COVER ARTICLE

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EMERGING ICT DESIGN AND **CONSTRUCTION PROCESSES**

INTRODUCTION

The information and communications (ICT) design and construction process has evolved significantly over the past 20 years, with a significant advancement of incorporating ICT designs into the overall architectural/engineering (A/E) design process. Not too long ago, ICT designs were an afterthought, and planning lacked at the proper stages (i.e., conceptual/schematic design); while still not perfect, ICT project requirements are being driven early and often by end users, engineers, designers, integrators, etc. Early onboarding of the ICT design team allows for a holistic approach to the design and integration of ICT systems on a project versus a rush at the end of a project (when ICT systems are installed) to get systems commissioned and complete the project turnover process.

This article will aim to convey how the process is evolving and where we are going from here, with the evolution from design/bid/build (DBB) to alternate (i.e., LEAN) project delivery methods, including design-build (DB), design-assist (DA), and integrated project delivery (IPD). In addition, the importance of 3D modeling programs required to design, schedule, and deliver a coordinated design and specification not only with the A/E design partners but with the trade contractor partners as well, will be reviewed. At this point, most projects of size are not DBB as there is too much risk involved with not incorporating a holistic approach from the earliest onset of a project.

BUILDING INFORMATION MODELING (BIM)

BIM (building information modeling) is still a relatively new term to the ICT industry; however, BIM has been in the A/E industry for over 20 years at this point. The importance of BIM on design projects is now being fully realized as it is not only a drawing tool but a robust database of information that can be used in a variety of ways throughout the design and construction process. There are various levels of BIM (LOD or levels of design) that a project may require. This article will keep to a high level of introductory BIM requirements, as a dedicated article/presentation would be required to take a deep dive into the different components of LOD.

BIM is basically a database that has annotation and 3D capabilities that are built in to allow design teams to derive sheets, specifications, and details for installation on any given project. In the ICT world, the most fundamental of BIM is the “items” or “parts” placed into the model, which represent the scope of the project, as specified below.

Each BIM "item" represents not only a 2D representation of the part that will be installed on a project, but also has a 3D representation of the part and specific parameters that can contain specific information (e.g., manufacturer, model number, cost [material/labor], specification section, product data sheet) about the part. All this information is stored in a database format that can be scheduled for a variety of purposes, including real-time estimating, specification and submittal development, and cross-coordination of interdisciplinary requirements (i.e., line voltage power adjacent to a low-voltage outlet).

One of the most useful aspects of interdisciplinary coordination within BIM occurs in the ceiling cavity. Early on, one of the most important cost constraints within a new facility is floor-to-floor heights; each additional increment of vertical increase drives cost throughout the project. Architects and structural engineers will challenge the mechanical, electrical, plumbing, fire protection, and technology engineers (MEP/FP & T) to maximize the ceiling height within various spaces on a project, ultimately, minimizing the ceiling cavity space which MEP/FP & T infrastructure (e.g., cable tray) will reside in. The ability to have BIM objects with clearances (e.g., no-fly zones) built into them allows for a relatively easy coordination process during conceptual/schematic design, where a lot of crucial decisions are made. Once the MEP/FP & T ceiling zones are established, if everyone models according to those agreements, design progress in the ceiling cavity is easy.

BIM has the capability to be heavily customized on the software side of things through internal programming modifications and script sharing; however, there are some risk factors associated with it as well. The biggest risk factor, it can be argued, is having a qualified BIM technician on your project team that truly understands the software (not just at a surface level) and can carefully/efficiently work within the model during the design and construction process. Project team members (e.g., construction managers (CM) and architects) will demand accurate modeling during the design process as quality assurance/quality control (QAQC) checks will be made, issues will be communicated, and resolutions will be needed. If accurate modeling is not able to be achieved, this can present issues with acquiring future work with some construction managers/architects.

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Finally, the BIM model produces the 2D construction documents that will be used for ICT integrators to build from. No matter how well the 3D representations are in the model, if the information is not accurately depicted on the build plans, errors and omissions are a real possibility. That is why it is extremely important to still perform manual QAQC checks from qualified ICT staff (e.g., RCDDs) either via hard copy or PDF to verify that the intent of the scope is accurately depicted on the construction documents.

DATA-DRIVEN DESIGN & SPECIFICATIONS

It is no secret that there is a severe talent shortage in the ICT Industry, both on the design and installation side of things. The number of individuals who are retiring, combined with fewer individuals (replacements) joining the trades, has created the perfect storm for producing quality ICT designs, specifications, and installations. As stated before, BIM is much more than a drawing program. It will be discussed below how the "gold" within the BIM model (e.g., data) can be used to assist in future design and specifications of ICT systems.

