanted.

Question 4:

As a presentation tool, it is great. It really adds a lot in terms of conveying the content of the conceptual estimate: what is in there, what is not in there, how you counted things. But it is not reliable yet in terms of cost. In other words, we are still running the number manually and not purely relying on the output of the DProfiler. So, in terms of conveying the cost, not great but in terms of conveying the information it is excellent, much better. Much clearer and much more information!

You said that you have to calculate the estimate manually?

We are not comfortable yet, that the numbers created by DProfiler when we do a model are accurate enough that we rely on them. We don't just double check them , we actually…at this point an estimator is still building a cost estimate by himself, and applying that stuff to the model. We are not counting yet on the numbers created inside the model. We are getting there!

By numbers, you mean to say Quantities or Cost?

The cost!

You mean to say you are inputting the line items in the database by yourself.

Yes, and also in some cases we are also manipulating the formulas because we are not…there are some cases where we are not confident in take off for quantities. There are only few of those, they are usually in unusual pieces or places where we haven't got deepen in to the formulas yet.

Question 5:

Its great. Really, what I love about it gives me the opportunity too…when I make a model, lot of time especially when working on conceptual stage you don't have much information that allows you to convey exactly what we did and we did not include and because it is visual, because you can look at all sides of the model, you can look at the inside, you are communicating something that sort of…it in a manner that an Owner or Architect or Engineer are used to look in at, it doesn't require them to take away a document read through all the clarifications. We can sit down in a meeting and instantly they can see decisions that we made in the budgeting that are may be different that they have intended in the design. That's been the biggest and most significant benefit for us of the software at this point.

Question 6:

Yes! Not always, but frequently. And lot of times that happens in connecting the site, in other words, we might be doing a conceptual estimate of sketch of a floor plan and front elevation when we have to build a model and we have to do the other three sides of the building, lot of times we find things we might not have assumed otherwise. And you find that stuff particularly when you are working in 3 dimensions. Even if you are provided with all the four elevation, when we build the model we find that the places where they are not coordinated, co-ordination is not there and we have to solve the stuff to get it working in three dimensions that relates the costs.

Question 7:

Yes, it varies. It depends on what the situation is, etc. But I can think of one in particular where we presented to the Owner and the A, and the A was not sophisticated in modeling and they were just excited about the information that we presented and the fact that we can show them, issues that we found as we were pricing-- you know what I said about building in 3D--and we are really excited about possibility of having us onboard and working with us as long as they understood that we know the building, it wasn't just the dollar per square foot thing.

Interviewer: Whenever we get the 2D sketches and narratives and they get the opportunities to see that information in 3D space, they get excited and think that its apples to apples and not apples to oranges.

Interviewee: Right. It gives them a lot of comfort to them when we put a number in front of Owner that we are considering all the things that they want us to consider in their buildings. We are not low balling, we are not going to come back and say, 'Oh no! All these designs that you are adding are not included!' It

gives them that comfort level, which is really nice and makes them want to work more with us which is good.

Question 8:

You mean our team, internally! Yes. I think one of the thing I hope to do in future is really use it more…once we get comfortable with the calculation and what the output is in terms of $, I think I would like to be using it with some regularity so that we can take it, I mean that can be included as we move along in the process and we can use it to work with design teams and with our operations team. I mean we will move pretty quickly if we get it in that situation to a MicroBIM model. But even at the conceptual level we can use it with business development and we can start to use it with operations to get their understanding of the building at more thorough level as we are going through negotiation.

And would you see same collaboration with your project participants using MacroBIM?

Absolutely.

Question 9:

Site analysis! I think only it relates to sustainable design. I don't think it really do much thing for me. I guess I can do parking counts and stuff. The site tool are pretty limited. I think they need to work on those and have some expansions. Once they have it in 3D, then I think I can do sloping, I can do cut and fill and I can work on parking and retaining walls and get some angle parking and start to understand how to use it would be better. Right now what I can do with Site is pretty limited. In terms of sustainability, I really like it. Because it let me do a really high level of analysis. In other words, taking a quick view of weather, a move that you might take to LEED point is actually going to result in lower energy cost in your building or not. You kind a get the 50,000F look in that. You can get a sense before the design team does a lot of work designing it as to whether it's going to be valuable or not. And I think that's the real power of MacroBIM at sustainable level. I do not think there is a lot of benefit to it after that, but the real benefit is seeing whether things that you might do before the design are actually going to have cost impact.

Multiple Design Scenarios?

It depends on the nature of those design scenarios. If you are looking at different kinds of skin or if you are looking at a 10 storey vs. an 8 storey building, it can be really valuable. If you are looking at changes on the interior or you are looking at significant footprint changes, you know it's still valuable, it still helpful…but it's not any faster than it would be to do that by hand essentially. Because when you have to make…there are certain kinds of changes when you really have to start with ground up with the model, you know what I mean! So things like skin change are really quick and you can do an analysis of the cost difference quickly whereas if you are changing the actual shape of the footprint of the building, you are starting all over again.

Question 10:

I need whole lot more of site tools. And I know they are working on that. They are very close to releasing it. But I really need some three dimensional sites, so that I can out building in a site the way it really is and so I can look at the cost, associated with that site. Here in south east, there is lots of cost that goes into a project related to the site. That's a big hole right now for us. And some more flexibility with parking layout. Like angle parking, stuff like that. A lot of site tools. Right now, I can only layout parking layout at 90 degrees. I can only layout parking spots that are predetermined size. I cannot make compact spaces. If I do aisle that are one way, I have to draw all those bays by hand, there is no automatic…I need more options in terms of that kind of stuff…and I would like to see it more user friendly, in terms of creating things like landscape islands, instead of having draw them all individually. And then there are some basic functionality tools that could be helpful, such as you are creating a area that is multiple points, in other

words it's just not rectangle, it would be nice to be able to….if you are drawing a parking area for example. It would be nice to be able to add points. In other words, if I missed a curve, or missed an angle, I would like to be able to add points to that area, so that I can make another jog in it, w/o having redraw the whole thing. Its just little things like that, but make things move little smoother.

We have discussed about the problems that goes with the modeling phase. Can you think of any problem that goes in costing phase?

We are basically using the modeling part more here as compared to costing. Because I think the biggest problem with DProfiler is…We bought it a year and a half ago and they came in saying all the great things we can do and looked fantastic but in reality to use RS means that way doesn't make any sense and really…I think what they are trying to do with the software is embed the formulas, that calculates the cost so that we don't have to think about it. The problem with that is, every estimating department does it differently and in order to know that we are being accurate, in order to get comfortable with it, we need to see inside. And it is very difficult to see inside and see exactly how things are calculated, where cost is going. Having said that, in the past years, they have added tones of tools…database upload spreadsheets to create a custom database, that are starting to make it really useable. And I think as they develop those tools, it will improve the significant problem which is just that RS Means is not that useful. I think it is fine if you are doing it for some Govt. experiments, what might this be and what that might be. But for the private company, when you are working for Private developers and private corporations, they just don't spend that money on experimentation. They want to know when you build it they cost was accurate, and you cannot use RS Means for that. Additionally, with the RS Means database, there is not a medium level, you get way more detail than you would ever put in a hard bid estimate or none. There is not a medium level. In other words, when I do plumbing, it gives me a whole number for all the plumbing, or it gives me every detail down to the elbows. Neither one of those works. And that's another reason RS Means just does not works for us. I cannot evaluate the cost if it is divided down to how many pieces of straights and elbows are in the plumbing. But I also need more information than just Division 16 or Division 32 or whatever. In order to make RS Means work, they need to moderate the level of information it needs to spits out. More beneficial can be is the custom database stuff and really, I am starting to get there. And some of it is really time invested. I don't think there is a way to not invest the time. There is not a shortcut.

When we look at roofing, the way we estimate here, there are certain type of things we assume is included in that and it's not necessarily the same. RS Means might include more pieces in that or fewer pieces in that and so our numbers would be thrown way off. So even the total that is coming out at the bottom, we have no way to back track and look at it on a division basis. The total might have been within 2% of what we have expected, but when you look back at different divisions, they were off by 30% in some cases. May be metal was way higher and concrete was way lower rebar was in metal and not in concrete and we put it in concrete, you know that kind of thing! And when you go in to dig around and look at it, that's when you get to what I was saying about the plumbing. There is just so much information that you throw up your hands. There is not a way to find a problem when a thousand line items in plumbing alone, it just doesn't make sense.

You said that you guys stil do not trust database or estimatioin that came out DP, and I was wondering what is your current methodology to get the process done. Are you using some other application to do estimation or doing it manually.

Well, we use On screen take off and MC square, when we have drawings. But at the conceptual level, we usually don't have drawings, to work with. Then it basically by hand, historical database and creating conversation with the design team.

When we do not know what is going on with the application, that is the legitimate concern.

The great thing with DP, is we get a sketch, we can make a model that have that accurate sizing as opposed to…there is not really a way if it's a sketch that is not to the scale that we are working with, there

is no way to trace that in on screen. You have to do all the calculation by hand while with DP, we can still make a model out of it, and have something to count.

So basically, I see you guys have some Fear and trust to see what is coming out of DP. Some problems with the equations that is in DP, things like that. I was wondering, what would give you to lower your fear to use DP.

I think DP has been on the way form past 6 months to give us those tools. I come to a conclusion now that we have to build our own DP cost database that we use of the items we use, the standard type of projects that we do, and we need to consider it being custom for every project when we need to alter

To my understanding DP allow to create your own database, isn't that right?

Well, supposedly it did it in the beginning. But it is so arduous to actually understand what info will needed. It wasn't user friendly enough to be reality. I mean you will have to spend a year in programming. Now, in past 6 months they have created something, they have got spreadsheets and so on that makes it easy to lay in the information that is needed to upload into a custom database. That's where we are now, in developing those things, I think once that now we have those spreadsheets to use, we can spend a little time to test them. Because you got to develop databases and building types as you go and then test them. And once we can test them, because starting with the RS Means created the Fear. Because everything was out of whack. So now, once we create our custom database, we need to be able to test it on multiple building types and once we test it I think we will move ahead to get over that fear. Now I think its just a matter of time, matter of spending time.

New tools for site modeling?

If we have drawings, we have XYZ tools. For conceptual, really at this point, we are esti by exp. The way we do before, blah blah blah.

We don't have this info abt the new software. We could go outside seeking the info about the new piece of software but we don't want to. That's why we bought DP for. At this point we don't see value in spending bunch more money bunch more training in getting another piece of software that still not ties to the cost. The point of having DP is be able to look at the cost tied to it. So, even with on of those pieces of software, where we can do some analysis and get some more information, but we are still putting the cost on it manually and it still not coming out unless I put it in line item by line item and apply it individually and not coming out on DP. What I wanted to be able to do is, lay that information out in my DP model, so its the part of the estimate and its calculated based on the size of the grade and so on and not just on the line items that I inputted in it.

How many people you have in house to work on DP?

Its just me.

You wish to get your DP model exported to Revit?

I am not married to the idea to import it. It would be nice to get the basic geometry, but for the most part, we are getting the Revit model from the Architect anyway. If you wanna draw in-house, really we need to draw it ground up. Because what DP does is just kind of a mass model. So other than getting the basic geometry, I am gonna have to model it anyhow. I just don't see it saving a tone of time. I don't see it really an important piece of operability cause I don't see it saving a tone of time, may be an hour or two.

How architect like your model?

Well

What did you gave them?

Images. There is viewer that the Architects can open the model, turn it and look at it. But other than that, it's just still images that I exported out of the model.

You mentioned that earlier before using DP, there were experts in cost estimates to perform the task ans get the estimate done conceptually, and now since you have started using DP you are handling the task of conceptual estimation in DP from past one year, how you sync the task between you and earlier experts of conceptual estimate who used to do it w/o DP?

The answer to that question is really I am not doing it. I am working on this software operability side by side. I am making nice images and stuff, what is relevant but he is still doing it by hand, at the same time, I am working on developing the database, so that we can start to do it. I focus on the model and the aesthetics of it. He will focuses on the content and what the line items needs to be. And then we get together to make sure, how it is calculating. And he will use the model to get the quantities at this point sometime but, ultimately, it would be he will still prolly,. Gimme a checklist of line items that needs to go in to the db of that building, I will create the model, then we will review it, adjust it and whatever we need to do.

How many projects have you been working with DP?

30-35

I think then you have gained a pretty good insight about the software?

Yes, and that's where my hesitation is. It has taken me that much use to get the good understanding of what I need to be doing to build the database. I think it's a much harder thing for someone to think that they just going to walk in and build their db and move on. I mean, I am sure there are some people who can, but it really takes a combination of understanding the estimating portion of what needs to go in and understanding of how that model goes together. How the information goes into the model is not how it spits out an estimate. And I think that's the big challenge. An estimator wants the model to go together in the way that they assemble an estimate, but it doesn't. It goes together in the way an architect design the building.

How long do you think it will take you to work on that database?

If I hop in and jump on that, it wont take me more than 4-6 weeks. But I cant just do that. So, it will take a while. It depends upon how much time I get to focus on it.

CONTRACTOR #3

Interviewee: We do our own sketches, like the hand sketches. We would take generally what we take in conceptual area would be a floor plan and one elevation usually front elevation like a main elevation. And it may be the main line up of the buildings. And so lots of our projects have 20 or 30 buildings on it and we may only get only 4-5 in that first elevation and so what we would have to do is to make some front sketches of the buildings we did not get sketches for just for estimating purposes just to do a budget. We did not really share this with the owner we just did it for ourselves to make sure that we were thinking through the process.

Interviewer: And for estimation you guys have your own database of $/SF to get the cost estimate?

Interviewee: Yes. A lot of it is I would not even say square foot. I mean we do have our square foot analysis of things across. A lot of what we do is repetitive. So, do a lot of best buys, do lot of what is retail so lot things are the same building over and over again.

Interviewer: Does D-profiler play any role in saving labor hours in quantification and pricing than it takes going through standard procedures?

Interviewee: No. I don't know that it saves a tremendous amount of labor hours in what we do. What I will say that it gives us concise depiction of what we do. What I mean by that, like I told you before we would do sketch up we would necessarily give that to the owner in what we describe in qualifications and that is open to interpretation. And what D-Profiler lets us do is give them a model to show them what we are doing and where we are doing it. So, if we are saving anything we are saving it in time of qualification and telling people what we price with the help of visual instead of happen to go there and describe it.

