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2006

A Productivity Comparison of AutoCAD and Autodesk Architectural Desktop

Autodesk Architectural Desktop extends the functionality of AutoCAD to offer a simpler, more natural approach to the way architects work. 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.

CONTENTS

More than 20 years after the first release of the AutoCAD® software, architects are still using lines, arcs and circles to represent building objects. But typically they refer to those drawn objects by the entities they represent—walls, doors, windows, and columns. Autodesk® Architectural Desktop extends the functionality of AutoCAD to offer a simpler, more natural approach to the way architects work. Architectural Desktop offers libraries of thousands of ready-made real-world building objects to choose from. These objects maintain intelligent relationships to each other, and the building model becomes the single data set for generating project documents—plans, elevations, sections, and schedules—so that anytime there's a design change, documents update accordingly. 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.

Designed by Autodesk and commissioned to independent contractor and consultant John Janzen in February 2004, the study consisted of the design of a three-story office building in both AutoCAD and Architectural Desktop applications. (Janzen worked with AutoCAD 2005 and a pre-release version of Architectural Desktop 2005.) The design was broken down into nine tasks and a series of subtasks that represented the typical stages in the design of a building. All of the subtasks were timed and the times logged onto an Excel spreadsheet. Although it took relatively the same amount of time in both program to create standards and to layout the building plan, productivity gains in Architectural Desktop were seen in the editing of the design and in the creation of construction documents. Changes in Architectural Desktop propagate through the entire design and documentation, creating less manual rework. A detailed description of the study follows.

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Task 1: Standards

Before getting down to the business of designing a building, the first task is to create a palette of styles and symbols for use throughout the design. Standards for the office building in this study included several objects (wall, single leaf door, double door, column types, beam types) and tags (door, window, and room) and a title sheet along with a template file of project data and a user palette of tools.

A style is a specification for variations of a particular object type that makes an object correspond to the characteristics of its real-life counterpart. A tag reports essential non-graphic information about the object, such as the dimensions and fire rating of a door, that later appears in the building schedules (see Schedules). Tool palettes are a selection of tools and hatch patterns presented graphically in the user interface so that the user can drag and drop the items from the palette into the design.

In AutoCAD Janzen manually had to create all his geometry. He used lines and arcs to represent doors, windows, walls, columns and beams. He then stored these as blocks in a separate AutoCAD directory. To create a tag in AutoCAD, he added attributes to simple blocks that he would later insert into the drawing just prior to scheduling the objects.

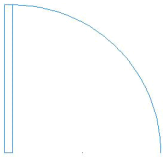

Figure 1. Simple lines and arcs are used to create a door object in AutoCAD.

In contrast, Architectural Desktop offers a library of intelligent objects that you can scroll through and select from. In fact, Architectural Desktop ships with thousands of pre-created object styles, annotations, furniture, and schedules. Relevant portions of the shipping content are based on the U.S. National CAD Standards. Janzen selected the objects he needed, added them to his palette, and modified them as required. In Architectural Desktop, these intelligent building objects know their form, fit, and function and behave like their real-world counterparts.

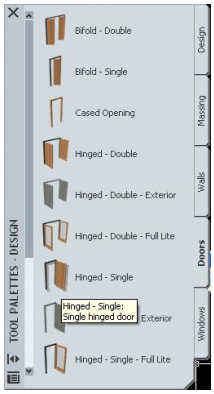

Figure 2. To create a door object in Architectural Desktop, the user scrolls through a list of intelligent objects to select the exact type of door needed.

Adding tags in Architectural Desktop also is automatic. When you add a tag, the program automatically includes in the tag information from the design. A door tag, for instance, reads information from the door object and the room that the door is located in. If a room number changes from 101 to 102, the door number changes from 101A to 102A accordingly. These updates reflect in the door schedule as well.

It took 1.5 hours for Janzen to complete the standards in AutoCAD and one hour in Architectural Desktop. Although the differences may not appear significant in this three-story office building, the time savings would be considerable for a much larger complex.

