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White Paper

AutoCAD 2004 and CAD Standards

CAD Standards Defined

Ask 10 CAD managers to define "CAD standards," and you will probably get 10 different answers. Although most standards include some sort of layering scheme, most offices also include guidelines for plotting, file and directory naming, as well as many other areas that affect the quality of CAD output.

Modern CAD systems, such as AutoCAD® 2004 software, are extraordinarily flexible and can be tailored to fit just about any workflow. This flexibility comes at a price, however; different users can use vastly differing methods to produce a drawing, with different visual results. As a CAD manager you need to establish standards to ensure that your firm's output is of a consistent high quality, no matter who produced a particular drawing, or when.

The concept of ensuring consistent output from a design or drawing office is not new. Even in the days of the drawing board, responsible firms followed design and drafting guidelines that specified standards, for instance, sheet sizes and scale, text and dimension sizes, and styles. Modern technology has introduced many new ways to produce drawings. Although computers and CAD systems have brought many productivity benefits, they have to be carefully managed to produce the desired results.

The following sections include examples of basic CAD standards components.

Layer Standards

Layer standards are common, and most design firms, large or small, have rules for layer names and properties. If you are introducing a layer standard, it is best to start with a simple scheme. A policy as simple as "Place all text on the *Text* layer" and "Place all dimensions on the *Dimension* layer" brings immediate benefits.

At the other end of the scale are the American Institute of Architects (AIA) layer guidelines, which go into great detail, breaking down layer names into a hierarchical organization of discipline, major and minor groups, and status. (For more information on the AIA layer guidelines, see "National CAD Standard," later in this document).

An important decision in establishing a layering standard is the level of detail required. What are the criteria for separating a set of objects onto a new layer?

Some examples include the following:

- **Unique audience.** For example, if you put all lighting components on a single layer, the lighting contractor can switch everything thing else off and access only the relevant information.

- **Plotting characteristics.** You may want to highlight walls to be demolished on a plot with everything else screened to 50 percent gray. Putting all the walls to be demolished on their own layer helps achieve this.
- **Data publishing (schedules and bills of material).** It is a lot easier to count common items (manually, or with a software routine) when they are on a unique layer.

Linetypes and Line Weights

Having a scheme whereby common items are always drawn with the same linetype (for example, storm drains are always drawn with a "dash-dot" linetype) makes interpreting drawings much easier.

Text

Text on a drawing creates a powerful initial impression: untidy text translates to an untidy drawing. There are many settings that affect the appearance of text, including paper space versus model space, text size scale, and font. A company standard for text settings is imperative if consistent drawings are going to be produced. Adopting standard text styles, and using the tools available in AutoCAD 2004 to make sure they are adhered to, can pay immediate dividends.

Dimensions

Crisp, neat dimensions help create a favorable first impression of a drawing. As for text, there are many settings that affect the appearance of dimensions. Setting up standard dimension styles helps take the guesswork out of dimensioning and makes it easier to check drawings before distribution.

Project File and Directory Organization

Although not affecting the appearance of your drawings, data organization can have a profound effect on ease of access. Coherent organization of your project data also cuts down on the amount of data that is copied, reducing that risk of propagating out-of-date information.

Following is an example of a simple project file and directory organization structure:

Sample Project Folder
>Conceptual
>Schematic Design
>Design Development
>Construction
>Images
>Releases
>Xrefs

Another option is to prefix each directory name with a number, as follows:

00 Predesign
10 Schematic Design
20 Design Development
30 Construction Documents
40 Administration
50 Bidding & Negotiations
60 Construction

The advantages of this approach are that it preserves the folder hierarchy in Microsoft® Windows® Explorer and that the system can be expanded by adding directory names prefixed with intermediate numbers.

File Reference Policies

File referencing is a convenient way to break up a project into manageable, smaller components that can be distributed across your design team, while retaining the ability for any member of the design team to see and reference what others are working on. A file reference policy should cover the use of relative versus absolute paths and base points. The advantage of using relative paths is that a project folder can be moved to another server, or even sent to another user, and the file references still resolve correctly.

Block and Detail Libraries

Standard details that are used repeatedly should be stored in a central location, so that drafters don't have to re-create them for every project.

Advantages of Using CAD Standards

CAD standards are the backbone of the design industry. Today, more design teams are dispersed, with design information shared between individuals, departments, and corporations. Without appropriate standards, you risk delivering inaccurate design documentation, with potentially disastrous consequences.