Interviewer: So, you create a model in sketch up and to put the qualification report along with the model of the sketch up.

Interviewee: No. What we do we put the model in the Google earth and then send it to the owner. So, I actually send the kmz file to the owner with my budget so that he can look at what I budgeted.

Interviewer: Along with D-Profiler we can put the model on Google earth but you were talking about utilizing earlier before using D-Profiler you used to do modeling in sketch up.

Interviewee: No. Before D-Profiler we would hand sketch to determine what we needed to price. And then we would write the description of what we sketched up and so we never gave the owner our hand sketches. We would just write the description like paragraph for each building describing what we did. Like there is so much brick, so much storefront, so many awnings are fabric or metal, this many skylights so we would describe all that. And what D-Profiler lets us do is send the model instead of describing it you know we won't have to describe as much. We will say here is we based our model on the attached sketch that the Architect did and you can see different how we did the different buildings which aren't done by the architect.

Interviewer: So you used to send the model do both architect and owner or just to the owner?

Interviewee: Just to the owner usually so that he understands. And sometimes we will have meetings and go over the model. We will talk about what we did and how we did it and so it's again visual in discussing in what our assumptions were.

Interviewer: Architect also provides sketches at early stage with very limited data. So how does D-Profiler help there? Or is it like you send back after sketching the model as per like when we receive sketches from architects then you use those in creating model in D-Profiler and send it back to model or images or like what is the work process like there in terms of you and Architect?

Interviewee: Architect is not going to use our model. Our model is more conceptual so it's very vague representation of what architect did. I mean there is not as much detail on our model as the architect might do even on the sketch. But there is enough detail that you can see how the pricing is based. Also you can see the elevations that the architect did not sketch. And that's kind of where it's most helpful, the architect might give only the front sketch of the building but we have to draw it in 3-D so we do the back of the building. So, architect and the owner can see what our assumptions are.

Interviewer: What do you think about the reports/documentation which the D-Profiler spits for the estimation at early stages?

Interviewee: There are lots of things which I have not used in D-Profiler which can be helpful. As far as the cost reports it's based on I am using my own cost database and so you know it's basically the report is the function of what I put in. So, the report is as detailed as I want it to be based on how much data I put in my database for the conceptual estimating. And in level of cost estimating I do there are not couple of thousand of line items in the database it's a very limited database because you know the budget is very conceptual.

Interviewer: At early stage I am speculating why the database is limited because at early stage the data is very limited. So, what we can do is use cost $/SF so the database is very limited because we do not know what specific things are going to go into the building and that information is very vague. Am I right?

Interviewee: Yes. And like I said though the type of stuff we are doing a lot times it may be very vague but it may be very accurate too because some of the times things are very predictable as far as the cost. So, when I predict when I am doing cost estimating for best buy I have done 20 best buys so even though I am using very vague cost its very predictable it is something that is repeating.

Interviewer: You mentioned best buy. I did not get that?

Interviewee: It is a retail store.

Interviewer: As compared to standard procedure how was your experience with D-Profiler in conveying the assumptions to the project team and participants. Like you mentioned that some of the views like different elevations that have been created in D-Profiler and because of that the assumptions are very clear. So, just like that what are the other aspects and effectiveness of D-Profiler in conveying the assumptions?

Interviewee: One of the things is that there are two things about doing a budget one of things you got to be cognizant is constructability that is what you are doing is it really feasible. You know and some issues can come out very early when u model in 3D that would not come out if you did not model it. So, you begin to find out things that do not work in early stage and that allows you to convey it to the owner like lost revenue or additional cost they may have to incur to cover there revenue. Or maybe you know there could be potential additional cost in other part of the building to make something work. So, you know we don't necessarily try to fix those things right of the bat because we don't know how they are going to fix it. Atleast we get the idea that there is something needed to be fixed. Good example is stairs open add on where there is no platform. I have had buildings that were offset and hit storefront that was almost behind the wall. Those things u would not see in just an elevation but when you do the model you realize that oh this is going behind this building when u do one building at a time elevation you don't see that.

Interviewer: It's interesting that D-Profiler can be well exploited for constructability analyses as well. You mentioned that after creating a model like staircase it did not have any platform. Is it like you received sketches from the architect and created a model and found out that there was no platform or is it like you started creating your own model and then figured out you skipped a platform?

Interviewee: Well architect had a sketch that did he actually did the stairs he had stairs backward on his floor plan so that they landed in between the floors outside the building. One of the doors would have been half way between the floors and it was below grade so door was opening on dirt looks good on plan view. It did not work in the model he did not predict the door in the elevation he had it on the plan. Door belonged in the plan view it did not work on the elevation so early in the process I could realize that it was not constructible. They had to fixed before they could do any detailed drawings.

Interviewer: We are studying that micro bim process creating model in revit and then doing constructability analysis in Navis works to find out the clashes. But it is interesting in very early stage where we do not have detailed drawings it is possible to do the constructability analysis.

Interviewee: And you know not just constructability but feasibility also matters. You know is it reasonable to make a way for that door to appear. I mean how much it is going to cost to make that door appear. So, it raises the feasibility issue at same time. I mean if we ended up raising the building 4 feet to make that door appear then there were height restrictions on the building. So you know it is also the feasibility issue u run into.

Interviewer: Does D- Profiler help in solving those feasibility issues?

Interviewee: Not completely, but it does help you visualize them. It helps you get a better picture and helps you understand what is going on. When you draw its one thing too, to apply cost to mathematical model. And here is what I will say, about how we used to do things and now what we do with D-Profiler. D- Profiler helps us save lot of time in doing the budget because we had good mathematical models of buildings that would give us cost of the building which was very accurate. And I would say D-Profiler increases our accuracy somewhat but it also because there is reason why it increases the accuracy because we are more aware of what all is going on with the building, we are modeling more visually than mathematically.

Interviewer: What is your point of view about the visualization capability of D-Profiler at the conceptual stage with limited data?

 Interviewee: I would say the ability to put the model on Google earth so that you can share it with just anybody. I would say it is wild factor for people who are not involved in the 3D modeling. That they have not seen it before and when they think that there model is associated with cost they feel more comfortable with it. There is lot of perception with the visualization. You know the truth of the matter is it maybe more model, elevation that the architect draws has more detail then what I can draw on D-Profiler. As far as the architectural articulation that D-Profiler if I get too precise with what I am drawing. For instance if I have a storefront in front of the building that has lots of mullions and I draw all those mullions in my model well the model gets very cumbersome and very hard to deal with and basically I will draw very big blank area with transparent appearance. It will give some idea of the storefront but then it does not have mullions in it. And so there are other things I might not be able to draw as detailed, for example I have a cornice that goes across the top of the building, there might multiple lines of depths on that cornice piece, and I will only draw the top and bottom of the cornice. So capture the cost. A detail of the cornice piece is not there but the cost is. So you know graphically cornice is represented by a line at top and the bottom but is not represented truly on the 3D I might just draw flat at top and bottom of the building so you can see there is a cornice but I am not putting as much detail into cornices as the architect does . And the reason I don't do that because the model will get too big if I put all the detail in there.

Interviewer: To my understanding the main purpose of the D-Profiler is to spit out the cost right?

Interviewee: Well yes. The main purpose is cost but it also helps me represent those costs that are required and are not specifically presented by the architect. Most of the times what we do is we get one of the elevations and do not get the other three. And we may get stuff you know we may get buildings separate and that really go together and we don't know how they interchange those buildings affect each other. So

we have to model some costs that architect has not anticipated yet. Architect is just trying to get floor plan to understand the space required and elevation to understand for the city, what city is going to require and what owner wants. So it is up to us with D-Profiler to figure out how those things integrate to come up with whole cost. We my have to cost things they have not yet thought about.

Interviewer: You mentioned sending kmz files to owner for Google earth. It must involve the site analysis. What is your point of view about the capability of D-Profiler to do so?

Interviewee: Yeah they have not finished the complete site package yet. And so the site information we have for D-Profiler is just 2-D. And so we still are working on site package. They are working on 3-D site package so we are going to have the whole new deal. But what Google earth does is let us show how the building will be set on site and how the site fits into the surrounding area. But it does not help us analyze the site other than building requirements of setbacks and things like that.

Interviewer: By creating a visual model did you gain any insight into the cost of the project that you may not have received if you used the traditional estimating process?

Interviewee: Yes and what I would say by that. Like I said our mathematical model, they may be very good but they may not depict something to us about the building. Let's say an item in building that requires extra finish that u might not put in there otherwise. By modeling you would be able to put a cost to that extra finish. There might be places you can save money at. So we can say no need to do this so we can raise questions then.

Interviewer: Saving money example? Little interested to know if the visualization capability of D-Profiler can help save money?

Interviewee: Here is a good way to think about it. If I have a grade change I have a step in the building I can decide whether I need to put the step at top of the building if it's going to cost me more money like if I have to separate the buildings at the top or keep them continuous at the top. Depending on what the architecture is there maybe a reason for me to save some money? What I mean by that is it if I step the building there maybe a separation that is going to be finished and it is going to cost me and it is hard to you know talk about this without a model. Lets say we are looking at the front of the building the it has multiple floors so one building has a floor at 102 and one building has it at 100 elevation. The top parapet there might be a required separation between the buildings. Well that separation if the parapet is kept the same is hidden but its lower one of the buildings at the parapet where the separation is exposed and I may need to finish it. If its I can see whether it is cost effective to use the separation wall or if keep the parapet height the same and hide the separation wall quickly. So it gives me the ability to model things cost wise whether or not I can save money one way or the other. One of the other things we do is change the material, change the material like paint an area of one material change it with stone. Applied property function in D-Profiler say I have stone areas and want to change it to painted wall. So I can get the analysis of something that is not to be exposed may not need to be stoned and make it painted.

Interviewer: Multiple design scenarios?

Interviewee: It may be something u may not have design for things so what you are doing is looking at the best way to do it. You may be saving architectural fees here. You can go thru the multiple design scenarios in real time and save architectural fees. So, we are giving them options without having architect to draw them. That is how we can save architectural fees. Architect does not need to draw these options.

Interviewer: Do you think by using D-Profiler the client and the architect provided any opportunity to collaborate with your team?

Interviewee: You know I would say that it is you know the most of the process we go thru is very collaborative. We do not do work if it is not intensely collaborative. And while it may be u know we have

not gotten that far down the road with projects to say you know totally what the end result is on lot of things but I would say overall it cuts down on the collaborative time if we use D-Profiler. You know we already have collaborative process in hand for what we do and so we not necessarily we are not making more opportunities to collaborate with d-profiler we are already in that collaborative process. It is just helping us fine tune our collaborative process.

Interviewer: Yeah that is what I wrote down here, that if already we are putting collaboration stuff with architect and owner in practice if we have good collaboration system with project participants I believe at that stage d-profiler can be exploited very well, right?

Interviewee: yes

Interviewer: what Is your opinion of d-profiler capability in sustainable design?

Interviewee: You know I think we have not used the energy analysis process a lot just the preliminary. You know but it does give u that ability to look at things constructability wise anytime that you can reduce the process being sustainable and so we are producing time on process or changes on the process that is something we cannot document on the sustainable project. But it is making it more of sustainable project. It may be that is a innovation on the project. We could look at just the process and look for innovation point one of the things with energy analysis that you know with the energy profile finding the efficient way of putting building on site. It lets u evaluate other things different materials; you know that's probably the real benefit as far as sustainable goes. Only one project with leed in California with d-profiler it will be hard to say if it made difference for us constructability wise and you know I could not really tell u if it really helped us in sustainable aspect. Other than like I said it's a linear construction process we need to look into for innovation.

Interviewer: about using d-profiler so far a guess estimate on how many projects have you used d-profiler?

 Interviewee: I would say 60. I don't have one that is complete yet. We did 60 this year. So, but no project is near completion. We are strong on it and going to continue it. The reason we are not starting the work is because of economy. But we have a lot in the pipeline. So, in next year we will hopefully start. There is lot of potential work we doing with d-profiler.

Interviewer: what did you mean that you did not start the project, I understand its economy, but I am wondering if d-profiler will help you in the construction phase.

Interviewee: I don't know about you know once it moves into, like I said it helped in the design development so as far as design we have couple of projects drawn on d-profiler we have couple sets of CDs that have been prepared using d-profiler so we are very pleased with the process too and understand how we get to the final drawings. But we have not gone into that phase with these projects yet.

Interviewer: You mentioned about design development with d-profiler like spitting out documents what documents are you talking about like drawings?

Interviewee: we are not using d-profiler to get construction documents. We are using d-prof for we are keeping the process moving with d-prof parallel to the design development so as we make changes in the design development we model those changes in d-prof so that's our collaborative work we continue to maintain our model until the cds our done and project goes out for bid.

Interviewer: are you using BIM in the detailed design?

Interviewee: No, we don't architects may but we don't. we are still in the front end stage

Interviewer: What are the problems with d-prof and you wishes you want with d-prof in future?

Interviewee: For me an all around tool we need to put the site part of it. Till we get that the use is limited, site would get in there also wish that some more kind of detailed drawings like floor plans what I mean is we would be able to do some more the main thing is its u know its very conceptual tool and it could be utilized on more detailed things. If it had few things added to it I think its being worked upon and will be pursued.

Interviewer: about detailed take offs to my understanding with d-prof gives quantity for what we draw in 3D.

Interviewee: you know most of the stuff if u using rs means lot of stuff is parametric like when u do a room so lot of things, lot of take offs are parametric as opposed to actually drawing like I go ahead and do wood base in a room I would like to able to it. Maybe not in 3d but draw the base and takeoff. Better define and articulate the scope of the work.

Interviewer: any other problems other than the site and detailed take offs?

Interviewee: I think it is you know there a few kind of break down issues in reporting the cost they have improved on that's kind of important to you make sure you manage breakdowns of cost. Its been progressed along the way. To keep that as part of the program instead of taking the information outside the program

Interviewer: we talked about the software issues here do you see problems with the process, in the process of estimation in early stage to detailed to construction?

Interviewee: well I know one thing that the d-profiler have better conversion to revit. So the process will go to schematics to design .so that's one thing I know better served in the process to have revit type model to continue the process in.

Interviewer: d-prof to revit is like transporting the like phasing out from macro to micro bim right?

Interviewee: Right.

