AUTODESK UNIVERSITY 2013

Confessions of an Autodesk® AutoCAD® Evangelist Who Discovered BIM

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AB3418 Do you use Autodesk AutoCAD software for your building design and documentation? Have you resisted the move to Autodesk® Revit®-based software because it's too different from AutoCAD? Do you have valuable data in DWG™ format that you don't want to lose? Do you think Building Information Modeling (BIM) is too complicated? Do you work exclusively in 2 dimensions, with no need for 3D? Is your time and budget tight? If you answered "yes" to any of these questions, join me, a dedicated AutoCAD evangelist, on my journey to BIM enlightenment.

Learning Objectives

At the end of this class, you will be able to:

- Identify similarities and differences between AutoCAD and Revit
- Link and import AutoCAD drawings in Revit
- Explore the benefits of integrated 3D modeling
- Investigate the return on investment of moving from AutoCAD to Revit

About the Speaker

Heidi Hewett has dedicated her career to educating people on the use of AutoCAD software. She began using AutoCAD as a student in 1986. Soon after earning her B.S. in Architectural Engineering, Heidi transitioned from an Autodesk customer to an Autodesk employee. During her career at Autodesk, Heidi has held a variety of positions including Product Support Technician, Training Specialist, and Senior Applications Engineer. In her current role as the AutoCAD Technical Marketing Manager, Heidi assists the marketing team in developing and delivering technical marketing material for AutoCAD. She continues to educate Autodesk customers, partners, and employees through Webcasts, seminars, and her AutoCAD Insider blog. It is her passion for education that inspired Heidi to earn an M.S. in Technical Communication and an M.A. in Information and Learning Technologies.

Similarities and Differences

History

AutoCAD was first released in 1982 as a replacement for paper/pencil drafting across multiple disciplines. **CAD**

Revit was first released in 2000 as a 3D parametric modeling tool for architects and building professionals. Revit was acquired by Autodesk in 2002. **BIM**

CAD vs BIM

CAD, also known as computer-aided design and drafting (CADD), is the use of computer technology for the process of design and design-documentation. CAD software is a type of computer program that replaces tedious manual drafting with an automated process.

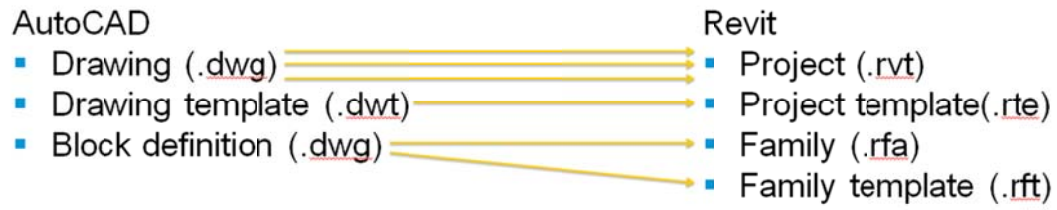
Building Information Modeling (BIM) provides insight for creating and managing projects faster, more economically, and with less environmental impact.

File Format

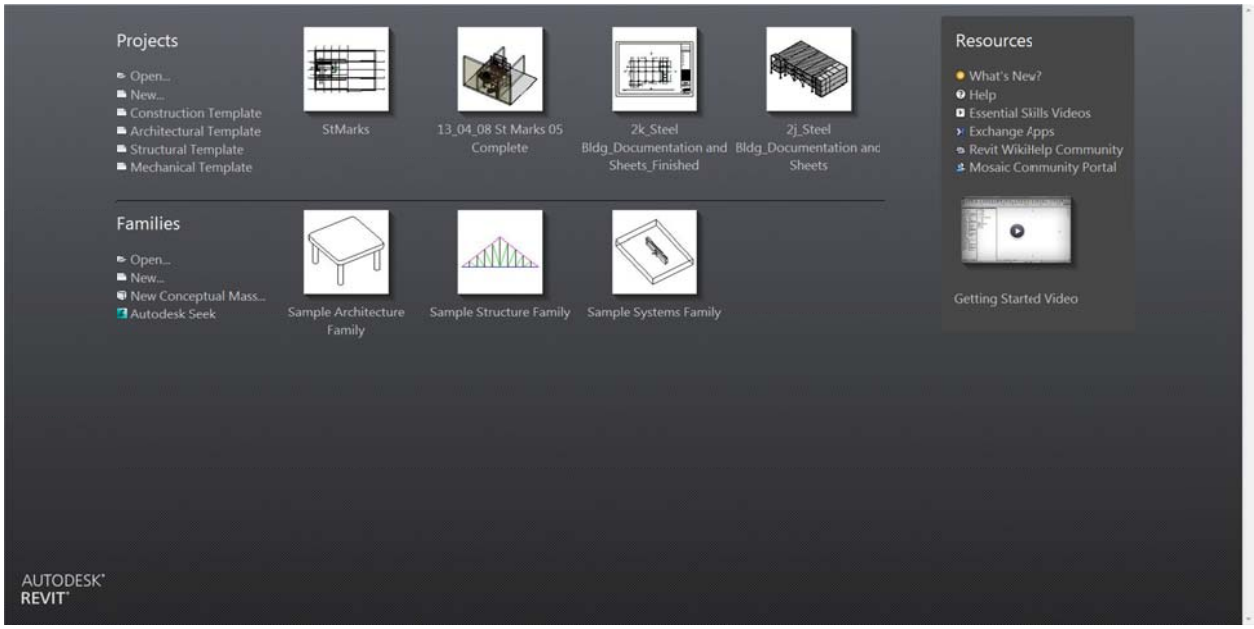
Revit has two primary file formats: Projects use RVT file format and Families use RFA file format. A project in Revit is similar to a set of drawings in AutoCAD. In AutoCAD you likely have many different DWG files to describe uour project. In Revit, you rely on a single integrated and powerful project file.

