THE LANGUAGE OF BIM: INDUSTRY FOUNDATION CLASSES FOR THE REDUCTION OF CONSTRUCTION TIME

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ABSTRACT

Industry Foundation Classes, or IFCs for short, exist for the safe transfer of digital building information between professions. The language of IFC has been prevalent between some architectural firms and their corresponding engineering firms since the inception of BIM (Building Information Modeling). The transfer of this IFC data between persons, programs, and business systems has allowed for a much-enhanced project delivery, resulting in less waste, less frustration, less money spent, and consequently less construction time. However, as it is, only few firms utilize BIM technology, and fewer understand and/or utilize Industry Foundation Classes. Though there is relatively clear dialogue between the designer and engineer via standardized technology, there is much dissonance between 'architecture language' and 'contractor language.' This paper provides analysis into the topic of Industry Foundation Classes as the interoperable language between architect and contractor, and how IFCs can be utilized effectively by both architect and general contractor in creating a smarter construction schedule, thereby reducing construction time. It aims at providing hope for the dissemination of this knowledge to all professions involved in the building trades, and for better communication of information between architect and contractor.

INTRODUCTION

“BIM is no longer the future of the design industry. It has become the standard.” (Stack, 2012) To validate such a statement brings into light a much more basic question: What is BIM? Devenney Group Ltd., Architects, future-bound firm based out of Phoenix, explains in great detail why they implemented BIM technology:

> “It is a term used to describe a process used by architects, engineers, owners, and contractors to coordinate drawings between disciplines in a three-dimensional environment…BIM allows a diversified team to collaborate at a level with an efficiency previously unavailable in the industry. (Stack, 2012)

DGL, dedicated to the advancement of healthcare facilities nationwide, actively promotes BIM technology through multimedia within their firm’s website and throughout larger media outlets such as ‘YouTube.’ It would seem that these modes of expression are the most appropriate method of advocating a seemingly futuristic method of delivery. Yet they in their creative pursuits they strive to explain the usefulness of BIM in the current years; not of those to come. Other such firms, ranging in size from multinational to multi-personal, have taken the oath of comprehensive modeling.

Previously, documents proposed to clients and to tradesmen were reviewed and carried about in two-dimension. A project was designed, then bid upon by a select or open group of interested contractors, then built. Clash detection relied solely upon the designer and upon verbal communication, often resulting in heavy delay if a problem arose. Drawings would have to be manually traced, which resulted in human mistakes in an unforgiving construction industry. Misalignments between drawings may have been spotted even during building erection, causing not only delay but heated anger. If a mistake was before construction, it still resulted in the painful operation of fixing the instance in every drawing set manually. Designs took time and caution and therefore, barring the best designers, did not stress individuality. Rather, convention was the only truth.

Today we see difference, and it is prevalent in most recognizable built works of the 21st Century. In reviewing the structure, systems, cladding and spatial layout of a virtual model, we can envision and pursue one marvel after another. Automatic clash detection provides for designs that are built in less time, providing happier contractors and wealthier clients. Changes to one drawing will automatically update to all other drawings. In short, productivity is much higher with BIM technology, and it can be implemented into any scale project. Healthcare facilities and skyscrapers are not the only typologies that have already been positively affected by BIM.

To begin a debate about the values of Industry Foundation Classes, a case must first be made for the historical uprising of Building Information Modeling: how did it come to be?

As it is known today, the BIM Market was shaped by in Soviet Russia by two separate programmers, during the latter years of the Cold War. “Leonid Raiz and Gábor Bojár would go on to be the respective co-founder and founder of Revit and ArchiCAD” (Bergin, 2012). In 1982 in Budapest, Hungary, Bojár began his private business. It was also rumored that he “wrote the initial lines of code by pawning his wife’s jewelry and smuggling Apple Computers through the Iron Curtain” (Bergin, 2012). In this way, the software ‘Radar CH’ was produced in 1984 for the Apple Lisa Operating System. ‘Radar CH’ later became known as ArchiCAD. Thus, it was ArchiCAD, and not Revit, that paved the way toward an architectural modeling program on a personal computer. Ever since, Graphisoft, the current software provider, estimates rather proudly that more than one million projects have been designed using ArchiCAD.