Interviewer: is there anything I did not ask and you would like to add?

Interviewee: No, that's pretty much it.

COST CONSULTANT #1 & #2

Interviewer: How did you use to do the conceptual estimation earlier before started using DProfiler?

Interviewee #1: Well, basically we used base specs and then we get to the square footages, based on the owner program and then we would do some conceptual sketches that would give you a general idea what it would probably take. We will try to identify some basic quantities, but like I said unless you really knew what it took in terms of structure, and mech and elec engg aspects of it, your guesstimate was usually quite a bit off what it came out to be at the end of the project. And quite honestly from the owners standpoint i.e. end users, that's all difficult to them to understand why we cant get closer in the estimating aspects of it. With the advent of this MacroBIM is, that's the real advantage of it is it can really get you close. It wont be exact but it will be close enough that they have reasonable idea what their project is gonna cost to make adjustments earlier that there is not lot of time and effort spent on trying to design something that ultimately they cant afford to use and then having them to take all the time to redo it to develop something that we actually cant do.

Interviewer: Does DProfiler play any role in saving labor hours in the processes of quantification and pricing, as compared to what it takes in standard procedure? Is there any other domain in which you think DProfiler saves time as compared to standard procedure?

Interviewee #1: oh ya, definitely it does, because once you gotta pretty good idea of building's shape and form and you developed into the model, that saves a lot of time before you had to draw quite a bit and then have somebody to take the time to take it off whatever type of software they are using. And you are looking in and putting in quite a few hours to do that even though it's a conceptual estimate. Now, it's a lot easier and a lot quicker. So, it saves time and money obviously.

Interviewer: What do you think about the reports and documentation provided by DProfiler in the process of estimation at the early stage?

Interviewee #1: we find it very beneficial. In our projects we had Beck Tech do number of models for us and we had to adjust the numbers a little bit depending on the exact characteristic of the building but they have been fairly close on all their estimate they have gone to full procedure when we have looked at. They have done very well, giving us a very pretty good idea from the conceptual stage of the project what the end product would be ni terms of cost.

Interviewer: In many projects, Beck Tech was involved to create the model and to assist in the cost estimating process. I was wondering, what was the reason why beck-tech was involved in the projects. Is it like they are providing consulting services to you?

Interviewee #1: Actually, with Beck Technology, we develop this software. they understood better than anyone else and the fact that they had people with the background and the ability to use the software better than us. Obviously, we are learning now, but they were able to provide us with much better technical assistance on and providing those estimates. So, probably projects might be little bit complicated, which still wanna use them because of their expertise, but as we develop our skills in using those software, we probably will use more and more.

Interviewer: As compared to standard procedure, how was your experience with DProfiler in conveying the assumptions to the project team and amongst project participants?

Interviewee #1: well, that's been pretty good. I mean, once we get the breakdown of what the costs are, as we typically have….like our key estimators have a look at it and when he looks at the quantities and the costs, it gives them a pretty good idea if it looks reasonable based on the size and the quality level of the building. The breakdown has been pretty good. We are able to look at it, it gives you a lot of information and gives a better understanding from the owners point of view where the cost are at in a building, what

they can expect to be paying and the things that are obviously too expensive to them, they have a better understanding of what the old method is used to be, giving them the cost, and then just giving them possibly by division, what you would expect to see. Now you are getting a breakdown and that's been beneficial especially to the clients who are experienced in the construction. Those that are less experience may accept the 16 division breakdown that we used to give them. But, the one who are lot more sophisticated, they wanna see a lot more information, and DP or other BIM software actually gives that. So, actually it works much better for the estimators group, the architects group and INCLUDING owner.

Interviewee #1: You can identify the systems that you are proposing to put into the building. And usually, you can do that fairly early. I mean, you have a pretty good idea. Obviously, as an engineer you can start the calculations and finding the numbers. They may change the systems that you are planning to use but atleast you have the money identified for the mechanical systems, for electrical systems, and lot of times, using that DP will identify typically what goes into that. You may change it as you may get further into the design for other reasons. You may need other type of system, but atleast you have identified one that you typically use in that building.

Interviewer: We cannot draw any MEP system in DP, rt?

Interviewee #1: No,aah! Well, Interviewee #2 is working on one project in Arkansas, where they have actually used DP to identify steam pipe lines in mech systems. So, they can but again, that was beck technology who was doing that because they have the expertise and the understanding to use it a little bit better than those of u who has just started to use it. But you can do that.

Interviewer: What is your opinion about the visualization capabilities of DProfiler at conceptual stage with limited data?

Interviewee #1: Well, I think that the model itself Is not overly sophisticated. It is usually pretty generic model. Typically you can define different cladding stuff that go on them and that benefit as the cost associate with it. I think its beneficial to owner, being able to see the model and letting them to understand the pricing as based of the quantites with model identified and I might bring Interviewee #2, he knows specifically in pricing.

Interviewee #2: I spent most of my career in fortune 500 companies. And the initial purpose of the BIM modeling is for the presentation purposes, since it takes the Owners eye. Anything new in the technology catches people eye. And in that arena, the process was somewhat stagnated until it was more developed. Now, from another perspective, at Turner, we build a NY Yankees new stadium. And we use BIm as a conflict resolution tool which was unbelievable. We probably save 8% of the construction cost due to been able to resolve the conflict before it became a conflict. For example, laying out various trade, structure with elevator, we were into DD phase. In the old days of construction, we used what we called light tape. It was 4 1 by 12 nailed together with a plexi-glass screen and a T8 light fixture. So you would take structural dwg lay it over there, and then you will take architectural drawing and lay it over that and we will all gather in a room, usually have about 8 people and we will look for any conflict. And then we will take mechanical and lay it over electrical. And that's how we did conflict resolution. We used to miss a lot and it was very tedious. With BIM, when the models are integrated, we can pull em up on the screen before that work happens on the field. From the contractor and owner standpoint, if we can resolve the conflicts in an office, before thay become the conflict in the field, its money savings, its schedule savings, and that's what we all want. From an estimating standpoint, the old saying in estimating is 'garbage in-garbage out'. You can have timberline or any estimating software which is a program. You and I both can sit down and write our own program that pulls info and totals up. At the end of the day, tis just calculation. The number that gets out is just exactly that you put in. So, if you don't enter the correct information, you don't get the correct information out. That is the only drawback that I have with BIM as an estimating tool and I worked closely with Beck tecchnology and the Interviewee #2s with Beck-tech to make sure that when we make a DP model, conceptual mode, there we shud actually have a legitimate cost, real time cost that we are not getting out of book, or coming out of with that end, and we have been doing very good in

that. And that's I like about BIM from conceptual estimating standpoint. You know, in the old days, if you were a owner you came in and said ' you know I got 50M and I wanna build an office bldg. What you wanna look like.' And we will start the process basically on the piece of paper and you would say, 'what can I build, I wanna say 8 floors'. We would sketch that out and will say, OK where you are looking to build it at. Across the street. Well, historically, the soil has been like this, so we can use this type of foundation. This type of foundation equals that dollar per square foot. So we will build thru that step and you had a pre-liminary budget that most of the time may be with in 30%. With BIM, we were able to tighten in that down to probably 5-8% realistically at the conceptual stage, keeping in mind that if you utilize best practices the one to the market, keeping our cost model updated, our pricing updated.

So the advantage is to the owner and to the contractor. For the owner, you come in and you say I secure 50M for this building what can I get. Well, we were there again within 5-8% and so midway between the design, you are not going back and changing the designs of the building and going back to the bank and get the money. Owners never wanna do that.

And Owners are like wives. I used to teach estimating at Syntex construction and Owners are like wives. When you are with your wife, you go to the jewellery store to pick out the wedding ring, the guy behind the counter is looking at you. What you say doesn't really matter. What she wants, that matter. So, you have got this counter that starts from $100 and goes to $50,000. He is gonna start down there. She is gonna see the diamond which is that big, she is gonna say,'hey Honey'. And that initial visual is always gonna stick in her mind. That carries over to an owner. When the architect comes with a rendering or model and you got this shiny 8 storey building with glass and you got the drive-in and everything that looks beautiful. And the Owner will sit there and say, "Aah! I will get all of that" Then, you will go to the next stage and you will start real time estimating, then you will go back to the owner and you will say, "You know, how about a two storey building with brick." Well, the owner doesn't want that because you have already shown him the big shiny beautiful building, and in his mind that's what he want. He doent want this. So, with BIM we are able to tighten that initial first couple of estimate, a lot closer before we get into the conflict resolution. We were able to tighten those down. From the contractors standpoint, you are able to give the client the confidence that he wants, confidence that he needs, and you are able to use your own resources, whether the sub-contractor pricing, market pricing, you are able to establish that and the goal of any estimator or contractor, when you give that conceptual estimate, 9 months or a year later when you finalize GMP, you really want to be with in about 2%. Its our job to forecast, a escalation and so on. And it all goes back to initial model. If we haven't included all of that into the initial model when we've show them the shiny picture and everything, then when we get down to there, we haven't done the service to him. With BIM, been able to fly through everything, where we can go inside the building and say 'Ok, I know you want the terrazzo flooring but with this budget we gonna have to do portion of that.' And to be able to walk inside the building, and turn and look at elements as well as you structured, it gives the owner that much more confidence that ready to goes to the next level.
Coz we can spend millions of dollars doing estimates, if the owner doesn't has that confidence to spend his 50-100M…he is gonna move somewhere else. And I will say Turner, from fortune 500 standpoint, has probably done a better job than anyone else in pushing BIM. Because we were able to go in and the owner sometimes….he has sometimes sophisticated owners, sometimes they are not so sophisticated and will say, 'you know what, the last building which I build which was in 1988, we had terrazzo, and we had this and we had all of these upper line finishes. And that's what I want. And you would try to convince the owner, that 21 yrs later, you cant afford that, and on paper, you tried to show that. With BIM, you can pull the images up, real time cost and been able to swap out finishes. Its an awesome presentation tool to an owner. From us inside, the initial estimate, with us sitting down with some one and walking thru everything, pretty much goes away. Because, now we have got that model built, we can pull different elements of that model in to create the projects. And with BIM, we can leave less out at the early stage conceptual estimate. Because it is we can see it and we can look at it, we can look around it, rather than just using prior knowledge we have up here.

Interviewer: What is your opinion about the visualization capabilities of DProfiler at conceptual stage with limited data?

Interviewee #2: In effect, using BIM in an early stage, and Interviewee #1 may agree being an architect…the one I will give example I did with Beck tech. Terellton state college. The master utility plan for whole campus. In the conventional mind set, we would have sit with architects and engineers. We would have went thru the stages of pulling up the old plot of the property. Then the engineers would have had to use his best judgment to over lay utilities and so on. With BIM, they imported all of the site plan and everything into that and we could now put a real time cost to it, but at the same time doing the presentation to the owner, the owner was countering with…'well you know what, we have this section of land. What if we did this. What if we build another building. How will that impact. And we said ok, they gave us a basic square foot, so that we could stick a box in that and it represents that. Run the utilities and you will see the overall impact on your heating and cooling loads, your energy loads, the best use of land. We have real time on that. We had one board of regents said, I wanna put a XYZ center over here, horse and livestock and so on. We put this on and the amount of ancillary space it was about to take up, want the best usage of land. Another regents said, lets put a baseball field there.

So, what is the division 1 and division 2 baseball field cost. And then we bring that model in and it works better for that area. So, from visualization standpoint, it cant be big. From conceptual to all the way to conflict resolution. Well, I don't think any one is greater than the other. CR at yankee stadium, we were well into construction of structural member. As design were going, we were getting feedback from the subs upgrading the BIM model, starting to do overlays. We realize, that only east side, where the bank of escalators goes to second level, we had a row of structural columns. Well, we don't use light table anymore. So, thru the integration of BIM and been able to rotate that model and drag it in, all of a sudden we were in a room and we said, wow! You gonna ride the escalator right into the column. Well, we cant change the column, so we end up moving the bank of escalators. Now, had we gone 6 months down the line and all the electrical and everything had been roughed in to the bank of this escalator or OTUS just manufacturing the escalators part, or the structural Interviewee #2 is doing this to receive all the escalators, had we gone that far in the field, and someone said oh! We got a conflict. All of this work , we would have been taken out…you know, it would be probably 3m dollars. So, some owners hesitate to pay for BIM, until they see something like this. And 3M dollars more than paying for BIM on that project, and we used it one 200 resolutions in that project.

Interviewer: And you are saying that you did conflict resolution in DP?

Interviewee #2: Yes. Basically, we overlay shop drawings in DP. So, if you have HVAC ducts that is as big as this rooms, and you have a dedicated space for this and the mechanical engineer drawn in that way, the structural engineer agreed to structural support it, there is no issues, but then may be at the next step, you have gotta go out and do the electrical design and he has also got the bank of conduit or the raceways that have to come thru this room. You know, at the old days, you have this bunch of old Interviewee #2s standing on the job site who is gonna put their stuff on that space and it cost money. We were able to take the shop drawings overlay and say, oh! Wait a minute, your electrical is schedule to be 10' off the floor but that's gonna go right thru the middle of this. So, we now have to drop this.

Interviewer: I believe you are talking about finding the conflict resolution in 2D. what about finding the conflicts in 3D?

Interviewee #2: But, now I believe it has moved to 3D. I am not sure since it's a long time we did conflict resolution. I imagine with our Parkwin project, we will use it to do the conflict resolution. That project is big enough, dollar wise, it is 1.6billion, we have enough opportunity there. The owner there believes in the program, has seen the program, and watched to use it.

Interviewer: In 3D I believe, its not possible, since we cant import the model into the DP

Interviewee #2: I don't know if we can or not.

Interviewer: By creating a visual model, did you gain any insight into the cost of the project that you may not have received if you utilized a traditional estimating process?

Interviewee #2: As an estimator, not so much. As a owners team and as a contractors team and the design team for that matter , absolutely they did. Those three teams benefited the most, because the estimators have already a pretty good idea what things are really gonna cost, but typically, for those three groups…and that's why I think you gotta find in future more and more archi firm have this software and be able to use because, the initial stages of the projects that's really when they need it and the engineering firm too, because its going to help them design something that is actually within in the cost requirements of the owner.

