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WHITE PAPER

AUTODESK REVIT: IMPLEMENTATION IN PRACTICE

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1. ABOUT THIS WHITE PAPER

The intent of this paper is to provide detailed information on how Revit is currently being implemented in architectural practice, selected data on measurable ROI collated from a survey of Revit users, and some key insights into the successful deployment of Revit and Building Information Modeling (BIM).

It has been prepared by integrating the results of two separate studies, which are described in more detail in the following sections.

1.1 Research Study on Revit Implementation

The author conducted a detailed research study between October–December 2003 to investigate how Autodesk’s premier BIM solution, Revit, was being implemented in architectural practice, determine its key strengths and identify the challenges involved in implementing it, and gauge the impact of Revit deployment on business processes. The study was performed by conducting surveys of several architectural practices that were in various stages of deploying or evaluating Revit, and resulted in a comprehensive study report. This paper incorporates several findings from that research study report, which would be relevant to firms evaluating a Revit implementation in their own practices.

Ten architectural firms participated in the research study, with sizes ranging from 3 to 700 people. Specific efforts were made to select firms of varying sizes in order to add diversity to the study. The surveys were conducted using written questionnaires and phone interviews. In addition, an in-depth onsite study was conducted in two of the practices that were aggressively implementing Revit. The names of the participating firms will be kept confidential in this paper, and will simply be referred to as Firm A, Firm B, etc.

1.2 Autodesk Revit Web Survey

Autodesk recently conducted a web survey seeking information about how firms have implemented and are using Revit, with the intent to investigate the ROI on Revit implementation. The invitation to participate in the survey was posted on Revit Users’ Chatroom in November 2003, and over a hundred responses were received. The questions in the survey, being primarily in a multiple-choice format, were more specific than the broader, essay-type of questions in the research study, and were focused on the nature of the firm, the usage of Revit for different design and documentation tasks, how training and support for Revit was received, and the impact of Revit deployment on productivity.

2. KEY FINDINGS

This section distills all the diverse input that was received from the research study and web survey into nine key findings.

2.1 Overall Satisfaction Quotient

Most of the firms that participated in the research study expressed a strong liking for Revit and a great deal of respect for its capabilities, in spite of some challenges in implementation (described in more detail in Section 3.3). Several of these have already committed to using Revit; the remaining few are large firms whose evaluation process is still ongoing. Some firms found Revit easy to learn and use; on the other hand, others have described the learning curve as steep, even for tech savvy users. One firm described how they started off with great excitement with the application, experienced a drop in momentum as they had to work under project pressures to achieve real results within the expected time frame while figuring out a new process and workflow, and are now on the upswing again. This alternation between highs and lows seems to be a fairly typical reaction to Revit implementation.

Not all users “get” Revit, but for those who do, they have come to love the application and dread the prospect of going back to the old way of designing and drafting. One respondent described Revit as “the first car compared to the first horse,” and having experienced the speed, efficiency, and effectiveness of the car ride, none of these users want to go back to using the horse.

In the web survey, more than half of the respondents strongly agreed with the statement that the use of Revit has helped their firm to increase the level of service, quality, and performance that they are able to provide to their clients. The average response to this question on a scale of 1 to 5, where 1 denotes strong disagreement and 5 denotes strong agreement, was 4.22, indicating a high degree of satisfaction with the product.

2.2 Impact On Business Processes

The research study did not yield many hard metrics on the impact of Revit deployment on architectural business practice, as none of the participating firms had carried out any formal measurements. However, a 300 person firm that was the most advanced in its Revit implementation did report that for several projects on which Revit was used, they had used only half the number of staff that had been originally budgeted and completed the work twice as fast. The web survey also yielded some hard data that can be used to determine ROI. After an average productivity loss of 25–50% during the initial training period on Revit, it took most respondents 3–4 months to achieve the same level of productivity using Revit as with the previous design tool. Thereafter, the estimated increase in productivity as a result of migrating to Revit ranged from 10% to over 100%, as shown in Figure 1.

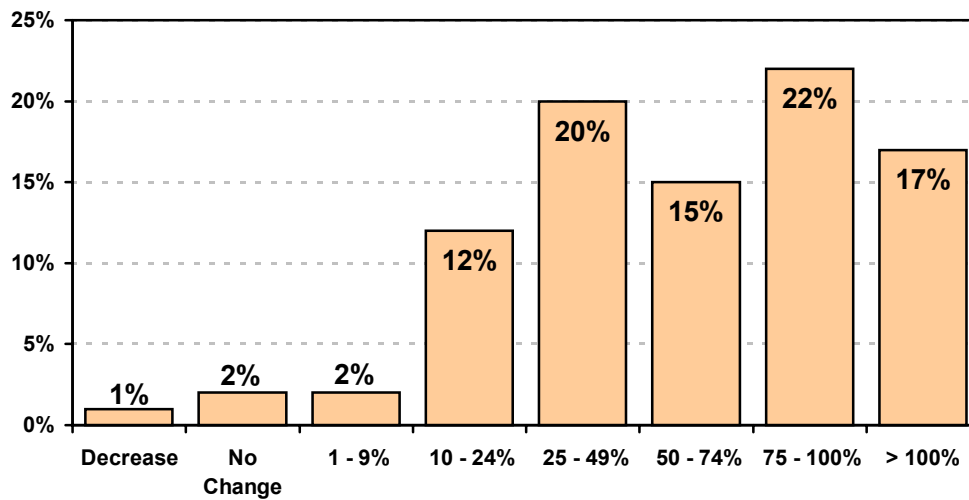


Figure 1: The increase in productivity as a result of migrating to Revit from the previous design tool, as estimated by respondents to the Autodesk web survey.

