autodesk

White Paper

Productivity Gains Using AutoCAD 2004

Executive Summary

With every new release of AutoCAD® software, CAD managers are faced with a series of crucial questions: *When should my company upgrade to this latest release? What increases in productivity can we anticipate? How quickly will these gains offset the costs associated with the upgrade?* Findings outlined here should provide you the baseline information needed to cost-justify your company's upgrade to AutoCAD 2004 software.

Autodesk commissioned Professor W. Mike Martin and Humberto Cavallin from the Design Practice Group of the College of Environmental Design, University of California, Berkeley, to examine the productivity improvements that users can expect when working with AutoCAD 2004 software as compared to earlier versions. The study involved the evaluation of a series of tasks designed to simulate the day-to-day production drafting environment, and the time required to complete those tasks.

The time savings documented in the study was then combined with survey data from a cross-section of Autodesk customers that showed, on average, how much time their users spent performing the tasks investigated in the study. Once you evaluate how this data fits with your own company's work processes, you can then take the time savings estimates provided in this paper, adjust for the size and business practices of your own company, and generate a cost/benefit analysis for upgrading from your current version of AutoCAD to AutoCAD 2004.

The new features of AutoCAD 2004 incorporated into the study were selected because they have the greatest potential to enhance the day-to-day productivity of AutoCAD users. These features included the use of the new tool palettes for the editing, creation, and deletion of blocks and hatch patterns; the improved multiline (Mtext) text editor for the creation and editing of paragraph style text within a drawing (notes, numbered lists, etc.); and, finally, the use of the new external reference manager to assist teams in modifying portions of a shared drawing.

The study results, when combined with a separate user survey, revealed that these features can save the average AutoCAD 2004 user between 3.3 to 4.5 hours per week per task. The study also pointed out how CAD managers can be most effective in their use of these new features, especially in the creation of customized tool palettes for use in repetitive tasks in a production work environment.

Introduction

The AutoCAD "Red Deer" (the code-name for AutoCAD 2004) Productivity Study commenced as soon as a stable beta version of AutoCAD 2004 was available, with the purpose of identifying improvements to AutoCAD that impact users' productivity. Care was taken to utilize methodology that would deliver unbiased, but user-based feedback and ensure statistically meaningful results. This report provides background on the study design; detailed results obtained for each section of the study, observations, and analysis; and finally, conclusions that can be drawn from those results.

Study Design

The Design Practice Group of the College of Environmental Design, University of California, Berkeley, was selected to perform this study because of its extensive background in the study of tools to enhance architectural practice. The Design Practice Group is a research team interested in design and design practice in architecture and other design disciplines. Since 1995, the group has been developing research on both the nature of the practice of architecture and non-collocated collaboration in the San Francisco Bay Area.

The study was performed at the San Rafael, California, training facilities of Autodesk, Inc., under the management of the UC-Berkeley team. The study participants were recruited from AUGI® (Autodesk User Groups International) groups located in Northern California. All were experienced users of AutoCAD 2000/2000i (17 subjects) or AutoCAD 2002 software (17 subjects); none had any experience with AutoCAD 2004 beta software (only beta, or pre-production, software was available at the time of the study). All had been using their AutoCAD applications in a production environment for at least two to three years (some for quite a while longer). Forty-seven percent of the participants worked in the architectural industry, 18 percent in civil engineering, and 14 percent in mechanical engineering. The remaining 21 percent of the participants worked in electrical engineering, interior design, landscape design, and piping engineering.

The features selected for testing were:

1. Tool palettes and their use to create, scale, rotate, and edit both pre-defined blocks and hatch patterns. The hatch pattern use focused on adding color schemes to enhance a drawing for presentation.
2. Mtext, the enhanced text editor, and its use for the creation and editing of notes in the body of a drawing.
3. External reference notification. This is a new AutoCAD 2004 feature that notifies users when another team participant is modifying a drawing.

