

A Productivity Comparison of AutoCAD and AutoCAD Architecture Software

AutoCAD® Architecture provides the best AutoCAD software-based design and documentation productivity for architects. This study details productivity gains over AutoCAD in designing and documenting a building.

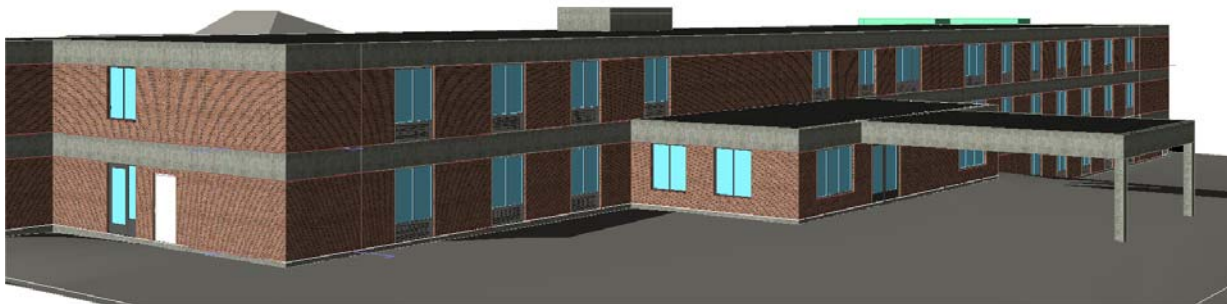
Executive Summary

An independent consultant and architect with over 20 years of experience preparing construction documents in AutoCAD® recreated a set of design documents using both AutoCAD and AutoCAD Architecture. Tasks ranged from drawing floor plans and sections to creating details and making revisions. The result: he completed the same set of tasks 32% faster using AutoCAD Architecture.

A White paper by David S. Cohn

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Background

More than 20 years after the first release of AutoCAD software, many architects are still using lines, arcs, and circles to represent buildings. AutoCAD Architecture makes AutoCAD better for architects by providing additional features and tools designed specifically for architectural drafting and design. This study provides details on these design tools and demonstrates the productivity gains they provide over traditional AutoCAD when it comes to designing and documenting a building.

The Study

Designed by Autodesk and commissioned to independent consultant David Cohn, the study consisted of the re-creation of ten sheets of an actual set of construction documents for a two-story addition to a hospital in both AutoCAD® and AutoCAD Architecture. The original drawings for the hospital were created in 1979 using traditional drafting methods.

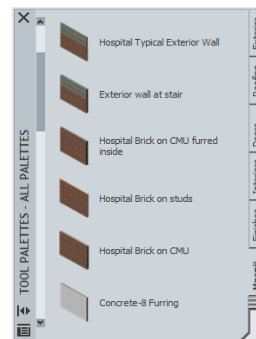
By removing the building design from the process, the study focuses solely on the productivity gains users might expect from drafting and documenting the design. The hospital consisted of two main floors of approximately 14,500 square feet each plus a partial basement level of 10,000 square feet, and a 7,000 square foot single-story wing. The study was broken down into nine tasks representing the typical stages in the creation of a set of architectural construction documents. The time required to complete each task in both AutoCAD and AutoCAD Architecture was recorded.

Although times required to create standards and layout the building plan were similar in the two programs, productivity gains in AutoCAD Architecture were significant in the areas of detailing, creation of section and elevation views, scheduling, and making modifications to existing work. A detailed description of the study follows.

Task 1: Floor Plans

When creating a set of construction documents, most architects begin with the floor plans. Before beginning the styles and symbols that will be used throughout the project have to be developed. For example, the hospital required a collection of building objects, such as walls, doors, windows, columns, and beams; and symbols, such as tags used to identify doors and rooms.