BIM has so many advantages. A lot of time, you run into owners for colleges, for example, SMU. We used to do a lot of work at SMU. They have a standard that every building is gonna pretty much look alike. They have a certain brick that's is manufactured by XYZ brick. Nobody else can buy it. Its only manufactured for SMU. All of their roof tile is all quarry tile. It came from the same quarry since 1800 when the Dallas hall was built, its cast stone. So, when all these elements combine, every building gonna look pretty much the same. But SMU wanna make sure that every building gonna looks the same. So, in the early stages of BIm, we were able to show that model. Because, at SMU, the board of regents..I met with them many time, its an old money. It's a group of very financially well off older, sometimes very opld Interviewee #2. They don't give a damn, when its gonna build, who s gonna build it and how much its gonn cost. The one thing is, is this building gonna look like every other building in the campus. Is it gonna have the tile roof, SMU brick red, and the cast stone. Show me a picture, I don't care how good your estimate is, show me a picture before I sign this paper, that this building gonna look like every other building in the campus. And when pulled that up in a presentation, turn it how ever they wanna look at it, and they say, phew, finally.

Two yrs ago, at Texas A&M, when I was at Turner, we did the proposal for the master planning project program management. 5 year program. We presented it at college station. Various groups with the Board of regent was there and we had two 72" monitors, and BIM flow in to the presentation. We were on a 5 teams. We downloaded images of the campus, images of what we were told the projects included in program management. From not only the CS campus, but from A&M commerce, A&M canyon texas, various campuses and they were completely blown away by the visuals. Because it has lessen the amount of thought they had to put in to it. They are not thinking. And we said, we are gonna do this.

We were able touch and drag the buildings in. as I was talking through the presentation, we had our young Interviewee #2 that was doing the BIM, who had about 6 weeks exp with, and he was dragging and doing the different things. We invited, you know, come up and play with it and touch it, see what happens, it was amazing. Those Interviewee #2s came up and basically, at that point, they did not care what I had to say about estimating and construction. It was that new toy, that new technology, and how that technology gonna serve us for this program. And it went from us- as a presenter trying to win the project-to them referring us as a program manager. OK, so we sing you Interviewee #2s up. You gonna use this. So, we sign you up today, how long it will be ready to go. It will be ready to go now. What you see is real time. So, everyone gathered around and we basically spent next 30-45 minutes with them hands on, playing with the model, doing different things, discussing amongst themselves, the advantage of doing this, the advantage of having that. Because now they are not looking at 10 different campuses, they are not having to go to 10 different campuses. They are not having to deal with the people at those campuses. They are now at one room, all gathered together, and they can move that building to here, or can move the building there. So, it basically won us 900 million dollar of contract.

Interviewer: You used DP in doing that?

Interviewee #2: Yes.

Interviewer: As you were saying, that everyone was sitting in one room and did not require to go places. So, I as wondering, does it help in collaborating with the team? In fact, my next question was that itself.

Interviewee #2: Oh ya. Its unbelievable. Because, especially, when you are doing the conflict resolution, you can identify and send out that conflict. You can resolve that conflict in a room, whether people wanna come in or net meetings. And you post the resolution or the conflict, if we are on this large screen, and we have a conflict and we are on 2D and we show the conflict and we have the capabilities emailing that almost instantaneously to everyone. So, we identify the conflict in a room and as you know everybody can be remote but we are in a room, we identify the conflict, we resolve the conflict, and we send the resolution to the team. You are cutting out the old process of mechanical Interviewee #2 having a conflict with electrical Interviewee #2, writing an RFI sending it to the architect and to the engineer and then either involve the owner into the resolution or as part of his responsibilities, resolves the resolution. Drawing that out, sending it to all parties, and then all parties have to confirm, and that's the big part. Because its very easy for the mechanical Interviewee #2 to say, 'I never get that. We are proceeding as the mechanical drawing shows'. In that way, the addendum has been delivered, we are confirmed that everyone got it. Its priceless.

Interviewer: that was kind of new knowledge to me. Because, so far I have been told that DP can do wonders in conceptual estimation, but the CR is a kind of new knowledge to me.

Interviewer: In the future, given the opportunity, would you see value in collaborating with your team using Macro BIM.

Interviewee #2: Oh yes. We are starting to use BIM on everything we have to begin with. As long as I have the oversight on the costing and the items that go into it, we will use on every project to begin with as long as it is feasible. Some projects, you really cant use it, 90% you can. And yes we will continue to use it, and we gonna grow it. We will come to a point that we are using it on probably 99% of our projects on initial for our conceptual estimates and going through that into the DD stage and also on the presentation.

As a matter of fact, the Army Corps of Engineers, we have a project in Arkansas, and they have agreed to use our project as a R&D funding source for integrating this into Army milcon database. So, which is a huge step, because the government is saying, Wow, it has tremendous value. The state of texas has just signed and agreed that all their other project are going to run thru BIM.

Interviewer: What is your opinion about the capability of DProfiler for doing multiple design scenarios, sustainable design and site analysis?

Interviewee #2: When the cost database is accurate, its probably the best tool we have. Interviewee #1 and I were finalizing a project we have with General Services in Houston Texas and it is 24 storey building. And, this was kind of a finest estimate for the client and the engineer. We get the image up on the screen, and the owner says, 'ahh! You know what, we are actually wanted to pull the front of the building out.' Kinda new to us. The engineer said, I thought we are doing it over here. And they said 'Ah! You know what, we were thinking about that but rather than pulling out here, we are gonna pull this part out. So, our BIM specialist says, oh! You need this, like that…couple of changes, and there was the model. And the GSA was like Wow! Because, it adjusted all the quantities she did that and adjusted the bottom price. Right there at that moment, they were able to look like, what is the change as well as the cost change.

Old days, Interviewee #1 would have been drawing and sending me the information, and I will doing the pricing by using the calculator. With that, 10 minutes time, we have the building bumped out, just the way they wanted there real time with the cost change.

Interviewer: And what its capabilities in sustainable design and site analysis?

Interviewee #2: Well, I think that for site selection, we used it on just about every site initially where we can. Its gonna be more ad more routine, because, you are able to change…I have another project in Austin, 50,000SF medical dental clinic and the site layout changed 3 times. So, and being able to do something like that…again, you are waiting to say, 'oh! What if we do our retention pond over there and move our parking out and make our patient drop off over there' OK, lets do that, go back to the architect, redraw it all, sends that out to every one for approval. You were able to do all of that in real time.

So, from that standpoint, its nothing but a benefit. Again for the utility program, you know Beck coming back now to do the cut and fill, the earth work, depths of pipe, depths of utility. So, if we want to do the torrental state project again, we would now basically have something, that from our BIM model we can almost go to the civil contractor for him to bid.

Are you aware of Texas Department of Transportation project? When Tex-DOT bids a project, a lot of time they give you the quantities. And you assign the cost to it, that's how you bid. If they do not provide the quantities, they want you to provide the quantities. Because of you say a 1000' of 24" storm line and you get to the site and it is 800', they gonna pay you for 800'. If it is 1200' they gonna pay you for 1200'. But they want those quantities. Now if we were to take that master plan of terrelton with all the pipes laid out with the depths, we could generate a bid form that will go out to the contractor for the market and will say 'Ok. You got all your quantities, rt. Price it with your mark ups and everything on it and send it back. You cut the whole design-bid process by atleast 9 months.

Now, we have a project while back in New Orleans. The Corps of Engineers came up and say, 'you know what, we have to do something to keep it flooding again. So there idea is basically 36 miles of loop underground storm drainage. The storm drainage is 14' wide, 24' tall concrete tunnel basically looping these areas. The designers did it on BIM. The core given un 11x17 drawings which you cant read, you cant make out the details. You can barely read and scrutinize. We were able to do that in BIM, and take that to the core in New Orleans, they said 'wow, its running right thru the middle of the hospital. We gonna be disturbing the streets. Lets take it and move it over here to this old area, and move it down, and by pass this area. And, again you cannot put a price on something like that. We were able to mitigate any disturbance to the hospital district by just been able to see it. The attorneys told us that we probably saved about 27 million in litigation cost, for disturbing these historic areas, shutting down the hospitals. You know, if someone is in need of critical care and they cant get to the hospital or late getting to the hospital and they will pass away. They gonna sue us.

Interviewer: You were saying that you will be able to do all that stuff if the cost database is accurate. What do you mean by if cost database is accurate. Is it like, you are making your own customize database and using that, and if that database is wrong, the $/sq.ft you are putting is wrong, you mean to say that?

Interviewee #2: Right. That's why I continually update it. RS Means is pretty standard database and it is good for certain things, but we found not nearly as accurate as I have been. If you take any standard publication that is updated once a year, specially in such a volatile market that we have, its not …we will use Means for labor production rates, sometimes for shipping rates , but the actual construction cost, we get it from the upper tier of the subcontractor in the market. So, that's why it really makes it so successful for us. We did it on few schools with beck and the local school district said, 'Interviewee #2s, we got the 500,000sq.ft of roofing. And you are at $14 per sq.ft. We did it last year and we got it for 8. Correct, last year gas was $2 a gallon, right now gas is $4 a gallon. Which means any petro chemical product has raised. So, we were able to go back and keep a hand on that.

Also, at that point, with BIM we have been able to identify changes in material. When an owner may say, 'you know, they want the building to look fantastic and in Texas-more show than anyone else-we will built beautiful building and will put asphalt parking lot in front of that. An asphalt is petroleum and gravel. Historically, we use asphalt, but because of the price of the oil, we need to put prtland cement out there now and it it look so much better. We have done that on schools and on govt. projects.

Interviewer: What are the problems you feel currently with DProfiler and what are your wishes that you would like to see happening with DProfiler in future?

Interviewee #2: The only issue that I have, DP is like any other program its only as accurate and its fast as the person that is building the model. That's the only real issue. You have to have the experience. On a couple of project, I think there is been some lacking of experience. That's the only downfall. Because I think more and more people will understand the capabilities, the actual benefits of when to use BIM and when not to use BIM. My wish, I wanna see more 3D model integration and more interior finish.

One project that is 24 storey building and it was in access to 100M. the engineer's only comment, he has a pet pief about finish schedule. He said, 'when I go to the contractors office, I see a finish schedule. Some one sit down and they taken a color pencil and they will color the carpet one color, tile another color, etc. So, I can walk in and I can see this pretty model, everything colored. I want BIM to show me that 4x4 to see, where I got the carpet, where I got the tile, where I got all of that.' That was the only comment. May be a little further defining of the interior elements.

There is an old saying that 'civil contractor gets rich from the unknown'. Because majority of the time, if you are a KOR, I am gonna give a geo-technical report and I am gonna say, its seal down to here, its clay down to here. You gonna go this deep. You will say, you know, I disagree, I worked on this area and I know that its rock everywhere. So , you go out there, you take a tractor, you dig a hole, and you go rock. And the price just went up. It's the unknowns that make the millions out of tractor operators. And I think being able to do the site work and been able to do a lil bit of conflict resolution has tighten that portion up.

Interviewer: You mentioned that currently you are using DP on 90% of the projects, where it is feasible to use DP. I would like to know what is lacking for that 10% not to use DP? Is it the tool, or the wish of the owner that they don't wanna use it or its just the complexity of the project.

Interviewee #2: Prime example I have is an airplane example at Dias air force base. And they are going to convert it to a paint shop. The project consist of redoing the hangar doors, putting a 8x8 cement block building. The rest sticking fans around. Its really not something that will require to do BIM. Its more lika a renovation. It's a renovation project.

Interviewer: Ok, talking about the renovation, can we do all that stuff on the renovation project as well?

Interviewee #2: the project in Houston which Is 24 floors, and we were basically…the building leaks real bad. So the initial phase of the project is to replace all the cladding,   and glazing because it hass to meet all the anti-terrorism measures…so blast resistant glazing. I did it initially on paper to some degree, because BIM doesn't have the capabilities to go in and zero in on the floors. We take the new glazing and attach it and we have to have bracings and all of thise small miscellaneous work. Its really not an advantage on that. Even from a presentation standpoint, its probably prohibitive using BIM on that. Zeroing in on the miniatures, things like that, its not feasible.

You know when we change the ductwork, we know that we have to take the ceiling out. So, we gonna take the ductwork out, all the way back to the unit. We only know where the unit is located, so where we gonna show there. So on that type of renovation, not so much.

If we don't look at the miniatures of the building, if we look at the master plan or the utility plan, then we will be able to do that.

Interviewer: How do you take into consideration the excavation cost?

Interviewee #2: On the Torrentol state project, everything was underground. Beck Technology laid the pipe out. I basically used the best practices and said,'Ok, we are crossing roads, its more feasible to do borings than road cuts, lets make an assumptions that we will not be deeper than 4 feet. So we do the

excavations for all the pipe that is at 4'. Now with the improvement coming up, we actually balance the site, and will provide cuts for it and will be able to provide quantities. Right now, for any excavations, anything like that, we are making an assumption on the depth. At this point, its just in the spread sheet, nothing goes in the model.

Interviewer: You Interviewee #2s have DP in house or you take the help of Beck-Tech.

Interviewee #2: We are taking the help of Beck-Tech and Cox and Shepp. We just had in last 2 week. We are still learning it.

APPENDIX E

INTERVIEW TRANSCRIPT-ARCHITECT

ARCHITECT #1

Interviewer: Can you just give me a gist about the project, who was the project participants, what were their roles in this project?

Interviewee: This is a center of structural engineering research in University of Texas in Arlington. The client was University of Texas in Arlington but I think there was an involvement from the University of Texas, OHPC and the cost consultant was us and they partnered up with beck that has a Dprofiler as their software and essentially we just worked all together as a team sort of in a pre-negotiated style working together and to get the cost estimate.

Interviewer: If contractor uses DProfiler to create 3D model for conceptual planning and feasibility studies basically to get the conceptual cost estimated and do the site analysis stuff, do you see any value coming for the architect and if yes, what are those values?

Interviewee: The contractor, who is the expert at cost estimating should be able to produce better cost estimates than even a cost estimator, an independent cost estimator could do and certainly better than an architect could do, so surely the value would be the effort is in the lap of the expert, the personal with the expertise so if that contractor knows how to use the profiler to extract cost information from an architectural model and can do it well than he would be able to produce the accurate costs, that's where I see the benefit to be.

It could be better than the cost consultant because he knows the street values that day--the difference of contractors feels--and so we can really get a good accurate sense of being on budget so that will be not end up with costly RFI's in the field later on and the sneaky ways of increasing the cost

Interviewer: You are talking about these things in terms of giving them a model or giving them the drawings to the contractor and then the contractor gives you back with a model?