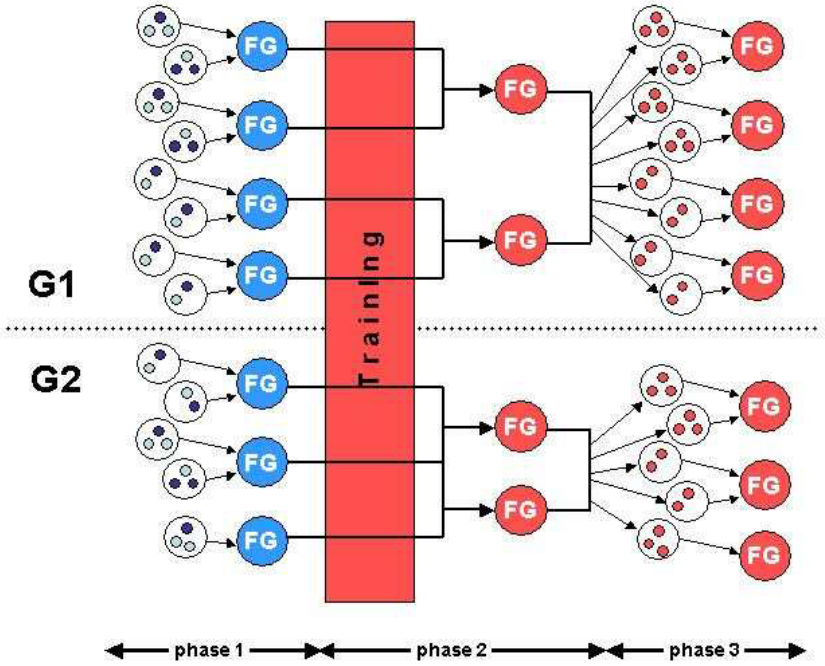
These features were chosen because they are likely to be used by the majority of AutoCAD users, and they could potentially improve the average user's day-to-day productivity.

The participation section of the study was broken into three phases, as shown in Figure 1 below:

Phase 1 - a day of exercises with the original software package (either AutoCAD 2000 or 2002), followed by survey(s), and a focus group discussion

Phase 2 - a day of training on AutoCAD 2004, followed by a focus group discussion

Phase 3 – a day of exercises using AutoCAD 2004, followed by survey(s) and a focus group discussion



G1 and G2 correspond to the first and second rounds of study participants. The dark and light-colored dots inside the circles on the left-hand side represent users of AutoCAD 2000 (light) and AutoCAD 2002 (dark). FG indicates the points where focus groups were performed.

Figure 1. Schematic of Study Organization

During the exercises, participants' performances were measured for both individual and team tasks. After each day of exercises was completed, participants were requested to complete a satisfaction survey. Focus groups were also conducted to obtain participants' subjective impressions of the exercises they performed and to collect their opinions of the software itself.

Exercises performed by the participants included:

Individual Tasks

Task 1. Using Tool Palettes to Manipulate Blocks

Participants were asked to create five sets of drawings using seven predefined blocks (scaled and rotated in different ways) already stored in 12 different drawing files provided by the researchers. In Phase I exercises, participants performed this task using AutoCAD 2000/2002; palette functionality was not available in these software versions. In Phase 3 exercises, the participants performed the same type of task using AutoCAD 2004 software; however, before creating the required drawing sets, they first had to create a tool palette that included the seven predefined blocks.

Task 2. Using Mtext to Annotate Drawings

Participants were asked to create a parts list based on the blocks created in Task 1. In Phase I, they performed this task using AutoCAD 2000/2002. In Phase 3 exercises, the participants performed a similar task using AutoCAD 2004 software, utilizing the new Mtext (multiline text editing) functionality.

Task 3. Using Tool Palettes to Manipulate Hatch Patterns

Participants produced a color presentation for each of the sets produced in Task 1. In Phase I, they performed this task using AutoCAD 2000/2002. In Phase 3, participants performed a similar task using AutoCAD 2004; however, they were required to create a tool palette with a predefined color scheme that could be used to create the color presentation in each of the sets.

Task 4. Publishing

Participants were required to publish a series of drawings in both digital and paper format. In Phase I, they had to rely on the functionality of AutoCAD 2000/2002. In Phase 3, participants were required to use the enhanced publishing features introduced with AutoCAD 2004.

Shared Tasks

Task 5. Using External Reference Notification and Collaboration

This shared task tested whether the use of external reference notification enhanced participants' awareness during the design collaboration, thereby improving overall performance. In both phases, two or three participants were asked to work in parallel on a problem in which each needed to make drafting changes to a shared drawing. The task participants were physically located in separate spaces; after the first 20 minutes of the one-hour task they were allowed to communicate using only commercially available instant messaging (IM) applications. During Phase 1, participants used AutoCAD 2000/2002 and did not have access to the external reference notification feature. In Phase 3, participants used AutoCAD 2004 and could now rely on the external reference notification functionality to inform them of changes made to the drawing by their partners.

