

THREE DIMENSIONAL MODELLING IN AUTOCAD 2000: PRODUCTION OF DRAWINGS USING MULTIPLE LAYERS AND LAYOUTS IN PAPER SPACE

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Abstract

The use of Computer Aided Design software, especially AutoCAD, is gradually becoming commonplace in architectural practice. Despite its relatively clumsy interface and acknowledged complexity, several leading architectural firms now produce impressive working and presentation drawings using AutoCAD. The production of three-dimensional drawings is however rare, and the techniques used to produce two-dimensional drawings are often inappropriate. This is sometimes a result of inadequate training and lack of understanding of certain concepts in Computer Aided Design and Draughting. The Universities lack the resources and institutional support to produce computer-literate architects; thus most architects learn computing in practice. The recent release of AutoCAD 2000 however has the potential of helping reverse this unwelcome trend. The introduction of several architect-friendly features, especially multiple paper spaces called layouts, makes the production of drawings in paper space more intuitive. While certain improvements to AutoCAD are recommended, schools of architecture must urgently establish a national curriculum for computer training of architects, and acquire the facilities necessary to properly train the next generation of architects.

General Features of AutoCAD 2000

AutoCAD 2000 is a major release with several improvements over the popular versions 12, 13 and 14 commonly used by Nigerian architects. It is a general purpose design tool with full three-dimensional modelling capability, shading and rendering. Autodesk describes the most important improvements as the heads-up design environment, improved access and usability, expanded reach, streamlined output and enhanced customisation and expandability.

The *heads-up design environment* is probably the most significant to all users. You can now open several documents simultaneously and copy or move objects between the drawings. The Design Center simplifies the manipulation of blocks, layers and named objects. Other improvements include quick dimensions, parallel and extension object snaps,

polar and object snap tracking, real-time 3D rotation and enhanced toolbars.

Improvements in *access and usability* include the properties window, the object properties toolbar, shortcut menus, enhanced solids editing, easier text editing and the layer properties manager. The *expanded reach* now makes access to the World Wide Web easy apart from support for electronic plots and enhanced hyperlinks.

The *streamlined output enhancements* include layouts, nonrectangular viewports, object lineweights and significant improvements to printing. *Customisation and extension* of AutoCAD can now be achieved using Visual Basic for Applications (VBA).

These are very significant improvements, and they combine to make AutoCAD much more powerful and easier to use. Now a true Windows application, AutoCAD is easier to learn and manage. The management of most input and output devices is now left to the Operating System. On the other hand however, AutoCAD 2000 requires more powerful hardware. The minimum is a Pentium computer with 32MB of RAM (64MB recommended). It also requires almost 200MB of disk space for a full installation and an SVGA Monitor. AutoCAD 2000 has several new options and additions and is therefore far more complex. Autodesk has however succeeded in making it easier and simpler to use.

One of the most important improvements is the introduction of multiple paper space environments called layouts. A layout is a paper space environment that simulates a sheet of paper. It provides a predictable plotting setup, with the capability to print to various printers using various settings, plot scales and paper sizes. A layout displays the drawing, as it will be plotted on the sheet of paper. The layout often contains a title block or other geometry as well as viewports. The viewports are like windows through which you see objects in model space.

Paper Space versus Model Space

All AutoCAD objects reside in either one of two primary spaces: model space and paper space. Model space is the space where most people work in AutoCAD. Model space typically contains two-dimensional or three-dimensional geometric models. Thus the plans and elevations drawn by an architect are in model space. Objects in model space can be accessed through the *Model* tab. Model space is used for creating drawings or models.

According to Autodesk, paper space is “used for creating a finished layout for printing or plotting, as opposed to doing drafting or design work”. A layout contains viewports in paper space showing specific views and annotations of drawings and models in model space. Paper space is used for creating layouts for plotting. Objects in a particular layout can be accessed through the appropriate *Layout* tab.

What are Layers?

A layer is a logical grouping of data that are like transparent overlays on a drawing. Just as in manual draughting, you can view layers (transparent overlays) individually or in combination. A major difference is that layers are three dimensional while drawings on tracing paper or transparencies are two-dimensional. In addition, all layers in AutoCAD are synchronized. Thus a point at particular coordinates on one layer occupies the same space as a point at the same coordinates on each of the other layers.

