THE APPLICATION OF BIM FOR INTERIOR DESIGN & THE IMPLICATIONS FOR FACILITY MANAGEMENT

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Building Information Modeling (BIM) provides interior designers the means to simulate, analyze and solve design problems as active members of a collaborative design team.

Interior designers also use BIM to organize, document, and ultimately disseminate all of the detailed information about the solutions they develop.

This information is important for the design and construction team and is essential for the owner’s operation and maintenance of the building.
Instruction of BIM and the associated software applications are integrated in the second semester of the sophomore level within the interior design program curriculum.

Students are also introduced to the purposes and benefits of BIM including its uses within integrated project teams and the implications and benefits of its use for owners and facility managers.

BIM applications are utilized as tools throughout the remainder of the interior design studio courses in the curriculum.
Anderson’s ACT-R theory can be utilized to structure the primary education of BIM in interior design. ACT-R (Adaptive Control of Thought—Rational) was developed by John Robert Anderson at Carnegie Mellon University.

The basic premise is that cognitive tasks humans perform consist of a series of separate actions and procedures. ACT-R’s main assumption is that knowledge can be classified as declarative and procedural.

Declarative knowledge is factual knowledge, while procedural knowledge is how to perform cognitive tasks.
According to Anderson, procedural knowledge is acquired in three stages of skill development: cognitive, associative, and autonomous.

The cognitive stage represents the phase in which “subjects develop a declarative encoding of the skill; that is; they commit to memory a set of facts relevant to the skill,” (Anderson, 1995).

The associative stage results out of repeated practice as a result of which performance becomes smoother and more rapid, thus leading to proceduralization.

As the procedure becomes more automated through practice, the autonomous stage emerges.
Anderson’s ACT-R general implications for teaching procedures start with students developing an accurate and elaborate declarative representation of the desired procedure (actions) and conditions under which it should be used.

Using the expository or discovery methods for teaching can allow the teaching method to be teacher-centered (expository) or via discover (Anderson, 1995).

The accompany chart (Table 1) summarizes the application of ACT-R theory to teaching the Building Information Modeling philosophy and Revit.
## Anderson Act-R Implications for Teaching BIM & Revit

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<th>Task</th>
<th>Process</th>
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| Develop accurate and elaborate declarative representation of BIM   | Begin with fundamental premise that Building information modeling is about the management of information throughout the entire lifecycle of a design process, from early conceptual design through construction administration, and even into facilities management.  
Examples of concepts covered to help students develop an accurate and elaborate representation of BIM and Revit are the following: Parametric Objects and Parametric Relationships; Bidirectional Associativity; Embedded Relationships; User Defined Rules; Model Categories; Annotation Categories; Subcategories; Families in Revit–System, Standard, and in Place Families; Modeling Basics–Levels, Walls, Floors, Roofs, Ceiling, Doors, Windows; Modifying Elements; Color-Coded Drawings; Presentation Graphics; Construction documentation; and; Sharing Files. |
| Expository Methods (Teacher centered instruction)                   | Using the expository methods involves teacher centered instruction to help students develop declarative knowledge. The above listed topics are presented in PowerPoint and interactive presentation lecture format and hands on demonstration to students. |
| Discovery Methods                                                   | The discovery method allows students to learn through discovery. Outside of class exercises will help students practice the concepts learned.                                                                   |
| Feedback Component                                                  | Feedback is an important component, because it fosters proceduralization. Any misconceptions and disequilibrium is fixed with feedback and constant critiques and pin ups.                         |
| Automatization                                                      | Continued practice leads to automatization and this will be evident in upper levels in the curriculum in the complexity developed in the quality of the student work. |
Two case studies, the Law Office project and the Art Gallery project illustrate experiences from the sophomore level interior design computer applications course using Revit.

Students develop the complete detailed interior model in both projects with all interior walls, doors, windows, flooring, ceiling systems, lighting, furniture, equipment, millwork, signage, assign applicable finishes and specification data.