Families in Revit are similar to block libraries in AutoCAD. For example, in AutoCAD you might have drawings with block definitions for your different doors and windows. In Revit those variations of doors and windows are defined by families.

Revit projects and families (RVT and RFA files) have corresponding template files similar to use DWT template files in AutoCAD. RTE files are project templates and RFT files are family templates.



When you launch Revit, the Recent Files page is automatically displayed. In here you can see your most recently opened Projects and Families. If you haven't opened many projects or families, you'll see sample ones that were installed with Revit. On the left side you can open additional files or create new ones.



Similarities

While AutoCAD and Revit started as two very different software applications, they have both evolved considerably over the past decade bringing their user interfaces closer together. These are just some of the similarities you'll find between AutoCAD and Revit:

- Ribbon
- Properties palette
- Quick Access Toolbar
- Navicaiton bar
- ViewCube
- Draw/select/edit
- Implied window/crossing selection
- Command prompt
- Direct distance entry
- Object snaps
- Esc, Esc, Esc, Esc….
- Zoom
- Sheet Set Manager/Project Browser

Differences

But, to be fair, I want to point out a few significant differences that may trip you up as an AutoCAD user. How many times do you enter U at the command prompt without even realizing you're doing it? Well, let me be the first to tell you that won't work in Revit. There *is* an undo tool. You just don't type U to access it. To Undo in Revit, you can choose the Undo tool from the ribbon or use the Control Z keyboard shortcut which you may already know is standard behavior for Windows applications including AutoCAD! So, if you break your U habit in Revit, you can take your new Control Z habit back to AutoCAD with no problem!

Don't think that U is Useless in Revit. U brings up the Units dialog box. You can also type UN just like in AutoCAD. Notice, however, that you don't have to press the Enter key. The Project Units dialog comes up immediately after typing UN. You can review each of the unit settings in your project and change them as necessary. Regardless of your settings you can use any units at any time. Revit understands units as long as you use an appropriate symbol. For example, even though the default unit for length is feet, you can enter a value followed by m if you want to use meters.

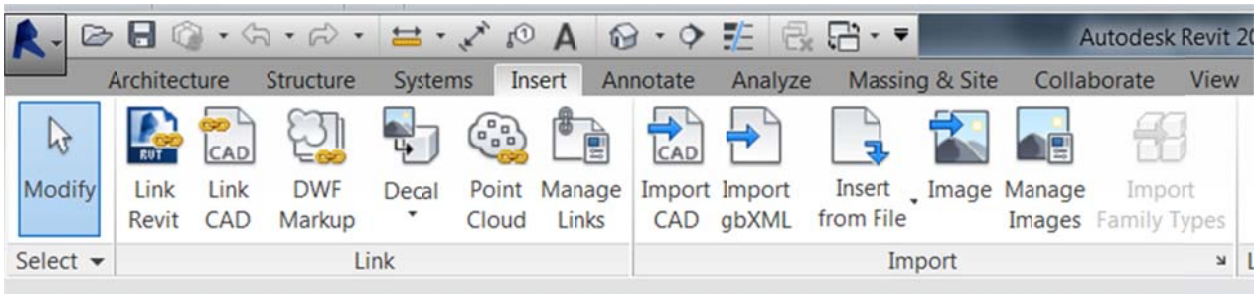
The Project Browser is similar to the Sheet Set Manager in AutoCAD but organized a little differently. You can minimize the ribbon and close the palettes but I encourage you to keep them open because you'll be using them often! If you close the Properties palette, you can turn it back on from the right-click menu just like in AutoCAD! You can also turn on the Properties palette and the Project Browser from the View ribbon tab, under User Interface.

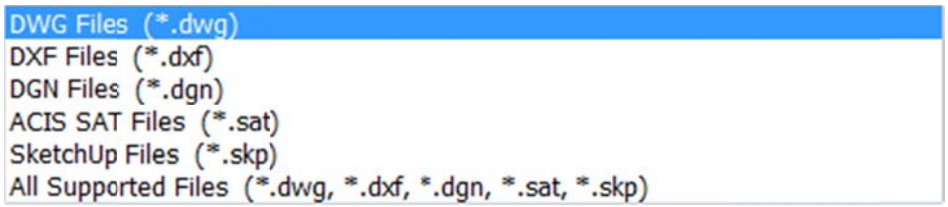
To save screen space you can combine the Properties palette and Project Browser into one window with tabs for accessing each. You'll drag the Properties Palette away to undock it and then drop it on top of the Project Browser's title bar. Tabs at the bottom of that window enable you to switch between the Project Browser and the Properties palette. If you prefer to see both at the same time, you can drag and drop them into position similar to how you dock multiple palettes in AutoCAD. This tabbed form takes a little getting used to coming from AutoCAD. But I think you'll find it an efficient use of screen space.