In the research study, it was found that for firms in the initial stages of implementation, the time savings in efficiency and accuracy were offset by the time required to learn the application and customize it for the firm's practice. Firms further along the implementation path have realized several benefits, many of which, however, cannot be quantified: more time for design; better understanding of design; better presentation of design concepts to clients; no fear of making last-minute changes; better documentation with less errors; less tedium; more confidence in taking on projects; lesser divide between the designer and the "CAD person"; and so on.

Most firms were still focused on productivity gains resulting from the automatic drawing generation and coordination capability, but long-term goals include performing energy analysis, quantity take-offs, and cost estimation from the model. Thus, potential gains from these abilities haven't been realized yet. Also, most of the firms in the research study hadn't taken Revit all the way to the construction document stage. This means that even further productivity benefits and cost savings remain to be realized from the elimination of the duplicated effort in preparing construction documents.

The most tangible impact of Revit implementation on business practice in terms of profitability was felt by one of the participating firms in the research study that does work where information management is critical rather than traditional architectural design work. The firm specializes in leasing management, facilities management, infrastructure studies, and programming jobs. The ability to derive and deliver accurate and coordinated drawings, spreadsheets, and 3D views from the same set of information has had a major impact in extending their abilities, letting them break into new markets efficiently.

With regard to the ROI issue, some firms in the research study felt that the big ROI picture for Revit implementation was not as important in the near term as the immediate and internal benefits of

adopting it: “An application should be easier and better off the bat, and accomplish immediate goals.” These firms preferred to start small and build up the case gradually to the full BIM benefits of Revit.

2.3 Need for an Effective Implementation Strategy

Implementing Revit effectively requires profound changes in the way architects work at almost every level within design. Most firms in the research study have found that Revit implementation not only requires learning a new application, but also requires learning how to reinvent the work flow, how to staff and assign responsibilities, and what to model and what not to.

Take the case of the makeup of the project team. Traditionally, a project is divided up among team members by drawing type (plans, sections, elevations, etc.). But when drawings are automatically generated by the model, as in Revit, the division has to be addressed differently. How should a project be divided to make the best use of Revit? One approach is to dedicate one team to creating the objects, and have other teams assemble them into buildings. Needless to say, there may be other, more effective approaches as well.

It was found that almost all the firms are grappling with the same fundamental issues of change. Thus, it appears that they could all benefit from a clear set of guidelines outlining an effective strategy and methodology of implementing Revit.

Autodesk notes: Services supporting Revit implementation are available from Autodesk Consulting and from Autodesk Partners.

2.4 Need for Professional Guidelines on Leveraging BIM

Revit is currently benefiting adopters as a better and more efficient tool for the designer. The promises of its building information modeling (BIM) capabilities that will facilitate building lifecycle management (BLM) are more remote. Most firms in the research study reported that building owners and clients are still unaware of BIM and BLM and are not demanding it, let alone offering to pay more for these services. This also explains why, in the web survey, the average response to the question of whether Revit usage has helped the firm increase the amount of repeat business that it receives from its clients was only 3 (on the same scale of 1 to 5 as previously described). It indicates that for the average architectural firm, Revit implementation does not immediately translate into more business.

It was found that most of the firm principals and technology leaders are struggling with the same basic questions of how to best leverage BIM: How can the greater design efficiency and better building quality enabled by BIM be translated into more profitability—for design firms (either by charging higher fees or the same fees for less effort) as well as building owners and developers (by having a more cost-effective building along with reduced operational costs)? How can the added intelligence in a BIM model of a building, which includes valuable information but takes more time for firms to

produce than traditional 2D documents, be priced? There are still no concrete answers to these questions. Guidance on these and on other aspects of BIM such as what is valuable to model and what is not, what is required for lifecycle management, and how much time it will take to include that information, is not yet readily available to technology decision-makers. Once a clear set of professional guidelines addressing these issues has been developed and disseminated, Revit's advanced BIM capabilities can be leveraged to even greater benefits.

2.5 Organizing and Working on Large Projects

A reasonable question with regard to a fully integrated BIM application with a centralized database like Revit is what happens as projects get larger. At some point hardware limitations and the overall quantity of the data must limit the utility of the model. Compounding this is that large projects generally become exponentially more demanding to manage as they grow in size, no matter what technology is used to support them.

The research study participants were generally apprehensive about this issue, and most of them had quite reasonably selected smaller projects for their pilot Revit implementations. Those who had attempted large projects were challenged by the high demand of the application on computer resources and the sluggish performance of the software as the project file got larger and more detail was added. It was clear that even average projects were quite demanding on computer hardware—top-end machines are required to run Revit efficiently.

For some study participants, however, large projects and slowness was not an issue at all. They pointed out that the additional time the software took to make a change was insignificant compared to the time and effort that would have been required to coordinate a similar change using their old tools. These professionals shared several techniques that they used for working with large projects more efficiently in Revit: be disciplined about modeling; purge unused elements; and find appropriate substitutions for complex or overly detailed geometry (for example, a perforated panel was changed into a hatch pattern rather than modeled with actual elements). All these would reduce the file size and speed up operations.

Autodesk notes: Autodesk Consulting provides specific guidelines for working on large projects in Revit. Autodesk also provides a large sample project that customers can use to try out the software themselves.

2.6 Interoperability and Customization

The web survey revealed that Revit is primarily used in conjunction with AutoCAD or AutoCAD LT, as shown in Figure 2. This was also true for most of the firms in the research study. Since they found that communication between Revit and AutoCAD worked well, interoperability in general did not rank very high on the feature wish-list for most of these firms. However, a definite need was expressed for

more import and export options for exchanging data with various 2D and 3D formats. Many firms also asked for a two-way communication of the building information in Revit with the information in other applications and databases. This would allow, for instance, data to be pulled into Revit from a Web page, or a change made in a linked spreadsheet to automatically update the Revit model.