Task 1: Standards	Subtasks	AutoCAD (hrs)	Architectural Desktop (hrs)
	CMU wall style	0.00	0.00
	stud wall style	0.00	0.00
	single leaf door	0.25	0.00
	double door	0.25	0.00
	column types	0.25	0.00
	beam types	0.00	0.00
	door tag	0.25	0.00
	window tag	0.25	0.00
	room tag	0.25	0.00
	title sheet	0.00	0.00
	template file	0.00	1.00
	Total time:	**1.50**	**1.00**

Task 2: Building Plan

Once standards are complete, the next step is to draw the building plan. The goal in this task was for Janzen to create a building with three 20,000-square-foot floors. Each floor had to surround a common building core and have a curtain wall exterior shell. In this task, the subtasks were to create: a building shell, floor partitions, a roof plan, ceiling plans, floor spaces, a structural grid, ceiling joints, and blowups for the restrooms (one set per floor), building core, stairway, and entry. It should be mentioned that during the Architectural Desktop drawing stage, a lot of decision making took place and things were edited and sometimes redrawn. In contrast, the AutoCAD drawings were based on the Architectural Desktop design, thereby reducing the time it took to create them.

When it came to designing the exterior shell of the building, AutoCAD allowed Janzen to create only a 2D representation of the curtain wall. In Architectural Desktop, however, he was able to use a 3D representation of the curtain wall, known as a curtain wall object, that allowed him to set rules to model the complete shell of the building. It ended up taking him 3 hours to create the building shell in Architectural Desktop compared to 2.5 hours in AutoCAD. In Architectural Desktop, however, it's important to note that this extra work set the basis for the automatic generation of building sections and elevations, that ultimately saved time on the project as a whole. [See Task 4]

In AutoCAD, the floor partitions were created as individual drawing files with simple linework and then copied out to the other floor plans. The area was calculated through perimeter polylines drawn within the rooms.

To create the floor partitions in Architectural Desktop, Janzen completed a drawing of the first floor and copied it for use on the second and third floors. Using space objects, he was able to quickly generate the room area based on walls and polylines.

Architectural Desktop offered no advantages over AutoCAD in creating the ceiling grids. The procedure in both programs was the same, however, Janzen was able to locate an

Architectural Desktop VBA routine to speed the placing of ceiling grid objects within the rooms. (Many Autodesk partners offer shareware to improve some tasks in Architectural Desktop or AutoCAD.) Using this tool, he was able to create the ceiling plans in 1.5 hours in Architectural Desktop compared to 4.5 hours in the AutoCAD software.

Creating ceiling joists took three hours in Architectural Desktop using structural members and gave a more accurate 3D representation of the sections. Janzen skipped this subtask in AutoCAD, since there was no benefit to creating structural framing drawings in a 2D environment.

Overall, it took 23.25 hours to generate the building plan in AutoCAD and 21.75 in Architectural Desktop.

Task 2: Plan Creation	Subtasks	AutoCAD (hrs)	Architectural Desktop (hrs)
	building shell drawing	2.50	3.00
	1st floor partitions	5.00	4.00
	2nd floor partitions	2.00	1.00
	3rd floor partitions	2.00	1.00
	roof plans	0.50	0.50
	1st floor ceiling	1.50	0.50
	2nd floor ceiling	1.50	0.50
	3rd floor ceiling	1.50	0.50
	1st floor space	0.00	1.00
	2nd floor space	0.00	1.00
	3rd floor space	0.00	1.00
	structural grid	1.00	0.50
	1st columns	0.75	0.75
	2nd floor columns	0.75	0.75
	3rd floor columns	0.75	0.75
	1st floor ceiling joists	0.00	1.00
	2nd floor ceiling joist	0.00	1.00
	3rd floor ceiling joist	0.00	1.00
	restroom blowups	1.00	0.50
	core blowup	0.50	0.50
	stair blowup	1.00	0.50
	entry blowup	1.00	0.50
	Total time:	**23.25**	**21.75**

Task 3. Building plan edit

In the real world of building design, small changes are unavoidable. To reflect this in the study, this task was included to provide a series of minor edits and see how each product handled change. These tasks included: move, add, and remove doors; move core walls; add rooms; and relocate and modify the ceiling grid from a 2x4 to a 2x2 tiling pattern.