When creating walls and other objects in Revit it's helpful to watch the command line, just like you do in AutoCAD. But I've found it even more helpful to pay attention to the ribbon. There are many contextual modes in Revit. A contextual ribbon tab displays in green with tools that are relevant for placing walls. Even if you finish drawing a wall, you're still in a contextual mode as long as you see the green ribbon tab. If you try to select something for editing as you're used to in AutoCAD, you may accidentally place another wall. To ensure you're completely out of these contextual modes, you can press the Escape key (sometimes twice). Another option is to choose the Modify tool. In many cases it will cancel you out of the contextual mode and enable you to select object.

Link and Import AutoCAD Drawings

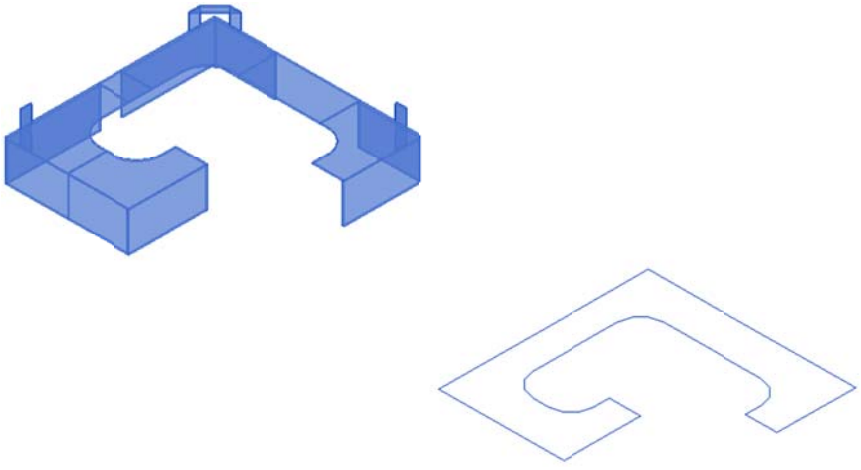
You can reuse AutoCAD data in Revit by linking or importing dwg files. Both of these tools are available from the Insert ribbon tab and support DWG, DXF, DGN, SAT, and SKP file formats.





Link to AutoCAD drawings from a Revit project similar to attaching externally referenced files in AutoCAD. If the original file changes, you can use the Manage Links tool to reload the reference.

Import AutoCAD drawings into a Revit project. There is no link to the original file but you can explode geometry. Only 2D geometry is maintained. You can bring 3D geometry into a Revit Mass family and explode it into Revit Mass geometry.



Integrated 3D Modeling

From Revit Help (http://help.autodesk.com/view/RVT/2014/ENU/)

About Revit

The Revit platform for building information modeling is a design and documentation system that supports the design, drawings, and schedules required for a building project. Building information modeling (BIM) delivers information about project design, scope, quantities, and phases when you need it.

In the Revit model, every drawing sheet, 2D and 3D view, and schedule is a presentation of information from the same underlying building model database. As you work in drawing and schedule views, Revit collects information about the building project and coordinates this information across all other representations of the project. The Revit parametric change engine automatically coordinates changes made anywhere—in model views, drawing sheets, schedules, sections, and plans.

What is meant by parametric?

The term parametric refers to the relationships among all elements of the model that enable the coordination and change management that Revitprovides. These relationships are created either automatically by the software or by you as you work.

In mathematics and mechanical CAD, the numbers or characteristics that define these kinds of relationships are called parameters; hence, the operation of the software is parametric. This capability delivers the fundamental coordination and productivity benefits of Revit: change anything at any time anywhere in the project, and Revit coordinates that change through the entire project.

The following are examples of these element relationships:

- The outside of a door frame is a fixed dimension on the hinge side from a perpendicular partition. If you move the partition, the door retains this relationship to the partition.
- The edge of a floor or roof is related to the exterior wall such that when the exterior wall is moved, the floor or roof remains connected. In this case, the parameter is one of association or connection.
- Windows or pilasters are spaced equally across a given elevation. If the length of the elevation is changed, the relationship of equal spacing is maintained. In this case, the parameter is not a number but a proportional characteristic.

How does Revit keep things updated

A fundamental characteristic of a building information modeling application is the ability to coordinate changes and maintain consistency at all times. You do not have to intervene to update drawings or other content. When you change something, Revit immediately determines what is affected by the change and reflects that change to any affected elements.

Revit uses 2 key concepts that make it especially powerful and easy to use. The first is the capturing of relationships while the designer works. The second is its approach to propagating building changes. The result of these concepts is software that works like you do, without requiring entry of data that is unimportant to your design.