Interviewee: We would never trust the contractor to do the model from our drawings. It's a kind of at their own risk I see it in. If suppose we did everything in 2D and there was no model on architect's side then that's fine if the contractor wants to make its own model but realistically we are moving into a trend where every building we do is modeled already so I would much rather just hand them over my model so there will be more accurate, less waste of time and if they are the selected bidders, I don't think I do have any problem releasing that to them and as far as legalities are concerned, to me if its printed on the construction documents, that's kind of binding everything else at their own risk. But I still see benefit in that.

Interviewer: Ok, you give those guys your model prepared in Micro station, Revit?

Interviewee: Right. They can take it and do whatever they want. Typically those models alone wont solve their problems with their service of basis, where they can build their cost models on top of. So if they are using Dprofiler or any other program, they can find some way to import or model and then just trace over it essentially.

I think that's another way what we are enforcing and what we calling what's we developing and evolving as integrated project delivery, in which no longer do we design and bid and we build but we

either have a teaming relationship with the contractor and the owner and we are privy to each other's information in that case we will be always wanting to sharing our model, or electronic files to the contractor so that they can take it and work as efficiently as possible

Well, this is basically sort of goes into another trend, traditionally things have been design, bid, built. So you do all the work upfront and then you hand it over to the contractor later on who's been out of the picture all the time and he's not there to help you, cut cost early on and give you advice, but now we are using BIM, it sort of turns that process on its head so its task been design-bid-built and goes to design-build, where we were working together at the very beginning and by putting our risks together, we share the risks, we share the rewards and ultimately we end up by saving cost and probably saving time as well on value engineering thing like that.

Interviewer: Did you find the reports and documentation that provided by contractor using Dprofiler any helpful?

Interviewee: I think I would say, they are like any other cost estimate that I have ever seen. From designer's point of view, we look at carefully when you receive it because some assumptions are made that are incorrect and those assumptions have to be changed and get modified so that better result is produced so when we receive this we look at very carefully, we looked at whether all the systems are been intended were covered or addressed and we want to make sure that it wasn't anything in the report that was extraneous or not didn't belong in our project and I think we found both categories, some missing and some need to be there. So, when we receive electronic file, we printed it to hard copy and we reviewed it. Then, we began to find things up in there. So, I guess it will help in overcoming some assumptions that cost estimator makes but there were some things that were not entirely correct

If they have to make assumptions, that needs to be detailed enough and in the early phases of design that will be the case and so they have to start making some assumptions on flooring materials, finishes and things like that, when we never said that we want them to be and so this is more of a human error than it is computer error, because the model never said so in the first place may have make assumptions.

Interviewer: Do you find Dprofiler helpful in clearly translating the assumptions with the project participants?

Interviewee: It's like garbage in-garbage out. As long as they understand the intent of the project from outside then the software will be very helpful in making their assumptions but it can't make their assumptions for them. It all seems back to communication of the very beginning of the project.

As we understand it, when we provided model to the cost estimator, they actually re-created the model in their own format and in doing that they may have missed something, or they have added something, or suit something differently or whatever, I think if that has to be done every time, the Dprofiler is used to create the cost estimate then it's not making use of the architects model as directly as it should.

It's the limitation of technology because the software we are using isn't the same as theirs, so the best they can do is just throw away our old model and bring in the new one and trace over it again. It's a kind of the best we can have it at this point or may be in 5 or 10 years of time better ways to translate them.

Interviewer: Yes, exactly it is like kind of duplication of work?

Interviewee: Right. They are getting model from architect and looking at it getting a proper and good perspective of model and of the design provided by the architect, but at the same time they are creating the same model again and another engine at another platform of Dprofiler and giving you the output of

Dprofiler. What would be the ideal way would have been assumed is getting the conceptual design model and then translating it to their environment directly translating all the parameters mention in your architects model translating into Dprofiler, getting the cost estimate and then providing the model to you guys. So then, the process will be more transparent and translatory.

Yes, I would agree that would be much more efficient. With our experience, I think they have done a pretty faithful reproduction of our works. I don't think that the our things got lost but that speaks more to the ability of the person making that model and how much attention did he paid to the details.

Interviewer: Since contractor provided 3D model and images portrayed by deprofiler instead of just numbers, what architects historically use to get with just a spreadsheet, do they help you to get better understanding of the cost of the project and did it influence your design?

Interviewee: It just gives me confidence that we are on the same page, because I can see some of the assumptions they made, when we created the model and I did not find too many deviations. May be for instance if I had to make a complex curve roof may be the software can do complex curve roof than to do flat roof, so I have to flag them on and say, well even though your software can make complex curved roof, you should take that into your considerations, so little things like that we have to work through, but I like to see what they producing to generate just to give me visual confidence that they understand what my intent it. But I don't think it influence the design because we already had the model at the first place.

Interviewer: Did you get a better understanding of the cost of the project as compared to what happens in standard procedure?

Interviewee: I felt more confident on myself. Let's say KOR did not use Dprofiler and he just have a set of 2D plans and elevation, if that was the case I would feel lot more confidence using 3 dimensional program vs just 2D traditional CAD process, because I am not for sure, if its making all right assumptions just based on plans, elevations and sections. He can do things very quickly with cost/sq.ft. and be very accurate but volumetrically speaking, something may be a mess, if schematic design and having cut out my sections yet, you are looking at floor plan, you really have no idea how tall the room is. You just make the assumption, that it is 12 feet.

Exactly, a good example would be the boiler room. If you give a floor plan to the contractor for a boiler room, a contractor might assume the height of the boiler room would be like 20 or 16 feet and the height will vary because in conceptual cost estimation it goes with the volume. So, then the cost gets completely deviated and if the assumption is not properly translated back to the architect, it will be like apples to oranges and not apples to apples.

Right, that's why I am saying that we have a level of 3 dimensionality in volume comparison vs. standard area comparison that we typically get.

Interviewer: Do you think that since contractor use Dprofiler on this project, you as an architect had provided better opportunities to collaborate with the team of contractor?

Interviewee: I think so. Because we can, if we want to use certain material and we are not sure if its gonna be too expensive or not, we can consult with them and if we know its way out of budget early on, we can make the decision to change it vs. at the last minute where we have to take things out which becomes much more costly.

If we have contractor on work and that contractor could use the Dprofiler program to inherit what the estimators have did, there might be a way to integrate the design and the contractor's effort to make construction more smoothly and more efficiently or less costly.

Interviewer: How much you were comfortable when you got the estimate from DProfiler, since it was not done by traditional method and done with the help of new software?

Interviewee: Well, when I saw them I was confident. But, you know, it was young people who are working on it. I was not familiar with their expertise of how building goes together. They certainly understands DProfiler. Untill, we actually met with them and until when we sat across the table and we talk with them, I couldn't be confident in it until I knew that the person that is actually putting it together understood our building. It took a dialogue like that in order to be confident with them. That is how work with me.

With me, it was pretty similar, but basically it was a third party cost consultant. And the cost estimator works with a young guy who uses DP. Two of them paired well because, one has the expertise to say, no you are not modeling it correctly and on the other hand, you have the person to tap into that technology. So, you really have to have both of those together, to work and have the confident number at the end. Because, anybody can open up the program and start building but not really have the clue how it goes together.

Interviewer: How was your experience with DProfiler in practicing sustainable design and doing site analysis at the conceptual stage?

Interviewee: We examined the buildings office layout. They used DP to analyze the two concepts. And they gave us the relative cost to it. We did not necessarily need to know that the model builders know everything about the building, but as long as they have the same characteristics. One became favorable from another from the cost standpoint.

We have not used this for sustainability. All we need to know the material and the cost associated with that. And in my model, I have already incorporate those things. I have already study day lighting, heat gain, so those are the things that are already being taken into consideration.

Interviewer: Did you use DProfiler for the tasks like space planning and preparing floor plans and cresting multiple design options? How was your experience with DProfiler in performing the tasks like space planning, preparing floor plans, and cresting multiple design options for the project?

Interviewee: We don't have the software, so we have to trust them. All we have is Microstation, we don't have DP.

Interviewer: What are the problems you feel currently with DProfiler and wishes you have that you would like to see happening with DProfiler in future?

Interviewee: I wish there is more direct translation with the file first of all. I wish there is more user accessible, so that there is some way where architect can tap in directly. I think its proprietary, where we have to go to third party. I don't think where we can just go to store and buy DProfiler.

As far as output is concerned, we are very pleased about it. Again it depends upon the person who is really putting up those models and the number so as to gain that level of confidence. We were not being able to navigate through the model because we don't have the DProfiler. Also, the main purpose was the cost. We did not have to manipulate their model. If it was a contractor who is actually making corrections and modifications to a model, then in that case, we would want to share the same model and we would have to maintain all the architectural elements and characteristics. But for this project, we did not have any need to manipulate their model. We just wanted to see of they have seen what we have wanted them to see. Again, it depends on the user. You have to bring the experience on board along with the technology just to make sure that both of those are satisfied and then you have a good estimate.

ARCHITECT #2

Interviewer: If contractor uses DProfiler to create 3D model for the conceptual planning and feasibility studies, do you see any value coming for the Architect? If yes, what are those values?

Interviewee: One thing that the architects are very visual and we think interms of building that we are able to view the DP model and be able to click on different faces of the building, or windows or elements and the cost come up directly associated with those. Its lot more intuitive, for us as a designer to be that way, something that is system as a part of the model rather than having us to read thru all the spreadsheets. You know, even the model is not the direct representation of the design, but we can look at that and question, like did you miss this large piece of the project, because I ddont see the portion of it in the model, and you know some ins and outs, and it can begin the dialogue with the cost estimator just to make sure that different elements are included. And the cost estimating, from our experience, you know some things that not actually shown in the model, but that did have included in the estimate, but its more just kind of a line item, allowance that they kind a plug it in, it's a detail to put it on the model, but its beneficial just to start the discussion going in some of those areas.

Interviewer: I believe, you played the role as an architect in this project DIST Public school. Can you gimme a brief abt this project. I mean, what was your role and what are the documents that were provided to the contractor and in turn, what you received from the KOR?

Interviewee: We have worked with an independent cost consultant on a project that is affiliated with a construction company, but that is kind of a separate department and they offered us a service as a like a consulting type service. Even the construction would be the competitive sealed proposal, you know this is most likely will not awarded to this contractor that's doing the actual modeling, you know its beneficial to us as far as cost estimating goes. It's a 235,000sq.ft high school primarily new construction. It's a 3.5 storey new construction. 3 storey with a small basement. There is a additional one storey building across the street and that's new as well. That's the house, an autotect learning facility there , where they will work on the cars, repair cars and have couple of classrooms. There I n existing building where we will be doing some renovations to create couple of program elements for the school. I think that renovation portion comes out to be 20,000sq.ft. So, the cost estimator were able to clearly differentiate the new construction from the portion of renovation, the mian bldg to separate from autotect facility, so that we can talk about those things independently. The CE has been very detail, you open one folder, and bunch of other element with that folder, and when you open those folders, there is more detailed pricing information in that. We are at the design development stage right now. We have just issued the design development drawings and in the afternoon we just had a draft, DD cost estimate review with the folks working on the cost estimate. It's a useful meeting to have, the CE have their model open and their estimate open and we were able to look at that and they were able to move around the model for us and we ask questions. This is the third estimate they have done for this project, a very pre-liminary estimate, that was done prior to SD, that was done more kind of a prrgram scope to budget estimate. And then we have a schematic design package that we presented and issued as well. They do some take offs, before that in other elements phases used in allowance, kind of a square foot take off kind of element type rather than getting detailed into the specifics. But for the DD, they were able to take our drawings and specs and get lot more specific about the cost of these particular items, and the concept of the building is much more accurate estimate. Hopefully, we will continue to develop further as we go from 50% to 75%, 95%, and 100%.

Interviewer: You said for the first estimate, the information was very less and the estimate was kind of preliminary. What are the documents you provided to the cost estimators?

Interviewee: We did gave them CAD files where they were able to use. It turns out that they did most of their take offs from pdf's. We gave them floor plan, elevations sheets in pdfs, they did a lot of their cost estimating from that. I think the model was based on our CAD file that we gave them. But different elements of the building, that weren't costed with the model, they may have been costed it by hand and putted it in the model. Theye did takeoffs from pdf's. In DD, we gave them pdfs of all our sheets, they

started their estimate with that and then when we issued las week the final DD drawings, we get back to them as well. All this is in digital format pdf format. We did not give any hard copies to them. So they were able to kind of compare, what changes that might have taken place from the preliminary.

Interviewer: You said after that you prepared, DD drawings, what is their detail level?

Interviewee: I say, it was like 50% construction documents. There is lot of information in this DD package that we normally do for a project. Its just because of the requirements of this particular client. They want to see things at this phase. So, we were really considered it as more of a 50-60% CD. We have all the FP laid out civil grading, demo plans, preliminary sewer and sanitary landscape paving and planting, interior elevations, stairs, wall sections, materials and connections which was probably more than we do at this phase. We got complete finish schedule for all of these rooms. Most of the finishes were chosen at this point. There will be plenty of changes from this point on as we continue to develop the design and document. But that is one nice thins about DP, that it clears out quite easily, make adjustments. We got roofing plan, detail structural layout, mech systems, detail electrical outlet locations and switchings, lighting cut sheets. We have complete draft of specifications, at this time, as well.

Interviewer: So, they are using this detail drawing and specification to get the estimate in DP?

Interviewee: Yes.

Interviewer: And what about the first estimate , when these detail specs and DD drawings were not available. You might have given them very limited information, rough sketches I believe for the new building. So, were you comfortable with the numbers what has been spitted out by DP? How was the numbers for three diff independent structures?

Interviewee: Well, you know, we have been impressed. We think that the numbers we were expecting…my boss kind of proud of himself that what he has estimated the square foot cost in $, what he said probably would be what it kind of was.

They did lot of assumptions at the schematic design phase. I hope the assumptions we are amking now are less and less. The SD number a bit inflated, we ended up at the last minute cutting some million dollars out of it haphazardly to get it in within the budget for the client to see. We are not doint it really at this point for DD, cause it has to be more accurate estimate with less assumptions. I hopeful that is more based on current economic const cost and ternds in const and biddgin and some of the cost ois based n PM type numbers. It's a competitive sealed proposal, there might be some 5-7% perhaps that estimate for actual bid may come in lower the estimate in… we cant say we can count on that but its some of the things we are discussing.