Needless to say, the professional business climate originally resisted this change toward personal computer-aided design, and so progress was perhaps stifled. This was partly due to the fact that personal computers were not widespread at the time. It was also largely due to the resistance of change to a timeless profession, and the technological gap that razed the older ‘professional’ but exalted the recent graduate. In recent years, it has sprung into popularity, primarily for developing smaller projects in Europe. Current strides toward better collaboration and improvements in user interface have made ArchiCAD a “major player in the market.”

Though Graphisoft was the innovator, it indeed was not the only software developing company to pursue parametric modeling. Only a matter of years after Graphisoft began Radar CH, the new company Parametric Technology Corporation (PTC) was founded in 1985. Focusing on a constraint-based parametric engine, this software continued to push the limits of their modern technology in a different but related way. Thus, the first installment of Pro/ENGINEER was created in 1988.

Where ArchiCAD was lacking was depth of architectural typology (at the time), and other developers desired a software that could handle rather larger projects. This led to the creation of

‘Revit,’ in 2000 which with a more sophisticated user interface earned the respect of the architectural world in ways ArchiCAD had not previously. Autodesk, a burgeoning software company, bought out the small firm that owned Revit, and since it has grown with surprising speed.

> “Revit revolutionized the world of Building Information Modeling by creating a platform that utilized a visual programming environment for creating parametric families and allowing for a time attribute to be added to a component to allow a ‘fourth-dimension’ of time to be associated with the building model. This enables contractors to generate construction schedules based on the BIM models and simulate the construction process. One of the earliest projects to use Revit for design and construction scheduling was the Freedom Tower project in Manhattan. This project was completed in a series of separated but linked BIM models which were tied to schedules to provide real-time cost estimation and material quantities. Though the construction schedule of the Freedom Tower has been racked with political issues, improvements in coordination and efficiency on the construction site catalyzed the development of integrated software that could be used to view and interact with architects, engineers and contractors models in overlay simultaneously.”

Autodesk has clearly devoted itself to parametric modeling in not only three dimensions, but in four. The element of ‘Time,’ proven so prevalently in the above mentioning of the Freedom Tower in Manhattan, provides clear analysis into one of the base deliverables provided by Building Information Modeling. That is of the ability to export “coordination and efficiency” within a wisely created construction schedule. It is to use BIM to calculate quantities and takeoffs where it would be otherwise less accurate and/or more difficult a person to accomplish. And those that govern and regulate time in the built environment understand the ever-present plight of unpredictability in any given project; time is a precious commodity.

This rivalry between Graphisoft and Autodesk has ultimately led to a better set of end products, more reasonable software costs, a greater understanding of client opinion and more standardized user interfaces. However, there remains a problem that has plagued the architectural community since the beginning of this push toward parametric modeling in 3D. The file type produced by Revit does not open or work within ArchiCAD. Similarly, an ArchiCAD file cannot work or open in Revit. They are not compatible. It seems that capitalistic growth of the individual companies has and still will preside over the general opinion that a common file type between the software would be a wonderful addition to the architectural profession. Both programs are relatively similar and have modeled themselves against each other for the past 20 years.

And though a strictly neutral file type does not exist between both ArchiCAD and Revit, there is a transferable file type with minimal loss that can transfer information safely and confidently between different CAD systems, or other software systems in the building industry. This of course refers to IFC, or Industry Foundation Class. As illustrated in the IFC 2x3 Reference Guide for ArchiCAD 16:

> BIM, or "Building Information Modeling," is one of the biggest advances in the building industry's working methods…Three-dimensional geometric representation is only one part of the digital deliverables. A project includes non-graphical information, such as calculations that are used in surveying, facility

> management and energy calculation. A prerequisite for a successful BIM project is that intelligent information can be exchanged between different software and even operating systems, throughout the stages of the building process. This interoperability demands a neutral file format with an open standard that supports different systems. IFC is such a system, enabling us to synchronize building models between the disciplines much more easily."