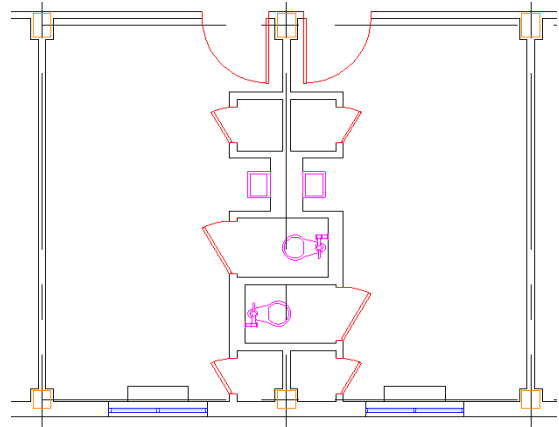
In AutoCAD®, the necessary geometry had to be created manually using lines and arcs to represent the doors, windows, columns, and beams. These were then saved as AutoCAD blocks. To create tags, attributes were added to the blocks. Later, when those blocks were inserted into the drawings, data such as room name and number would be entered and stored as part of the block so that the data could subsequently be used to create the necessary schedules. Tool palettes containing selections of tools and hatch patterns as well as the standard elements were also created, so they could later be added to the drawings by simply dragging and dropping.



While most of the symbols had to be created from scratch in AutoCAD, AutoCAD Architecture comes with a library of thousands of predefined objects. The needed components were simply added to the palette. In some cases, the objects were customized in order to make them conform to the unique requirements of the hospital project.

In AutoCAD, first the base drawings for the structural grid and existing buildings were created and saved as external references (xrefs) so that they could easily be reused in multiple drawings. A 2D representation of the walls was then drawn simply using lines. Working in 2D saved some time, since only the line work that would actually appear on the construction documents needed to be drawn. However, because AutoCAD doesn't "understand" what a wall or a door is, the lines had to be cleaned up manually.

Since the typical two-bed patient rooms consisted of a standard core that included individual toilet rooms and closets, this component was drawn one time and then copied to create each pair of rooms. After drawing the main portion of the first floor, the linework was copied to the second floor.



To create the floor plans in AutoCAD Architecture, a typical two-bed patient room core was created as a three-dimensional element that could be reused. As in AutoCAD®, the main portion of the first floor was drawn and then copied along with the walls, doors, and windows for use on the second floor. But unlike AutoCAD, AutoCAD Architecture works with objects that represent actual architectural components. When two walls intersect, the software cleans up the line work automatically. When the user inserts a door or window into a wall, the software automatically creates the necessary opening and cleans up the line work. As a result, it took considerably less time to create the walls in AutoCAD Architecture than to simply draw the geometry in AutoCAD.

After creating the plans, dimensions, annotations, and tags were added. The automatic dimensioning tools in AutoCAD Architecture resulted in a modest time savings compared to the manual dimensioning commands in AutoCAD.

It took 21.5 hours to complete the two floor plans in AutoCAD versus 20 hours using AutoCAD Architecture.

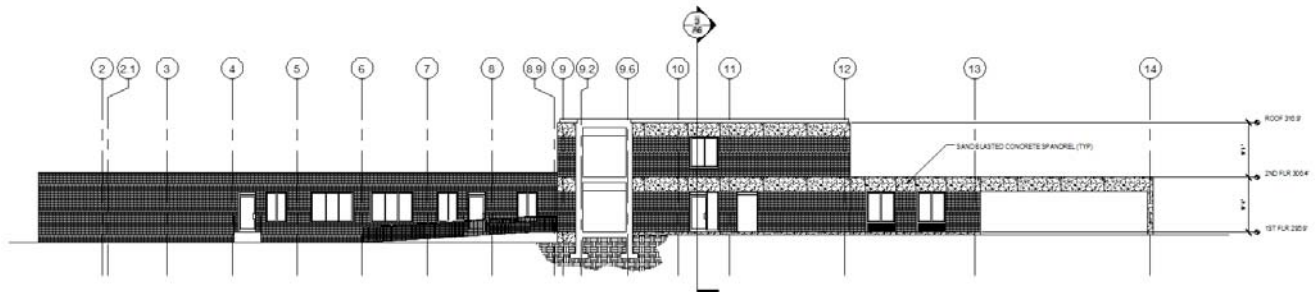
Task 1: Floor Plans	Subtasks	AutoCAD (hrs)	AutoCAD Architecture (hrs)
	Set up project	0.0	0.25
	Create structural grid and place columns	1.5	1.5
	Create outlines of existing buildings	0.25	0.25
	Create custom windows and doors	1.0	1.0
	Create custom wall types	0.0	1.0
	Create first floor	11.75	8.5
	Create custom tags	0.5	0.0
	Add dimensions and tags to first floor	2.5	2.6
	Create second floor plan	2.25	1.0
	Add dimensions and tags to second floor	1.75	1.0

