AEC Jobs in Healthcare Facilities Management through BIM

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Nancy Bounds graduated with a Bachelor of Interior Design from Louisiana State University in Baton Rouge, later obtaining her Master of Science in Healthcare Interior Design from Stephen F. Austin State University in Nacogdoches, TX. For over 35 years, Ms. Bounds has designed and managed a wide variety of projects, including major healthcare projects all over the world. She is currently an Assistant Professor of Interior Design at University of Southern Mississippi where she teaches BIM technology within the School of Construction. As a practitioner, Ms. Bounds has used Revit and BIM to improve interior design processes. Throughout her career, Ms. Bounds has worked closely with architects, engineers and facility managers and is keenly aware of the extensive data and coordination that large projects require. The aim of her research is to leverage BIM's capabilities in the interior architectural field and to train a future generation of interior designers to integrate their work with those of the architectural, engineering and facility management professions.

AEC Jobs in Healthcare Facilities Management through BIM: Preparing our students for the next level of detail

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Author's note: The visual presentation will hold the greatest focus on the educational aspects of this presentation. Through the visual medium, the terms, educational concepts and BIM working conditions can be more clearly illustrated. Other illustrations will cover the interdisciplinary aspect of BIM work, the STEM/STEAM debate, and ways that this defined path for BIM training can help our students to bring value to our society.

AEC Jobs in Healthcare Facilities Management through BIM: *Preparing our students for the next level of detail*

Abstract

The research provides an insight for engineering educators into the needs of the next generation of AEC students who have the opportunity to design, manage and build healthcare facilities economically and holistically utilizing BIM. The healthcare industry continues to be the strongest gainer within the institutional sector, in terms of construction activity, for the coming years. The process of design, construction, operation, and maintenance of healthcare facilities is among the most complex of all building types. Use of Building Information Modeling (BIM) over the lifecycle of a healthcare facility has been shown to be on the increase. The industry requires a BIM workforce that can take the model beyond a 3d visualization tool and utilize the data and scheduling capabilities of BIM.

The benefits of BIM can be passed to the healthcare system when the Facilities Management department is part of the Integrated Project Delivery process. The paradigm shift that is presently taking place calls for specialized staff, trained in both the architectural arts and computer sciences. Interior design, architecture and engineering education should be preparing a workforce for BIM technology in the healthcare sector. Talented and technically trained AEC designers will shape the visual 3D world using new tools that will help them to also leverage the data found within the model. As part of a techno-economic shift, BIM may be able to create jobs while helping people achieve a better quality of life.

Keywords: BIM, AEC Careers, AEC education, architect, engineer, interior designer, equipment planner, BCT, ACT, construction careers, IFC, facilities management

A gap in BIM education

A study of BIM's implementation in major healthcare projects across the US shows a rise in the need for qualified BIM operators and managers. The complex nature of healthcare facilities, calls for engineers, architects[1] and designers to be trained in a wide array of technology. The inevitable adoption of BIM by large healthcare systems will create a need for uniquely trained individuals. Healthcare facility BIM management is an area that could attract more females and minorities to this STEM oriented field.