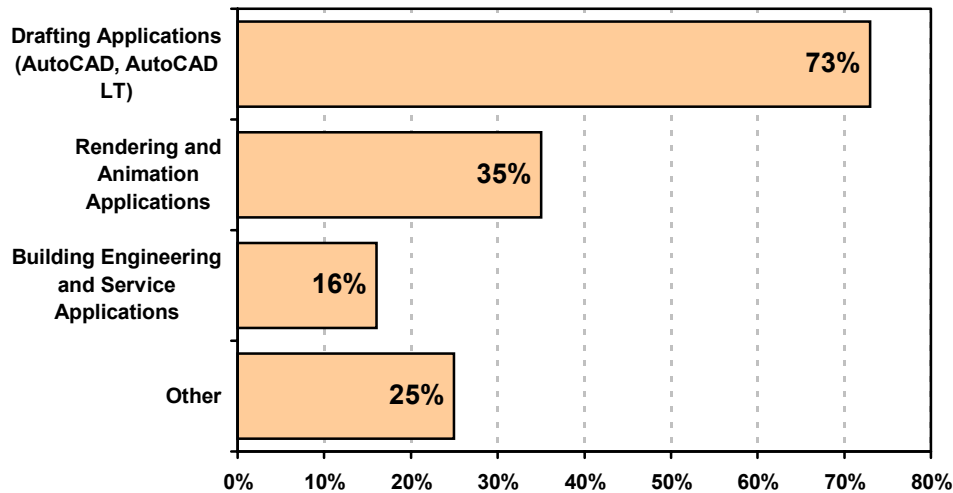


Figure 2: The software applications that are used in conjunction with Revit, according to the web survey respondents.

Only a single firm in the survey mentioned IFC compliance as a needed feature, since they felt it was becoming “the accepted standard for AEC data exchange.” However, when probed further for a business case supporting this request, they acknowledged that they were not yet using the IFCs themselves, but were asking for it because a client of theirs was requesting IFC compliance.

With regard to customization, only one firm had an API (Application Programming Interface) on their wish-list, indicating that despite all the noise about the importance of openness, firms have more immediate design needs from the application and do not necessarily wish to devote more time to mastering yet another programming or scripting language. They do, however, urgently need more customization options within the application itself, such as template files targeted specifically towards different kinds of design projects, and many, many more families of building, interior design, and landscape design components, preferably manufacturer-supplied.

Autodesk notes: In addition to Autodesk’s own ongoing efforts, a growing network of third-party developers and consultants is beginning to address both content and customization needs. Content and customization are also included in standard implementation services available from Autodesk and its partners.

2.7 Obstacles to Change

Since Revit is significantly different, both in interface as well as approach, from the tools in use before it, the story of Revit implementation in many firms is ultimately seen as more an issue of how to manage change rather than about the tool itself. So far, it has been a major effort by technology leaders in most of the firms to communicate and “sell” the benefits of Revit’s BIM approach to the rest of the firm. For some, the idea of BIM has immediate appeal and they want to implement it as soon as possible. But for most, it is something else to learn in the midst of trying to do their jobs, and therefore becomes a pain point. What also impedes implementation are the pressures of sticking with the project schedule, and the added expense upfront of trying something new.

While practically all the respondents in the research study cited professional resistance to change as one of the biggest hurdles in Revit implementation, a few elaborated on this problem in more detail, providing valuable insights not just on Revit usage but on BIM implementation in general. Resistance to Revit and the concept of BIM is not limited to a particular category of people in a firm; it runs across all levels and all positions. Many architects are very conservative and think that their designs are too unusual, too specific, and too customized to be modeled using a BIM solution, which is assumed to be useful only for modeling “standard” designs.

One respondent pointed out several other aspects of a BIM solution like Revit that fuel the resistance to change. Revit requires more communication and more collaboration than working with AutoCAD, which some people resist. Revit is a “designer’s tool”; it is more tactile and requires as well as facilitates a complete understanding of the project both at the micro and the macro levels. In current practice, several people work at only at micro levels and feel threatened by the application’s demand for a broader understanding of the project. Revit also is anathema to those who are not used to rigor in design. With Revit, you cannot cheat or fake the form of a design, and you cannot get away with missing information. All parts of the building are required to co-relate with each other. Folks who use traditional 3D modeling applications often create images that don’t coordinate with the project at all, and such folks end up resisting the rigor and honesty that Revit imposes.

2.8 Preliminary and Conceptual Design

Hand in hand with the ability of Revit to not fake—a plus during the detailed design and subsequent phases—also comes the inability for abstraction, which all firms in the research study found to be a negative during schematic design. As discussed in the last section, Revit requires complete modeling 100% of the time. This requirement does not match the needs of most architectural design processes at the preliminary design stage. It does not support the design flow, and is too restrictive and thereby off-putting to those who actually conceptualize the designs. This made several firms question whether Revit should be used by a design principal at all, given that it is not particularly “sketchy.”

2.9 Multi-Disciplinary Building Design

Only one firm in the research study was currently evaluating Revit to determine its suitability for their multi-disciplinary environment needs, indicating that current lack of support in Revit for design disciplines outside of Architecture is not yet an issue with most architectural firms.

3. DETAILED RESULTS

This section presents a more detailed description of the results of the research study and the web survey. It describes how Revit is being used, its impact on business practice for individual firms, and its main strengths and key implementation challenges.