Graphisoft has long stood behind IFC as the 'language' to bridge the gaps between systems and different building sector trades. The IFC format was established partially by the International Alliance for Interoperability. And though there has not been a government-mandated file type that can be exchanged between the two primary sets of software, IFC is the closest thing there is toward Interoperability.

One such professional, Tom Levi of Levi + Wong Design Associates, speaks of further interoperability. Speaking the language of IFC perhaps more fluidly than most, Levi is a strong activist for the use of IFC. He lobbies for the language to be used in less traditional means, and understands its potential as the bridge between architecture and other disciplines in the building industry. With regards to the questions pertaining to the future of architectural practice, IDP and disciplinary collaboration, to him the use of IFC is both fundamental and undeniable.

In the United Kingdom, "the Government's Plan for Growth, published alongside Budget 2011, highlighted the critical importance of an efficient construction industry to the UK economy. The construction sector is a major part of the UK economy" (UK Cabinet Office, 2011). The UK Cabinet Office breaks developmental spending down into three sub-sectors, listed here from largest to smallest in terms of billion Euros spent: Commercial and Social at 49b, Residential at

42b, and Infrastructure at 18b, as listed by the Office of National Statistics, 2010. This is all encapsulated inside 110,000,000,000 Euros spent on construction alone in the UK.

However, as listed section 1.4 of the aforementioned Plan for Growth, "Recent studies highlight a number of key barriers to growth and the efficient operation of the construction market. There is broad consensus, spread both across the industry and its customers, that construction under-performs in terms of its capacity to deliver value and that there has been a lack of investment in construction efficiency and growth opportunities." It can be assumed that this statement is as true in any western culture as it is in the UK. As trusted with the health, safety and welfare of the public we serve, it falls upon our shoulders as architects to "deliver value," and if there is a lack thereof we must search alternatives and make changes to ensure the health of our entire building sector.

It is this concern, spread broadly among architectural professionals that there is concern that the architectural profession, though making great strides technologically, is one of the least innovative professions where it matters: visible change. We largely do things much the same as we have in the past few decades. Drawings are produced and, a building is interpreted by its details, and is built. Like most higher organizations, the UK Cabinet Office is an instigator for change: "The principal barrier to reduced cost and increased growth is the lack of integration in the industry, compounded by a lack of standardisation and repetition in the product… Addressing them calls both for reform of the procurement process and for greater efficiency in the operation of that process."

This proposed change calls for two things. It calls for regulation for integration. This is to mean that integration of disciplines is the key for larger success in the building industry, for a greater deliverable, resulting in less waste, less cost, and less time in any built project. With this integration they anticipate greater governmental action to regulate change. It secondly calls for a greater process to promote efficiency in governing such a nationally mandated law. This will in turn provide support for the undoubtedly ‘shaky test years’ to come. This is explained further in section 2.2: “It is the intent of Government to use its scale in the procurement of construction to lead the process of change.”

What is clear to the UK is that integration must improve if the building sector is to provide a better product. As IFC remains the universal language shared between designer and fabricator, between fabricator and General Contractor, and between GC and architect, it must be better understood in order to utilize BIM in all of its intended ways. Project architects and General Contractors alike must have a clear knowledge of the potential of Industry Foundation Classes: what can they do, why are some firms utilizing them, and how can they help provide the client[s] a better product?

PROCESS

This article was written with only three months’ heavy of involvement with IFCs. With the collaboration of Dr. Ganapathy Mahalingam, a Graduate Research Assistantship was awarded for the author under the Fall 2013 Semester of his senior year, in pursuit of a Masters of Architecture degree at North Dakota State University. The collaboration took place between the author and Mr. Christopher Kidney, liaison and project manager for Kristi Hanson Architects of Palm Desert, CA. The project description was as follows:

> The study of sub-dividing a BIM model of a high-end residential project with parts and assemblies, to develop a construction schedule that would reduce construction time from 26 months to 18 months.