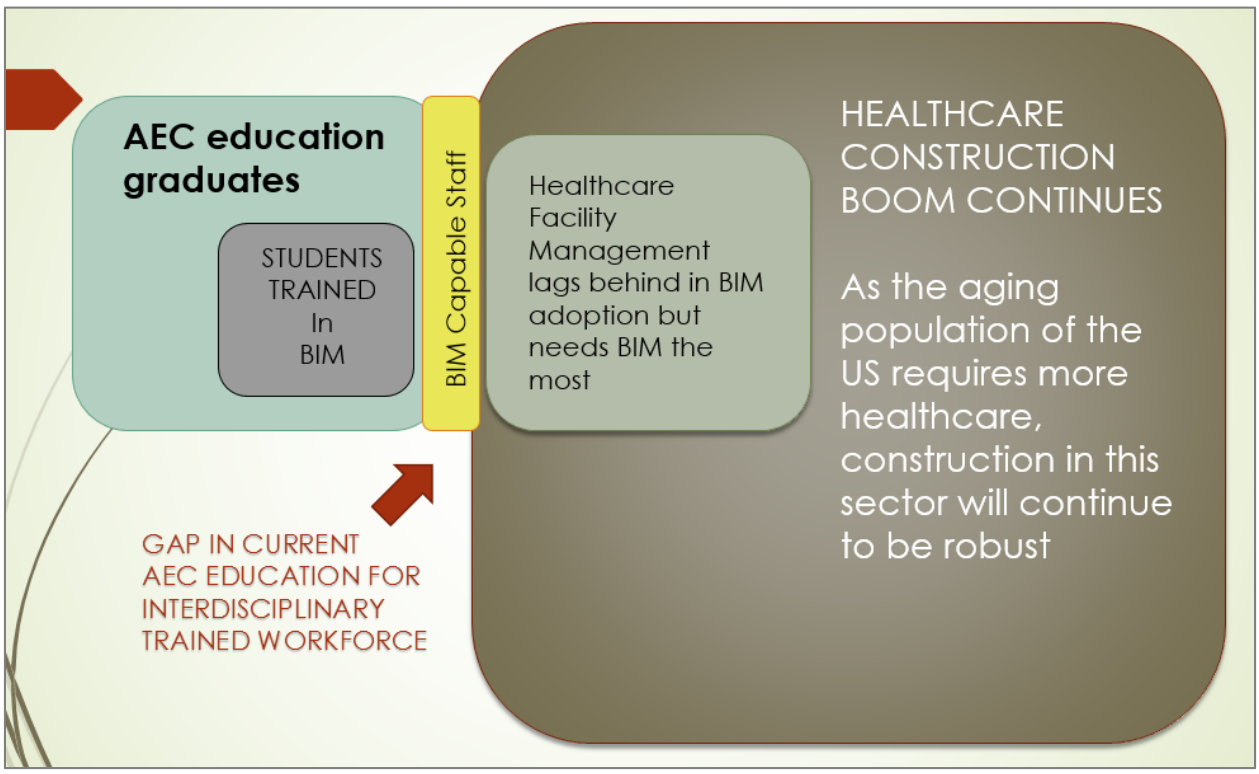

Figure 1. Identification of the training gap and opportunities for AEC graduates in the next 10 years.

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Why target the healthcare sector?

The healthcare sector in 2012 represented 33 billion dollars in construction [19, 25]. Healthcare projects are among the most complex projects to design, build and operate of all building types. The amount of information that must be channeled and acted upon is vast and in direct proportion to the size of the project. Shortened project time frames are among the reasons multifaceted healthcare projects have turned to BIM.

Equipment planners and interior designers, many of whom are employed directly through Facility Management (FM) Departments of healthcare systems, can utilize BIM to input and extract furniture, fixtures and equipment (FF&E) information and visual images. Volumes of information can accompany a large medical project. In addition to the items handled by the Facilities Management department, information generated by the architectural and engineering teams includes warranties, maintenance instructions, and submission of color and finish material samples.

Within the Architecture Engineering and Construction (AEC) sector, the adoption of BIM has grown consistently [13, 17], which in turn influences the Facilities Managers who may receive digital copies of this work.

Existing projects may have a conglomeration of drawing file types for a building asset. The FM department may be using specific facilities management software that is not interoperable with CAD software. The department may be reluctant to make a change to BIM and its data capabilities.

BIM has found a place in the delivery of large, complicated projects around the world, particularly in the healthcare [sector4]. **BIM is a "complex phenomena"** (Miettinan and Paavolo, 2014) **that requires a prepared future workforce.**

This new techno-economic paradigm (Miettinan and Paavolo, 2014) creates organizational change in the companies using the technology, as well as the educational preparation of the work force to use the technology. Miettinen [18] suggests it will take two decades before BIM is utilized to its capacity.

The need exists to educate architecture, engineering and interior design students today to work with data when the complete BIM model delivery becomes an inherent part of healthcare design and construction projects in the coming years.

Healthcare Facility Management and BIM need a future workforce

Approximately 40 Billion USD was spent on construction related to healthcare facilities (USCB 2013). Billions of dollars will continue to be spent as healthcare providers realize two important societal shifts:

1. Medical care is competitive – unattractive, cramped facilities discourage patient
2. Specific design features have been linked to positive medical outcomes and some have attracted the government's attention – reimbursement tied to environmental factors may cause a hospital to upgrade [5].

As per researchers, factors such as aging facilities, population shifts, stringent building codes, and others are creating the demand for new or renovated healthcare facilities [16] (Carpenter 2004). Furthermore, the Affordable Care Act is also having an impact on design requirements, calling for an increase in mental health and preventative care facilities[3].

The term Facility Management for this research encompasses planning and design activities, construction management, and operations. The activities vary widely from big picture strategic planning to highly detailed furnishings and equipment documents that include highly technical requirements of utilities and communications [26]. The FM may act as the Owner's Representative or Project Manager during the planning and design/construction phase

For effective use by the FM team, the data and the model need to tie into other software applications. To manage the data and visual needs, BIM offers some promise of handling the life cycle of the project in a holistic manner. Research identifies that healthcare projects are detailed and require copious numbers of decisions that could be BIM related throughout the design and construction phases [3,16]. Computer input of these items and the decisions themselves cause chokepoints in the design and building process.