It was at this stage that the productivity benefits of Architectural Desktop's intelligent objects began to show. Because AutoCAD objects contain no intelligence, even small changes created manual rework. In moving a wall a few feet, for instance, Janzen had to redraw the adjoining lines. And when he moved an AutoCAD block representing a door from one section of a wall to another, he had to heal the wall at the old location and re-break it at the new.

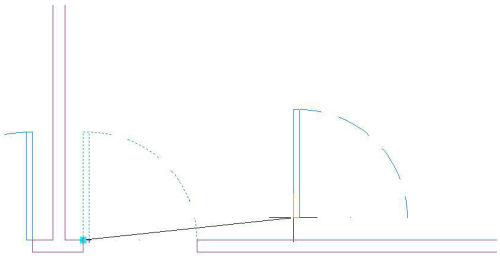

Figure 3. Objects in AutoCAD contain no intelligence so in moving a door, the user has to manually heal and re-break the wall.

In contrast, objects in Architectural Desktop maintain relationships and design changes propagate through the entire model, even the construction documents. When Janzen moved a door, the walls automatically updated to reflect the new location and wall and door tags—even those that existed as an xref in an adjacent drawing—updated as well.

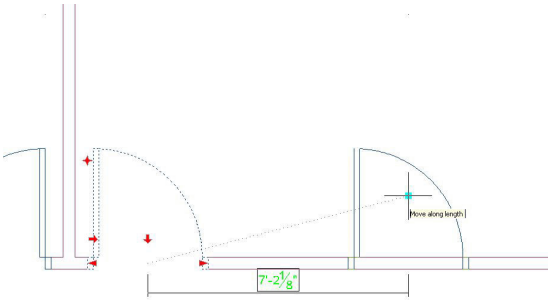

Figure 4. In conjunction with walls, doors in Architectural Desktop reposition automatically.

In the end, it took Janzen 10.5 hours to make the specified edits in AutoCAD compared to 4.5 hours in Architectural Desktop.

Task 3: Plan Editing	Subtasks	AutoCAD (hrs)	Architectural Desktop (hrs)
	modify doors	3.00	1.00
	move core walls	1.50	0.50
	move wall	1.50	1.00
	add rooms	2.00	1.00
	relocate ceiling grid	2.00	0.50
	modify ceiling grid to 2x2	0.50	0.50
	Total time:	**10.50**	**4.50**

Task 4. Sections and elevations

Sections and elevations show how the building looks from different angles and cross sections. They aid in the study of the design and are a significant piece of the construction documents. In this task, Janzen had to create four elevations—north, south, east, and west—and three building sections, two on the long axis and one on the short. One long axis section cut through the stairwell and the short axis section cut through the recessed front entry and building stairs.

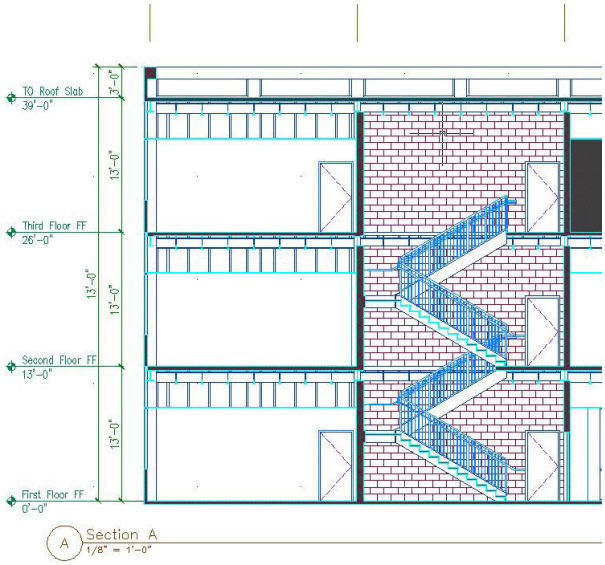

Figure 5. Lines are projected to create a section view in AutoCAD.

Because the AutoCAD building plan existed as a 2D drawing, Janzen had to project lines from the floor plans in order to create elevations. To create the sections, he had to reference each floor plate and project lines from the plans using the same techniques as in manual drafting.