To analyze the problem statement is to subdivide it. Therefore listed in the following few paragraphs is a thorough analysis of the project description, what it specifically asks and what it does not, dissected into its respective parts.

Of Sub-Division: a well-done design is like to that of any world-class relay team. It involves the commitment and perfection of each member, that they work together to provide the perfect race. If one member of the relay falls, the entire group may suffer likewise. This can be true of the collaboration between building processes, as well as its respective contractors and labor workers. Understanding that each type of element has its own constraints is the first step toward a holistic and successful built project.

Thus, a building must be subdivided to better understand the system, or relationship, between the elements. Any design executed properly uses ‘Layers,’ whether hand-drafted or computer-aided. Respectively, its layers will contain those elements common sense dictates. When used properly, layers are like to the grammar of speech. If used incorrectly, the spokesman appears unintelligible. Sub-division via layers and element type is crucial to the utilization of IFC in any BIM project.

There is a third type of sub-division to be discussed later; that is the Sub-division of building elements based on their IFC criteria. As that is explained in full later, it will only be mentioned as such here.

Of Construction Schedules: If a construction process were to have a heartbeat, it would lie within the page[s] of its respective schedules. Therefore a healthy construction period requires the excellence of its communication tools: the design's details and schedules. The collaboration between all members to establish an accurate schedule requires a different art or mastery than is currently expressed in most professional architects. Depending on the scale or severity of the project, the construction schedule may either be handled by the project architect, a designated project manager, or a general contractor. Each member should be knowledgeable of his/her necessary tools in order to sufficiently organize the project given them.

This article aims at perpetuating discussion and knowledge between each of the three persons mentioned prior: the project architect and/or project manager, and the general contractor. Construction scheduling is the focus; the actor is the scheduler, as that acted upon is time reduction.

Of Time Reduction: Time as a commodity cannot ever be exact. It is by nature a thing in flux. Thus, it is rarely estimated correctly regardless of the situation it is measured in. Time in the construction industry is typically measured positively. It will take a certain amount of man*work-hours to complete any given task. In X days, Task Y must be completed. Time measured negatively is, needless to say, bad. It is time wasted. Time measured negatively costs both labor, resources, transportation costs, etc. which in turn equals currency spent poorly (wasted). It can be argued that time for construction schedules, time is always positive. There can be no backwards-time. This, having validity, will be the only vector of measurement in this study; with the scope of this project, time can only be measured positively, and it shall be done so in basic work hours. Time is that which is acted upon in this article.

The reduction of said work hours requires the collaboration of all involved to improve upon the current construction scheduling processes. Design-Bid-Build illustrates the method of project delivery that most firms (especially those residential-based) still practice. The reduction of time involves, to the causation of this article, the need to understand IFC information. It involves the utilization of this technology toward better collaboration among building trade professionals, and the acceptance of emerging technologies as benefactors to each and every organization/firm involved. The reduction of time-the measured object-shall be that which is counted and analyzed.

But in order to better understand how Industry Foundation Classes can indeed benefit the professional (being an architect or contractor), it is necessary to understand what Industry Foundations Classes are, and what they are not.

As previously stated, Industry Foundation Classes is a neutral file format designated to transport project information from one person to another, regardless of software or operating system. It is comprised of the data that is transferred, which typically results in systems management, quantity takeoffs, and heating/cooling loads. It is an incredibly effective means of collaboration, if only both parties are willing to utilize it. IFC can be explained as the electrons present between firing neurons in a biological system. If BIM is indeed comparable to a biological system, IFC is perhaps the energy transferred between the components to keep all processes healthy.

IFC transfers information differently as per the ‘type’ of object that information is speaking about, to be interpreted by that object’s subsequently useful ‘reading’ software. Where one program interprets the spatial data, zone calculations, heating and cooling requirements, and such for a certain project, a different program will read the IFC data of the structure, the weights and loads of the structural elements. Available online are many free ‘IFC viewer’ computer programs, including DDS-CAD Viewer, Solibri Model Viewer and Tekla BIMsight. Each is useful in its own domain but will accurately receive an IFC model as provided by the 'IFC Translator.'