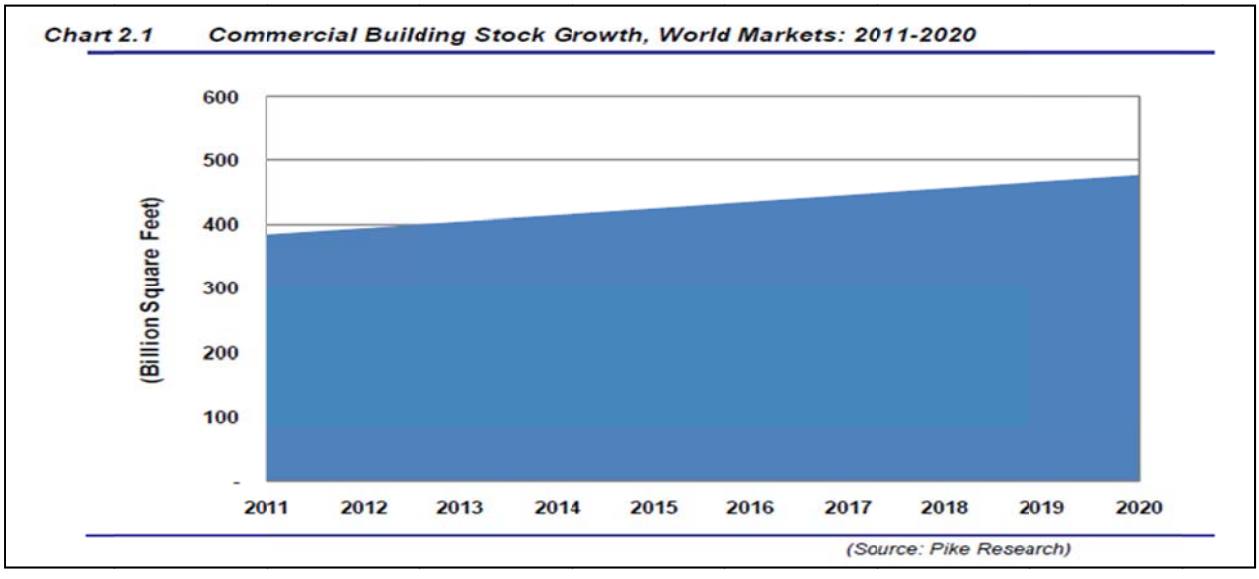
Return on investment

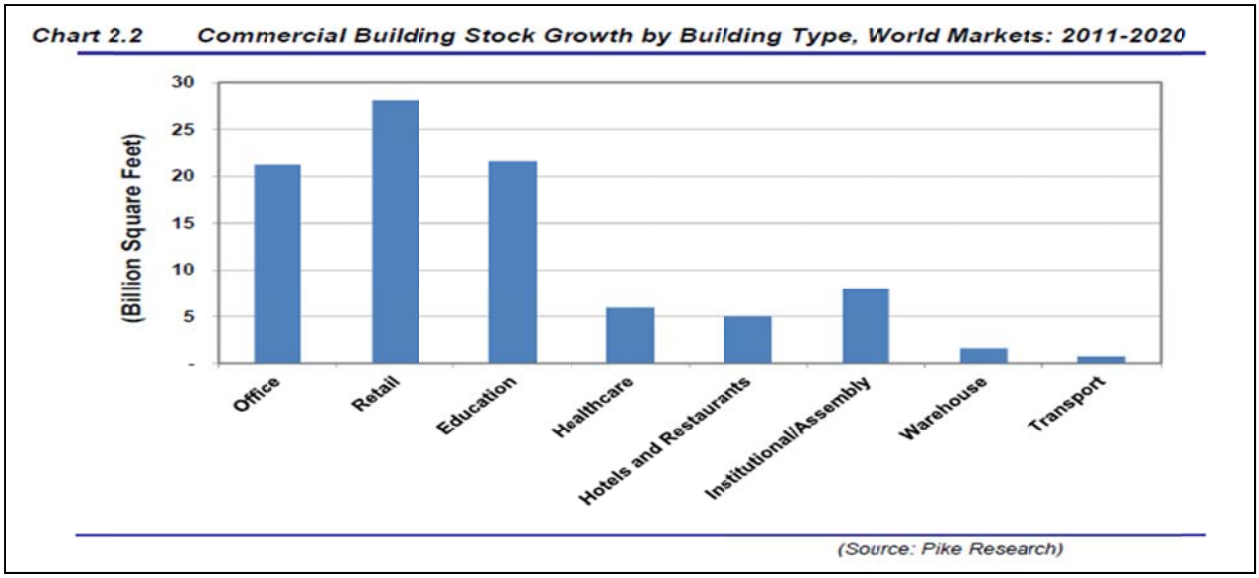
A global market analysis and forecast done by Pike Research in 2012 on Building Information Modelling in 2012 concluded that "For those who are, or have been, using BIM tools and collaboration techniques for a longer period of time, BIM has proven to be remarkably successful in the quality of the results that it can produce. As for building owners and financiers, BIM has driven costs down and made the estimation process more accurate. Additionally, BIM helps facilitate more visibility and interaction in the overall design/build process for the owners of a building, enabling them to take a more active role in determining the final outcome of capital-intensive projects."

In addition Pike Research suggests that "As energy conservation and carbon emissions become increasingly important on a global basis, the adoption of BIM tools and practices will become a higher priority, since it can significantly affect the efficient use of valuable and scarce resources.

According to Pike Research, "Early adopters of BIM tools and practices can gain a significant advantage over their competitors."