The primary purpose up to this point of the BIM model is to produce 2D drawings/specifications; however, the real power of the BIM model is the data that lies within it (Figure 1). As a reminder, each "part" within a BIM model can contain a significant amount of base and custom parameters that can be scheduled in real-time, so what you see is what you get. Let's take an example of an integrated operating room, which is one of the most complex spaces in a healthcare environment. If, say, a client requests a quote for the entire build of the OR space, including the medical equipment, integration technologies, structured cabling, and security requirements, it is as easy as opening the previous design model, grabbing the "parts" associated within the OR space, and scheduling them. There is a record drawing condition including final costs (with bulletins incorporated), a complete bill of materials, and product data sheets to present to the client for review. This completely streamlines the process versus pulling data from multiple sources that might be outdated/obsolete. **IMPORTANT: The data used in parts within the model must be QAQC'd before implementation; the idea of garbage in > garbage out is very real, and the anticipated data values might not be realized with poor data management.**

There has always been the concept of site adapt, which entails taking a full building design and reusing it on a different site (accommodating different site utility entrances, grading, landscaping, etc.); however, the concept of reusing different components of a specific building design on a myriad of projects is gaining traction throughout the A/E industry, including the discipline of ICT. As an example, a new greenfield hospital was recently completed in BIM. The same health network also needed 30 new ICU rooms within a different facility using the greenfield hospital ICU rooms as the basis of design. The team was easily able to pick and choose from the greenfield hospital model the different rooms needed for the fit-out and extract the data needed for designs, specs, and real-time costs to present to the owner. This streamlined the process of fit-out, and the team was able to minimize the construction schedule during the COVID pandemic, allowing these rooms to be used by patients in need.

Federal, state, and local governments (primarily) have started incorporating specific standards that allow multiple platforms to access asset data from various BIM