Translators are typically native to their own blanket program, such as ArchiCAD, but may be purchased or downloaded separately. A translator is useful for exporting only the information necessary to the designated audience (a HVAC specialist does not need nor want all of the structural data of a given project). When a project is ready for export, a translator may simply export all elements in the current view or select the layers the designer wants. These elements and their corresponding IFC data are then safely packaged for viewing in the IFC viewer of the next person's choosing.

Some IFC viewers have the further ability to trim an IFC model in-house. SimpleBIM, an IFC viewer, was designed for just that purpose. Within the program a person may select which IFC elements they want to further export or view. Many other similar viewers also provide remarkable 'model-viewer' windows, useful for visualization of selected IFC elements.

IFC viewers are useful for any professional in the building trade, architect or not. They provide either a primary or secondary method of trimming away unnecessary data. They allow a standard and free viewer, open to the public. Because of their widespread availability and growing popularity, it's important for designers to advocate their use to clients and professional relations, in order to maintain a positive and forward motion within the building trades. "The percentage of companies using BIM jumped from 28% in 2007, to 49% in 2009, and to 71% in 2012. For the first time ever, more contractors are using BIM than architects" (Bergin, 2012). Currently, 70% of architects, 67% of engineers and 74% of contractors use BIM technologies (to some extent or other). In a four year period, contractors have experienced a 24% increase in usage: contractors represent the second-fastest growing demographic of BIM users, behind engineering firms. Increasing 25% within the last four years, engineering firms' increased influence in the market is certainly felt. Architects, once the leaders of influence within the BIM charge, have only experienced a 12% increase in the same period (Bergin, 2012).

Nationwide, more contractors are utilizing Building Information Modeling than architectural firms. Whether this is an unsettling fact or not will remain unsettled, at least not within the confines of this article.

Each architectural firm will utilize BIM technologies to a certain extent, rather, to the extent that they know and trust the software. Many firms the world over do not understand the capabilities of programs such as Revit, therefore when using them they resort to simple drafting rather than complex modeling. IFC transfer is typically only handled between disciplines that all use IFC to the same extent. Therefore, it is typically assumed that most IFC transfer happens within either very large projects, or within very large metropolitan areas. However, it is certainly possible for IFC transfer to happen in smaller projects or less dense areas. It simply takes the eventual dissemination of IFC technology to all building trades within a designated region. A contractor will not utilize IFC if he/she doesn't know what it is.

A general contractor's primary work may be said to be scheduling, or the scheduling and overseeing of time and people, two very important resources to a project. In order to effectively organize and oversee the different sub-contractors and their respective tasks, a comprehensive list of tasks must be assembled-with durations, start dates, and finish dates-to keep all matters running smoothly. Thus when a construction schedule is completed, it represents the complete list of tasks, from site observation to the installation of detail trim work.

A general contractor may use many existing scheduling methods, or perhaps create his/her own. A schedule does not necessarily need to be digital in methodology or presentation. Modern general contractors will opt for digital scheduling software, as they provide easy changes between tasks, auto-fixing dates to align correctly without the need for monotonous corrections to each task manually. Though many scheduling programs exist, few are used besides Microsoft Project. MP, for short, is a vast, comprehensive scheduling software utilized by the majority of modern general contractors.

A schedule file may be created solely from MP, in which case all necessary fields are provided directly from the software itself. Or, a custom schedule file may be created utilizing custom fields defined elsewhere. Microsoft Excel, a branch of the Microsoft Office designated for the clean projection of data the world over, can export its information in a number of different ways for MP to read.

IFC model viewers such as SimpleBIM can export IFC data to Microsoft Excel (or .xls file format) in simple table view. Within this format, all necessary information can be clipped or cleaned for import into Microsoft Project, the preferred program of choice for general contractors. There, any IFC data that is ‘time-specific’ can be utilized by general contractors, who after all manage time and do so well.