Most BIM applications will be performed on new construction activities, although building retrofits provide a sizable market as well. One of the main reasons for performing a retrofit is to reduce energy consumption and the latest BIM tools support this work through the availability of rapid energy modeling technologies.





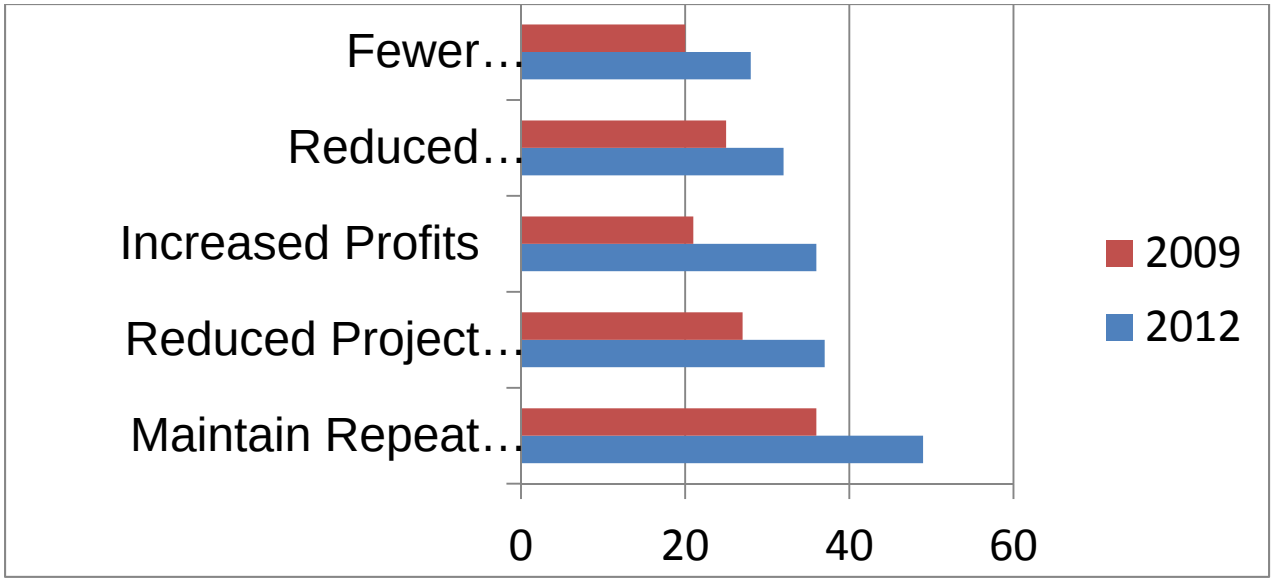
Some benefits of BIM can be experienced on a user's first few projects, such as reduced errors and omissions, rework and cycle time of workflows. Others require longer time frames to demonstrate their value, such as reduced cost, schedule and claims, or maintaining repeat business and increasing profits.

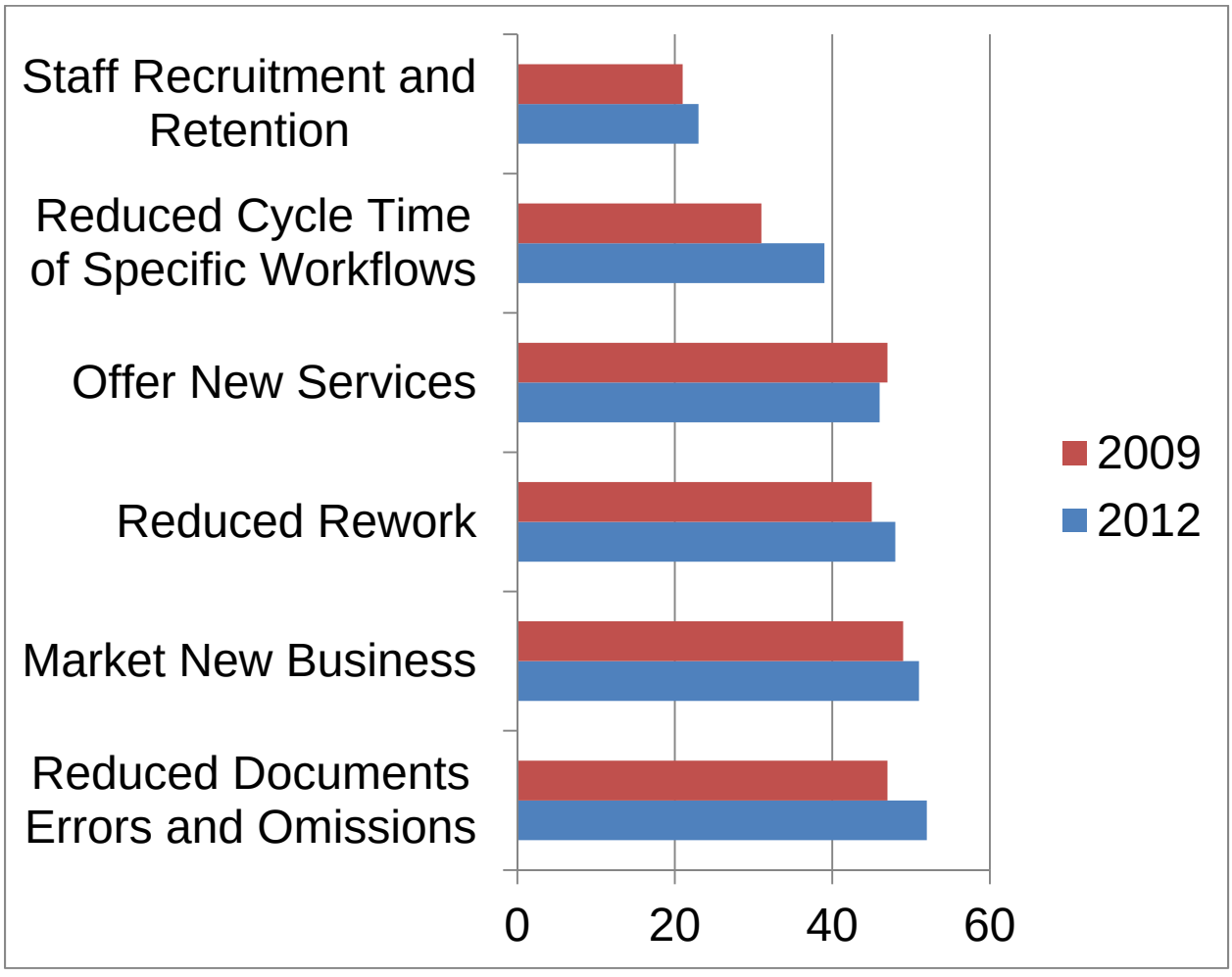
The top percentage gainers include:

- **Increased profits**: this rating expanded by 70%- from 21% and the next-to-last position in 2009 to 36% in 2012. This could drive use of BIM in the future- as BIM processes become more standardized and the initial costs of adoption and implementation are amortized, firms using BIM have the ability to see a sustained impact on profitability.
- **Fewer claims and litigation**: this benefit grew by 40% from 2009, growing from 20% in 2009 to 28% in 2012. This indicates a growing belief that as more problems are avoided during construction and claims measurably diminish, this will be a reliable benefit.
- **Reducing overall project duration**: this metric requires a substantial number if completed projects in order to be validated, and if the trend of increased importance continues- growing from 27% in 2009 to 37% in 2012- reduced project duration will become a powerful ingredient of a quantifiable BIM benefit calculation."

This research shows higher levels of importance for the ten of the eleven BIM benefits rated compared to the 2009 results. Interestingly, the largest percentage increases occur with benefits that take longer to validate, reflecting the increasing length of time BIM has been in the market and the increasing maturity of BIM users in evaluating its benefits.

-Pulled from the Smart Market Report.


Fewer…
Reduced…
Increased Profits
Reduced Project…
Maintain Repeat…
0
20
40
60
2009
2012


Staff Recruitment and Retention
Reduced Cycle Time of Specific Workflows
Offer New Services
Reduced Rework
Market New Business
Reduced Documents Errors and Omissions
0
20
40
60
2009
2012

Percentage of professions using BIM on more than 60% of their projects. BIM usage is increasing all across the board.

Architects

Architects have consistently been the heaviest BIM users due to the length of time they have been involved with BIM. They are projected to reach an industry-topping level of 75% at the intensity in 2014.

Engineers

Engineers reported the least adoption **of** BIM in 2009 (42%), so they had more light users (41%) than other categories. However, in keeping with their surge in BIM adoption from 2009 to 2012, light usage is projected to drop to 12% by 2014, and over two-thirds (69%) predict being at heavy (26%) or very heavy (43%) use levels by 2014.

Contractors

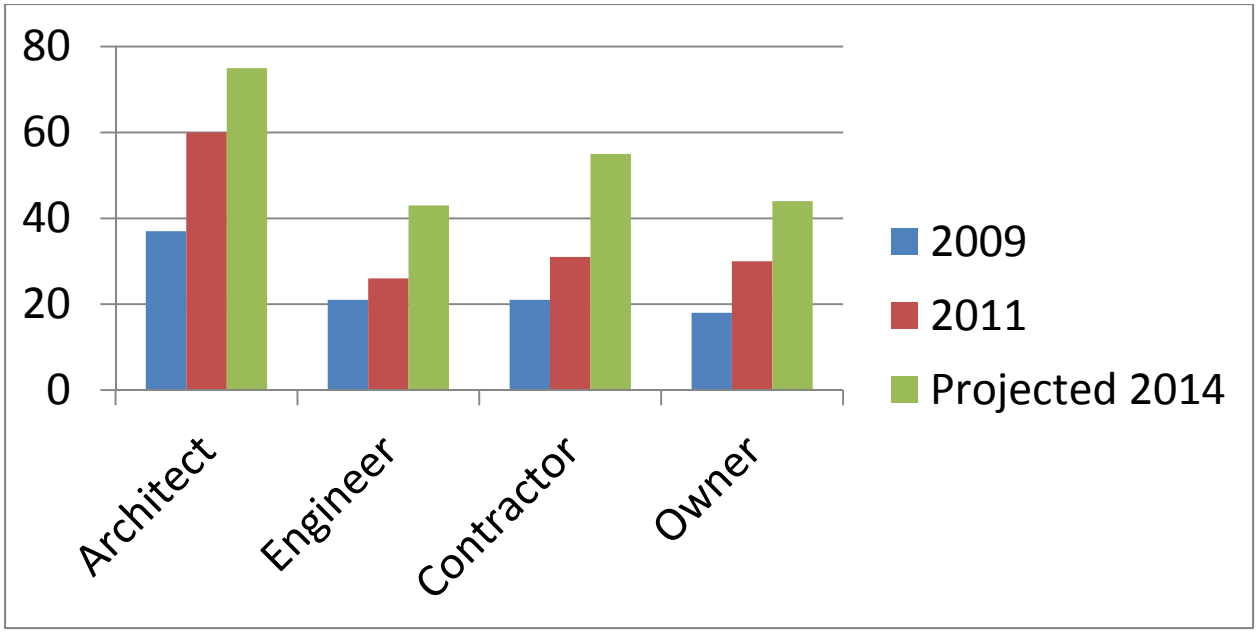
Contractors, who now lead the industry in overall BIM adoption, also show the most dramatic changes in implementation from 2009 to 2014:

- The ranks of very heavy users will almost triple from 21% on 2009 to 55% in 20**14**.
- Light users drop from over one-third (37%) in 2009 to only 6% in 2014.
- Over 80% say they will be at heavy (27%) or very heavy (55%) implementation levels by 2014.

Owners

Owners topped the light user category in 2009 to 2012 at over 40% each time, but only 7% of the 2012 research respondents believe they will still be at that level in 2014, and 44% of them predict they will be at very high level of implementation by 2014.”

-Pulled from the Smart Market Report



While these trends will shape the building industry over a long period of time, many firms are facing immediate business challenges, such as how to win new work, meet client requirements for BIM and sustainable design, and delivering projects more efficiently to increase profitability.

Firms facing these challenges must find ways to alleviate them by improving their business processes. They must examine how the services they provide will prepare them for the future demands of the industry and clients. They must understand why more owners and governments are requiring building information modeling, and how they can meet this need. And finally, firms must find ways to work with project stakeholders more collaboratively to improve the design and building process.

A Remedy for Better Healthcare Buildings

How BIM is improving the design, construction, delivery and management of facilities for Bronson Healthcare

The business value of BIM for healthcare organizations like Bronson doesn't end at just managing the building lifecycle process more effectively. We see potential for using the model to pursue regulatory compliance. Given the effort to document and defend submissions for reimbursements from state and federal agencies, it is becoming more critical to account for every square footage we have. With 3D Revit models, that space information is more accurate and easier to access.

— Steve Hyde
Energy/Facility Coordinator
Bronson Facility Planning and Development

Image left and above: $3 million renovation to construct four catheterization labs started November 2008 and finished May 2009. The new $1.7 million prep/recovery unit at the Bronson Methodist Hospital features a state-of-the-art nurse station and work core, and was the first project completed by Bronson using BIM.
Images courtesy of Bronson Healthcare

The U.S. healthcare industry is in the midst a building boom. In a recent survey at the Fall 2012 Healthcare Design Conference, 80 percent of healthcare providers reported that their design and construction activity grew in 2012 and 67 percent expect continued growth in 2013. In addition, two-thirds of the surveyed healthcare providers felt that the Affordable Care Act will result in increased capital expenditures over the next 5 years.

However, the complexity and critical nature of healthcare facilities make them one of the most challenging types of building projects due to the cross-functional collaboration required to ensure success. In response, many healthcare facility owners are turning to Building Information Modeling (BIM) to facilitate efficient design and construction processes and improve building outcomes. BIM is an intelligent model-based process that helps owners and service providers achieve business results by enabling more accurate, accessible, and actionable insight throughout project execution and lifecycle. The use of coordinated, accurate 3D building models during design and construction can result in substantial cost and time savings for the owner. And beyond the design and construction phases, BIM can help improve the performance of facilities over their lifecycle, supporting improved patient care and reducing operating expenses.

But the vast majority of BIM projects—for all building types including healthcare facilities—have been new construction of very large, multi-million dollar facilities. Do the cost and time savings from BIM translate to smaller projects, especially renovations or upgrades? In 2011, one Michigan healthcare owner decided to find out by launching a head-to-head project comparison.

Bronson Healthcare
Bronson Healthcare Group, located in Kalamazoo, Michigan, is a not-for-profit healthcare system serving southwest Michigan and northern Indiana. Bronson operates three hospitals that total 3.1 million square feet. After years of working with hardcopy drawings and 2D computer-aided design (CAD) files, Bronson began investigating the use of BIM for its building renovation and construction projects, and to support its ongoing facilities management, operations, and maintenance.

"We felt sure that the benefits of BIM would be worth its costs, but we had to exercise due diligence and prove the value of BIM to our executive team," says Michael DiFranco, manager of facility planning and development for Bronson. "So we embarked on a BIM pilot project to demonstrate the ROI for future build outs and, at the same time, gain support from our construction teams."

For the sake of comparison, Bronson decided to use BIM on a new renovation project directly adjacent to a recently completed renovation that used CAD. The completed project was a $3 million renovation to construct four catheterization labs that was finished in May 2009. The new project, which started in early 2011, was a $1.7 million renovation and addition of a 13-bed prep/recovery unit (PRU).