Layers are commonly used to group objects. A layer may contain all furniture or all walls. Layers are

often assigned specific colours, linetypes and lineweights to assist the user while draughting. A single layer can however contain a complete drawing or model irrespective of the number of objects, colours, linetypes and lineweights used to create the drawing or model.

Freezing and Thawing Layers in Viewports

A recommended technique for creating various views of a complex model is to place related objects on the same layers and then create views by combining relevant layers. A typical example is a house plan. The house plan may for example contain the following layers:

Layer	Contents
Walls	Walls, windows, doors.
Furnish	Furniture including sanitary installations.
Functions	Descriptions of the function of each space.
Electric	Electrical wiring
Finish	Descriptions of wall, floor and ceiling finishes
Hatch	Hatching of walls to show use of materials

Combining various layers as shown below can create various views of the house plan.

Drawing name	Layers
Presentation Floor Plan	Walls, Furnish, Functions
Electrical wiring	Walls, Electric, Functions
Working drawing	Walls, Furnish, Functions, Finish, Hatch

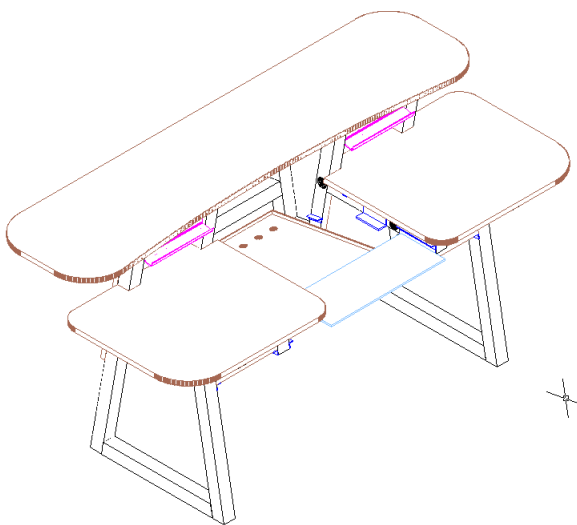


Figure 1: Axonometric view with lines hidden.

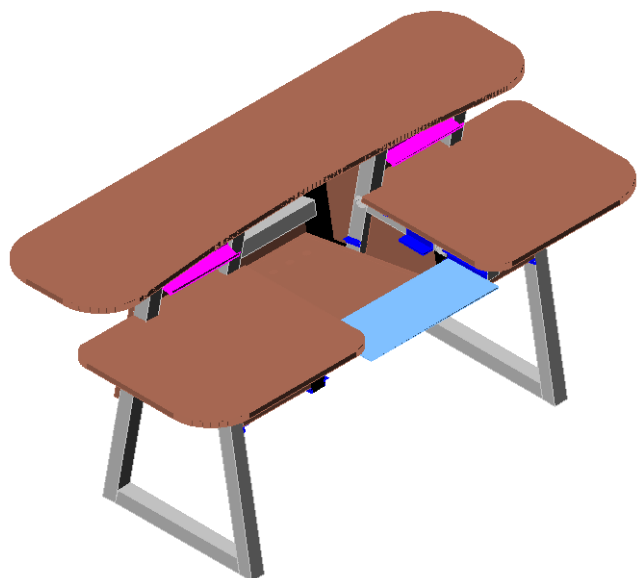


Figure 2: Axonometric view Gouraud shaded.

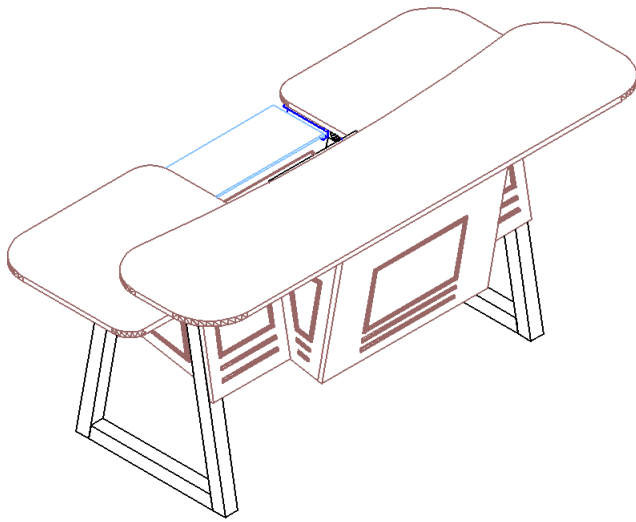


Figure 3: Axonometric view with lines hidden.