So it is that a process can be created for general contractors who do NOT currently utilize BIM software, let alone IFC. An architect or designer, using a model comprised of highly specified IFC data, can export into .xls for a contractor to better estimate time required for a given task. A different process can be inferred; that is one where the general contractor already uses BIM software. With prior knowledge, the conversion of IFC data into readable .xls tables should be a reasonable task, and prove all the better for the contractor and his improved schedule.

It was under this process, from ArchiCAD to SimpleBIM to Microsoft Excel to Microsoft Project that was taken by the author, with the attempt to shorten the construction time of a given residential project from 26 months to 18 months.

RESULTS

The building model, constructed in ArchiCAD 17, was comprised of 3,244 building elements (such as walls, slabs, columns, beams, windows, doors, etc.). Though ArchiCAD is intended for BIM purposes, the model was only built for visualization, and was not tied to the actual plans, sections and other construction documents that were actually used in the construction process. This means that partition wall 118, for reference, was only listed as 'empty fill' instead of gypsum board over light wood framing. The two-dimensioned wall of the construction documents has all information necessary to carry out a construction; the three-dimensioned wall of the 3D model has only geometry, a surface appearance, and dimensions. IFC information thus had to be added to each element as per that element's unique IFC parameters.

Adding these 'parameters' provided the model filters for which to view the model in. The final filters for this experimental model were: Task ID, Task Name, Name (as determined by the AC 17 preset), Zone, Primary Trade, Level, Start Date, Duration, and Finish Date.

To add these parameters, or filters, in ArchiCAD is a very well-documented process. It is not necessarily difficult, though if set up wrong can be disastrous. The instruction for the addition of custom IFC parameters is not a pertinent topic toward conclusion of this article. Indeed, that is a topic worth an entire article in itself. It need only be known that custom IFC parameters were added, and that they were standardized parameters for each and every building element.

Because the three dimensional model was built without BIM in mind, it took several months' intermittent time to actually add all of these filters to each element as necessary. Arguably, it could be assumed that over 70 hours were spent doing just that. There is a way to protect against this needless work.

In order to fully utilize IFC, a BIM file must be set up with pre-determined construction types (composite walls, floors, roof systems, etc.). Those pre-determined construction types can then be given custom IFC properties, with values auto-filled as each element is placed in the model. Thus, a model can have complete IFC information (or as much as the firm cares to export) in real time as the building information model is completed. This then excludes the architect from unnecessarily going back and re-labeling every single element with its corresponding information.

Eventually, the model in question had all of its elements given values for its empty IFC parameters. Because the problem statement focused on construction time reduction, attention was then shifted to the individual Task IDs, and their corresponding elements. For reference, task #27, which was called "Set Basement Embed Columns," had precisely 100 columns comprising that task. A person could then assign a generic value of hours toward each column to come to a total number of raw hours designated toward that task. Conversely, a person of greater knowledge of column erection might assign very specific hours for each singularly different column based on its placement, size, shape, or connection.

It was intended that the general contractor of the project in question, who had given an original construction schedule for review and acceptance, might take the MP file provided by the author and therefore add his own Durations for each element of any given Task ID that he chooses, and in so doing perhaps he can come to a more accurate total Duration for that Task. This was not to assume that any of the original Task IDs had poorly estimated durations, nor to state that the author had better knowledge of duration times or general construction proceedings than the project's general contractor.

Rather the opposite. The author had little knowledge beyond his own scope, and indeed little of light frame steel construction. It was assumed by him that all or most of the Tasks given by the general contractor in the original construction schedule (composed of 221 tasks) were relatively accurate. However, it would be a foolish philosophy for any general contractor to assume his/her schedule would hold true until completion day without any change. Therefore, there is to be assumed some wiggle room either between tasks or within them. This article, through the methods mentioned before, aims at clipping the fat within the tasks: that if there were ever a poorly estimated task duration, the general contractor would himself be able to utilize IFC element durations to provide a more accurate total duration for that task.

