CONSTRUCTION AND PLANNING

by Wes Brooker

BIM: Building Information Modeling

Providing powerful value, Building Information Modeling (BIM) is driving an unparalleled revolution in the construction trade using digital modeling software to more effectively design, build, and manage projects.

At the same time, it is chipping away at barriers between industry firms by encouraging the sharing of knowledge throughout the project lifecycle and closer collaboration to integrate valuable fabrication, construction and operations expertise into the overall design. This improves constructibility, adherence to schedule and budget, lifecycle management and productivity for everyone involved.

Other industries such as aerospace, automotive and shipbuilding companies have already improved productivity by adopting modeling technologies and integrating their design, production and operations activities. In effect they build the product twice, once digitally to ensure maximum accuracy, then physically in exact compliance with the model, at a high level of quality and production efficiency. This process contributes enormously to improved productivity, safety and product quality.

This proven approach has now been introduced to the construction industry as BIM. All businesses will be affected. We are entering the most transformative time our

industry has ever experienced. BIM is a revolutionary game-changer, forcing the industry to examine existing processes to best leverage this new technology.

What is BIM?

Building Information Modeling (BIM) is the process of generating and managing building data and its various components during its life cycle. Using three-dimensional, real-time, dynamic building modeling software to increase productivity in building design and construction, the process produces the BIM, which encompasses building geometry, spatial relationships, geographic information, and quantities and properties of building components. Modeling is essentially "proof of concept".

Going beyond geometry and addressing issues such as cost and project management, BIM provides a way to work on most aspects of the building's life cycle concurrently, including the processes of construction and facility operation. Quantities and shared properties of materials can be removed, replaced and reorganized easily. Scopes of work can be isolated and defined. Systems, assemblies, and sequences can be shown in a relative scale with the entire facility or group of facilities.

BIM achieves such improvements by modeling the actual parts and pieces used to build a building. This is a substantial shift from the traditional computer aided drafting method of drawing with vector file-based lines that combine to represent objects. The objects used in BIM are scaled to represent the actual dimensions of materials used to construct various types of projects.

BIM Adoption

Large General Contractors have embraced BIM technology as early adopters while architects and construction product manufacturers have in some cases been more reluctant in their acceptance. BIM usage is increasing daily as additional users discover the great advantages of various types of software. The top benefits of BIM include easier coordination of various software and project personnel, increased productivity, improved communication across project team members, and enhanced quality control.

Beyond switching to new software, BIM calls for changes to the very definition of traditional architectural phases and data sharing than most architects and engineers are accustomed. Adequate training, senior management buy-in and the expense of the software have been hindrances to the adoption of BIM.

Key Concepts of BIM

Architects, engineers, contractors and others in the construction field have always designed and developed projects with 2-D images, whether on paper or software. With new 3-D design modeling technology, designing from the ground up is more efficient and comprehensive. The ability to review, revise and perfect designs before groundbreaking has implications across all subfields of the construction industry.

Historically, each trade—Site work, Architectural, Structural, Electrical, Mechanical, etc.—has multiple pages of drawings in the 2-D plans which must be continually reviewed manually for changes that may impact what each trade is doing, let alone other trades. BIM provides the tool for each trade to review their

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work and to submit changes for visual comparison of all trades, thus economically building the project virtually long before expense of field construction starts.

Being able to design an entire building and move throughout the model to completely review the project means fewer design errors. With scaled models of each piece, from frames to wiring, each phase of planning is represented with their own objects. The detail and level of accuracy of 3-D modeling is unsurpassed, with details down to frames, purlins, and girts. Detailing so specific allows for simple mistakes to be caught; misplaced doors, duct work and ill-fitting appliances can be fixed before the foundation is even laid.

While many contractors continue to use 2-D design for initial project layout and design, moving the building to 3-D BIM images is beneficial in later stages to prep for on-site construction and verify that once on-site all pieces and parts are assembled correctly.

Most of the important benefits of BIM can be tied to three fundamental concepts:

- Database instead of drawings
- Distributed model
- Tools + Process = Value of BIM

Database Instead of Drawings

Over the years drawings have become the standard documentation—plans, elevations, sections and details. The method of creating these documents is a major obstacle to improving integration and coordination. Typically there are hundreds or thousands of documents for each project and each is an individual, stand-alone segment of the total design. With no central repository to efficiently combine all pieces of information for a representation of the entire project, each section requires human interpretation to integrate the parts to create a whole. The constant challenge of effective coordination between the design disciplines and communication of design intent to the field is what BIM hopes to improve.

A BIM project is not "drawn" in the traditional sense; it is "built" digitally as a database in BIM software, using objects that represent all the elements of the project. Instead of having to look at separate drawings, schedules, specs and cut sheets for all the information on a particular element, all the pertinent information is built into the object in the BIM. Once placed in a BIM it will automatically represent itself in any plan, elevation, section, detail, schedule, 3D rendering, quantity takeoff, budget, maintenance plan, etc.

The building owner gets a digital copy of the completed project model that can be used for decades of operation and maintenance. The significance of a digital copy of the completed project is that all the information related to the building, including operating equipment, can reside on a single computer instead of 20, 30, or 40 boxes of plans.

Distributed Model

BIM users are taking a "distributed" approach to modeling that combines the value of authoring tools with the power of analysis tools.