Add floor and roof slabs	0.0	0.25
Create basement level	0.0	0.4
Model topography	0.0	1.0
Model stairs and ramps	0.0	1.25
Total time:	21.5	20.0

Task 2: Elevations

In this task, four primary elevations—north, south, east, and west—and an additional partial elevation showing the western-most end of the hospital were created. In order to accurately depict the building, several of these elevations also showed cross-sections through portions of the building.

Because the AutoCAD building plan existed only as a 2D drawing, the sections had to be created by projecting lines from the floor plans, the same technique used in manual drafting. After projecting the geometry, each elevation had to be created manually by first creating blocks to represent the windows and then adding those 2D windows to the elevations. Hatch patterns were used to indicate the brick walls and concrete spandrel beams. Window elevation blocks and hatch patterns were added to the custom tool palette for reuse using drag-and-drop techniques.



AutoCAD Architecture automatically creates elevations by extracting the necessary line work from the three-dimensional model. All the user needs to do is place appropriate elevation callout marks on the floor plan and indicate the direction of the view. AutoCAD Architecture provides specific callout tools for sections, interior/exterior elevations, and details. These callout tools automatically create associated views from the three-dimensional building model. The resulting elevations automatically depict the proper materials because the material type has already been included as part of the wall type definition.

It was at this stage that the time required to model the building in AutoCAD Architecture began to pay off. It took 6.75 hours to create the building elevations using AutoCAD® and only 3 hours to complete them using AutoCAD Architecture.

Task 2: Elevations	Subtasks	AutoCAD (hrs)	AutoCAD Architecture (hrs)
	Project geometry from floor plans	0.75	0.0
	Create 2D blocks of window elevations	0.5	0.0
	Complete elevations	5.5	3.0
	Total time:	6.75	3.0

Task 3: Reflected Ceiling Plans

Reflected ceiling plans show the arrangement of ceiling grids and the locations of light fixtures. To complete this task using AutoCAD, the floor plans were retrieved and layers that would not need to be visible in the ceiling plans were turned off. A custom hatch pattern was then created to represent the 2x4 ceiling tile pattern needed for the hospital. The perimeter of the ceiling of each room was then outlined using polylines. With the outlines completed, ceiling tile pattern in each room was created as a hatch pattern.

A dynamic block was then created to represent the light fixtures and was placed on the tool palette. The drag-and-drop method was then used to add light fixtures to the ceiling plan.

In AutoCAD Architecture, space objects were used to automatically create outlines for each room. Task-specific tools were then used to quickly place 2x4 ceiling grids in each of the rooms. Light fixtures were inserted by locating pre-drawn light fixtures supplied as part of AutoCAD Architecture's extensive content library and dragging-dropping them from the DesignCenter™ feature. This task took 3 hours in AutoCAD and less than 2 hours in AutoCAD Architecture.

Task 3: Ceiling Plans	Subtasks	AutoCAD (hrs)	AutoCAD Architecture (hrs)
	Draw first floor ceiling plan	1.25	0.75
	Add light fixtures to first floor ceiling plan	0.5	0.5
	Draw second floor ceiling plan	1.0	0.25
	Add light fixtures to second floor ceiling plan	0.25	0.35
	Total time:	3.0	1.85