3.1 Revit Usage

Most of the firms that participated in the research study have been using Revit for about 2 years. It was found that smaller firms were able to make a commitment faster and start using Revit on real projects, whereas larger firms are still in the process of evaluation and just starting out on pilot projects. For example, a 670 person firm that has been involved with Revit in an evaluation capacity for three years, started their first pilot project only recently. On the other hand, a 25 person firm started using Revit for projects only 2 months ago, yet is aiming to migrate 80% of all its new work to Revit in a few months. Most of the firms chose to implement Revit after evaluating it versus competitors and finding Revit the better solution.

Most of the respondents in the web survey have personally used Revit for over a year, and so have their firms, as shown in Figure 3.

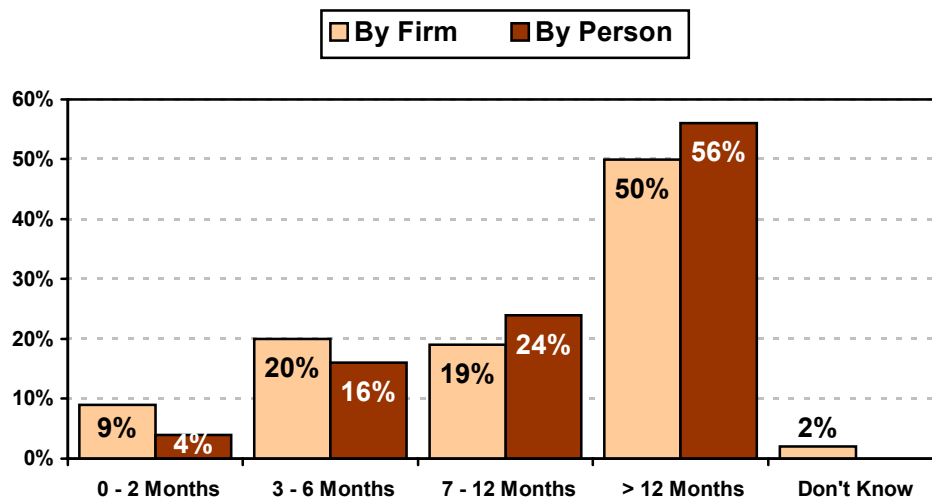


Figure 3: The duration of Revit usage by firm versus person in the web survey.

The type of projects on which Revit is being used includes residences, small commercial buildings, interior design projects, clubhouses, villas, spas, small hotels, health care facilities, garages, dormitories, and property and facilities management. The largest project spatially was a 200,000 sq. ft. dormitory renovation, while the largest project file size was 26 MB. Because of file size issues (as discussed in Section 2.5), limited detail is added to spatially large projects to keep the file size under manageable limits. The use of Revit has also been found to be most effective with small teams of people.

The web survey revealed that for more than half of the firms, Revit is typically being used in place of other 3D architectural CAD software. As shown in Figure 4, a sizable number also reported that Revit was replacing standard 2D CAD applications such as AutoCAD and MicroStation.

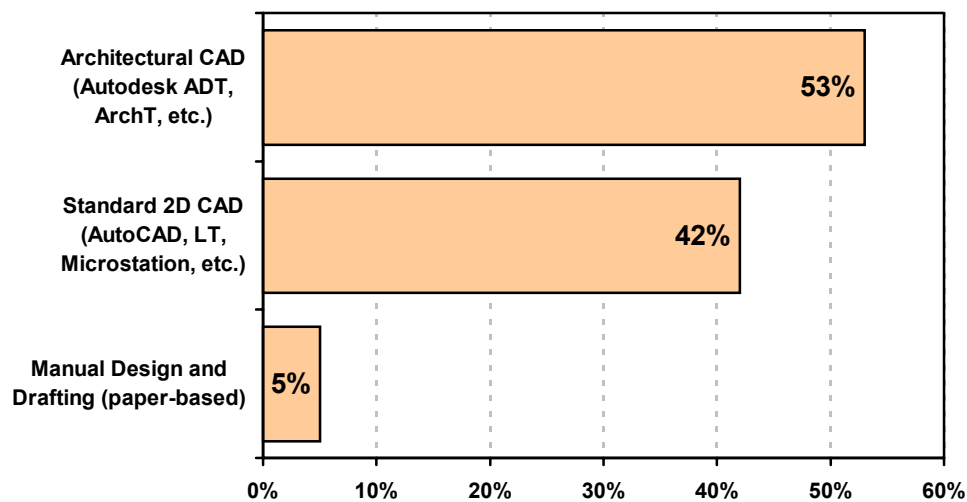


Figure 4: Revit is replacing the use of 3D architectural CAD applications and to a smaller extent, traditional 2D CAD applications as well.

With regard to the usage of Revit in different design stages, most of the web survey respondents used Revit as the exclusive or primary design tool for concept development and design as well as documentation, as shown in Figure 5. Considering that most of these respondents had been using Revit for over a year (as previously shown in Figure 3), it indicates that the transition from the previous applications to Revit for performing core architectural tasks has been quite swift.