Interviewer: you said, you cut down some 2M dollars to be in budget. Did DP played any role in cutting down the budget, like doing the MDS and coming into the budget?

Interviewee: At that phase, I don't think. It was done at the last minute.

Interviewer: Did you find the reports and documentation that provided by contractor using DProfiler any helpful?

Interviewee: Like I was saying before, they have a summary page that kind of list different categories and what substructure cost is the interior finish vs. skin of the building. It just kind of have these big things line items there. One nice thing they has is this presentation they had simple bar chart of the…here is the estimate, SD estimate as compared to DD estimate. Here is the area that has increased in cost and here is the area that has decreased the cost. So, we were able to kind of talk about, why those things has changes, and what the difference was there.

And there was one I saw a change that we quite been able to know looking at that folder. Kind of expand that folder, we find out that with the diameter of the piers underneath the foundation is contributing to the increase cost. And so we don't need that.

Interviewer: Did you find DProfiler helpful in clearly translating the assumptions within the project participants?

Interviewee: DP is an interim step between autocad and BIM. Hopefully, down the road, we will use the same model to create the CD and designing, like using Revit, for example. And also tied it up to the cost estimate. So, we as a designer are very aware of every single element that is being repeated. Cuase, I think there always has been with cost estimate, you have these staff of something handing off to the cost estimators to do their own drawings and calculations, and they kind of trusting that. I hope they are trusting that information. Hopefully, in future, the designers will be more in control of the model because I think one of our fears was that we, OK we see your model here but doesn't looking exactly like ours. That made a lil bit uncomfortable and cause us ask questions as far as just to make sure that you have included all the details and after putting it all together, that might increase the cost and effect over all SOW, so make sure its kinda matching our designs.

Interviewer: Since contractor provided 3D model and images portrayed by DProfiler instead of just numbers, did it help you to gain a better understanding of the cost of the project? Did it influence your design?

Interviewee: Well, yes. It did helped us. When first she went thru the building and clicked on some façade, the price elements came up. We were really be able to have tangible connection between what we see as the design end product with the budget. A large expanse of stone on the wall, that we knew will be much expensive, masonary brick, we were able to say, ya you are right, it's a big piece of wall. We did change the brick instead of limestone, we were able to think about the VE kind of options more easier by just having the visual in front of us.

At this point, we just kinda leave the design as it is, but we make a kind of note that perhaps substituting brick with some different material might be good thing. We might do that down the road, but we are not gonna make that change this time.

Interviewer: Do you think that since contractor used DProfiler on this project, you (as an architect) had provided better opportunities to collaborate with the team of contractor?

Interviewee: Well, you know I don't think so. Honestly, we worked with KOR before on another projects and I think a smart KOR will have a pretty good understanding of the building, whether it's a 3D model or a 2D drawing, and hopefully we will be able to suggest some areas of elements to change to save cost ir they could perhaps suggest some way to detailing something or a diff material. I guess, I have really good exp with couple of last project, when we really worked with the CM @ risk and they really want us to do the cost estimating all the way thru and they are really the ones who had been contracted to do the project. We had teamed up with them from the beginning. And they had a lot of good suggestions, import the project…keep our design intent….distinguishing element to the project w/o loosing it completely where we have been able to change something in construction in some different ways or cheaper. So, I guess my experience with this is folks are working with they are not so much the ones who are doing with the construction. They are more cost estimators, I donno, they have this much…they can…final outcome of the project…it was a CM@ risk type of project…

Interviewer: So, I guess, if you would have been working with the contractor, you would have been given the more opportunity to collaborate with the team?

Interviewee: I think so, yeah! It's the actual folks who are gonna be building the building. And they are the one who are estimating using DP. I do think that would help the dialogue between us.

Interviewer: How was your experience with DProfiler in practicing sustainable design and doing site analysis at the conceptual stage?

Interviewee: Well, we dint use DP for sustainable design. I guess I wasn't aware of that it could help us in that, so we dint do that. Can you sxplain how DP can be used for sus design, like sun angle or wat?

Interviewer: yeah, they have the energy analysis tool to calculate the NPV for the MEP stuff.

Interviewee: I am not aware of the capabilities of the software, so we have not used it that way.

Interviewer: Do you have in-house estimator?

Interviewee: No, its just the client hires a independent cost estimator for most of their projects. And actually the estimator usually use is very busy so that estimator hired somebody else to think on a few projects. So, the person they hired, they are part of a construction company. They are division I guess, just the cost estimate. I think they do have the large database of the knowledge just with the overall firm they pool from. But its not the same as having the folks that are actually building that project, doing estimate.

Interviewer: Did you use DProfiler for the tasks like space planning and preparing floor plans and cresting multiple design options? How was your experience with DProfiler in performing the tasks like space planning, preparing floor plans, and cresting multiple design options for the project?

Interviewee: No. We are basically doing some of the projects in Revit. And Corgan is moving in that direction. In this project, we use the combination of AutoCAD and SketchUP for our design.

Interviewer: I remember, you said that after creating the model in DP, you wanted to use that model in Revit for the further design development phase?

Interviewee: You know, 10 or 20 yrs down the road. That would be really cool. If the model we are actually doing the drawings from is the same model for the cost estimate that's gonna be from. That's definitely will give a better level of comfort to the architects and to the designers.

Interviewer: So, currently are you trying to export the DP model to Revit for design development?

Interviewee: we are not using Revit at all on this project.

Interviewer: In this project, there are three structures, two are new, one is existing and you are doing renovation. So, the cost estimator provided the estimation in DP for the renovation building?

Interviewee: Ya, they did use DP for that. What they actually did was for the building that is being renovated was…it dint even looked like a building. It was just a couple of blocks, and the information is put into….its like a large one storey couple of blocks

Interviewer: What are the problems you feel currently with DProfiler and wishes you have that you would like to see happening with DProfiler in future?

Interviewee: Well, I guess there is a little bit of confusion that there model doesn't look like the design. We have to make a little bit of dialogue really to make sure that they are covering everything.

May be they can give us the actual DP model, and we can look at by ourselves too. I am not familiar enough to say what big changes that would like to see with DP.

It does forces you to make a lot of assumptions upfront, like for example, when you are doing the SD, you don't necessarily know exactly what type of glazing you are gonna be using. They need to put in that always sells to fill up the information to come up with a number, so they make certain assumptions that the glazing is going to be 1" insulated glass but we made a side that we need operable windows down the road and that's gonna be an additional cost and we may say that, no we don't want that, we want single pane glass, because its gonna break the window all the time and it will cost money to replace that all the time. So, I think there are lot of assumptions that has to be made upfront. When we run into Revit, you just cant put a door graphically, you will have to mention what size of door and what material of door to set upfront. So it lay down at the beginning and it can cause some confusion. When we show them the estimate, they say we don't want this, we want this. So, it create some confusion for the client at that point.

Owner asks that it's the building that we were talking about!

ARCHITECT #3

Interviewer: If contractor uses DProfiler to create 3D model for the conceptual planning and feasibility studies, do you see any value coming for the Architect? If yes, what are those values?

Interviewee: I worked on one project, and I think it has tremendous value. I tell you why. When I look at a cost estimator, the result output is a big spreadsheet. Sometimes it is 100 of pages long and it is very detail. As an architect, I am not trained to understand the spreadsheet. I usually understand certain points, but I have to present it to my client as facts. I wont be able to do that if I don't have complete understanding of what it is. With this software, I was not just presented with pages and pages of numbers. But I also presented with 3D images. When I see the images, I realize that the cost estimator has completely understood the length and the width and the height and all the parameters of the project. It gave me and my client a much better confidence level that everything is included. We can physically see the boxes and we can physically see the things that are included that we wanted to include. Architects are very visual. When I see a picture I understand it instead of pages and pages of numbers. It is much harder for me to understand it. So, just a fact that it is 3-dimensional as oppose to just pure spreadsheet which is very valuable and raise my confidence level.

Interviewer: Did you find the reports and documentation that provided by contractor using DProfiler any helpful?

Interviewee: At the end of the day they gave me a big spreadsheet with a bottom line number. I am not sure that it is any different than any other program. But the fact that I could see it and I could understand it and I could answer them more intelligent question, just to make it more helpful to me.

Just as an example, the project which I was doing, it was a big massive army building, and we were looking at 6 different possible additions to make on this building. He gave me a 3D model of that building which showed different colors for 6 different possible additions. And for each possible addition, it showed me how it interface with the building, how it interface with the site, it showed me the height. I will just look at that, and that is big enough. It showed me in a very convincing manner, that when we do the addition, it is a 6 sided box. I can tell it is high enough, wide enough and deep enough which is a visual kind of confirmation of everything he was suppose to do.

Interviewer: Did you find DProfiler helpful in clearly translating the assumptions within the project participants?

Interviewee: At the end of the day, I am looking for the quantities, prices, square footages, and such things. And that has to be still down to cost. The cost is the bottom-line.----------. I use BIM all the time and I know what a powerful tool the BIM is and when I saw he was doing BIM, It just short circuited a lot questions that I would have had and lot of doubts I might have had. Ordinarily, you just sit down with the cost estimator, talk with him and have him proved to you that he has understand everything. He has to demonstrate to you. You have to make sure, that he has included everything, he has not forgotten anything. You would be surprised seeing how often they include just 5 out of 6 sides of the box. That level of confidence that level of need to demonstrate that everything is included, was really short-circuited.

Interviewer: Since contractor provided 3D model and images portrayed by DProfiler instead of just numbers, did it help you to gain a better understanding of the cost of the project? Did it influence your design?

Interviewee: In this particular case, it really did not. We are the one who designed it. We knew how it looked like. When he gave me his 3D images, I want surprised, because I knew how it looked like and when he showed me. But the fact that he basically build that BIM model. I gave him AutoCAD drawings in 2D and got back 3D image which just convinced me that he understood and it was complete. It's a very nice confirmation and it makes his job easier. I don't care if it makes his job easier. It's not of my interest.

My interest is the fact that its complete and he has confidence in it and I have confidence in it, and it did that very well. And I can see that in an instance and it might influence the design. I can sit there and say that if it is little bit shorter, its more cheaper. So, let's make it shorter and show me how it looks shorter and cheaper. So, in another instance I can see it as a valuable design tool but in this particular case it wasn't since it was already set.

Interviewer: Since you get these images in 3D, you thought that both the architects and contractor are on the same page.

Interviewee: We do BIM all the time. We sit there and make the building taller or shorter. You can manipulate the building in 3-dimensions and I can see the changes on square footages. I can say how other things changes, how it changes aesthetically, etc. If I make the building shorter, it reduces the number of square footage of wall, and it will give you the cost difference. So, in the other instances, when the design is more flexible, I can definitely see it as a design tool.

Interviewer: Do you think that since contractor used DProfiler on this project, you (as an architect) had provided better opportunities to collaborate with the team of contractor?

Interviewee: I say yes. It changes my relationship with him. Because usually, you think of a cost estimator as an accountant, where he is sitting with his spreadsheet and numbers. And now he also became a part of the design team. Because he just did not gave me a full bucket of numbers which I didn't understand, but he also gave me images which I did understand. So, it changed the way how I looked at him. He became more valuable to me.

Interviewer: In the future, given the opportunity, would you see value in collaborating with the team using Macro BIM.

Interviewee: Oh absolutely. When I do this next time, I will ask for this.

Interviewer: How was your experience with DProfiler in practicing sustainable design and doing site analysis at the conceptual stage?

Interviewee: In this particular case, sustainability was not an issue, but site analysis was an issue. As I said, it was a very large building and we were putting additions on it and we were looking at 6 different options. Basically they were 6 different conceptual model and the main purpose for us was cost estimating. But because he build a 3D model of both the building and the site before he put these additions on, we saw not only cost information which was absolutely primary but we also saw how these different addition interacted with the building and interacted with the site. The number one importance for us was the cost which helped us for doing the site study.

Interviewer: Did you use DProfiler for the tasks like space planning and preparing floor plans and cresting multiple design options? How was your experience with DProfiler in performing the tasks like space planning, preparing floor plans, and cresting multiple design options for the project?

Interviewee: In this particular project, the only thing for which we used this is for cost estimating. In this particular case, the design was already set. We gave the design to the cost estimator. The cost estimator used this to develop the 3D images and to develop the cost. I can see that we can use it in many other things, but in this particular case, we used it just for cost estimating.

Interviewer: What are the problems you feel currently with DProfiler and wishes you have that you would like to see happening with DProfiler in future?

Interviewee: In this project, it is only used by cost estimator and it's primarily used for cost estimation and it did it very well. I am going to say, it was great. I am not sure if I can say I see any improvement

because it did exactly what we wanted it to do and we were impressed by it. We have a very limited role in the project, and it did it very well.

Interviewer: You gave a set of drawing and in return you got cost estimation and that make me wondering a little bit when you actually worked on estimation with DP? It looks like you had some set of drawing designed when you had someone on estimation. When exactly you asked that guy to work on cost estimation?

Interviewee: This was a study for the army to add on to this building. Architecturaly, we had developed 6 different options. Its pretty interesting, because usually we work in BIM. In this particular case, it was just a study. Hence we did not go that far. We were working on AutoCAD. We were working on 2-dimensions for this specific project because it wasn't a building project, it was a study. So, we developed CAD drawings of 6 options. We gave the cost estimator the building plan, we gave them the site plan, we gave them both narratives and plan of all the 6 options. What we expected to get back was the pages and pages of numbers which is really hard to understand. Since he used DP, he gave back to us a 3D model of the building and the site and 3D model of the 6 different options. So, I was personally surprised. Because, usually we go through the trouble of doing BIM and now he went through the trouble of doing BIM. So, what we usually looked at always is the 2D project which suddenly became 3D project.

Interviewer: Yeah, it was kinda interesting to me as well bercause, as far as I understand , DP basically developed to look at the alternative options, and what happened to this case, I think is you guys has already developed some alternative options already using 2D CAD and gacve those options to the guy who was working on the DP to get some estimation. So, basically, you got some benefit in terms of expediting the estimation process using the DP. That's how I have understood.