Most design professionals agree that the successful implementation of drawing standards in an organization produces tangible benefits and positively affects the bottom line. Standards save time and money by providing

For designers:

- A smooth transfer of information between architects, engineers, and other design team members
- Reduced preparation time for translation of electronic data files between different proprietary software file formats, and predictable file translation results
- Reduced data file formatting and setup time
- Reduced training time
- Streamlined drawing checking process for references and omissions
- Consistent, higher-quality design documentation
- Fewer errors

For contractors:

- Consistent organization of data for all projects, from all sources
- Consistent drawing sheet order and sheet organization (information appears in the same place in all drawing sets)
- Fewer discrepancies, reducing the potential for errors, change orders, and construction delays
- Consistent detail reference system

For clients:

- Consistent organization of data for all projects, from all sources
- Clearer communication of design intent
- Streamlined post-project electronic data management
- Enhanced potential for automated document storage and retrieval

Industry Standards Organizations

A number of well-established standards provide a starting point for implementing CAD standards in your organization.

National CAD Standard

The U.S.-based National CAD Standard (NCS) is a system for organizing and classifying drawing-centric building design data. It includes

- A system for naming model files, drawing files, and drawing file layers
- A system for organizing the drawing set
- Drawing set hierarchy
- Drawing sheet layout and format
- Schedule layout and format
- Plotting guidelines

The NCS incorporates the

- AIA CAD layer guidelines
- Uniform Drawing System, Modules 1–8, published by the Construction Specifications Institute
- Plotting guidelines developed by the U.S. Department of Defense Tri-Service CADD/GIS Technology Center

The NCS layering system is based on the AIA CAD layer guidelines, with the layer names organized as a hierarchy. You can select from a number of options for naming layers according the level of detail required.

There are four defined layer name data fields: **Discipline Designator**, **Major Group**, two fields for **Minor Group**, and **Status.** The Discipline Designator and Major Group fields are mandatory. The Minor Group and Status fields are optional.

Discipline Designator: Disciple Designator denotes the category of subject matter contained on the specified layer. It consists of a two-character field, with the first character the mandatory discipline character, and the second, an optional modifier.

Example:

A	Architectural
AI	Architectural Interior

Major Group: Major Group is a four-character field that identifies a major building system.

Example:

A-WALL	Architectural, Wall
AI-WALL	Architectural, Interior, Wall

Minor Group: This is an optional, four-character field used to further define the Major Groups.

Example:

A-WALL-FULL	Architectural, Wall, Full height

A second Minor Group field can be used to further delineate the data.

Example:

A-WALL-FULL-TEXT	Architectural, Wall, Full height, Text

Status (Phase): Status is an optional single-character field that distinguishes the data contained in the layer according to the status of the work or construction phase.

Example:

A-WALL-FULL-N	Architectural, Wall, Full height, New work

For more information about NCS, visit **www.nationalcadstandard.org**.

Uniform Drawing System

The Uniform Drawing System (UDS) standard goes beyond establishing graphic principles for construction documents. In essence, it is a manual for the organization and presentation of information for the planning, design, construction, and operation of a facility throughout its lifecycle.

The UDS consists of eight interrelated modules that include standards, guidelines, and other tools:

Module 1—Drawing Set Organization establishes set content and order, sheet identification, and file naming for a set of construction drawings.

Module 2—Sheet Organization provides format for sheets. It includes drawing, title block, and production reference areas and their content, as well as a coordinate-based location system and preferred sheet sizes.

Module 3—Schedules sets consistency in format, terminology, and content. Additional guidelines include how to create a project-specific schedule and an organizational system for identifying and filing schedules.

Module 4—Drafting Conventions addresses standard conventions used in drawings: drawing orientation, layout, symbols, material indications, linetypes, dimensions, drawing scale, diagrams, notation, and cross-referencing.

Module 5—Terms & Abbreviations provides standard terms and abbreviations used in construction documents and specifications. It provides consistent spelling and terminology, standardizes abbreviations, and notes common usage.

Module 6—Symbols addresses commonly used standard symbols, classifications, graphic representation, and organization in creating, understanding, and fulfilling the intent of construction documents.

Module 7—Notations provides guidelines for notation classification, format, components, and location; use of notes; terminology; and linking to specifications.

Module 8—Code Conventions identifies types of general regulatory information that should appear on drawings, locates code-related information in a set of drawings, and provides standard graphic conventions.

The goal of the NCS Plotting Guidelines is to produce consistent plots in accordance with the originator's intentions. This includes line weights, colors, linetypes/styles, text, and standard sheet sizes regardless of the CAD application used. To obtain consistent plots, it is necessary to create tables that define the relationships between the drawing in the display and the finished plot. This includes the mapping of drawing elements to plot elements using the proper pen tables, color tables, and character tables. In addition, there must be consistency in the size of the printed areas for standard sheet sizes.