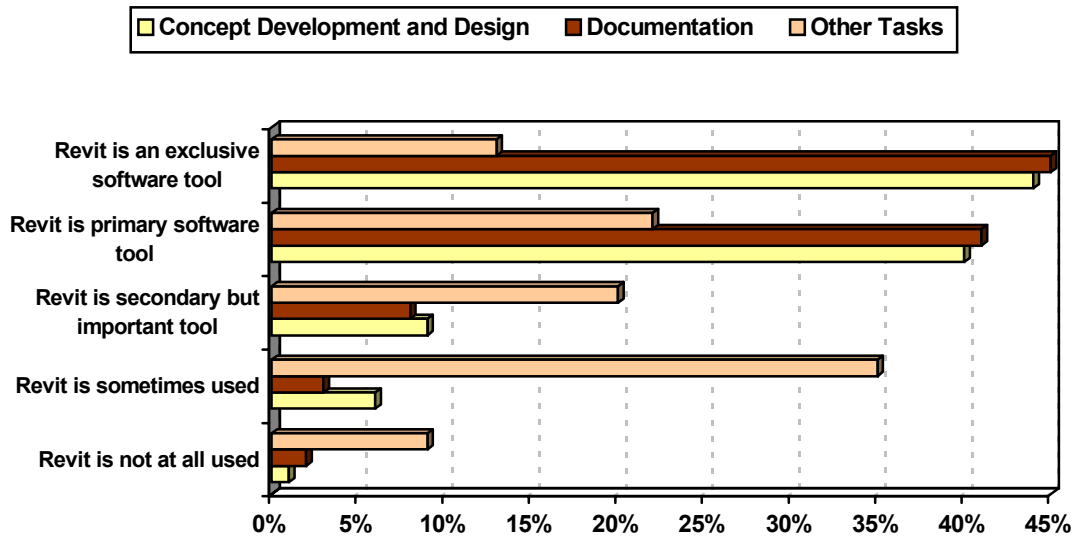


Figure 5: Revit is being used as the exclusive or primary software tool for the core architectural tasks, according to the web survey respondents.

In the research study, it was primarily the smaller firms that had used Revit for the entire range of design tasks for a project, from schematic design all the way to construction documents. The other respondents found Revit not sufficiently abstract and fluid to be useful in conceptual design. Also, because of issues with interoperability and coordination with the extended design team, they were still very often exporting the Revit building model to AutoCAD for preparing construction documents. The use of Revit, across the board, was found most effective at the design development stage as well as for generating renderings, walk-through animations, and area analysis. This was more so for complex projects that would be hard to visualize otherwise.

3.2 Impact on Business Practice

Most of the firms in the research study were positive about their use of Revit and reported significant benefits to their business practices, as described below:

- The ability to derive and deliver accurate and coordinated drawings, spreadsheets, and 3D views from the same set of information has had a major impact in extending the abilities of the firm mentioned in Section 2.2, letting them break into new markets efficiently. This 50-person firm uses Revit for leasing management, facilities management, infrastructure studies, programming, and design visualization and rendering. They find it most effective in information management (which comprises a large part of their work) and in 3D modeling.
- Revit has helped a small 3 person firm gain confidence that they are making good design decisions, which in turn makes them more confident taking on new projects. They are not afraid

to adjust or redesign individual areas because they know the drawings will stay coordinated. When clients ask for changes, they are happy to oblige them because Revit enables such changes to be made with ease. The phenomenal ability to visualize a design in 3D so quickly has changed the way this firm approaches and thinks about architecture.

- The use of Revit on a pilot project is allowing the designers of a large 670 person firm to focus on resolving design issues rather than CAD issues. Having witnessed the power of the BIM approach, many of these users have expressed worries about going back to plain CAD to work on future projects.
- While most firms did not yet have any measurable metrics or hard ROI on the impact of Revit usage on their practice, a 300 person firm reported that for several projects on which Revit was used, they had used only half the number of staff that had been originally budgeted and completed the work twice as fast. This firm uses Revit for a variety of tasks including design studies, area calculations, schedules (door, window, room, components), plans, sections, elevations, detail coordination, 3D perspectives, and in some cases, to study a particular problem in 3D.
- A 80 person firm has found that with the use of Revit, design is more efficient and presentation work takes far less time. They have used Revit for design, documentation, and presentation for two medium-size projects and various small scale competitions. One project was taken all the way from schematic design to the CD phase with Revit.
- Another 400 person firm that does both architecture and engineering has found the use of Revit more successful as a space planning and design development tool with few team members. The impact of Revit on the practice has been disruptive but intriguing. In addition to the time savings and reduced errors achieved by the automatic coordination capability, the near-elimination of traditional CAD standards is a big plus, saving time and reducing frustrations for both designers and IT support.
- A 150 person firm that does a great deal of work in property management is exploring the advantages of using a building information model to manage the different tenant spaces in a multi tenant building. They have found that one key benefit of using Revit in a tenant fit-up project is the ability to provide the building owner with more accurate data on sq. footage. They are also starting to see benefits in construction estimating. They have found the use of Revit most effective in interior fit-out projects.

The impact on business practice of the two case study firms that were studied in more detail using onsite visits is described in detail in Section 4.

Respondents to the web survey were asked to rate how their use of Revit affected their productivity in the various design stages, compared with their previous design methods and tools. As shown in Figure 6, major gains in productivity were reported in both the concept development and design as well as documentation stages.