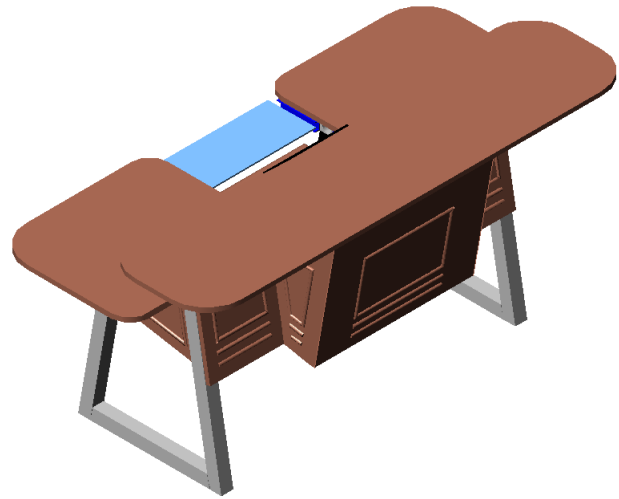


Figure 4: Axonometric view gouraud shaded.

Advantages of Using Layouts

The most practical advantage of using layouts is the simulation of the paper on which the drawing will be actually plotted. Paper space has been available in several previous versions of AutoCAD, but many users were unaware of its existence or could simply not understand it.

The previous versions had a single paper space environment and thus only one layout on which all “sheets” could be laid out. AutoCAD 2000 has multiple layouts; thus a layout can be created for each plotted sheet.

The introduction of multiple layouts is supported by improved plotting. Each plotted sheet (layout) can now be customized for a specific printer, paper size, orientation, scale, plot style, print quality and practically any other customizable plot setting. These settings are saved with the layout and plotting can then be achieved with a few mouse clicks. The new batch plotting option even allows plotting of several sheets with a single command.

The ease of using layouts also encourages the production of several drawings from the same model, as opposed to producing a model (usually 2D) for each drawing. This drastically reduces the file size and therefore improves the response time of AutoCAD. Drawings are also more accurate since usually one model is used, and all aspects of the model can easily be synchronized through comparison. The use of layouts saves time and effort, reduces duplication and makes drawings more accurate.

Production of Drawings

Plans are the easiest to produce using layouts. A layout tab is created and renamed for example “Ground Floor Plan”. The required paper size and plotting options are specified for the layout in a dialog box that pops up when a new layout is being created. The system also creates a viewport by default. The plan is then positioned in the viewport by zooming and panning. The user can then switch to paper space and resize/reposition the viewport, insert an information panel and generally design and complete the page.

A significant aspect of producing a drawing from a model is the freezing and thawing of layers. The layers that make up the particular drawing are thawed (made visible in the particular viewport) while others are frozen (made invisible in the particular viewport). A single layout can contain several viewports. The scale and orientation of each viewport can be set independently.

Elevations and isometric views can be produced by changing the viewpoint, that is by looking at the model from a different angle. AutoCAD generates sections automatically from a 3D model. The section is generated onto a layer. There is however often need for touching up the generated section, by modifying object lineweights to show section lines. Hatching and labelling of the section also has to be done manually.

Problems of Using Layers

The successful use of layouts created by selecting specific layers for viewing demands discipline in the placement of objects on layers. The model must

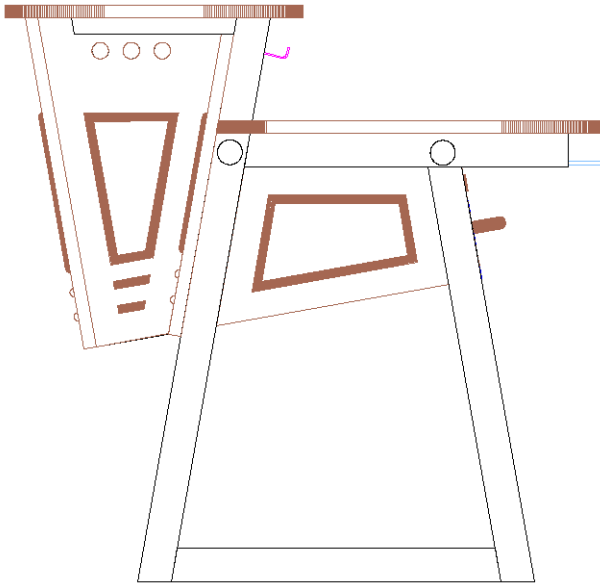


Figure 5: Side elevation with lines hidden.

be properly planned from conception and the layer structure determined. Many people find it difficult to change their drawing habits and embrace layer discipline. Unfortunately, managing objects on layers is less than intuitive, with several restrictions and limitations. There is the need for AutoDesk to enhance the implementation of layers to make manipulation of layers and the objects they contain easier.