Interviewee: I am not gonna say whther the estimator was better or not. But it was clear, it was easy to understand and it was well illustrated, more intuitive and the disconnection between the architect and the contractor has completely cleared up. We both were speaking the same language. We were speaking 3D drawings.

Interviewer: My question was if you have the chance to work again on the 6 different alternative options, and then knowing what DP is capable of with those alternative options, what would be like for you to work with DP from the beginning researching different options that you may think about even before marching on 2D drawings?

Interviewee: Well, I think if we would do this again, we want to be smarter about it. We probably would have started working with the cost estimator earlier. And rather than us coming up with the options and handing to him, we probably made him to help us to come with the options. I think we could have used him earlier in the process and he could have more of a team. Rather than waiting till the end and giving him the finished product, which is 6 option in this case, may he could have helped us in developing the options. And it might have more collaborative effort and would have saved some time.

Interviewer: Another option you can think about is to have youtr own people to be able to workj on DP and work with you as a team in the same company. And I guess, last time when you were working on the project on DP, you obviously outsourced the guy who was working on the DP. Is it cost effective to you guys to have your own staff and your own application within your own company and then kind of continue to work with you all with every new project you were investigating?

Interviewee: I think it might be. We use BIM for most of our projects. The software we are using is REVIT. I think Architects in general just kind of scratching the surface what you can do with Revit in BIM. And, I could see the cost interface bringing in earlier. It is kind of foolish, to completely design the entire building in BIM and then giving it to a cost estimator. And by using this program, like integrating this program with our application, we can get the cost estimation much earlier. As we develop the project,

we would be getting the cost feedback. I don't know if it work that way now, but I am sure if it could work that way, then it would be wonderful.

Interviewer: That's one of the pitfall that we found from the DP as well. As you pointed out, there is no way to use the DP model again for the Revit application, so that's obviously something I guess software vendor in the future can do to improve their application.

Interviewee: And with Revit right now, when we build the model for instance, there are third party programs that can integrate to it and can do energy analysis at very early stage. I have not seen anywhere you can do cost. But I can imagine you can. There is some way to do it.

Interviewer: I heard you are using Revit for other projects, and then whenever I hear any company working on Revit or any other BIM applications, I was always wondering, whether they are using that model for estimation as well. I know you guys are using BIM for speeding up the design process. But are you using the BIM model for estimation as well?

Interviewee: I don't believe so. What we do is, we will have the BIM model. Then we will flattened it to 2D drawings and will then give the autocad dwg to the cost estimator.

Interviewer: And you think this is because how people working on estimation, or because there is some lack of functions in the BIM applications?

Interviewee: I am going to guess that what lot of cost estimator do is by traditional old fashion. For instance, I did a project recently where we had to get the information to the cost estimator so that he could work up his estimate, and he asked for the paper copies. I said I have sent you the CAD files, but he said I want paper copies. They just sit around the big tables with paper copies with scales. I said that's old fashion, how about I give you the CAD files. They said no, that's how they operate. So, I think a lot of estimators are very traditional like they have always done this way and they will keep on doing this way till they retire. And they are not versed with Revit or BIM and certainly they hardly know AutoCAD. You cant expect them to jump into the BIM which is why this one cost estimator where I worked on this project, I was pleasantly surprised that he was more savvy than we are as what we can do to the software. I never seen that before, but obviously, he know what new technology were, and new software were and he was using it very nicely.

Interviewer: Well, obviously this case is lil bit diff that I expected to see. Because I expected to see DP being utilized by people at the early stage of construction planning when you don't have any set of drawings at all. But in this case, I guess you already have 6 different set of drawings and then you guys used DP as one of the estimation tool and you are still happy looking at the outcome which is very interesting case to me.

Interviewee: Yes, and like I said if we do it again in a smarter way, we would be using that program earlier where you can leverage the power of it. This time I was looking for just the cost estimate. I wasn't looking for anything. Next time I think I will look for more, like using as a planning tol as oppose to just a cost estimating tool.

ARCHITECT #4

Interviewee: We are doing addition and renovation to the city of recreation center. Our traditional role is we have started with the schematic design, DD and we are currently starting construction documents right now. So, we have furnished our Revit information to personally to Beck at the end of the schematic design and at the DD stage. They have taken that info and used that to develop a cost estimate.

Interviewer: If contractor uses DProfiler to create 3D model for the conceptual planning and feasibility studies, do you see any value coming for the Architect? If yes, what are those values?

Interviewee: I don't really think there is much value out there out of what contractor produce, because from building the Revit model we end up using the visualization tool using that which is lot mature than the things we are getting from the contractors. I think from the standpoint of the cost estimating, I think the help that's been we see I guess the quantity take which is pretty detail. So, we do appreciate that part and I think they are taking straight off from that model. And so that we can tell a little bit if we see a number that we think it looks a little bit smaller or bigger than it should be, we go back and start verifying the quantities, and just compare. We have done that couple of time.

Interviewer: You mentioned that it is not efficient as Revit, so, I was wondering that like at the conceptual stage, do you use Revit for 3D modeling?

Interviewee: Ya, we use Revit and we also use SketchUP sometimes. We can develop model more accurate than what contractors has furnished us as a part of the estimate. And he actually did develop some models surprisingly pretty close, but in terms of total accuracy, they are not just quite detail as what ours Revit models are.

Interviewer: On this project, what was the information provided to the KOR or the third party?

Interviewee: We have been just giving them the dwg for our project. They take the dwg and construct their model. And they are passing back the images.

Interviewer: So, did you find the reports and documentation that provided by contractor using DProfiler any helpful?

Interviewee: Yes. We definitely did. And I think the information, that they develop…they develop not only the estimating part of it, they also develop the list of the assumptions that we were able to go back thru and review and if we needed to, we respond back to em. So, if there is something in their part that they were not totally 100% sure about it, they did raise an issue or question about them.

Interviewer: Did you find DProfiler helpful in clearly translating the assumptions within the project participants

Interviewee: Yes.

Interviewer: Since contractor provided 3D model and images portrayed by DProfiler instead of just numbers, did it help you to gain a better understanding of the cost of the project? Did it influence your design?

Interviewee: I would say from my review point, the answer would be no. Because I think the model that we develop from the Revit side, is actually better. I think the model they develop is pretty accurate. Atleast the images they develp is pretty accurate. But I think from my review point, we are more interested in numbers than anything else. Its still the data that is producing.

It did not influence our design. Not at all.

Interviewer: So, say for example, if the fflooring is of some particular type and is getting expensive as compared to what it would have been conventionally provided. So, in order to bring the bidget down, in that terms, did it influence your design for the project.

Interviewee: Absolutely it did in that regards. What it does, it makes us stop and think…we did not had any budget issues so it has been nice, but atleast it confirms that what we are designing is within our budget. We run across couple of items on this last go around and their numbers actually increased in cost and I think that prompted us to just take a look to make sure that we have correct information on our documents. So, I think the detail information we can pull from that and it definitely would help us in that regards.

The model and the images they furnished us is strictly expterior. I am assuming they went thru the process of modeling the spaces and then doing the take offs of the spaces of the building.

And may be I think the confusing thing for us is that, we did not know that they were doing this and honestly, this si a kind of thing they kind of work on their own. this was not a kind of thing that you know, we were working together on or anything like that. It is something that they can produce on their own. And it was great, I don't think we have fully understood what it was. We don't have a license for DP. If we would have a model and if we would clicked on the elements on the model, and can see what the cost of that elements to be, that might be helpful for some projects. We have just the breakdown of the costs, like sums of the cost of bricks for instance, give us each area of the building or anything like that.

What we actually did is, our third party cost estimator is furnishing this information to Beck to create the estimate. So, we don't have the direct contract with beck in this case.

Interviewer: Do you think that since contractor used DProfiler on this project, you (as an architect) had provided better opportunities to collaborate with the team of contractor?

Interviewee: I would say no, the only reason is because we do not hold meetings with estimators, Beck in this case. It was not a construction manager like situation where they were involved in every meeting. It ws just a one time cost estimate they used on. So, we kind of furnished information and they give us an estimate back and we then review it. The only point of contact we had with Beck is just for the questioning about some of their cost information or the quantities may be. And that's about the extension of interaction we had with them. We haven't actually wit down and look thru their model at all on this project. I think, the capabilities are there, but I guess its just we have not experienced the interaction with the contractors side yet.

I think they have a lot to do with the relationship. Like we are using pretty traditional model. I think the firms that are doing the design-build, working on a project that has a construction manager, you gonna have a lot more sharing of model like that, things like that, it takes place. In this particular project, it was not like that.

This is one of the hard bid jobs that we do. The contractor will be selected later. So, this will actually issue to several GC's to bid against each other in an open bid situation.

Interviewer: Did you receive any documents on sustainable design from the estimators or did you happen to practice sustainable design on your own?

Interviewee: No. Specifically, there was no requirement on this project. Other than our normal design criteria we use, it was not the one that we were looking to pursue. So, we did not pursue that with the estimators at all.

Interviewer: And what about the site analysis at the conceptual stage?

Interviewee: Because it was an addition, it was pretty minor in this particular case. We had specified area that we could add on to building. And it make our design fit.

Interviewer: So, did they create the whole model of the building, or they created just the addition that goes into the building.

Interviewee: Looks like they actually did model the entire building. Primarily, may at the renovation aspects, they need to do that.

Interviewer: What are the problems you feel currently with DProfiler and wishes you have that you would like to see happening with DProfiler in future?

Interviewee: I don't work on the design-build stuff that we do here, and I don't think we have any other projects currently where they are utilizing DP right now. This was our first use of it. And now we have got the data that extracts from the model. We haven't seen the model and we don't know what additional benefit we need from those things.

We haven't exposed to DP program, so I think it will be more beneficial to learn more about this program.

Were they able to import Revit model into DP? So the KOR has to rebuild the model in DP. So it looks like it is repetition of work. They build the model from our 2D stuff.

I think in design-build, if the KOR can give the cost information about a building with very less information available, then I think, it's beneficial in decision making in that regards. You can test various types of exterior finishes and the skins at the very early stage, with that kind of limited information, I think that is great.

APPENDIX F

INTERVIEW TRANSCRIPT-OWNER

Interviewer: Can you give me a gist about the project?

Interviewee: We will be for another 4-5 months. We typically stay involved even after the construction just to make sure that everything is going well. It's a 3 storey, 62,000 sq.ft specialty hospital, 24 beds, 7 OR's, emergency room, and obviously all your administrative areas that would support by nature. And its all on a 1.4 acre site which doesn't allow much creativity. Its very tight, downtown dallas, very visual site, high profile for this type of project.

Interviewer: If contractor uses DProfiler to create 3D model for the conceptual planning and feasibility studies, do you see any value coming for the Owner? If yes, what are those values?

Interviewee: It's a two-fold answer. I was a general contractor 11 years before. I moved over to construction/development side. For company like ours, Duke Realty, we built….as far as our main product nationally..we built industrial houses, and office buildings. And almost every time, effectively it's the same. There is not much change, except once, may be just a little bit bigger which doesn't take a lot of work to figure that out. So, in a situation like that, I don't see DP being all that helpful because its so…we got a product that we produce, we own it and its pretty straight forward. I think you would spend more money and time putting it together from a BIM or DP than you would just being able to use the pieces and tools that we have in place.

Now, on the flipside of that, from the health care side, when you get into items that are specialty hospital, a cancer center, or an archeology center, you know whatever it might be, its specialize and it does not get repeat over and over and over again, I think it has tremendous capabilities and tremendous asset to an owner and a contractor because you can quickly put together something visual for an owner who may not be able to see and understand sketches. Plus you put the historical prices from the market together pretty quickly as oppose to have a full blown take off which you may or may not include everything. So, for bigger specialty project, I think its very beneficial.

We built…I am on a healthcare side, but I know nationally we do a lot of industrial office parks and by saying that all they are 250,000-500,000 to 1M tilt wall boxes. So, that being said, there is not a lot to that. And its really easy to sit down and go OK, we know what our specs are, we know what are our parameters are, we know all of that. We can change that, manipulate that very very quickly because we do the same way every time. The only thing that is different is whatever that site has to offer and the square footage. There are some few other items but that's typically all that it is. Since we repeat, we already have a baseline. So it wouldn't benefit us to have someone coming do something like that for us, unless you are a developer who doesn't do that all the time. He decide to go out and get a GC to do all of this, then yes, that would help. I think any person or any developer who is not an owner, or not construction savvy or doesn't repeat items over and over again, then any product would benefit them and that would help sell that product and help sell that GC or that company.

Interviewer: Did you find the reports and documentation which provided by contractor using DProfiler any helpful?

Interviewee: I do. I do. I thought it was helpful. I keep similar archive or historical database so that I can compare numbers that I am used to say against my GC's and I believe that the one that seems far has been relatively accurate. Specially, from my conceptual standpoint, its hard to be exact because it is conceptual

and you don't have complete design, but it does encapsulate everything that is require and has reasonable historical figure, I think that's right in line everything I have seen.

Interviewer: Do you guys do internal estimate?

Interviewee: Yes. I do internal estimate on every project that we build. And I do that for specific reason, that's because except my background, that's the only way I know how to learn the ins and outs of the project. I estimate it, and I continue massaging it and I believe that's true for anybody whether a GC or anyone else for that matter. So, I do it for my own purpose as well as requested or required out of my pre-construction managers. They do the baseline estimate, you know at the SP stage, so that they understand what they are looking for, looking at and understand what the cause and effect is in regards to the potential changes in overall cost and value of the project, so that we can track that from the baseline.

I will say one thing, I don't say I will find out most developers or most owners that they may go out for the third party group to check those numbers but, I don't think you will see a lot of developers or owners who have an internal group that can do that. I do believe why you need. For 10-11 years, I never saw anyone who will detect my number from internal standpoint. It's always a third party group.

Interviewer: Does DProfiler helps in reducing the overall risks of a project?