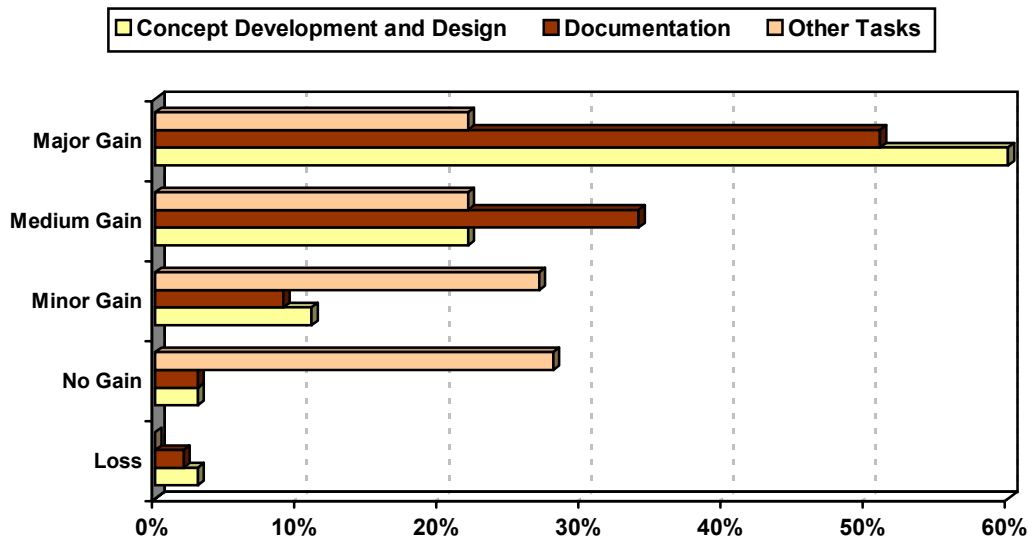


Figure 6: The web survey respondents reported major productivity gains from the use of Revit for core architectural tasks.

3.3 Key Strengths and Implementation Challenges

These are the main strengths of Revit collated from the responses of the firms who participated in the research study:

- Ease of use compared to other CAD and BIM applications, and thoughtful design of features.
- Coordinated views and documents, and instant update of all views when any change is made to the model.
- The ability, once set up, to automate many tasks related to drawing setup and coordination; this eliminates tedious and redundant grunt work and allows for more time to be spent on design.
- Accurate, informative drawings and 3D views that provide instant feedback on design decisions and force the designer to think three dimensionally, which in turn puts the fun back in design and ultimately leads to a better thought out design.
- The ability to conceptualize a project as a single 3D model in a single file rather than a multitude of 2D drawings, often in separate files.
- The speed with which quick 3D massing and rendering visuals can be generated and presented for expediting client approvals.
- Overall better communication with clients and builders.
- Built-in and accurate scheduling capabilities that provide instant schedules.
- The ability to capture specification information in the model.

- Good 2D-3D interoperability with AutoCAD, allowing AutoCAD plans to be referenced into Revit, and the developed drawings to be exported back to AutoCAD for the creation of construction documents.

These were identified as the main challenges in implementing Revit in architectural practice by the participating firms:

- Overcoming the resistance to change, and getting people to understand the potential and the value of building information modeling over 2D drafting.
- Adapting existing design processes to a new workflow.
- Training people in Revit, or finding employees who know Revit well. Some people “get it” but many don’t. Despite the ease of use of the application, the learning curve is still quite steep.
- Overcoming the presumption that Revit is a limited, unscalable design tool.
- Guaranteeing reliable output when projects get complex and a deadline approaches.
- The high-end hardware resources needed to run Revit efficiently.

4. ONSITE STUDIES

This section summarizes the findings of the detailed onsite studies conducted as part of the research study in two architectural practices that are aggressively implementing Revit. For the sake of confidentiality, they will simply be referred to as Firm A and Firm B.

4.1 Firm A

This is a 25-person firm based in San Francisco, CA, primarily doing interiors. They had been looking at Revit for some time and purchased a license to 8 seats in March 2003. At the time of this study, it had been in use for about 2 months on a pilot project.

Despite such a recent start, Firm A has the aggressive plan to transition 80% of all its new work to Revit within a few months. A few key factors are behind this decision. The firm is currently on AutoCAD R14, and a transition in application is long over-due. Other solutions were evaluated and Revit was found to be the best, with the potential to automate many of the tasks around drawing setup and coordination that are now done manually. The principals at the firm believe that building information modeling (BIM) is the future of the building industry, and they want to be one of the early adopters to gain a competitive edge as well as influence the industry to move to a newer and better technology. Being an interiors firm, the switch to a BIM application from a CAD application is easier to make, since the changes made by external consultants such as HVAC, electrical, and so on do not need to be re-entered into the project file. While the use of Revit at this point is focused on the creation of drawings, from space plans through construction documents, the future plan is to focus on its

advanced information management capabilities as an additional service to offer to the building client. Efforts are underway to determine the best way to market this additional service.

Firm A has faced several challenges in its implementation of Revit. Being an interiors firm, one shortcoming they found in Revit was the dearth of furniture libraries, requiring them to create a lot of custom content themselves. Also, contrary to their expectations, they did not find Revit ready for use out of the box and had to spend a lot of time developing a template with custom sheets, views, and so on that they could use across projects. Workarounds were needed for specific features that didn't work well for interior design, such as floor to ceiling heights for walls and continuous ceiling grids passing through walls. Another stumbling block was poorly timed training, that was provided prior to the development of the necessary project templates—leaving the staff trained but the software in a state not yet ready to be utilized.