In a distributed BIM environment separate models are usually authored by the appropriate design and construction entities. These can include:

- **Design models**—architectural, structural, MEP and site/civil
- **Construction model** - breaking the design models down into construction sequences
- **4D/Schedule model**—linking the work breakdown structure to project elements in the model
- **5D/Cost model**—linking costs to project elements in the model
- **Fabrication model**—replacing traditional shop drawings and driving fabrication equipment
- **Operations model**—for turnover to the owner

This is a marked improvement over the current fragmented practice of numerous individual sets of drawings. For example, they can be viewed together to identify clashes and other potential problems that can be fixed digitally to avoid field problems. Design components can also be viewed in segments.

Tools + Process = Value of BIM

While modeling tools provide significant benefits for individual users, utilizing BIM with an Integrated Project Delivery (IPD) system leverages the power of modeling to facilitate collaborative decision making.

IPD brings key construction management, trades, supplier and product manufacturer expertise together with design professionals and the owner earlier in the process to produce a design that is optimized for quality, aesthetics, constructibility, affordability, timeliness and seamless flow into lifecycle management.

Using model-checking applications to detect system clashes is an effective IPD activity because of their ease of use and powerful visualization capability. They also offer the opportunity to collectively resolve expensive, time consuming conflicts in a non-confrontational, collaborative process during design. Instead of wasting valuable time on the job site these clashes are still relatively inexpensive to correct while in the design stage.

It is the powerful combination of modeling and analysis tools with integrated, collaborative processes that is creating the sea change related to BIM.

Time is valuable from the estimating process to the job-site. Wasting time costs companies money and disappoints the customer. Using BIM to coordinate after design and while on the job-site can save that valuable time.

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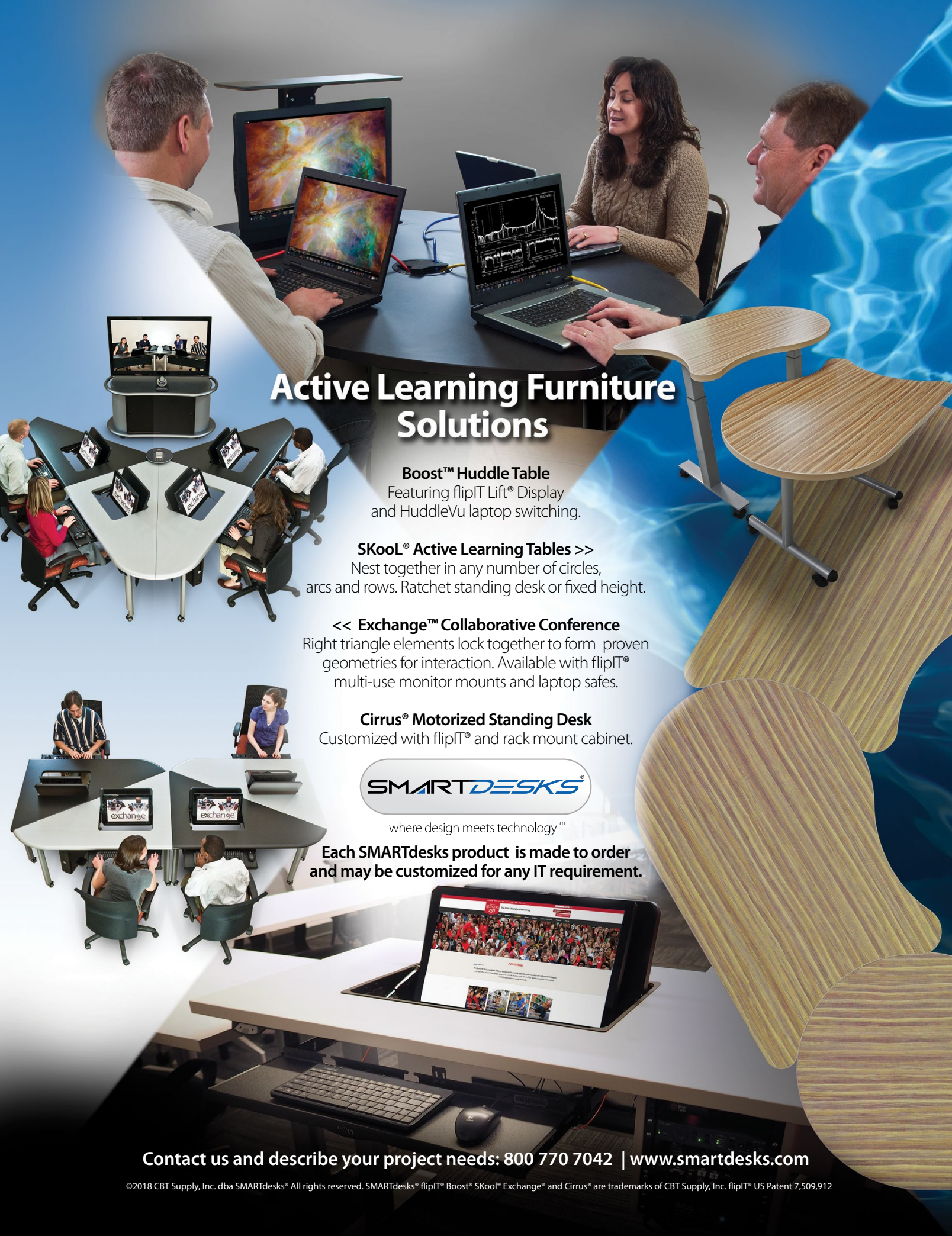
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