Interviewee: I believe it does. I think if the average or the typical owner or developer out there was looking at a DP estimate or even the BIM model, they could see where…from what I have been able to see from my past thru my experience…you can see where you going to have issues, you can see where….there is not enough detail, so you may have to carry additional costs because it hasn't been thought thru far enough because it is still at the conceptual stage. It lays that out and in the DP uses that information to lay out to produce a number. The one item that I will say and again this gonna do to my own internal estimates that, again the way that I understand a project is I build a project in my head and build it on my paper and transfer that you know on to a spreadsheet. Actually doing take off, but its not just taking off with a digitizer or a wheel, its more looking at it and building in from a constructability standpoint. I think that's the one thing if I…I mentioned to a guy who proposed DP and the BIM modeling is that…I don't want some one to come over here and say, here is your number, here is the building gonna look like here is your façade your road, your foundation, your deck, so on and so forth. I want someone to come in over here and say, 'Listen, when I was looking at this from the constructability standpoint, in my past experience your grade beam aren't gonna handle this load or your paving here is gonna interface with the way your slab on grade works or whatever that might have been, because after putting the plan how all of that interfaces, I don't know enough about it to be honest with you, but I don't know that it will think logically in a sense that will your fire line in your civil plans come in here but your plumbing line in your plumbing plans makes it here. I don't know whether DP sends us alert these don't match, there is a discrepancy here and so there is an issue. When you estimate both sides of the plan, you are looking for those things. You are looking for the constructability for that project as opposed to plugged it in on OST or digitizer or having a program to take that all information that you put in and apply numbers to it. And that's no different than MC square or timberline or any other product that we are using in the path. You still have to have that experience to understand how a job is really build.

For a GC, who is going out and chasing a lots of work from a conceptual standpoint or may be responding to RFP type format and then going in there on a building that is lets say one tiny building suit or whatever that might be, I think it's a very powerful tool as well as a very powerful selling point. But when you do get into constructability, you know no offense to anybody, but I don't want a first year kid out of school and plugging in the numbers. I want someone who have that experience, does that make sense.

And the whole clash detection…that has been a just an amazing introduction in the last 4-5 yrs, and it has reduced our overhead MEP systems as far as the problems you run into, able to detect that from very early

stage. Not to mention, it makes the project,specialized project like the hospital where 40% of your cost gonna be at the MEP related items. It just outlines it perfectly to where you don't have any issues, you have a better install which gives you a better product which gives you a longer lasting product.

Interviewer: Do you think that it is a issue old people learning new software?

Interviewee: Oh yeah. I think, that's always gonna be the challenge as far as trying to sell a software. I know that prior to coming over here, I was senior estimator for a group where we use MC square. And one of our senior guy was actually VP there and used MC square for many many years. But he still use a lotus program, from the 80's. He wouldn't change, they are not technical savvy as the young guys that are coming out of school. And I am one of those, I need to admit it. I got a handful of people down here who are much more technical savvy when it comes to computers and programs than I am and definitely there is someone who always been interested and trying to keep up with everybody and I know that's the direction everyone is going, so I need to do that.

Interviewer: Since contractor provided 3D model and images portrayed by DProfiler instead of just numbers, did it help you to gain a better understanding of the cost of the project?

Interviewee: Ya, I think it does. It does help tie cost to an actual visual product. Because been able to see something, specially from a lot of owners perspective, really helps. In a past, when I put RFP, I had an architect who put together all the rendering for me to just go along with the numbers so that kind of get a feeling what those numbers represent. When you got the DP and the BIM modeling together, you got the 3D view to a certain degree that's everything that gonna be on there and I think Owners see that and they actually see what their building is gonna potentially look like. Like I said, its definitely a huge selling point I believe for a GC or a company to present to an owner or a developer. It just helps them tremendously. Anytime when they see pretty pictures, its gonna help you know.

Interviewer: Ya, the architects may provide the renderings, but I think owners are also curious to know the numbers that goes behind that number.

Interviewee: Yeah absolutely. Because, they gonna sit there and they gonna scrutinize why it is so expensive or why certain line items so expensive. When you got a 3D model, you can justify a lot easier.

Interviewer: Now that you have said about 3D model, does the contractor provide the owner with 3d model or does it provide images?

Interviewee: It can be either ways, it depends. I think in a RFP process, you have may be an image that is included in the hard copies. When you get to a point when the GC might be shortlisted, and in the interview process, that's where they gonna sell. They gonna sit down with their technical support, get in there and pull up that 3D image/model and walkthrough the project. And right there, when they do that, that's how they are selling, and that's why you are seeing so many GC's really starting to come towards a model like this where they have got the 3D image and the software to back it up to the estimate solutions. So, DP, the BIM modeling, that's the very….like I said, it sells itself. It depends on how much it cost though. I dint have the nerve to ask that guy how much it cost, but it's a very powerful tool.

You know, I don't know if this will help your research, but you know in the past I have led the charge to bring the estimating software for the different companies I have worked for and the licensing can get extremely expensive and that would be the challenge I would offer to them is may be to have a one time licensing fee that's a pretty expensive fee. Instead of offering a single license per person, they should offer a some sort of package deal. You don't have to pay one license per person, but you have some sort of discount to an office and to the amount of volume they do to support their need so on and so forth.

Interviewer: Do you think that since contractor used DProfiler on this project, you (as an Owner) and the architect had provided any opportunities to collaborate with the team?

Interviewee: Ya, I think that definitely help. Your architect, they like to see obviously, that is something that they gonna want to worked with and be involved with because what it does makes there life easier. I think there is some issues about the interface, between the Revit, CAD and the BIM modeling, I don't know enough about it to really get into detail, but if all of those could be intertwined somehow, and be able to communicate, on the same platform electronically I think that would be huge leap and I think what that would do in grand schema thing is I think it will take your conceptual pre-construction portion that might be a 6 months design and help us to bring that time down to the 4 month design and which we know time is money…so the quicker they can get it done and you know if an architect put something on Revit then they can send that to a GC and then they can plug that it into a BIM and DP, I think you are saving time there as opposed to having the plans made, having the digitized it, having it plug it into your estimating software. if that being seamless to where all those systems somehow talk to each other at the same platform I think that would be huge. But even we are at now with the modeling, I think we are in much better condition than we were without it, in a sense that the architect can see and understand a lot better where we are at and so they can communicate in a more positive and more quicker pace as to how the projects progressing.

Interviewer: Yeah, there have been some issues regarding the interoperability between the Revit and DP. Revit model cant be exported to DP.

Interviewee: Yeah, that is because you got competing systems of software that do not want to collaborate. There is some truth to that too.

Interviewer: Then, I guess, industry along with the software vendors need to be more collaborative. Collaboration amongst the project participant is one thing, and I think collaboration amongst the vendors is also needed, when we talk about BIM.

Interviewee: Absolutely. Absolutely.

Interviewer: In the future, given the opportunity, would you see value in collaborating with the team using Macro BIM.

Interviewee: Yes, without a doubt. There are so many areas that can benefit even a developers like us who do lot of repeat business, but we have those off-shoots, specially the hospitals, bringing on a third party GC for an item like that has the capability, that's what we looking for. We want the people who has most sophistication.

Interviewer: Have you been provided multiple design scenarios for this project?

Interviewee: I think there were two different designs the last when I looked at. Although they were not so different, they were skewed a little bit. You know, I think the point in fact there is that going back and comparing those two different design DP was able to distinguish quickly where the changes were…where the increase and skin surface or square footage, where is mechanical for that matter, and it doest that in relatively quick fashion as oppose to an individual having to go to make that comparison on their own. So, I do think that by using DP and looking at different solutions and options that do change, may be the building may be here little bit there, its powerful enough to tell you the reason this version is more expensive than the first version because of the X, Y and Z. And I think it does that in a much quicker than, I must say, an estimator could sit down and do that.

Interviewer: So, to what capacity it has been helpful to you on this project?

Interviewee: Well, I think we were looking at first, we were trying to identify our budget and so that was the baseline that we had. About 6 months later and we came back out, OK this is what we gonna go with which is changed! And when they revised there modeling and the estimate for that matter, they were able to tell us what they have changed. To my understanding, it was relatively easy for them to do that. All they

have to do is to change the criteria within their model, and kinda made the changes and told you where those changes occured and you know, it was really pretty straight forward.

Interviewer: Since, we have talked about the constructability, let me get back there over there as well. To my understanding, DP has been used…I mean it can be exploited to max when it can be used in the design-build project and ideally in IPD's. So we were talking about the constructability, and from owners point of view, what do you think about collaboration between architects and contractors. We have already talked about you know issues between the software. Now, I would like to know what else an owner would like to see between an architect and owner going on in terms of constructability issues in the design build projects or IPD's?

Interviewee: Well, I think there always be to a certain degree that…a contractor or an architect is looking at in theory what these designs look like and what, you know put on paper. A contractor is looking at the constructability what will really works as oppose to what looking good on paper. And so, there is always gonna be that conflict, if you wanna call it that. I think an owner,may be in particular I am always there to make sure that my GC and my are working together or collaborating together to come up with the most efficient cost effective design that still gets me what I am looking for. That being said, you know, I think when you do have DP and you have the BIM modeling, I believe that when an architect is trying to design something, obviously, the bottomline is the cost is always important, they always wanna go play with everything, so you know you got a GC who can quickly ascertain what these changes are and turn back in quick time and say, "OK, this is how much gonna cost to do this different design or this particular portion of the project" So, I think in that scenario, an owner is getting a good value of…you got two people working and saving time as opposed to given someone a week to put out to subs and so on and so forth. They can turn around in two days. There is obviously the time factor that is very important.

Secondly, I think that if that KOR is willing to share and work with that architect instead of the architect to draw something and then have the GC to come back and plug it in, those two can work together in tandem to where they are sitting on the BIM modeling and going thru and like 'what if we do this….no no no, go back that out, lets come back to here and add a screen wall in front of this area over here and how does that effect' I mean both are working together as oppose to one working independently and the second one working independently. So, I think what it does is bring the continuity between the architect and GC, bring them close to one another and also I think it saves time.

Interviewer: Have you used DP or any other software for conceptual estimation?

Interviewee: We sat down and talk about almost a year ago probably 8 months ago. I don't see the need in our office for any software for that matter. I mean may be a digitizer at the most. But we self perform on the industrial and the office side is all of our work and again like I said its not rocket science. They are really pretty simple building. If you would ask me, when we get into the healthcare we will self perform the medical office building. And that why its pretty straight forward, its got all their standard in line, so really we gonna crank it out pretty quick. But when we get into the specialty area like the hospitals or one-off cancer centers, whatever that might be, you know, we usually go for the third party on that is a little bit higher level from a pre-con from a estimating and from a field staff situation. And so we will go out for a third party GC and that's one of the things we definitely look forward for interviewing is, do you do the BIM modeling and what softwares you use, whether DP or …

So, we look for but I don't think there any immediate use for us at Duke, there is just not.

Interviewer: Whenever you give RFP to KOR's, do you have any thoughts of putting this in clause that you want the stuff going on with BIM?

Interviewee: We are not specifically saying that we require to do it, but I will say that in those RFP's when we are putting a scorecard together for multiple GC's who are proposing on our project, they get

favourable consideration, if they have got the BIM modeling in there. That can get you the job, that can loose you the job, depend on you do or you don't do.

I think putting standards in RFP to use BIM gonna come in time. It will end up being an industry standard. I don't think I am at place or many developers or Owners are at a place to demand to that at a certain degree. Some obviously could but, I wouldn't. I mean, if I knew a construction company whio has done multiple hospitals or parking garages, that's their bread and butter, that's what they do, that's what their most efficient reputation in doing it, but they don't use the BIM modeling, I am gonna look at some of their other qualifications, look how they believe the cost is esp. if they are low. You gotta know if they are perfectly capable of it. However, I think the industry standards is eventually a lot of things will start to see that everyone else is doing this and it does really benefit not only to our company but it benefits the owner, benefits architect, benefits everybodyand there is no reason not to do it. So, I do believe it will eventually go that way. However, I don't know any time by next year I will require that in RFP.

Interviewer: What are the problems you feel currently with DProfiler and wishes you have that you would like to see happening with DProfiler in future?

Interviewee: Well, again I am not the 100% professional, or know everything that is to know about it. I have seen it few times, but I still believe--and this is how I have been taught--that in order to understand the plans, you gotta to dig into the plans, you gotta actually build that project from start to project In your head and transfer that on to piece of paper so that piece of paper, or proposal, or description, is understood all by a look at it. And in my fear, there is no different than 10 years ago when the OST came out and the people who were just connecting the dot, and saying ' Ok, its 4000sq.ft here' well, I don't believe a lot of times that there is a lot of people out there trying to understand what really happens in that 4000fq.ft. They are not really reading the plans. They are just lokoing at the screen and plugging it in. You have to have some sort of moisture remediation under that flooring because of the site condition, or the way the concrete was poured or what kind of situation you got or the climate control within that building…If I just plug in 4000sq.ft as oppose to really digging into in and understanding it what kind of project that it is, that's my biggest concern and that might just be I am a little bit more old school because I know there is many estimators who are very proficient with modeling and with the DP, or the systems similar to it. So, that would be my biggest fear.

And that also might be because I am not 100% familiar with it, which also leads me to the second part of, you know, what might be the negative aspect is but, there is a lot of people out there…they believe if its not broke, don't fix it, you know. They don't want to learn a new program that takes a lot of time to understand to figure it out which can be very frustrating. I have been down on that road with three diff types of software, although after a few months I feel like I understand this now, but when you get up to the older guys…we gonna complain a little bit, but I think that's the only thing you will see people saying, I don't wanna learn all this and attend all the classes or seminars, so on and so forth. But I don't think that's a big issue, but its growing so rapidly. And obviously, the cost again, I don't know how much it cost, but obviously the cost will always be a factor no matter what we are talking about but that will play a part into this as well.

Interviewer: Ok, so I guess, fear and trust are the two things.

Interviewee: mmmm hmmm!

Interviewer: What are the wishes you would like to see happening with DP?

Interviewee: With DP, the one thing I will say is all estimating software is as good as the input that we are putting into it. So, if you don't have some one that is monitoring the market, that specific market, I don't mean going out on the means book, I don't mean going out to regional affiliation, I mean monitoring that market and what that niche is and understanding what the costs are and making sure those are accurate within that template itself or database itself and honestly its all obsolete. And I so that happening, who

don't keep up with the unit price database, so the numbers that they are proposing they are not accurate and whats worse is if they propose one of those, they get the job and then they are in trouble. Or they propose on lot of jobs where they are way too high on, they are wondering whats wrong. They spend 100,000 dollars and its not doing anything for us. Well, better have someone there to understand that system well enough, to keep it up to date. And that takes time. It takes a lot of time to keep those figures accurate with what the market is dictating.

VITA

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