Study Metrics and Analysis

The researchers performed both quantitative and qualitative measurements of the tasks that were performed by study participants.

Quantitative Measurements

Study participants were timed by the researchers as they performed their tasks. The output of each computer monitor was also videotaped so that the research team later cross-checked the timing of each task based on detailed examination of the use of the software. In addition, the Autodesk "command count" utility was used to record the amount of time spent in each command and the order in which each command was used. Both the command count data and samples of the video recordings of the actual software usage were used as a method for verifying that the times recorded by the researchers were accurate and reproducible. For the shared Task 5, the volume of IM communication was measured by keeping records of their messaging logs.

Qualitative Measurements

At the completion of each phase, participants were surveyed to record their subjective impressions of the software. They also were asked a series of questions in focus group setting about the software and their experiences during the study. Feedback was recorded both by videotape and written note-taking.

One of the surveys used for measuring participants' satisfaction was the Software Usability Measurement Index (SUMI). SUMI is a consistent method for assessing the quality of use of a software product or prototype and can assist with the detection of usability flaws before a product is shipped. SUMI was developed by the Human Factors Research Group at

University College Cork, National University of Ireland. It measures the quality of a software package's attributes against a global standardized software users' satisfaction database.

Participants scored AutoCAD 2000, AutoCAD 2002, and AutoCAD 2004 as slightly above the SUMI "state of the art" standard (when compared to other application ratings included in the SUMI standardized database). The survey and focus group feedback along with the similar SUMI scores indicate that, at the broad level, users perceived few high level differences in satisfaction between the releases.

Analysis

The research team performed diverse statistical analysis of the collected data to ensure that differences observed in the tests and on the surveys were significant. In almost all cases, the data was significant at levels of p=0.1 or less. They were also on the alert for several types of "confounding" errors that can creep into this type of study. This included the methods used to recruit participants, variations in the hardware and software used, changes caused by being exposed to the same general type of exercises twice in a row that enabled participants to learn about the tasks, and the different levels of expertise among the participants. Both the effect produced by learning and the levels of expertise of the study participants turned out to have an impact in the results they reported. These are discussed in more detail in the Study Results section that follows.

Training

Phase 2—the day of training on AutoCAD 2004—was provided by representatives from the training department of the Autodesk Professional Services division. The materials used were those under development for the AutoCAD 2004 upgrade training to be offered through local certified Autodesk Training Centers. Course material was tailored to focus on the tasks that were being examined by the study.

Study Findings

Familiar Environment Made Learning Easy

One key takeaway drawn from the surveys and focus group feedback at each phase of the study was the perceived similarity of AutoCAD 2000/2002 and AutoCAD 2004 by participants. AutoCAD 2004 was a very familiar environment; participants felt that they could be productive using the software without major amounts of re-training. In fact, the team observed that with only a single day of training on AutoCAD 2004 software, the majority of the participants were significantly more productive as a result of easily taking advantage of some of the key new features of the application.

Average Users Scored Greater Gains

The study uncovered an interesting variation in performance between expert and average users. Through a screening questionnaire and a post-factual evaluation of users' performance, three user-types emerged: high performers ("experts"—15% of study group), average-performers (73% of study group), and low performers ("novice"—12% of study group).

In all of the study exercises, the average users experienced approximately 30 to 60 percent increase in performance, while the expert users experienced approximately 30 to 50 percent decrease in performance. Examination of the results followed by interviews with the participants uncovered the reasons for these findings. Expert users develop their expertise over weeks or months, not in a one-day training class. They are experts because they have learned to derive optimal performance from of their current AutoCAD version. Most users of AutoCAD do not have the time or level of interest to acquire that level of expertise.

The good news is that for repetitive tasks, the new AutoCAD 2004 features tested in the productivity study enabled the average performer to come much closer to the level of productivity an expert user experiences when using a familiar AutoCAD release in a production environment. The expert participants were slowed because the keyboard and process shortcuts they use in daily operations are faster than the new steps required to utilize the AutoCAD 2004 features tested. However, those expert-level shortcuts are much more complex to master. With extended usage, we anticipate that expert users will integrate the new AutoCAD features into their already optimized work process and experience an overall increase in speed. In the mean time, they can use their existing work tools (all of which remain available in AutoCAD 2004) and continue to be highly productive.

