OBJECT-ORIENTED FACTORY LAYOUT IN AUTO CAD

Dave Sly

Engineering Automation, Inc.
2321 North Loop Drive
Ames, IA   U.S.A.

ABSTRACT

Factory layout and design is traditionally a 2D process involving the creation of 2D CAD drawings for construction and space planning purposes. Moving from 2D drawings to a 3D model of industrial facilities has been a significant challenge due to the extensive requirements of equipment and manpower. A new object oriented approach (VisFactory) allows users to create 2D / 3D Models of their factories with less time and effort than it would normally take to create the current 2D drawings. The process and benefits of how 3D models of factories can be created effortlessly in AutoCAD and then communicated to simulation packages will be provided.

1   INTRODUCTION

AutoCAD is the predominant CAD package for factory layout and design. Most AutoCAD-based factory layouts are 2D pictorial representations of the facility, and are typically used for space planning and construction purposes. Integration of the AutoCAD-based layouts with other computer technologies, such as simulation, has been largely via use of 2D bitmaps and background images for simulation/animation viewers.

This paper introduces a new technology for factory layout and design called VisFactory. VisFactory was developed to run within AutoCAD release 14 using the new AutoCAD ARX object-oriented design environment. VisFactory adds new object classes to AutoCAD that allow for the drop-and-drag creation and editing of common factory geometry primitives. VisFactory primitives include such items as racks, cranes, conveyors, cabinets, workbenches, handrails, guardrails, fencing and mezzanines, and are used to quickly create highly accurate and intelligent 3D factory models that include logical equipment connections and data significantly beyond anything available within other current technologies.

2   OBJECTS EXPLAINED

VisFactory's Smart Factory Objects enable users to simply drag-and-drop standard factory equipment objects from toolbars on the screen, then snap these objects together to create intelligently connected production systems. Each Smart Factory Object is shown in either a 2D or 3D representation, depending on the view angle of the facility shown in the current AutoCAD Viewport(s).

Each Smart Factory Object is an instance within AutoCAD of an item in the VisFactory object library. As with standard AutoCAD primitives such as Line, Arc, and Circle, VisFactory objects may be moved, copied, stretched (as is appropriate to each object), rotated or snapped. VisFactory objects are stored in the AutoCAD drawing and DXF files by their object type and parameters, thus none of the lines, arcs, circles or other geometric primitives that make up a particular view of the object are stored within the drawing file. This feature allows 2D/3D DWG files of object-oriented layouts to be saved in much less space than would be required for a typical 2D-only AutoCAD drawing of the same layout. At the same time, these object-based drawing files are much more intelligent regarding the content of the drawings than are their geometric primitive-based counterparts.

3   BENEFITS OF USING OBJECTS FOR FACTORY LAYOUT AND DESIGN

At least six primary benefits of using objects for the creation of facilities layouts over using traditional CAD tools and techniques exist:

1) **Objects are easier to use than creating geometry in CAD** – users of objects do not draw in 2D or 3D. Users simply place, snap and size pre-created factory objects to create models (not drawings) of their existing or planned factory.

2) **Object drawing files are smaller than CAD files** – an AutoCAD DWG file of a 3D object-oriented

factory layout will generally be 70% smaller than a corresponding 2D file drawn using standard AutoCAD primitives and 100 times smaller than a corresponding 3D drawing.

3) **Objects display more quickly than primitive geometry** – since objects are more efficiently created and stored, the response times of the drawing are significantly faster during regeneration and viewing.

4) **Interconnectivity intelligence enhances plant modeling versus drafting** – objects are encoded with their corresponding snap intelligence, so only objects that are appropriately attached to one another will be. This built-in design intelligence greatly enhances the quality of the factory model and provides interconnection intelligence to external applications.

5) **Increased object intelligence can be shared** – objects contain information regarding their properties and sizes as well as production information that can all be accessed via standard MicroSoft Xdata commands.

6) **3D is essentially free** – objects are simultaneously 2D and 3D, which means that any layout you create in 2D with the Smart Factory Objects can be instantly displayed, flown through or animated in 3D.