Governmental agencies involved in healthcare environments are progressing toward BIM and are developing theoretical models to automate interoperability issues. The General Services Administration (GSA), the largest "facility manager" in the country, mandates that all new construction projects use BIM models. Tier 1 requires that fine details of plumbing, electrical and fire protection systems be modeled and identified. These models must be provided in both BIM-authoring formats (native) and open-standard formats such as industry foundation class (IFC). In the area of equipment, including furnishings, each item in the model is to have a globally unique identifier (GUID), which is machine readable, such as a barcode or RFID (radio-frequency identification)[2, 26].

The Department of Veterans Affairs and the Department of Defense Medical Health Service are exploring automated ways to compare a consultant's submitted model to the 3D medical guide plate that was provided to the architect for planning purposes. The guide plate would have 3D, intelligent icons for each required FF&E item. Furniture and medical equipment icons would be embedded with engineering data, material data and even cost data that could be used as a Programming document supplied to consultants prior to beginning Design Development of a project [24].

BIM helps achieve LEED and enhances lean delivery

Large facilities are being built with environmental aspects in mind. New computer programs are more compatible with most BIM platforms that will seamlessly perform energy analysis, with some exceptions. To a certain level, LEED calculations can be made through the BIM program. Further, BIM adoption offers Green alternative in that the technology has cut down on paper usage. In the past, printing a full scale set of drawings for a large project easily required over 100 sheets of 34" x 40" paper. No matter how few people receive a set to begin the project with, by the end of the project there is a voluminous amount of paper documentation. While official drawing deliverables will not be eliminated, the ability to find the updated plans with intelligent data on a portable field device (iPad) will encourage team members to abandon heavy paper drawings.

Common benefits of BIM for a Facility Management department are the capability for lean construction and integrated project delivery. One Kentucky hospital made early use of the BIM model to circumvent potential conflicts between the utilities and the structure. It is estimated that use of BIM and IPD avoided over $20 million in scope changes on this 781,000 square foot facility [9]. The ability to pre-fabricate building components off-site saved a great deal of time and cleared the construction site of unnecessary workers. The team for the Owensboro Health Regional Hospital, aka the Stakeholders, included more than 40 designers, engineers, consultants, construction managers and extended to more than 60 user groups, including nurses, physicians and facility managers. In addition, the contractor employed hundreds of workers. Communication on a project of this size is difficult without technology to support the efforts [6,9].

Project build out time is often a concern in large healthcare construction projects due to the flow of the funds and the critical need for new spaces. Cloud computing and a central BIM model allows remote teams to coordinate documents and changes on a daily basis. This project team structure allowed the Colorado Children's Hospital [7] to build a new 175,000 square foot building in 18 months. The model updates were run by two dedicated teams of architects. The model has been turned over as an as-built document currently being translated by the facility's staff architect for use in operational functions. This project incorporated a fast track for shop drawings in which the subcontractors also made use of the BIM model (HCD Conference, 2014). Siddiqui et al. [21] found that "BIM has the potential to support life cycle management and decision making for built facilities and represents considerable potential for eliminating process waste as part of the facility delivery process."

Facility Managers at healthcare systems using BIM.

Facility managers stand at the center of most healthcare projects. Often acting as the Owner's representative, they may be the primary liaison with A/E teams. In the broadest sense, the FM have to acquire, integrate, edit, and update massive information related to diverse building elements [26]. This department produces reports on real estate, department space needs, operational costs, as well as keeps track of warranties and specifications from a variety of vendors.

The complicated nature of BIM and healthcare both benefit from building models that carry a high *Level of Detail*, Level 5 [15]. **The LOD defines the amount and type of information held in the model** [15]. It is in the detailed data of the BIM model that the FM can extract and manage the building asset from the model. Through interfaces such as COBie, data can be transferred to more traditional FM software, such as CAFM and CMMS [8].

Maintaining BIM models will require FM departments to establish clear guidelines concerning the project's digital documentation and deliverables from consultants. The goal is not to overlap other sources of data, but to provide a centralized data delivery system that can also create plans, lighting layouts, 3D views and other forms of graphic communication during the life cycle of a healthcare facility, and access the data and the model from a variety of programs [6].

A key benefit of integrating BIM with FM is that information is not entered twice. By means of data extraction to spreadsheets, area-specific BIM models and other applications [2], the data can be poured into programs that act as databases that will infill custom forms and reports. Many

platforms for interoperability are identified. Research in academia is working to streamline or automate these data mining activities.

For data to transfer between platforms, the naming of files, maintenance of the integrity of the model and its data must be pre-determined. The team member's computer/IT skills must be at a high level to troubleshoot any issues. In order to coordinate and communicate amongst stakeholders and team members, data must be formatted for easy use by other programs (e.g., pdf, MS Word, Excel and Access).