Let us look at the results from each section of the study in more detail:

Individual Tasks

Tasks 1 and 3. Using Tool Palettes to Manipulate Blocks and Hatch Patterns

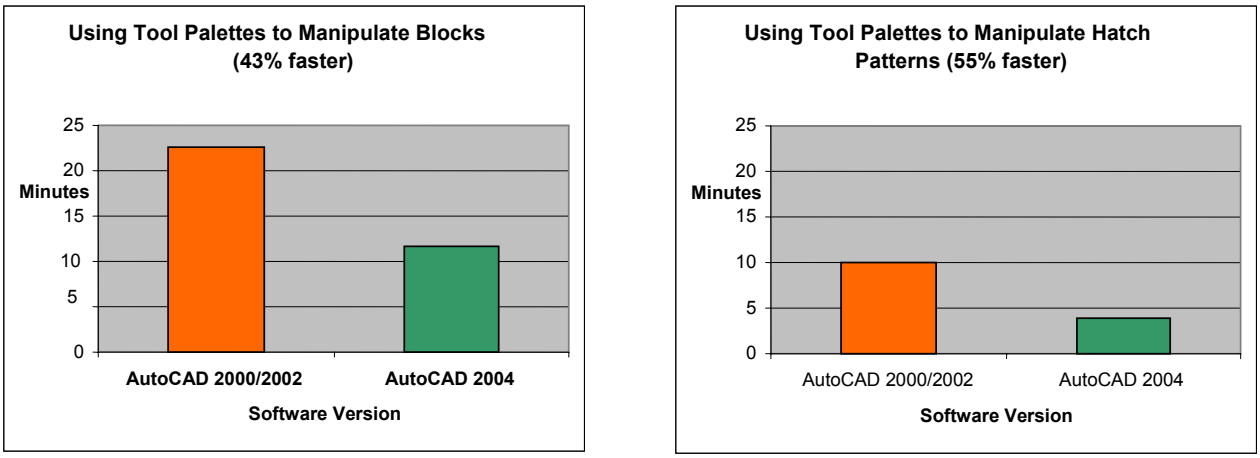


Figure 2. Study Results for Tool Palette Manipulation of Blocks and Hatch Patterns

For these tasks, the average and novice users found their performance improved by 43 percent and 55 percent; the expert users were actually slowed by 30 percent and 32 percent. Based on these findings, our recommendation would be to have your company's expert users create the standard tool palettes that your average users will then use in production. This will take advantage of the expertise of these users and allow them to increase the productivity of the rest of the company that uses AutoCAD. The expert users themselves can then transition to the use of tool palettes, where they make sense based on their work habits. As they work with the palettes over time, they will uncover shortcuts and work process changes that speed up their work. They can then quickly disseminate this expertise throughout the company by updating the existing tool palettes.

Feedback provided during the focus groups indicated that the new tool palettes feature is an important addition to the AutoCAD program. The participants believed that the use of tool palettes improved their productivity for tasks that required repetitive actions, as was the case for blocks and hatch manipulation. This was especially true for the CAD managers who participated in the study.

> *I find the tool palettes to be a huge advantage. I envision using these heavily upon upgrading to the next version of AutoCAD. I feel that the tool palettes will be a major improvement in creating standardized drawings.*
>
> —Productivity study participant

Task 2. Using Mtext to Annotate Drawings

The generation of notes through the use of Mtext in AutoCAD 2000 and 2002 versions was judged to be very difficult by the participants in the study. In the general satisfaction surveys and in the focus groups, the enhanced Mtext was one of the most enthusiastically praised features of AutoCAD 2004.