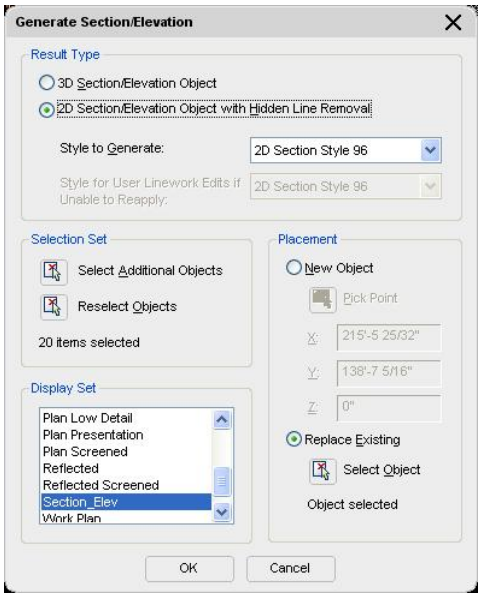

Figure 6. Objects are used to generate sections and elevations automatically in Architectural Desktop.

Architectural Desktop automatically extracts the line work to create sections and elevations. And because walls, doors, and windows are intelligent, details such as surface material and wall patterns are automatically extracted as well. To create his views, Janzen simply placed a section or elevation callout into the plan and indicated the direction of the view. Architectural Desktop offers specific callout tools for sections, interior/exterior

elevations, and details. These callouts automatically create associated views from the building model.

It took 12.5 hours using AutoCAD software to create the building section and elevation views, as compared to three hours to complete the tasks using Architectural Desktop—a significant time difference.

Task 4: Sections and Elevations	Subtasks	AutoCAD (hrs)	Architectural Desktop (hrs)
	initial creation	0.00	0.00
	wall section	1.50	1.00
	building section	11.00	2.00
	detailing	0.00	0.00
	Total time:	**12.50**	**3.00**

Task 5. Section and elevation edits

After sections and elevations are complete, it still may be necessary to make changes. In this task, Janzen was required to move doors, windows, and walls around and make sure those changes reflected in the sections and elevations he had just created.

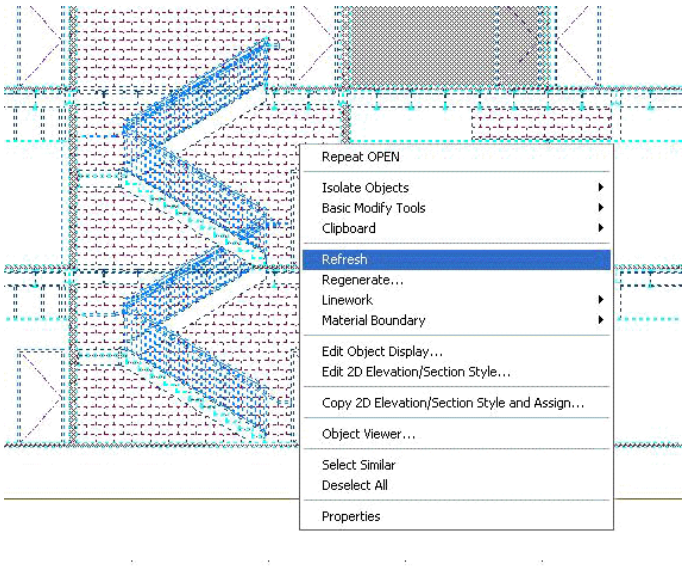

Figure 7. A "refresh" command in Architectural Desktop updates sections and elevations after a design change.

In AutoCAD, Sections and elevations are simple line work, so Janzen had to basically start from scratch in projecting lines to recreate the sections and elevations after design changes. This is a key point of differentatiation between AutoCAD and Architectural Desktop. In Architectural Desktop, because sections and elevations are linked to the model, Janzen did not have to make separate revisions to both his design and construction documentation. After making changes to the floor plan, he was able to update the sections and elevations selectively or across the entire project, so the task consisted of "refreshing" and checking the annotation.

In AutoCAD, it took seven hours to edit sections and elevations; in Architectural Desktop, it took only three hours.