Unfortunately, BIM is not able to perform complex reporting functions beyond creation of a schedule table. Project documents such as product specifications, cost estimates and quantity takeoffs may need to reside within other programs but be accessible to use from the BIM visualization platform. Thus, the need for a workforce that can handle the interoperability issues of BIM data extraction.

Energy analyses for new buildings has been difficult and often too late in the design process to be effective. Through the gbXML (Green Building Extensible Markup) data exchange standard, BIM software is now able to export energy analyses. Each energy consuming object is tagged and real time energy consumption can be calculated by area.

Commissioning of the new building can be facilitated through BIM. Barcodes can be associated with a BIM object. When the Commissioning team scans the barcode, the relevant documents are easily retrieved. In the ultimate lean practice, BIM can finally be used to direct maintenance workers to the optimal path through the building, reducing travel time [26].

In a medical setting, the equipment is integral to the construction, to the extent that the General Contractor is often given a copy of the equipment specification book to coordinate sizes and utilities. However, the equipment selections and the specification data/book represent a large investment in people hours. Ideally, the Facilities department would be able to place a piece of equipment in the BIM model and the equipment would populate the engineering information related to that equipment. The BIM model then becomes the communication tool among the team members.

BIM Careers

The more complex the healthcare project, the more important the setup of the initial planning model. There is a need for experienced BIM delivery leadership. The detailed flow of information, client requests, and project paperwork is critical yet challenging [20]. Would a BIM Manager directing traffic in the BIM model be the solution? Or does the designer or architect need to interface with the model and the data? The BIM model utilizes intelligent "Rooms" which can hold a large amount of information through Parameters. Labeling plans with square footage by room or area is often a first step in working out a hospital's Functional Plan (space program). As the plan is updated, square footages are automatically updated and can be scheduled for review.

Staffing can determine frustration levels during transition to BIM. Is the CAD operator able to manage BIM data? What do we do with the data once it is extracted from the model? How will

the database be set up to receive this information? Is the workforce trained to take on the new challenges these Models will offer? In one study, it was found that learning new processes in BIM enhanced the careers of existing professionals and created new career paths for young professionals [10]. Positions like BIM engineer/BIM manager did not exist, but today these are key positions in many companies.

BIM is also opening up opportunities for engineers and designers in the media, healthcare and facilities management [23]. While computer software cannot determine a person's future, the role of adopting new technology is important to sustain quality of life through making tasks less burdensome [22].

A new term – **techno-economics** – describes the changes that occur based on a new generic technology (BIM), the deployment of which requires new forms of organizations and work structures (Miettenen and Paav, 2014). It might be a new socio-economic paradigm that involves the creation of hybrid jobs that merge higher computer functions with design and architecture. There is a severe skills shortage [15]. Even the traditional role of the contractor is being challenged.

Call for Action

Project team integration will lead to more contractors learning to use BIM, calling for better preparation during construction engineering education. **Academia and industry both need to focus on "skills needed to adapt to change and increasing project complexity"** [22]. Information was lacking about specific new job types; however, most literature did note that the staffing for full use of BIM would be specialized [22].

Consider the term *AEC/O*, where the Owner is part of the decision making during all phases of the project and the final recipient of a workable BIM model. Where do the lines of the data merge? One question posed was to ask each member of the BIM team – "Why am I in a network with BIM?" [14]. Identifying the touch points where the Actors coordinate responsibilities in the virtual world could help a project go smoother in the real world.

Interoperability issues will continue to be studied as a prime chokepoint of the flow of information [12]. Takim et al. [22] determined that perceived usefulness of the BIM outcomes and the ease of use of the programs were the greatest limiters to adoption of BIM, beyond visualization tasks.

Another gap identified is the need for a unified call by the government for new construction projects to incorporate BIM if a project is over a specific size. The governments of Australia, England and Finland currently mandate the use of BIM because this holistic form of building utilizes technology to reduce waste, to study energy usage [11], to receive immediate feedback about the environment and to add to the productivity of the AEC/O industry.

An emerging class of BIM software referred to as model servers promises to manage the model in an IFC format and stores all the various documents for the building project. The model server would also assign a GUID number (unique identifier) and allow a variety of program platforms for viewing the model and the information.

The need for staffing in the AEC industry will grow due to further adoption by more entities. Governments, owners and facility managers will demand BIM to its full capability and the time to prepare the workforce is today. Beyond simply 3D modeling, the near future workforce will require people who can not only work with the design portion of the projects, but extract and manage the information that model can hold. The Level of Detail on BIM objects becomes greater as the project becomes owner (Facility Manager) driven. The capabilities of BIM are only just being realized and the benefits are just beyond the learning curve. However, today's educators can embrace this coming shift by preparing current students to handle the levels of BIM and its detail.

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