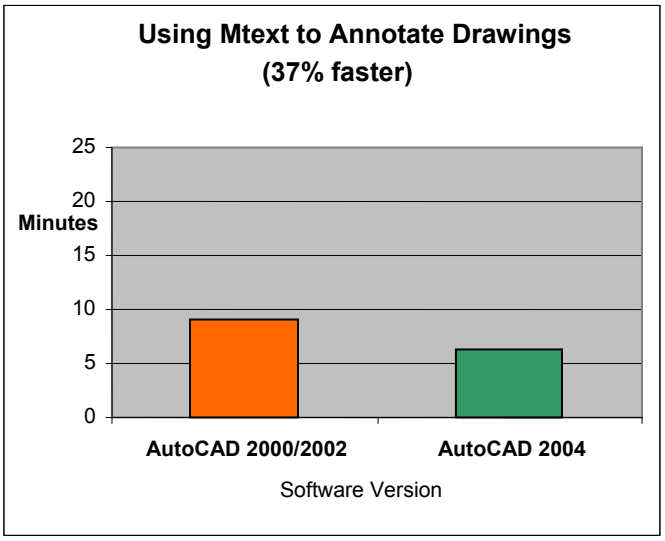


Figure 3. Study Results for Using Mtext to annotate drawings

Average and the novice users combined (85 percent of the study participants) found their performance improved 37 percent; the expert users were slowed by 52 percent. These results illustrate the same effect noted for tool palettes. The majority of your AutoCAD users will experience greater speed and lower levels of frustration with the use of the new Mtext command, but your expert users will continue to be more productive using the older commands they are most familiar with. Over time, the expert users will incorporate the new Mtext functionality into their workflow in an optimized manner.

> *I would upgrade to get access to the improved MText editor, time sensitive right mouse click, tool palettes, improved dimensioning, and the ability to get thumb nail previews of drawings in Windows Explorer.*
>
> —Productivity study participant

Task 4. Publishing

The participants were able to publish a series of drawings in both digital and paper format 30 percent of the time using AutoCAD 2000 and 2002 software, and 70 percent of the time using AutoCAD 2004. It should be noted that some portion of this result was based on the learning by participants that occurred during the first phase of the study. Many of the study participants were not familiar with using the DWF™ file format. During Phase 1 of the study participants spent most of the first exercise learning what DWF files were and how they are used in the AutoCAD application. When the second round of testing was completed, participants were much more effective, in part, due to experience gained during Phase I with DWF files and publishing. Based on this, the researchers cautioned against drawing any quantitative conclusions from this data; rather, they recommended focusing on the qualitative aspects related to the usability of the new graphic interface for publishing.

Subjectively, the participants were very enthusiastic about the ability to plot shaded viewports and raster images, and about the batch plotting capacities of publishing as well.

Shared Tasks

Task 5. Using External Reference Notification and Collaboration

The external reference notification task was a team-based task that involved a group of two or three individuals working on different parts of a common drawing. As changes were made, participants could communicate and coordinate their working using only instant messaging. This allowed the researchers to both measure the time to complete the task as well as the amount of communication between the people involved in the exercises.

The teams were given one hour to complete the joint portion of the exercise. Because not all of the teams were able to complete the exercise in this amount of time, the researchers estimated task completion at the end of the allotted time period (they did this using a scale of 1 to 5, with 5 indicating task completion). Based on this, the researchers measured "effectiveness" rather than percent time. Effectiveness was defined as the ratio of percent complete in the AutoCAD 2000 or 2002 releases, divided by the percent complete in the AutoCAD 2004 release.

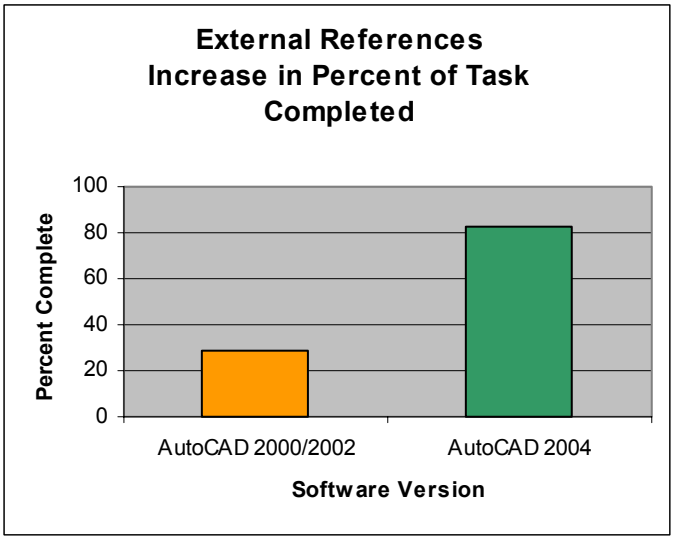


Figure 4. Study Results for External Reference Notification

The researchers found that, on average, all of the teams were 70 percent more effective with AutoCAD 2004 than they were with AutoCAD 2000 or 2002 software. This finding was confirmed both by observations and by the word count analysis that was done on the instant messaging logs saved from the exercises. On average the AutoCAD 2000 and 2002 users required 530 words to coordinate their changes; the AutoCAD 2004 users required only 156 words.