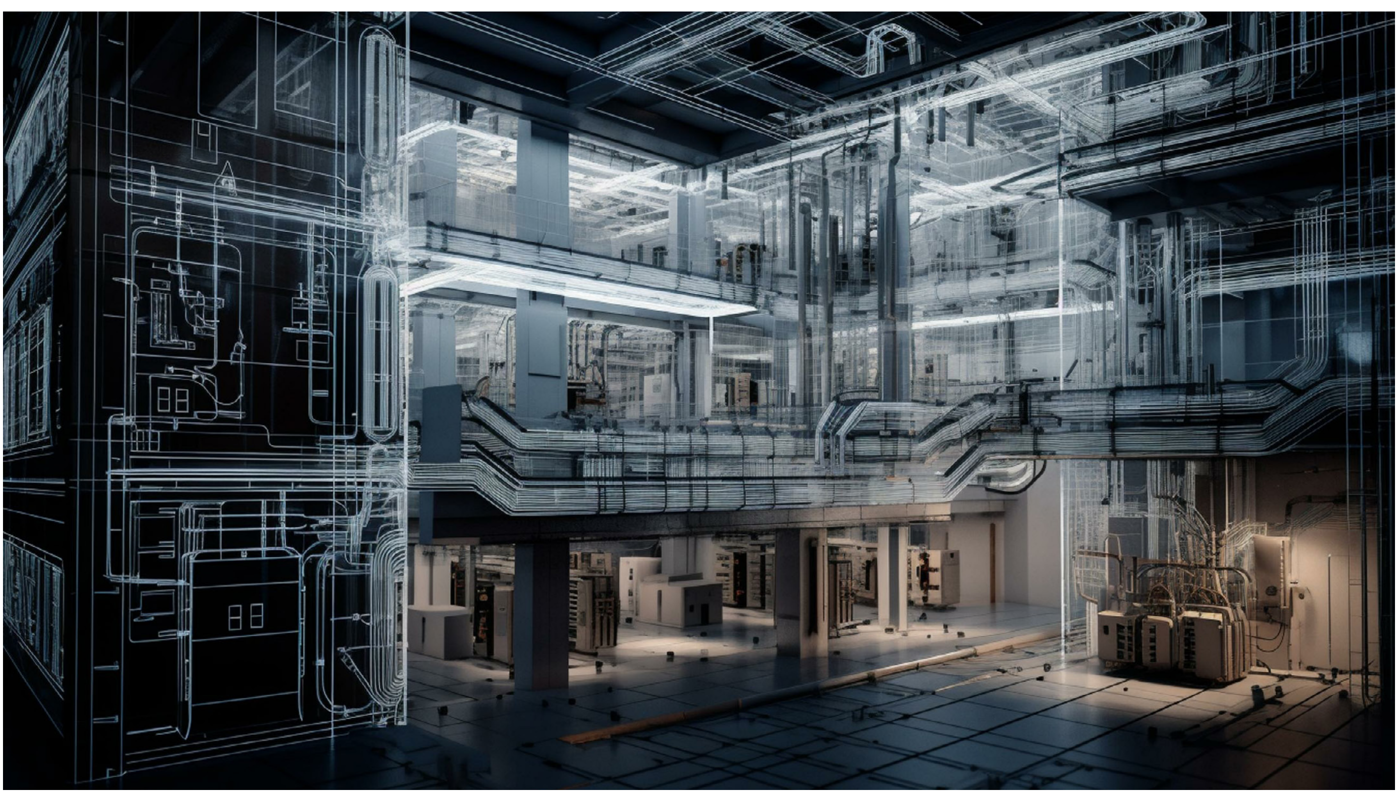

FIGURE 1: The BIM model allows for clearances to be carefully coordinated in areas of a facility in which space is a premium.

models—somewhat of an interoperability (middleware) function. Construction-operations building information exchange (COBie), dRofus, Bimeye, etc., are all examples of different types of interoperability tools that can be used on projects, and most are client-driven. This article is to provide a high level of understanding into what is possible in using BIM and not to get into the weeds of data science and custom scripts, since there is entirely too much to cover within the limits of this article. In general, the interoperability technology has been around for quite some time, and the project team will need a deep understanding of how the process will work to derive the greatest benefit of this software, high risk/high reward.

The ANSI/BICSI 003 Building Information Modeling Practices for Information Technology is a great standard that assists individuals who have little to no knowledge of BIM in becoming more familiar with the technology, how it applies to projects, and design requirements. This standard provides the fundaments of BIM concepts, data requirements, and annotations that are used in the ICT industry. There are also many resources online, including videos, tutorials, and parts (manufacturer-specific or vendor-neutral) available for download.

LEAN CONCEPTS

The term LEAN has been tossed around quite a bit over the last decade or so regarding design and construction processes, not necessarily quantifiable, but more of process improvements. LEAN is a set of management practices to improve efficiency and effectiveness by eliminating waste (i.e., nonvalue-added activities). The following design and construction delivery methods/concepts have been gaining steam for the last 10 years, and that trend is likely to continue due to all the concepts discussed in the article.

Design-build is a design and construction delivery method in which one entity (typically a construction management firm) will hold all the design/trade contractor contracts for the project, providing a single point of contact for the owner. Typically, the CM will have discretion (with owner input) on who participates in the design and construction of the project; therefore, it is important for ICT engineers/integrators to be familiar with the owner's upcoming projects and, typically, the preconstruction team at the construction management group that is leading the project. There typically is a little more flexibility in this project delivery process, depending on the complexity of the project. If an ICT integrator is fully capable of designing in BIM, there might be an opportunity for a design and build on their part in lieu of pricing/installing a design-only firm's design.

Design-assist is a design and construction delivery method in which the construction team (CM and trade contractor partners) are engaged by the owner via a separate contract than the architectural/engineering firm performing the detailed design documents. The process of engaging the CM/trade contractor partners is happening earlier in the design process, typically at the end of schematic design, where there is enough information for an ICT integrator to accurately scope out and price the work that is anticipated to be included in the project. The ability for the trade contractors to participate in the scope and pricing of a project (the earlier, the better) allows the entire team to avoid unnecessary rework when the budget will not support it.

In both design-build and design-assist project delivery methods, there is a great significance put into streamlining processes and not doing things twice. Take a typical design-bid-build project: A/E teams are designing in somewhat of a vacuum with no input on specific costs from either a CM or trade contractor, thus leaving open the possibility of an over-budget scenario that ultimately requires value engineering the design to get back into the budget. If these parties (CM and trade contractors) were brought on early during the design, issues such as budget and cost-effective options could be brought to the table early and often versus during the bidding process. Fun fact: In some federal/state contracts, if the A/E design comes in over budget by more than 10 percent, a redesign effort must occur at the design firms' expense to get it within budget, a contingency effort that was probably not planned for during design fee preparation.

In addition, having trade contractor partners on board may allow the design to be drawn once. For example, in lieu of a full design being completed, sent out, and bid, and shop drawings created that essentially redraw what has already been documented, the drawing process (once) can be alleviated by a design-build/design-assist process. In a design-build scenario, it is possible for the contractor to do both the design and installation, assuming they have the in-house capabilities to do both. In a design-assist scenario, an engineering design would take the documentation to approximately a 70 percent level, then hand the model over to the contractor for the final detailing of the design.