It is sometimes difficult to generate some traditional plans and elevations from a 3D model. For example, the view of a model of a house from a height of 1m above floor level does not resemble the traditional floor plan. A section of the model must be cut on this plane to create the plan. Such section must however be hidden in isometric and perspective views to have a clean model. Superimposing 2D drawings on additional layers can also create the effect of a traditional drawing. Another approach is to use 3D wire frames in conjunction with 2D drawings to create a 3D effect.

Practical Example

A computer table with space for a monitor is used as an example. The isometric views, plans, elevations, sections and details are all generated from a single three-dimensional model. See figures 1 to 6 for some of the views.

Attitude of lecturers

Architects-educators in our tertiary institutions share a common opinion on several aspects of computer education but predictably differ in several oth-

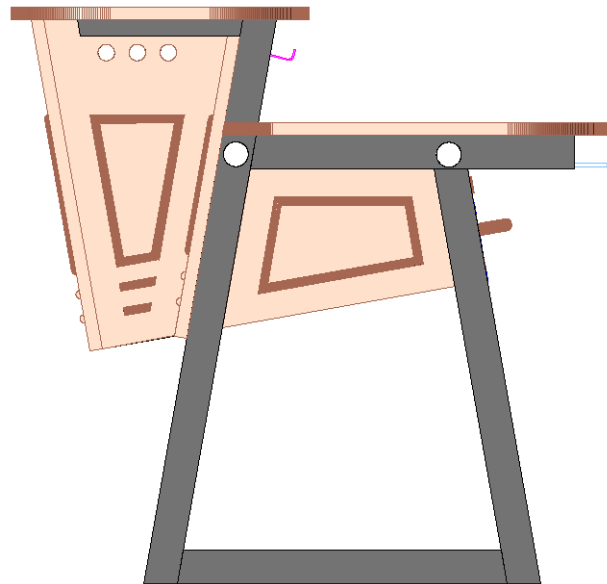


Figure 6: Side elevation gouraud shaded.

ers. The average lecturer has limited access to computer facilities and rarely benefits from regular computer training. He is however able to adapt to the new information age and through personal initiative and sacrifice synergise his traditional training and experience to guide students.

Architects-educators agree that architecture must come first; computers can follow later. The architecture student must be able to understand what architecture is all about, and be able to produce traditional drawings manually, irrespective of his ability to use computers. It is important to avoid a situation where the means (computer) becomes more important than the end (architecture). Creativity should never be suppressed or automated.

Many lecturers welcome computer technology and consider it an advanced form of the T-square. Others are more cautious, advising restraint. They believe the computer may be a passing fad, and while all-important today, may be superseded by a new technology tomorrow. The implementation of a policy on computer education of architects must be national but leave room for schools of architecture to implement such policy within the local constraints.

Conclusion

The enhancements to AutoCAD 2000, especially layouts, make the use of Computer Aided Design and Draughting more realistic. While there are areas for improvement, the software is now architect-friendly enough to be used full time in training and practice. The greatest obstacle to the intro-

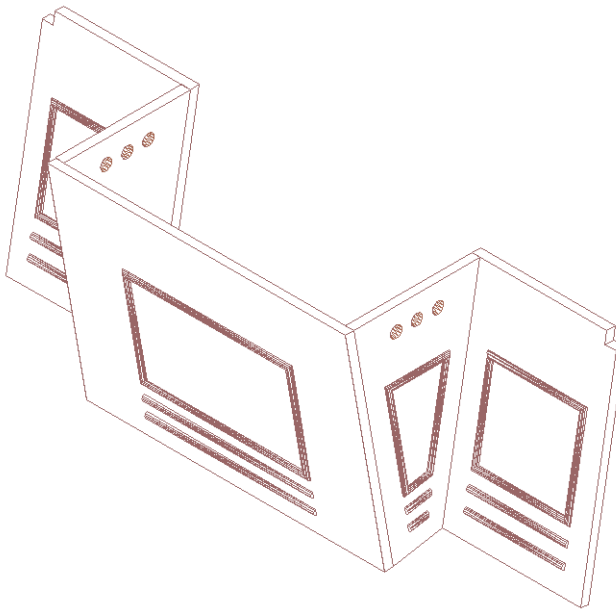


Figure 7: Axonometry of rear veneer plywood elements with lines hidden.