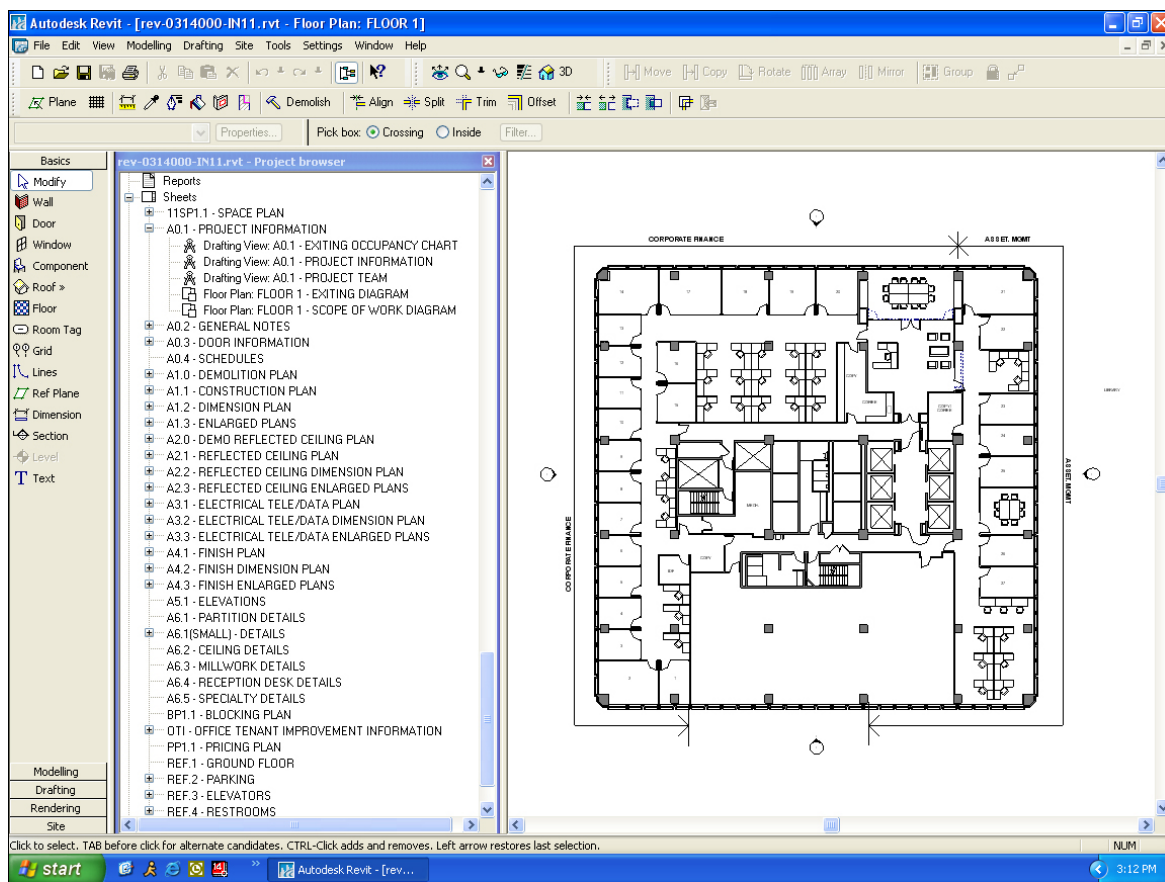


Figure 7: Much of Firm A's customization work in Revit has revolved around developing a template incorporating sheets and other office standards for use across projects, as shown in the Project Browser window. When complete, this template is anticipated to save an enormous amount of time and effort during design.

Firm A has put a lot of work into building a Revit template file incorporating their office standards that can be used across all their projects (see Figure 7). The template has all the necessary sheets set up to the required size, with the correct views on every sheet at the appropriate scale, along with schedules, sheet notes, key notes, generic drawing notes, legends, title blocks, and so on. The template

file also loads the most frequently used families used by the firm's designers. The firm anticipates that once this template is fully complete, the benefits of Revit will really start to kick in. The ability to click a button, open a template and start designing immediately, and already have the construction documents set up as the initial designs are taking place, is going to save them countless hours. The use of Revit will eventually mainstream a great deal of the workflow, allowing the designers to focus on the more important aspects of a project, which will ultimately lead to a better product for the client.

In summary, despite some frustrations to date, Firm A has committed to implementing Revit because they believe Revit to be a superior Autodesk product that will greatly improve the way they work and the work itself.

4.2 Firm B

This is a 64 person firm in Northern California, distributed across two locations. The head office is home to 50 employees; the smaller office with 14 employees is located some distance away. Firm B primarily specializes in educational facilities, from K-12 to university campuses, and has recently established a medical group to diversify its client base. The firm is fairly advanced in its outlook, and is implementing and evaluating several new technologies.

Revit had an early start in Firm B, right from version 1.0. It was evaluated and found potentially superior to other solutions, and has been used across a variety of projects since then. Of all the firms that participated in the research study with the exception of one, Firm B had the most advanced use of Revit, both in terms of the number of projects as well as the range of tasks for which Revit was used. The first complete project was an addition to a health clinic (see Figure 8), and Revit was used all the way from conceptual design to construction documents. The results were extremely positive, with a very low RFI (Request For Information) count. Several other Revit projects are in various stages of completion. There is a large hospital expansion project where Revit is being used to visualize both the massing and design aspects as well as the 4D construction/disruption planning and cost estimating. Revit is also being used extensively in several interior design projects for rendered realism and walkthroughs. Occasionally, Revit projects are transferred back to AutoCAD for final delivery or construction documents because of client requirements.