Collaboration is being taken to a whole new level with the introduction of a "big room" on construction sites (Figure 2). As with the names of these rooms, they are physically large, open spaces (shell space or multiple construction trailers) that can accommodate the entire project team for collaboration and coordination throughout the design and construction process. These spaces should have robust technologies (i.e., 802.11x Wi-Fi, large-format displays, video conference, and screen-sharing capabilities) along with access to the project collaboration software used on the project.

The goal of "big room" spaces is to provide an atmosphere in which team building can occur and issues resolved in a collaborative (non-confrontational) fashion. It should be anticipated that once issues have been identified and resolved, the same issues are not reoccurring throughout the project design and construction process, thus removing the "waste" out of the project design and construction process. There are typically a vast number of resources (e.g., individuals, data, submittals, online collaboration software) available within the space, so most questions can be answered relatively quickly.

FIGURE 2: The "big room" allows all AEC Partners to gather and collaborate within one space, whether in person or virtually, providing a holistic (and fully coordinated) approach to various construction tasks within a project.

PREFABRICATION

Construction, in general, has a shortage of qualified workers to build the vast number of projects being developed by design teams, and one way in dealing with this shortage is to use prefabrication throughout the construction process. Prefabrication allows for the assembly of different components to happen in a controlled environment before they are transported to the site for a plug-and-play type installation. Prefabrication facilities are typically located in a large warehouse, providing ample space to work around large components, almost comparable to a manufacturing facility with a line of assemblies occurring. These spaces are well-lit, ventilated, and clean for installation tasks to occur.

Regarding the ICT industry, there are a few different applications that are currently happening regarding prefabrication: MEP/FP & T ceiling racks, modular data centers, and modular patient rooms.

MEP/FP & T ceiling racks are prefabricated structures that contain mechanical ductwork and piping, electrical power conduits, water/sanitary piping, sprinkler piping, and low-voltage cable trays (among other miscellaneous infrastructure) (Figure 3). Each different discipline coordinates exactly where they are going to install their systems with the proper clearances, then the equipment is installed as coordinated. This approach allows for an installation in which preciseness can be met when there are tight space constraints; the most resilient facilities typically require an abundance of utilities located in the ceiling cavity.

Modular data centers allow end users to procure premanufactured facilities that are customized to their specific needs, including cabinets, cooling, power (normal, ups, and generator), fire suppression, and cabling distribution. End users will be working with contractors to determine the density needed within a facility and what may possibly be needed in the future. As previously discussed, this approach is taking a plug-and-play type installation methodology versus traditional construction; however, this allows the end user to quickly add on additional units of capacity to the data farm as needed.

In the healthcare vertical, prefabricated SMART patient rooms are being built that incorporate all ICT requirements before being shipped to the site, including all low-voltage rough-ins, low-voltage cabling (including service loops needed for either extension to the telecommunications room or consolidation point serving the area), nurse call devices, etc. Each room is constructed within a prefabrication facility, then sent to the construction site for installation within the healthcare facility where ICT technicians are on-site to perform the final tie-ins, testing, and commissioning before a project is turned over to the owner.

FIGURE 3: Prefabrication of MEP/FP & T ceiling racks can occur onsite/offsite with extreme precision, allowing Cable Tray to achieve the needed clearances for standards-based installations.

FIGURE 4: The future is here, and so are AI assistants. Use them as needed to assist in your ICT design and construction processes.

CONCLUSION

The AEC industry has been going through a massive shift over the last 20 years, from a world of 2D to almost exclusively 3D, and the world of ICT is no exception. Owners and design teams demand that projects are designed in a collaborative fashion to streamline the process, provide cost-effective solutions, and timely results, and ICT design is being integrated early into this process. All of this occurs using the ideas discussed in this article: BIM, data-driven design/specification, LEAN concepts, and prefabrication.

The thought that all design requirements will be copied and pasted is not real; however, every opportunity should be taken to maximize efficiency, use AI assistants (i.e., ChatGPT), data-based models, etc., to streamline processes, and create better work/life balance in an industry with a shortage of talent (Figure 4).

Finally, the economy at this point is somewhat shaky, but now is the time to get up to speed on these different technologies so you are ready for the next decade and can compete among your peers. Opportunity awaits!

AUTHOR BIOGRAPHY:

Nick Larkins, RCDD, CTS, LEED AP BD+C, has been in the ICT Industry for 19 years. Specifically, he has 15 years' experience in a team lead/project management/engineering role at a MEP/FP & T firm and four years' experience developing a technology solutions division within a construction management firm. Nick specifically focuses on Division 27/28 (non-fire alarm systems) in all verticals and is now involved in delivering a holistic approach to SMART Buildings and Division 25 Integrations within facilities. Nick can be reached at nicholas.larkins@danis.com.