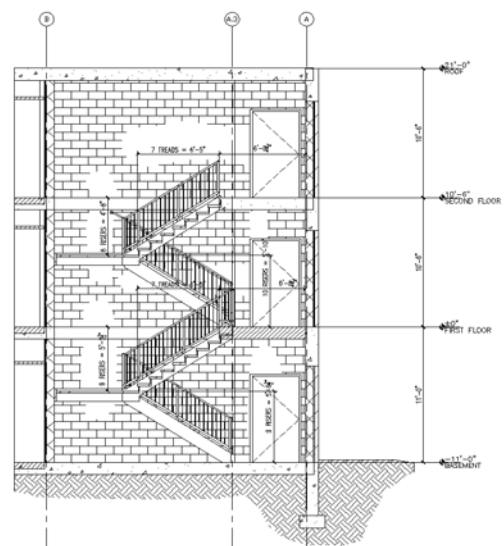
Task 4: Building Sections

Like elevations, building sections aid in understanding the design of a building and are a significant part of construction documents. While several of the elevations created in Task 2 showed partial sections through the building, two major new cross-section views were created through the building - one lengthwise looking north, and one across the width of the building looking west. The latter section also extended through the entire single-story wing of the hospital.

less than half the time to complete using AutoCAD

Creating the building sections in AutoCAD® was similar to what was done to create the building elevations. Lines were projected from the floor plan and then the line work was manually completed.

In AutoCAD Architecture, the building sections were created automatically using tools identical to those used to create the elevations. All that was required was to place the appropriate section callout mark and indicate the view direction. After the section was generated, the line work was adjusted to match the drawing to the office standards. Again, this task took



Architecture.

Task 4: Sections	Subtasks	AutoCAD (hrs)	AutoCAD Architecture (hrs)
	Create building section looking north	1.75	0.75
	Create building section looking west	2.0	0.75
	Total time:	3.75	1.5

Task 5: Sheet Layouts

With many of the basic views nearing completion, the next step was to prepare the individual sheets that would comprise the set of construction documents. Both AutoCAD® and AutoCAD Architecture use Sheet Sets to create the sheets, so the procedure was similar in both programs. Once the sheets were generated, files could be dragged and dropped to create viewports, setting drawings onto the appropriate sheets.

As part of the process, a perspective view of the hospital was to be placed on the cover sheet. Since the building was created only in AutoCAD as 2-D only, a simple 3D wireframe outline of the building had to be created. Two dimension elevation views, as blocks, were then applied to the three-dimensional armature as appliquéés to create the appearance of a 3D model.

But since the building was actually modeled in 3D in AutoCAD Architecture, creating the perspective view simply required the use of the camera tool. Other tools in AutoCAD Architecture also shortened the time required to place and adjust views on each sheet. After placing views, minor modifications were made to the elevations and sections to get them looking exactly as desired. In spite of this additional work, this task was completed in AutoCAD Architecture in less than half the time compared to AutoCAD.

Task 5: Sheet Layouts	Subtasks	AutoCAD (hrs)	AutoCAD Architecture (hrs)
	Create sheet set	1.25	0.1
	Create cover sheet including perspective	1.25	0.5
	Create sheets and place floor plans and ceiling plans	0.85	0.3
	Create elevation/section sheets and place views	1.0	0.2
	Create empty sheets for details and schedules	0.15	0.15
	Modify elevations and sections	0.0	0.75
	Total time:	4.5	2.0

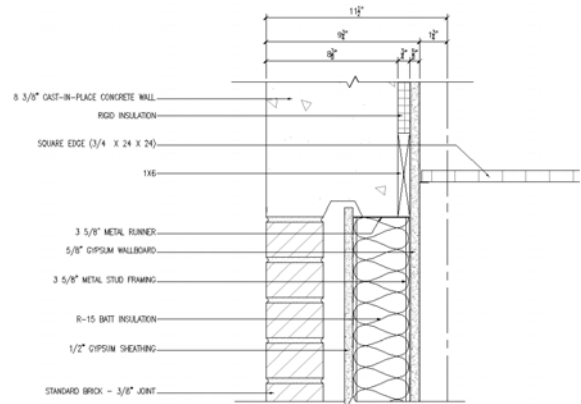
Task 6: Details

Architectural construction documents often include many sheets of large scale details. Rather than recreate the fifteen sheets of details comprising the original hand-drawn construction documents for the hospital, a single sheet that focused on several of the types of details that would normally be used was created. This sheet included an enlarged plan of a typical two-bed patient room, a section through the primary exit stair tower, a typical wall section, and large scale details of wall section showing the specific conditions at the floor and ceiling.