BIM Execution Plan
To prepare for BIM and get advice on the pilot project, Bronson turned to Kal-Blue, a local Autodesk channel partner that specializes in solutions and services for building lifecycle innovation. Kal-Blue has been an early advocate of extending BIM to a building's operational phase. "BIM is transforming the design and construction of buildings, and is being widely adopted by the AEC industry. But there's a disconnect when it comes to building owners," says Christopher (Kip) Young, President & CEO of Kal-Blue. "We help owners understand how new processes like BIM can improve the entire building lifecycle."

Kal-Blue works with owners like Bronson to develop a plan specific to their needs and communicate those needs to their architects and contractors, streamlining the data transfer during project delivery. In addition, the firm helps owners use BIM to support facilities management, operations, and maintenance.

The first order of business was to create a plan for using BIM on the pilot project and future projects, as well as the development of longer-term plans for using BIM for lifecycle management. Kal-Blue worked with Bronson to define the BIM goals and the deliverables for a capital project. The plan outlines requirements for each party including software and hardware requirements, and provides information regarding collaboration site usage, file naming conventions, model accuracy and tolerances, level of development definitions, and even MEP color-coding.

Apples-to-Apples Pilot
Bronson's plan specifies that the architectural firm maintains a building model throughout every project, reducing the potential for information loss at handoffs and creating a more consistent process. The project architect and engineer of record for the PRU project, Diekema Hamann, used Autodesk Revit Architecture software to create an as-built model of the area based on existing 2D AutoCAD layouts. In addition, the team opened up walls and ceilings to field-verify the accuracy of the layouts, particularly in problematic above-ceiling spaces.
The plan also calls for the architectural firm to use the virtual building model for project coordination and clash detection, which has long been recognized as one of the biggest benefits of BIM for design and construction. Diekema Hamann used Revit Architecture for its design of the renovated space, and also modeled the major building systems based on design and fabrication drawings supplied by the general contractor and subcontractors.

	Cath Lab (Trad.)	Cath Lab (by %)	PRU (BIM)	PRU (by %)	Results (PRU v. CL)
Contract Value (under)	$79,330 Under GMP	2.6%	$159,234 Under GMP	9.2%	↑ 71.7%
Cont. Value	$231,107	7.44%	$31,942	1.88%	↓ 74.7%
MEP Field Coord.	$94,456	3.04%	$1,700	.01%	↓ 96.7%
Change Orders	19	N/A	5	N/A	↓ 73.4%
Timeline Reduction	0	N/A	3/wk	11.5%	↓ 11.5%
Revenue Impact	0	N/A	1.41M	N/A	↑ 5.77%

Table of comparative project metrics

To promote team building and develop trust between all these players, Bronson gathered them all around a table at the outset of the project to discuss the use of BIM. "The BIM fee for the prep/recovery unit project was about $40,000, so we wanted to make sure that everyone was on-board with BIM," says Steve Hyde, an energy/facility coordinator within Bronson's facility planning and development group. "After the meeting, the teams agreed to reduce their contingency fees based on the prospect of a more coordinated project, delivered under budget and ahead of schedule."

Pilot Project Results
The results of the pilot were a resounding success—definitively proving the business value of BIM and Revit software on small-scale renovation projects.

The CAD-based catheterization project was 2.6 percent (approximately $80K) under budget. The contingency value spend was 7.4 percent and the MEP field coordination spend was 3 percent. There were 19 change order requests and no reduction in construction time. Bronson reports that these numbers are typical for a CAD project of this size.

Whereas on the PRU project, **BIM and Revit Architecture** software helped Bronson almost quadruple its savings. The project was almost $160,000, or 9.2 percent, under budget. The contingency value spend was only 1.9 percent, due to the upfront coordination work within the field and between trades. The MEP field coordination spend was only 0.01 percent, representing just $1,700 on the $1.7 million project. There were only five change order requests and the project was completed three weeks early. In addition, the PRU supports the catheterization labs and, as a result, the early completion of the PRU resulted in $1.4 million in additional revenue for Bronson from those labs.

Going Forward
Currently, Bronson is using BIM and Autodesk Revit Architecture on a $5 million, 25-bed construction project begun in April 2011. Revit Architecture was used to complete the MEP coordination during demolition, which helped shorten the project timeline. And the proven value of BIM helped Bronson convince the HVAC contractor to decrease its bid by more than $100,000 and the construction management firm to reduce its contingency from 8 to 2 ½ percent—saving Bronson an immediate $350,000.

Into the Future
The successful use of BIM has also convinced Bronson to launch a campus-wide BIM Execution Plan that includes using Autodesk Revit software to create as-built models of all existing buildings, and (with assistance from Kal-Blue) integrating that information with operations and maintenance systems. "BIM is helping owners like Bronson redefine how its buildings are designed, constructed, delivered, and managed," says Young. "Intelligent, data-rich models of existing buildings will help us organize and, at the click of a mouse, access the information we need to do our jobs and get that information to the people who need it in a timely fashion," adds Hyde. "BIM and Revit software will be used on all of our future projects," reports DiFranco. "Revit building models will help us better maintain our assets, make our staff more productive, and reduce our lifecycle costs."

Mortenson Construction, *Healthcare Industry and Design Trends*, www.mortenson.com/ResourcePage_Whitepaper_HealthcareDesignTrends, January 2013

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