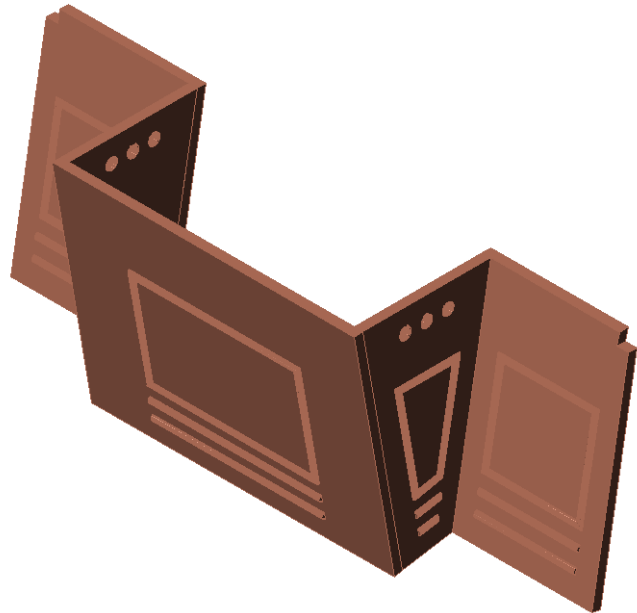


Figure 8: Axonometry of rear veneer plywood elements gouraud shaded.

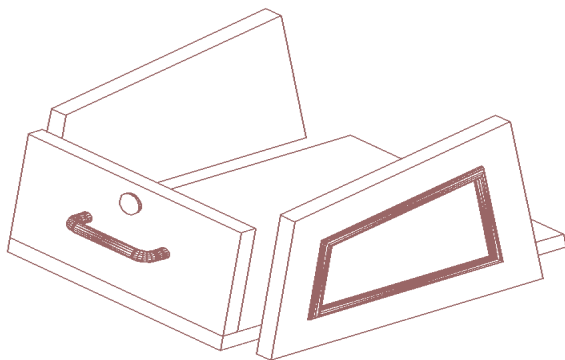


Figure 9: Axonometry of drawer elements with lines hidden.

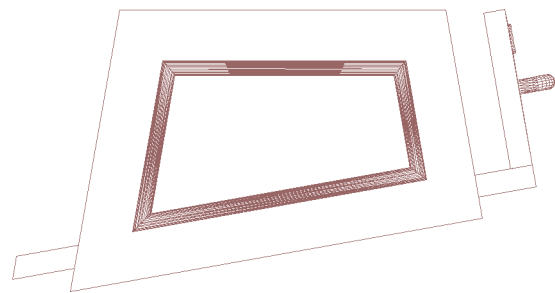


Figure 10: Side elevation of drawer elements with lines hidden.

duction of computers as a standard tool for training is lack of equipment and reliable power infrastructure. However, the lack of a national curriculum for computer training of Architects in tertiary institutions is also a big problem.

While acquisition of equipment must be gradual in our current economic reality, we can start working on a national curriculum for computer training of Architects. We have to decide what to teach students, and at what level. We also have to decide how to assess computer-based drawings, bearing in mind that such drawings can be easily plagiarized.

References

- Autodesk Corporation (1999). AutoCAD 2000 on-line Users Guide. Autodesk Corporation, California, USA.
- Autodesk Corporation (1999). AutoCAD 2000 Learning Assistance CDROM. Autodesk Corporation, California, USA.

Note:

The figures were produced by capturing AutoCAD screens using Corel Capture. The captured images were then manipulated using Micrografx Picture Publisher. Next, the bitmaps were inserted into Microsoft Word which was used to prepare this paper. The picture colour was changed to greyscale to suit the technical production of the journal. The choice of illustrations was also influenced by technical reproduction factors.