Using AutoCAD, a view of the first floor plan was placed on the appropriate sheet in the sheet set, and the size and scale adjusted so that only the two patient rooms were visible. Then the layer visibility was adjusted so that only the necessary information would be visible. But the other details needed to be created from scratch, which was done by projecting lines from the floor plan. Creating the section through the stair tower was particularly time consuming in AutoCAD, since each component had to be created manually. To label components, leaders had to be created and each note had to be typed manually.

In AutoCAD Architecture, creating the enlarged plan of the typical patient room required creating a new view drawing, a task that was automated using standard tools within the software. The stair section, on the other hand, required only placing a section callout to create a new model space view. The hatching then had to be adjusted and the appropriate dimensions and callouts were added.

To create the typical wall section, a detail boundary callout was placed onto the building section view created in an earlier task, generating the detail background. Then the detailing tools and extensive Detail Component Manager were used to finish the work. Similar methods were used to create the two large scale details at the floor and ceiling levels. Because AutoCAD Architecture knows which materials were chosen from the software's library, labeling components was accomplished by simply selecting each component and then using the keynote tool to place the keynote. No typing was required.



Completing this task took about half the time in AutoCAD Architecture as it did in AutoCAD. The task was limited to a single sheet. In an actual project, there would be many sheets of large scale details, so the time savings would be even more significant.

Task 6: Details	Subtasks	AutoCAD (hrs)	AutoCAD Architecture (hrs)
	Create enlarged plan view	0.25	0.2
	Create section through stair	2.5	0.3
	Create typical wall section	0.75	0.75
	Create concrete spandrel detail at floor and ceiling	0.75	0.75
	Total time:	4.25	2.0

Task 7: Schedules

In this task, door and room finish schedules were created and then updated to reflect changes made to the plans. For example, if a door size was changed, the resulting schedule needed to update to reflect the change.

Since door and room tag blocks that included attribute information were already created, the revised AutoCAD Attribute Extraction wizard was used to extract this data directly to schedules that could easily be placed on the appropriate construction document sheets.

In AutoCAD Architecture, the Door Schedule tool was used to create a door schedule based on the tags previously added to the floor plans. A similar method was used to generate a room finish schedule based on tags already placed on the floor plans. These schedules were easily placed as tables directly on the appropriate sheets.

Using AutoCAD®, table styles appropriate for the door and room finish schedules first had to be created, whereas AutoCAD Architecture already includes table styles appropriate for most of the typically scheduled elements.

Task 7: Schedules	Subtasks	AutoCAD (hrs)	AutoCAD Architecture (hrs)
	Create door schedule	0.75	0.15
	Create room finish schedule	0.25	0.15
	Total time:	1.00	0.3

Task 8: Project Modifications

In the real world of building design, changes are unavoidable. To reflect the types of changes that often occur in typical architectural projects, this task was included to provide a series of both minor and major edits, to see how each product could be used to make adjustments. These tasks included moving doors and walls and changing several rooms from four-bed patient rooms to two-bed rooms. The modifications resulted in changes that would be reflected in both the floor plans and reflected ceiling plans, in the building elevations and sections, and in the door and room finish schedules.

Because AutoCAD drawings did not contain intelligent objects, even a small change, such as moving the location of a door or changing the size of a window required a considerable amount of manual rework. In moving a wall a few feet, for instance, adjoining lines had to be redrawn. And when an AutoCAD block representing a door was moved from one section of a wall to another, the wall at the old location had to be healed and a new opening had to be created at the new location.



In contrast, the objects in AutoCAD Architecture maintained their relationships and design changes were able to be propagated throughout the entire model. When a door was moved, the walls automatically updated to reflect the new location. The opening also automatically healed itself at the old location and the new opening was created automatically at the new location.

This difference between the two programs was even more dramatic when the changes also had to be reflected in the building elevations and sections. Since the elevations and sections were manually created using simple line work in AutoCAD, each change required manual rework in each of these views. In AutoCAD Architecture, because sections and elevations are linked to the model, separate revisions were not required. After making changes to the floor plan, the sections and elevations could be updated automatically across the entire project.