For more detailed information about the Uniform Drawing System, visit **www.csinet.org**.

British Standards Institute

The British Standards Institute has an internationally recognized standard focused on the exchange of CAD data in the construction industry.

BS 1192-5:1998 Construction drawing practice. Guide for structuring and exchange of CAD data.

This standard gives guidance and information on the structuring and exchange of data between CAD systems. The guide covers conceptual classes of information important to construction industry users, methods of structuring CAD data, and recommended coding rules and conversions for naming files, submodels, and layers.

For more information about the British Standards Institute, visit **www.bsi-global.com**.

International Organization for Standardization

The International Organization for Standardization (ISO) publishes three primary CAD standards documents:

ISO 13567-1: Technical product documentation—Organization and naming of layers for CAD—Part 1: Overview and principles

ISO 13567-2: Technical product documentation—Organization and naming of layers for CAD—Part 2: Concepts, format, and codes used in construction

ISO/TR 13567-3:Technical product documentation—Organization and naming of layers for CAD—Part 3: Application of ISO 13567-1 and ISO 13567-2 (a technical report that explains how to use Part 2 above, and suggests ways of dealing with reference files)

These standards can be daunting, and, in fact, firms rarely implement an off-the-shelf standard. Most firms adopt the part of the standard that works in their environment and expand the standard where there are deficiencies.

For more information about the ISO, visit **www.iso.ch**.

Getting Started

One of the most important first steps in implementing standards in a design office is getting buy-in from senior management. Such support is crucial in the event of resistance to the proposed standard.

Selling Standards to Senior Management

Senior management will want to know the return on investment (ROI) for any standardization project. Standards can benefit the bottom line in a number of areas:

Minimizing Plotting Bottlenecks: Most project deliverables consist of a set of plotted drawings, and any problem that delays plotting can delay the whole project. If layering or plotting standards are not followed, it can take hours to plot a set of drawings. Project managers are especially sensitive to this argument because such delays invariably happen at the end of a project when there is no opportunity to make up lost time. The cost of these delays can be significant, not only in the direct costs related to fixing the problems but also in the indirect costs of missing a deadline. Missing a client delivery deadline because of an avoidable technical problem is something most conscientious managers will not tolerate. There is a direct link between the implementation of standards and the ability of your firm to meet its commitments.

Training Temporary CAD Technicians: CAD standards reduce training costs, as new technicians can focus on the drawing techniques and methods that are important to your firm. You can have candidate technicians perform a drawing test working to your standard to verify their knowledge of layers, text, and dimensioning. You can demonstrate costs by multiplying the number of training hours required times the labor rate times the number of new employees in a given year. You may be able to justify CAD standardization by this cost savings alone.

Automation: If your CAD standards made all your drawings perfectly consistent, manual processes such as plotting, could be automated. This is a powerful argument because

automating mundane processes improves the productivity of employees, allowing your firm to take on more work without hiring more people.

Consistent Visual Appearance: The ability to produce visually consistent drawings, no matter who created them or when, is the hallmark of a well-managed design office, and standards can help achieve this. Placing a dollar value on look and feel is difficult, but most managers agree that the image of the firm is important and that the engineering design and drawing set is one of the firm's most important products.

Setting Goals and Priorities

Companies sometimes expect CAD standards to do everything: improve production efficiency, increase precision, enhance plotted drawing quality, and enable better data extraction from drawings. You'll be more successful if you can articulate and prioritize your primary goals and focus your standards development to achieve them.

Developing the Standard

Once you have management buy-in, then the standardization project can start. In developing or revising CAD standards, you should involve your CAD users as much as possible. The odds of getting everyone to adhere to standards are better when those affected are part of the process. Some questions to consider:

- What parts of a drawing take a lot of time, and what is relatively efficient?
- What good ideas from users should be implemented companywide?
- What should be standardized, and what can be left to individual choice?

The best way to enforce standards is to build as many as possible into your CAD system with template files, standard block libraries, and menu macros, scripts, and AutoLISP® programs. At a minimum, your customized CAD system should make it no more onerous to create drawings according to company standards than to create them without any standards. In fact, by automating repetitive tasks, the CAD system should make it more efficient to draw according to company standards.

Using AutoCAD 2004 Software's Built-in Standards Tools

AutoCAD 2004 includes a powerful set of tools for implementing, managing, and enforcing CAD standards in your organization.

