

Interactive 3-D Modeling with Personal Computers

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Abstract

An interactive three-dimensional modeling system, called *Facet*, is presented. *Facet* was developed for use during the design of physical artifacts: from studies of simple shapes, spaces, and forms to detailed modeling of complex physical systems. *Facet* provides a visual medium for enhancing perception of the model and for exploring various alternatives during the design process. In order to make this 3-D modeling medium available and affordable to any interested design professional *Facet* operates on commonly available IBM or compatible personal computers. In addition to an overall description of *Facet* and its interactive modeling techniques, several underlying issues in the development of a modeling system are discussed. These issues include: the interactive user interface; 3-D display techniques; and ways of dealing effectively with model complexity. A number of areas for continued development, based on experience with the current implementation, are discussed.

KEYWORDS: configurable, interactive, three-dimensional, modeling, computer graphics, personal computer, design.

1. Introduction to *Facet*

Facet is an interactive 3-D modeling system for design professionals that runs on widely available personal computers (PCs). It allows a user to develop and manipulate 3-D computer models of shapes, spaces, and forms for use during the design process. Models are displayed on the screen in a *wire-frame* form while the user is interactively building or modifying the model. Selected views (including perspectives) may subsequently be rendered by the computer with shaded surfaces or may be output with a pen plotter or dot matrix printer. These two-dimensional pictures can then be the basis for working drawings or other enhanced renderings to be used for communicating the design to others.

Facet is initially directed to spatial designers who need to study alternative forms and shapes during the design process and create visual representations of physical systems. However, it will be readily adapted for use in other diverse areas of 3-D modeling such as generating input for graphic arts illustration systems as an aid in producing perspective drawings and renderings; building models, sets, and backgrounds for use by a 3-D animation system, when the elements being designed are static and do not require the expensive hardware necessary for real-time dynamic manipulation; and generating charts, technical

illustration, and other graphics to be incorporated with word processor output for document production.

A careful combination of features positions *Facet* as a readily available tool for 3-D modeling integral to the design process: a need that has not been adequately addressed affordably in the past. Some of the key aspects of *Facet* which recognize this need follow.

- Perhaps the most important aspect of *Facet* is the quality of interaction. The emphasis is on providing a modeling aid for use during the initial design stages. This is accommodated to a large degree in the way the designer is able to effectively interact with this electronic modeling medium. For example, the designer is able to quickly develop models of shapes, spaces, and forms; examine the model from many points of view to establish an accurate mental perception; and easily make changes in exploring different alternatives.
- A second key aspect of *Facet* is that it can deal with complex models. Unlike some previous modelers, project complexity is not limited by the computer's address space. Features are provided that enable the designer to organize the model with structure, grouping, and symbolic naming to work with abstractions and deal effectively with complex or detailed project models.
- Third, the ability to generate high quality shaded surface renderings, after interactively constructing the model, is an integral feature of *Facet*. The designer is able to assign various attributes to elements of the model that allow *Facet* to exercise the full capabilities of a high quality display device, if available, yet still operate effectively when using less capable display hardware.
- Finally, low cost is a significant feature of *Facet* to make it feasible for use by any interested professional designer. The basic personal computer system to support *Facet* can be purchased today for as little as \$2,000. (A much faster, full-featured system with the ability to generate full color renderings can be assembled for less than \$10,000.) Marketing strategy and pricing for the *Facet* software have not been finalized.

To be available to the largest group of users *Facet* runs under the PC-DOS (MS-DOS) operating system on IBM (or compatible) PCs. The minimum hardware configuration includes the basic PC with 640K bytes of main memory, a math coprocessor, a hard disk, a supported graphics display