Task 5: Sections and Elevations Edit	Subtasks	AutoCAD (hrs)	Architectural Desktop (hrs)
	redraw after plan edit	0.00	0.00
	wall section	1.00	1.00
	building section	6.00	2.00
	detailing	0.00	0.00
	Total time:	**7.00**	**3.00**

Task 6. Schedules

Shedules are used by the building contractor to quote work and order materials. A door schedule, for example, includes the door size, type, fire rating, and other information not represented by the door object in its graphic-only form. In this task, Janzen had to create schedules for the doors, room finish, and area usage, and make sure these schedules updated after any plan edits.

In AutoCAD, schedules are created manually. Janzen inserted blocks that contained attributes for the schedules into the drawing. Once all the blocks were inserted, he used the Attribute Extract command to extracted the information from the blocks into a Microsoft® Excel spreadsheet. He then formatted the data to properly represent the schedule and inserted the Excel file into the AutoCAD drawing as a table object. Afterwards, he made a small adjustment to one of the door tags. This created a break in the continuity between the door tag blocks, the Excel spreadsheet, and the drawing schedule. To fix this, he had to re-extract the attributes and reinsert them back into the table.

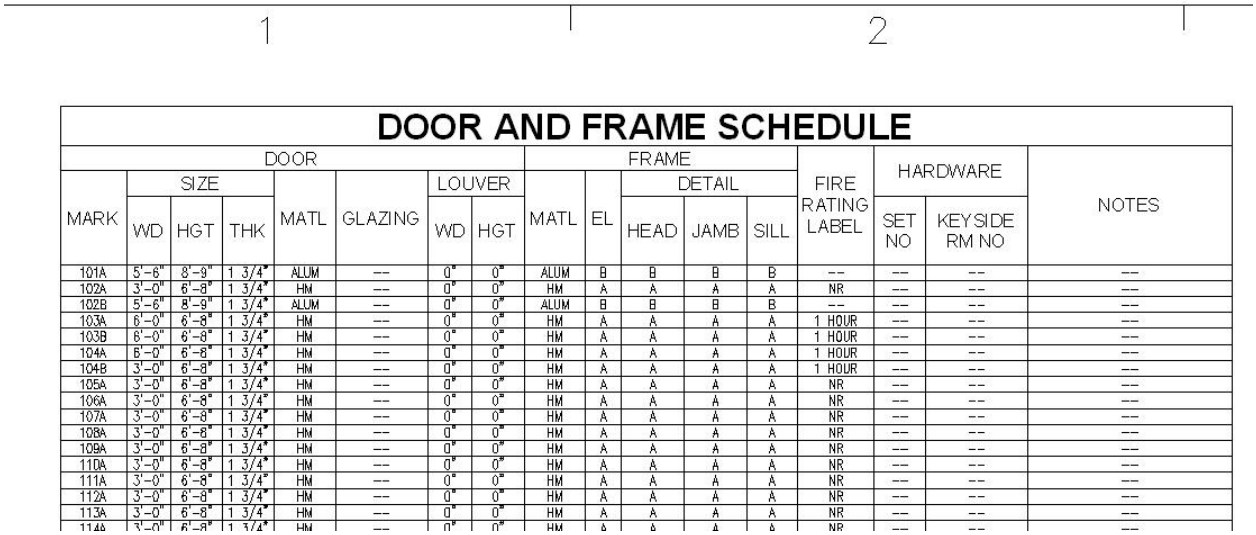

Figure 8. Door schedule in Architectural Desktop. Detailed schedules are created automatically from the building model.

In Architectural Desktop, the schedules are dynamically linked to the design data, allowing you to easily create detailed schedules from the building model. Architectural Desktop lets you choose from a number of templates to create the door, room finish, and room area schedules and then pulls the information from the objects themselves. Janzen did not need to create any additional tags as tags are only required to annotate the objects being scheduled. After making a change to a door, he only needed to send a simple update

request to the schedule object, and Architectural Desktop re-queried the drawing for the information. This ensures that the design information is synchronized with documentation. Scheduling took 13 hours in AutoCAD and 2.75 hours in Architectural Desktop.