CAD Standards

The CAD Standards feature provides a way for CAD managers to control standards. You can associate standards (DWS) files with AutoCAD drawings and perform interactive and batch audits to ensure that any discrepancies between a drawing file and its associated layer, text style, dimension style, or linetype standards can be resolved.

Analogous to a spell checker in a word processor, the standards interactive audit checks the drawing against the associated standards, reports any discrepancies, and suggests appropriate resolutions. You can either accept the proposed resolution or manually fix the problem in the AutoCAD program, without interrupting the audit process. Problems can also be ignored (appropriate in the case of construction geometry, for instance). Previously ignored problems may be reported in subsequent audits, depending on a user setting.

You can now also configure AutoCAD software or your industry-specific application to provide a real-time notification and warning when a standards violation occurs. This clear and instant notification can help you maintain consistency in your design work and minimize costly errors by staying within the defined standard.

For example, if you create a nonstandard layer, or modify the properties of a standard layer, the software warns you that the operation created nonstandard objects and offers you the opportunity to fix the violation.

The Batch Standards Checker performs batch audits on multiple drawings and generates a report of standards violations that you can view in a browser. You can check individual drawings against their associated standards files or check a set of drawings against a set of global standards. You can save multiple batch audit configurations in an external configuration file for reuse later. And you can use an operating system command-line version of this tool for scheduling batch standards checks or in server environments.

Layer Translator

The Layer Translator tool makes it easy to convert drawings from one layer standard to another using existing drawing or standards files as a reference. In this way the Layer Translator tool helps manage the process of sharing data with others. It complements the CAD standards functionality, extending your ability to correct standards violations quickly and accurately.

Using the Layer Translator tool, you can

- Translate from one layering standard or convention to another
- Force entity color and linetypes to ByLayer
- Purge unreferenced layers on exit
- View only the entities that reside on selected layers
- Use DWG, DWT, or DWS files for reference layers
- Create new reference layers on the fly
- Edit the layer properties for existing reference layers
- Save and reuse layer mappings

The Translate From list displays the names of all layers in the current drawing in alphabetical order. A dark layer icon indicates that the layer is referenced and cannot be purged. A white layer icon indicates that the layer is unreferenced and can be purged.

The Translate To list displays the layers being used as reference or target layers. Selected layers in the Translate From list can be mapped to layers in the Translate To list using the Map button.

Layer translation mappings can be saved to a selected file for later reuse. This is useful when you need to apply the same translation to other drawings from the same source, using the same layer scheme.

The Settings dialog box enables you to control translation behavior.

Standard Tool Palettes

New customizable tool palettes provide easy access to frequently used drawing content, including blocks and hatches. You can save time finding and inserting standard drawing content into your designs. For each tool on a palette, you can control properties such as layer, scale, color, and so forth to ensure that blocks and hatches are created according to your company standards.

AutoCAD 2004 software includes sample tool palettes to introduce you to this valuable new functionality. You can modify the existing tool palettes or add new ones.

You can easily create your own tool palettes and populate them with your most frequently used blocks and hatch patterns. You can control the order of the tool palettes, rename or delete existing tool palettes, and even import and export tool palette configurations for use on other systems.

You can create project-specific tool palettes, so users who are working on multiple projects can easily access the standards blocks and hatches specific to that project.

Reference File Management

File relationships can be complex. But with the Reference Manager, available in the AutoCAD 2004 application, managing them is simple. You can automatically manage all file relationships and dependencies generated by AutoCAD 2004 and industry-specific products built on the AutoCAD 2004 platform. Use it to produce a network-wide report on all the paths for reference files: drawings, images, standards, fonts, and plot styles. And if you need to update reference paths, simply specify your change, and it occurs globally.

Plotting with Standard Plot Styles and Page Setups

In most cases, the plotted drawing set is the final deliverable, and AutoCAD 2004 has powerful tools for ensuring consistency of plotted output.

Plot Styles can be used to resymbolize the same data in different ways. For example, in civil engineering drawings you may want to emphasize cut and fill with a particular line weight and hatch pattern. In an architectural layout you may want to show the same information, but deemphasized with a lighter line weight and color, and no hatching.

Page Setups can be used to store common plot settings for reuse, including page size and orientation, destination device, and plot style. For example, you can set up "Final" and "Draft" plot styles, where the "Final" plot style will plot full size in full color, and the "Draft" will plot half size.

Conclusion

Unfortunately, there is no silver bullet for standards. Effectively implementing standards in a design office is a long-term process that will challenge both your technical and managerial skills. AutoCAD 2004 software can help remove some of the technical hurdles by enabling you to create, deploy, enforce, and audit standards in your design office, providing measurable benefits to your firm's bottom line.

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