One particular task in the sample project was taken for example, to prove the usefulness of this methodology. Task #73-North House Set Steel For Columns and Roof-contained within itself 59 visible and distinct elements in the 3D model. It can further be broken down that Task #73 contained: 32 beams, 5 embed channels, 2 baseplates, 19 plates, and one embed plate (as determined by the author with the help of common sense).

Task #73's original duration was set between the 28th of October to the 22nd of November, spanning 20 working days. Without knowledge of the steel framing construction crew's statistics, it is hard to say how many man-hours 20 days comprises.

Without taking into consideration weather, labor issues, other issues prevalent in construction firms, etc., the total raw hours required to perform Task #73 was determined by the author to be 71.7 hours. Whether this is at all accurate remains to be seen, and it is only as a testing tool in the author's hands. In the hands of a contractor, this methodology could prove a dramatic reduction in time, if only a small amount of time were clipped from each task.

CONCLUSION

The research results did not provide an eight-month reduction in construction time, as requested by the client. It did not prove that the author was proficient in scheduling, nor that he know everything about each task in the schedule. The results provided a mainframe, a methodology of work which a general contractor can utilize with the hopes of creating a more accurate schedule.

This research purports that time is not the only quantity that can be more accurately measured using Industry Foundation Classes. Many preset IFC parameters exist already, which calculate such things as weight, cubic yardage, height, thickness, etc. However, a person or firm may also define a seemingly unlimited number of custom IFC parameters to better suit the project's needs and the different departments affected. IFC can be used to explain, illustrate, map, or calculate any sort of quantity and/or quality the designer has need of.

The limitations of IFCs are very clear. If the designated audience is not willing or able to accept IFC information, why bother? This is altogether too easy a philosophy to slip into. Only in certain instances, such as the one described above, can the target audience (i.e. general contractor) utilize IFC without even knowing it. It is to be hoped that the future promises heavier usage, or even knowledge, of these techniques. If IFC and furthermore BIM are to be the future- or the NOW- of the built environment, it has to be encouraged from all parties, whenever possible.

The primary challenge faced in this process was that the 3D model, built in ArchiCAD, was ill-done. Though the geometries were precise and very complete in shape, form, and surface appearance, they were little more than solid extrusions with a fake façade. Many of the windows were created as slabs out of ease. Most of the stone veneer elements were broken up, creating unnecessary elements to label. Each element seemed to have its own problems, minus the steel elements of which were created much more wisely. This is not to criticize directly the poor soul whose task it was to model such a complex structure, but to politely criticize the expectations of the firm, in the hopes that they utilize BIM technology correctly in years to come, for their own benefit.

Properly setting up the file cannot be stressed enough. Instead of playing catch-up the entire designing phase, a standard should be set. Each file should have a preset IFC Scheme with complete wall sections, floor and roof sections, all detailed perfectly before defining the actual geometries of the project. IFC parameters such as task identity could be defined before drawing walls. This all requires careful monitoring and knowledge of the current layer settings, which can become confusing and also speaks toward the importance of those as well. Carefully maintaining vigilance while designing a project may only make a small difference in a typical residential project, but when designing a high-rise it may perhaps make an elemental difference.

If a firm wishes to utilize IFC parameters, they only need to take the time to learn this information, and find professional relations (i.e. contractors) willing to utilize it as well. It may very well prove that architects will be the people who set this technology into trend, and that this may provide a healthier future, with less headache and a happier workforce. The success of the future lay in the proper collaboration between trades, and a common language must be found in a digital world. This language already exists, and is called IFC.

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Standard Office software (ArchiCAD, Excel, Project) shall not be cited, as per regulation.

AUTOBIOGRAPHICAL SKETCH

Matthew Weiss is a senior Graduate Student of Architecture at North Dakota State University at Fargo. His contribution as a creative thinker within his architectural studio year has led to the advancement of the group, and the pursuit of perfection. His work has been featured in the Art Museum at UND, and in Fargo. He pursues the arts in other forms, as a recreation artist and a composer of music.

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