In AutoCAD, it took several hours to make even the modest changes required by this task. In AutoCAD Architecture, it took less than an hour.

Task 8: Project Modifications	Subtasks	AutoCAD (hrs)	AutoCAD Architecture (hrs)
	Modify floor plans	1.0	0.5
	Modify reflected ceiling plans	0.5	0.25
	Modify elevations	0.15	0.1
	Modify sections	0.1	0.05
	Modify schedules	0.1	0.0
	Update perspective view	0.5	0.0
	Total time:	2.35	0.9

Task 9: Coordination and Publishing

Project coordination is often a very time consuming process. Architects must make sure that the drawings are complete, that all callouts correctly refer to the proper drawings on the correct sheets, and that all of the necessary information is provided. Then, the drawings must be sent out for production. If a detail, a sheet, or even an important notation is inadvertently omitted, the project can be delayed, or costly results may result.

In this study, the final task involved reviewing the sheets, making minor modifications to several of the drawings, adding additional callouts for various elevations, sections, and detail views and linking them to the appropriate views on individual sheets.

In both AutoCAD® and AutoCAD Architecture, this task is aided by the Publish tools, which enable all of the sheets in the set to be published in a single step. Rather than printing the construction documents, they were published as DWF™ files. The DWF file specification was developed by Autodesk as a medium for architects, engineers, and other professionals to quickly capture and securely distribute rich design data anywhere it is needed. Anyone can view and print DWF files using free viewing tools available on the Autodesk website.

The Publish tools provided as part of both AutoCAD and AutoCAD Architecture enabled these DWF files to be rapidly created. In addition to the ease with which the construction documents could now be distributed, the resulting multi-sheet DWF file had another distinct advantage over paper drawings: callouts within the DWF files were automatically linked to the elevations, sections, and details to which they referred. A person viewing the DWF file could therefore quickly locate referenced views by simply clicking on the callouts.

Task 9: Coordination and Publishing	Subtasks	AutoCAD (hrs)	AutoCAD Architecture (hrs)
	Add callouts and make other corrections and additions to the drawings	1.0	1.0
	Publish	0.25	0.1
	Total time:	1.25	1.1

Conclusions:

It required 48.4 hours in AutoCAD and 32.7 hours in AutoCAD Architecture to create identical sets of construction documents. The time saved using AutoCAD Architecture amounted to nearly 16 hours, making it 32% faster than AutoCAD.

	AutoCAD (hrs)	AutoCAD Architecture (hrs)
Total time:	48.35	32.65

This is even more remarkable considering that the consultant conducting the test had been using AutoCAD® software for more than 20 years and had only limited experience using AutoCAD Architecture before beginning this project.

AutoCAD Architecture clearly offers a level of efficiency and productivity for architects that is simply not attainable using general purpose CAD tools such as AutoCAD. And because AutoCAD Architecture is built on AutoCAD and has a familiar user interface, you can be productive right away with your existing ways of working and implement the program's increasingly powerful features at your own pace to realize the productivity benefits described in this paper. If you would like to find out more about AutoCAD Architecture, please visit www.autodesk.com/building.

David S. Cohn

David Cohn has more than 20 years of hands-on experience with AutoCAD as a user, developer, author and consultant. He is a licensed architect and began using AutoCAD in his practice in 1985. David is the publisher and editor-in-chief of *CADCAMNet* and *Engineering Automation Report*, the former senior editor of *CADalyst* magazine, a contributing editor to *Desktop Engineering* magazine and the author of more than a dozen books on AutoCAD. David was also one of the earliest AutoCAD third-party software developers, creating numerous AutoCAD add-on programs. As an industry consultant, David has worked with many companies, including both software developers and end users. He teaches college-level AutoCAD courses and is always a popular presenter at Autodesk University.

The productivity improvements that are the subject of this paper were derived from the results of a study commissioned by Autodesk in which the participant had an established level of expertise using AutoCAD software. The selected tasks discussed in the study were designed to simulate day-to-day production drafting. As with all performance tests, results may vary based on machine, operating system, filters, and even source material. While every effort has been made to make this study as fair and objective as possible, your results may differ.

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