4   DIFFERENT TYPES OF OBJECTS

There are three types of factory objects available within VisFactory.

Parametric objects are objects whose size and parameters can be varied dynamically with standard AutoCAD editing commands such as stretch, through the use of grips, or via their original dialog-box inputs. Thus parametric objects are fully adjustable in the 2D/3D and process modes. All parametric objects in VisFactory support both metric and foot-inch dimensional requirements

Non-parametric objects are objects whose physical size dimensions do not change, although their graphics and intelligence may change according to parameters associated with them. For example, objects of a conveyor motor may not be stretchable in any dimension; however, the graphical representation of this motor may change according to changes in its model number or type, simply by changing the value of the type parameter associated with the object.

Block referenced objects are objects that have no dimensions and no graphics, but reference their graphics from 2D and 3D block definitions. Block referenced objects have attributes and parameters, but these parameters do not affect the graphical representation of the

objects, as they are solely used for object validation, cost estimation, simulation and animation.

VisFactory includes over 100 new objects created to ensure that over 80% of the equipment in any layout can be fully represented in 2D and 3D with Smart Factory Objects. These objects include:

- Columns and structural steel (to the extent needed for Factory Layout)

- Lighting

- Mezzanine

- Catwalk/Overhead walkway

- Stairs/Ladders

- Platform (with rails and stairs)

- Toolrail

- Conveyor Equipment Pits

- Bridge Crane/Hollywood rail (with drives and supports)

- Overhead and Inverted P&F conveyor with v-curves, biased banks, segmented/nonsegmented turns, takeups, cat drives, expansion joints, etc.

- Body Shop Conveyors, turn tables, swivel tables, lifts.

- Monorail and Electrified Monorail conveyors with turns and droplifts

- Package conveyor, belt/roller/skatewheel with turns, V-curves and spurs

- Racking and Shelving

- Containers, barrels, baskets, boxes, racks

- Jib Cranes

- Cabinets (one to ten doors with one-way or alternating openings)

- Braze/Grind/Weld booths and curtains

- Fencing

- Piping Hand Rail/Guard Rail

- Benches

- Tooling

4   SIMULATION INTERFACES INTO FACTORY LAYOUT OBJECTS

VisFactory objects contain process data and factory equipment information that can be used internal to the layout environment for equipment connection validation or simple buffer calculation purposes. This information can

also be extracted to SDX files (Simulation Data eXchange) that can be read by simulation software programs for the automatic creation of production system models. Currently developers of both Witness, by the Lanner Group, and AutoMOD from AutoSimulations are working on interfaces to the SDX format by request from several large automotive firms desiring a common-model approach to factory layout design and simulation.

5 CONCLUSIONS AND RELATED OBJECT-ORIENTED TECHNOLOGIES AND STANDARDS

In addition to VisFactory for industrial equipment objects such as cranes, racks and conveyors, other Autodesk developers are joining to develop complementary objects of structural steel, walls, doors, windows, piping, and HVAC. These many object developers are quickly transforming the way people create facilities of all kinds.

It is anticipated that within only two years, the majority of office and industrial facility drawings will move from simple 2D drawings to 2D/3D object models using layout design objects such as those in VisFactory. In the Factory design field, it is these very objects that will bring simulation capabilities to the layout designer and begin to integrate the manufacturing design process into a model-based one in which data can finally be shared on an enterprise level.

REFERENCES

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AUTHOR BIOGRAPHY

DAVE SLY is the Executive Director of Factory Products at Engineering Animation, Inc. (EAI) in Ames Iowa. EAI is the leading producer of enterprise-wide visual process management, collaboration and communication solutions. EAI maintains its corporate headquarters and technology center in Ames, Iowa, and has offices worldwide. Dave received bachelors and masters degrees in Industrial Engineering and an MBA from Iowa State University. Dave is a registered professional engineer in the State of Iowa and a senior member of the Society of Manufacturing Engineers, Institute of Industrial Engineers and the Society for Computer Simulation.