Students also propagate some of the COBie information including spatial data and types/components by model element within the model to assign detailed specification information.
The law office project is utilized for expository centered instruction through multiple interactive demonstrations throughout the semester that are focused on helping the students develop declarative knowledge of BIM software and its application to interior design practice.
Instruction focused on space programs, interior building components include all interior walls, doors, windows, floor and ceiling systems, lighting, furniture, equipment, millwork, and signage.
The students also assign chosen materials and finishes and all applicable specification data.
Feedback is provided by the instructor throughout this project and with continued practice of the BIM tools and techniques utilized in the development of this model, automization occurs.
The art gallery project is utilized for the discovery method of education where students work independently to apply and expand their knowledge of BIM in the development of their own unique individual design solutions.
The students design an art gallery from the “inside out” developing the overall building geometry, core and shell with a complete design of the interior.

The interior elements include all interior walls, doors, windows, flooring and ceiling systems, lighting, furniture, equipment, millwork, and signage.
The students use the ElumTools software add-in for Revit to do the lighting calculations and analysis for the project.

The students also assign chosen materials and finishes and all applicable specification data.

They generate the entire model with fully detailed interiors and basic/generic exterior elements.
Feedback is provided by the instructor throughout this project and with continued practice of the BIM tools and techniques utilized in the development of this model, automization occurs.
Significant improvements to the operation, maintenance can be made achieved by a facility manager when the quality and quantity of information about the building is maximized (Sigh, Smith, & Przybyla, 2009).
The National BIM Standard (NBIMS) version 2, implements the Construction to Operations Building information exchange (COBie).

COBie is the platform that is now used to collect operations and maintenance data within the BIM. COBie secures the project data within the BIM as it is created during the design, construction and commissioning stages of a project (Sigh, Smith, & Przybyla, 2009).
Customized COBie schedule views and parameters are added to the model with the COBie Toolkit to assist the project team in producing the COBie deliverables in conjunction with their model.

COBie can summarize quantitative interior spatial data about floors, spaces and rooms for area calculations as well as function designations.
Interior designers can propagate the COBie information by model element within the model to assign detailed specification information for later use by the owner and facility manager.

As the students develop their models and add components, they enter COBie data in either the schedule views or in the object properties pallet.
As interior designers specify furniture, fixtures, equipment and finishes, they can provide the specification information such as the manufacturer, model numbers, performance criteria, maintenance procedures, and warranty information.

Typical interior scheduled information can be further detailed, organized and disseminated with COBie.
Another important benefit provided by BIM for facility managers is an improved method for visualization of the space, its systems and components.

Dimensioned drawings are typically utilized by owners and facility managers, but it is often difficult for many people to visualize how the two-dimensional drawings translate into real three-dimensional space.

BIM provides a complete three-dimensional representation of the building that can be used to better understand spaces and systems.
This year a new interdisciplinary project has been integrated as a component to the spring senior capstone courses of the interior design, construction science and architecture programs.

The students will utilize BIM applications and processes within an interdisciplinary team to solve the given built environment problem.
Future integration of the training videos being developed by the Building Smart Alliance for self-paced industry instruction of COBie will be integrated into the interior design capstone course in spring of 2014.

Senior students will then be required to populate the COBie information for space data as well as some component data in their project model and will be required to submit the COBie data spreadsheets.
CONCLUSION

- Current rising trends and demands the AEC industry are requiring early team formation and constant communication throughout the life cycle of a project.
- Building Information Modeling (BIM) provides interior designers the platform to simulate, analyze and solve design problems as active team members.
- BIM applications facilitate the organization, documentation and ultimately dissemination the solutions interior designers develop.
- Management of this information is necessary throughout the entire lifecycle of a building from the onset of its development in the design process, through construction and even facilities management.
- Educators must adapt to the demands of the profession by teaching BIM and facilitating interdisciplinary collaboration.