Task 6: Schedules	Subtasks	AutoCAD (hrs)	Architectural Desktop (hrs)
	door	6.00	1.00
	room finish	4.00	0.75
	area usage	0.00	0.50
	after plan edit	3.00	0.50
	Total time:	**13.00**	**2.75**

Task 7. Sheet layouts

Sheet layouts are the general building plans that are printed on large plotters. Before they are ready to print, the architect needs to lay them out and add annotations and views. Both AutoCAD and Architectural Desktop use Sheet Sets to create the sheets, so the procedure was similar in both programs. Once Janzen generated the sheets, he was then able to drag and drop drawing files to create view ports that set the drawings onto the sheet properly. It took one hour in both programs to complete this task.

Task 7: Sheet layouts	Subtasks	AutoCAD (hrs)	Arch Desktop (hrs)
	layouts	1.00	1.00
	Total time:	**1.00**	**1.00**

Task 8. Annotations

Once the sheets are created, an architect needs to go back and add dimensions to the floor plans, labels the doors, room, and window tags, and mark the detail or section cuts that need to be transposed to the building sections.

In AutoCAD, Janzen used standard dimension objects to add dimensions one at a time to the floor plan.

The same process was automatic in Architectural Desktop. Janzen used the AEC dimension object to place dimension strings over selected objects and add dimensions to sheets. He added general notes by using the Keynote tool to extract pre-saved notation information from the Architectural Desktop objects, and in some cases, he used standard AutoCAD mText to add general notes. He added callouts using Architectural Desktop callout tools.

Once images were placed on the sheets, there was still an additional task of drawing coordination. Whenever Janzen created a detail in AutoCAD, he had to manually insert a section or elevation callout tag that referenced the sheet number that contained the image of the detail, section, or elevation. Placing callouts within the model drawings in Architectural Desktop allows for automated coordination of these items. In both AutoCAD and Architectural Desktop, when a view is moved to another sheet, the referencing callout is automatically updated.

This task took 3 hours in Architectural Desktop and seven 7 hours in AutoCAD.

Task 8: Annotations	Subtasks	AutoCAD (hrs)	Architectural Desktop (hrs)
	create annotations	4.00	2.00

after plan edit	3.00	1.00
Total time:	**7.00**	**3.00**

Task 9. Perspective view

Figure 9. Positioning a camera icon is all it takes to create a perspective view in Architectural Desktop.

The task here was to create a view of the building as it would appear to someone standing out in front of it. In AutoCAD, Janzen used the DVIEW command to create the desired viewing angle. But because AutoCAD works in 2D, to create the perspective, he had to create a solid mass of the building shape, insert the 2D elevations as blocks, and then apply them to the surface of the massing as appliqués. Whereas, in Architectural Desktop, he simply inserted a camera object where the viewer would be standing and the program created the perspective automatically from the project model.

This task took three hours in AutoCAD and only half an hour in Architectural Desktop.

Task 9: Perspective view	**Subtasks**	**AutoCAD (hrs)**	**Architectural Desktop (hrs)**
	create perspectives	2.00	0.50
	after plan edit	1.00	0.00
	Total time:	**3.00**	**0.50**

Bottom Line

Total

	AutoCAD (hrs)	Architectural Desktop (hrs)
Total times for project	78.75	40.5

In tallying up the numbers of all the tasks, it took 40.5 hours to design the office building in Architectural Desktop compared 78.75 hours in AutoCAD:

About half as much time using Architectural Desktop as using AutoCAD!

This is even more remarkable given that during the Architectural Desktop drawing stage, the building was designed, a lot of decision making was taking place and things were edited and sometimes redrawn. The AutoCAD drawings, in contrast, were drawn from the

completed Architectural Desktop design, and did not include any design time--it was straight drafting.

Autodesk Architectural Desktop 2005 clearly offers efficiency and productivity for architects, as well as flexibility in implementation and use and versatile file-based collaboration. And because it is built on AutoCAD, you can get productive right away using your existing ways of working while implementing increasingly powerful and effective features gradually at your own pace to realize the extraordinary productivity benefits outlined in this paper. If you would like to find out more about Autodesk Architectural Desktop, please visit us on the web at *http://www.autodesk.com/archdesktop*.