> *The x-referencing features made the drawing more accessible. [It was] easier to keep track of when and who made a change to an XREF drawing….The XREF enhancements are a very nice improvement. Being able to be notified when an XREF has been changed and giving you the option to reload it or … is a welcome feature.*
>
> —Productivity study participant

Drawing Conclusions from the Study Results

The average decreases in time required to complete the tasks that were measured in the study are valuable only when placed in a real work environment. To convert these measurements into something meaningful requires an understanding of how much time users perform work that reflects the exercises conducted in this study.

User Survey Data

Autodesk surveyed 100 customers who use AutoCAD 2000, 2000*i*, and 2002 software in a production-level environment, in order to learn from those users how they estimated their time in the areas tested in the productivity study. The survey was directed to customers using 10 seats of AutoCAD or less (60 percent); between 10 and 100 seats (30 percent); and more than 100 seats of software (10 percent). The survey questions and responses are shown below.

1. **In the course of an hour, what percentage of the typical CAD user's time is spent inserting and orienting blocks in a drawing (i.e., placing on a layer, rotating, scaling, etc.)?**

[1]Avg. percent of time spent by CAD User= 19% [2]Average hours per week= 7.6 hrs

2. **In the course of an hour, what percentage of the typical CAD user's time is spent inserting and orienting hatch patterns in a drawing (i.e., placing on a layer, rotating, scaling, etc.)?**

Avg. percent of time spent by CAD User= 13% Average hours per week= 5.2 hrs

3. **In the course of an hour, what percentage of the typical CAD user's time is spent annotating drawings? This would specifically apply to creating and editing paragraph style text (i.e., general notes, bullet lists, numbered notes, etc.)**

Avg. percent of time spent by CAD User= 23% Average hours per week= 9.2 hrs

External references are used by a limited number of AutoCAD users, therefore the external reference question was preceded by a series of questions designed to identify heavy usage, interactive users of external references. This turned out to be 11 percent of the total group surveyed. This percentage is lower than in many previous surveys, where up to 50 percent of companies indicated that they perform team work on shared drawings, but still gives some time estimates that can be used for planning purposes. The question and response from this group was:

4. **Based on your answer in the previous question, what percentage of time does the team spend in the course of a day communicating xref changes to each other?**

Avg. percent of time spent by CAD User= 16% Average hours per week= 6.4 hrs

The data collected from the survey was then used to determine the amount of time the average AutoCAD 2000 or 2002 user can save per week in a production level environment.

[1] Weighted average calculated from 100 responses
[2] Based on 40-hour work week

AutoCAD Tasks Tested	Time Spent Doing Task (hrs/wk, average)	Time Savings Using AutoCAD 2004	Time Saved per User
Using tool palettes to manipulate blocks	7.6 hrs	43% faster	3.3 hrs/wk
Using tool palettes to manipulate hatch patterns	5.2 hrs	55% faster	2.8 hrs/wk
Using Mtext to annotate drawings	9.2 hrs	37% faster	3.4 hrs/wk
Using external reference notification	6.4 hrs	70% more	4.5 hrs/wk

Figure 4. Potential Time Savings Gained Using AutoCAD 2004 for Specific Tasks

> *I consider this release as important, if not more than [AutoCAD] 2000 or Release 14. It is a positive step in a very competitive CAD world. It is a good sign that Autodesk is listening to our needs.*
>
> —Productivity study participant

Summary

AutoCAD 2004 contains a compelling suite of new features, and some, in particular, that will enhance user day-to-day productivity with a minimum of disruption to your existing work practices. A small gain of just one hour per week by a single user saves more than one person-week per year. Multiples of those savings, available by upgrading to AutoCAD 2004 software, can add up to real dollars and a competitive edge for your company.

If you are still not convinced, we encourage you to investigate the potential productivity gains in your actual production environment. AutoCAD 2004 is available as a 30-day free trial. To request a trial CD version of AutoCAD 2004 software or to begin your assessment immediately by using the Web-based streaming trial, visit www.autodesk.com/autocad-trial.

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Autodesk, Inc.
111 McInnis Parkway
San Rafael, CA 94903
USA