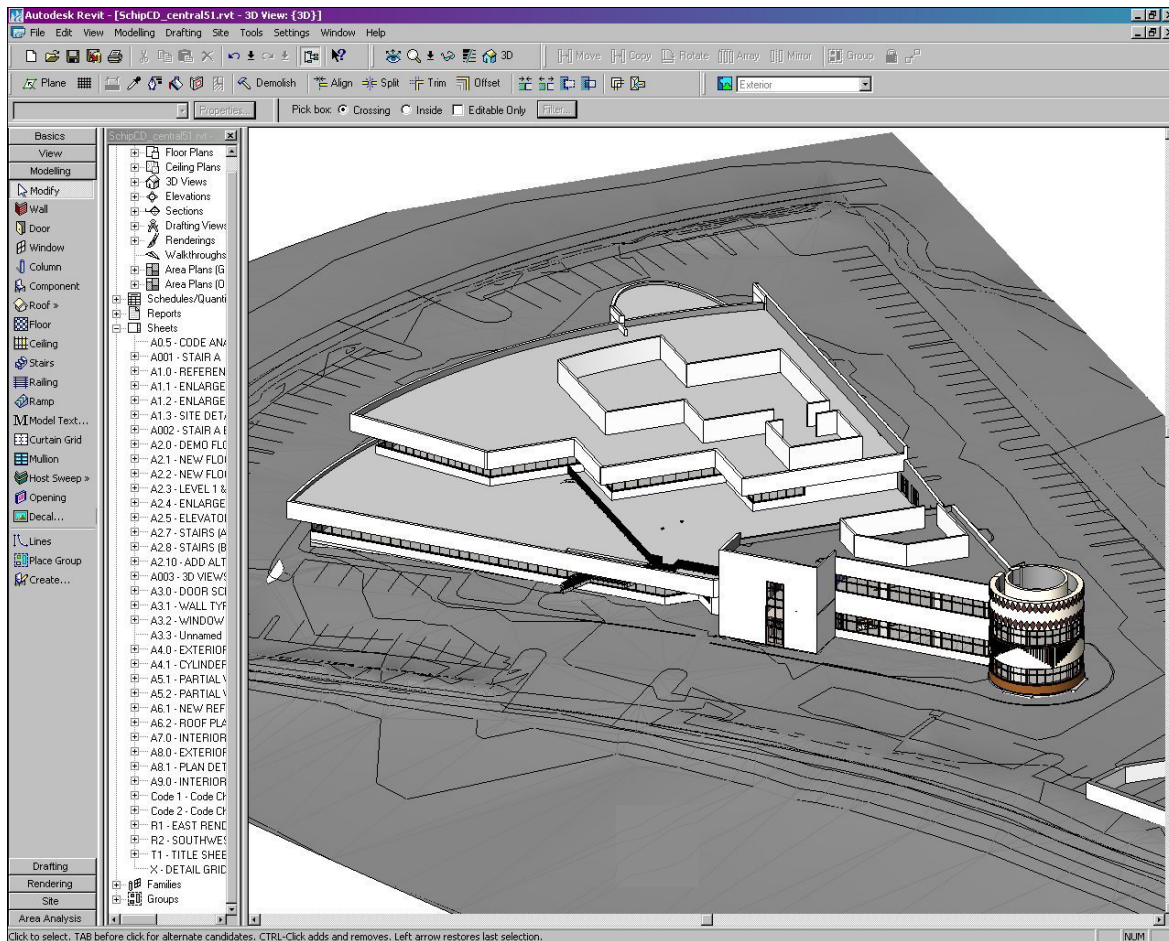


Figure 8: In Firm B's health clinic addition project, Revit was used all the way from conceptual design to construction documents.

Revit has caused Firm B to revisit all their established procedures and policies, from electronic deliverables to integrated rendering and preliminary cost estimating. The overall experience with Revit has been very satisfactory, and once users have become trained and comfortable with it, they do not want to go back to AutoCAD. Firm B sees simplicity and ease of use as the greatest strength of Revit, along with the fact that it is a complete, all-in-one solution for 4D building design, cost estimating, and rendering and animation. The ability to instantaneously see any desired view of the building brings a new understanding of design. Revit also expedites client approvals by allowing quick massing and rendering visuals to be generated, which clients understand far better than traditional floor plans and elevations. While the current use of Revit is focused on improving internal design processes and deliverables, the firm is in the process of determining how to leverage the building information modeling (BIM) capability of the application into more business and more revenues for the firm.

With regard to implementation challenges, the most critical one is how to define and enforce the guidelines necessary for working with large projects, given the firm's specialization in educational facilities. Also, Firm B designers find the use of Revit for conceptual design a little problematic as it is too focused on constructability, forcing them to think more about how the building goes together

rather than about design issues. There has been some reluctance among longtime AutoCAD users who are fearful that the switch from AutoCAD to Revit would make their skill set obsolete and require a new learning curve. However, once they saw how easy Revit was to learn and use, resistance dropped off dramatically.

In summary, Firm B has made tremendous strides in Revit implementation and is reaping its benefits in terms of speed, efficiency, productivity, and quality.

5. CONCLUSIONS

Both the research study and web survey have highlighted some clear facts. First, Revit implementation undeniably entails change. 82% of the web survey respondents noted that their design process was changing as a result of using Revit, and 80% reported that their deliverables were changing as well. Thus, Revit adoption is not going to be easy for those who are uncomfortable with change. As noted in Section 2.7, the resistance to change can be a difficult obstacle to overcome, since it deals with the architectural profession as a whole rather than just the technology group in a firm. Education and awareness, not just about Revit but about BIM is well, are critical to tackle the resistance to change.

Also, given that almost all the firms implementing Revit are grappling with the same fundamental questions of how to reinvent the work flow, how to staff and assign responsibilities, and what to model and what not to (as described in Section 2.3), they need to give priority to developing a clear and effective implementation strategy. This will also put them in a much stronger position to take better advantage of all BIM-related technologies as they evolve.

Despite the challenges involved in its implementation, the respondents to the research study and the web survey have, on the whole, clearly rated Revit as a superior application. Most firms who have evaluated it are moving ahead with implementing it on pilot projects, and several have already committed to it as their BIM solution of choice. After the tedious, redundant, time-consuming, and error-prone world of 2D CAD drafting, the parametric building modeling technology of Revit, with its automatic document generation and coordination capability, has revitalized the architectural profession and brought the fun back into design. Those who have persevered in their learning and use of Revit have come to love the application and find it anathema to go back to traditional CAD. For them, the practice of architecture will never be the same again.

