EMERGENCE OF CAD/CAM CONSTRUCTION

Most early CAD systems

Most early CAD systems were intended for use as drafting systems. Their primary purpose was to speed the process of creating traditional construction documents, to reduce the cost, and to reduce errors. They represented designs as sets of two-dimensional drawings–floor plans, elevations, sections, details, and perspectives–often organized in "layers" that explicitly recalled the drawing layers that had been drafted on translucent sheets of paper or Mylar. To facilitate construction of drawings, they provided layout grids, snap operations, geometric construction operations (such as insertion of an arc through three points), and copy-and-repeat operations. These early systems proved particularly effective in large-scale commercial, industrial, and institutional interior projects that involved extensive repetition of bays, columns, standard floor plates, and standard items of furniture and equipment. In projects with less repetition, their benefits were less substantial.

An obvious extension of CAD drafting technology is to provide facilities for associating nongeometric properties with graphic elements. This soon became a standard software feature of more advanced CAD systems. Thus, for example, a designer might associate vendor's name, product serial number, and various items of technical data with the graphic symbol for a chair. The data could then be retrieved interactively by pointing at a display, and it could be used to compile sorted and tabulated reports, such as furniture and equipment schedules. These features greatly enhanced the usefulness of CAD software at the construction documentation and postoccupancy facility management phases of architectural and interiors projects.

A less obvious, and technically more difficult, move of CAD software designers was to begin building CAD systems around three-dimensional digital models rather than sets of two-dimensional, digitally encoded drawings. To succeed, this strategy depended on the availability of far more powerful computers, the emergence of software technologies such as three-dimensional surface and solid modeling, and the development of more complex and sophisticated graphic interfaces. Gradually the technological pieces fell into place, and three-dimensional CAD modelers had become commonplace in architectural and interiors practice by the 1990s.

One advantage of a three-dimensional model is that it can be used, in conjunction with rapid-prototyping devices, to produce three-dimensional physi-

cal models as well as two-dimensional prints and plots. An even more important advantage is that it can be used to drive computer-aided design/computer-aided manufacturing (CAD/CAM) machinery and on-site positioning machinery. This establishes a new type of linkage between the digital model and the constructed building, as was shown in Figure 14-2. CAD/CAM technology translates the digital model directly into full-scale physical reality, thus *eliminating* rather than automating the production of traditional construction documents. Conversely, new three-dimensional imaging and electronic surveying technologies facilitate construction of three-dimensional CAD models of existing buildings.

CAD/CAM technology first developed in the manufacturing industry—particularly in the automobile, ship-building, and aerospace areas—and has only more recently moved into architectural and interior design and construction. The variety of CAD/CAM machinery now available is immense. There are digitally controlled machines for cutting and bending steelwork, for cutting sheet materials such as glass, plywood, and sheet metal into complex shapes, for milling wood and stone, and many more. They will play an increasingly important role in fabrication of components for architectural and interior construction.

MULTIMEDIA DESIGN AND CONSTRUCTION PROCESSES

Today, an architectural or interior design and construction process is likely to involve most or all of the types of representations shown in Figure 14-3, together with most or all of the translation paths among them. Designing and building have become truly multimedia activities.

The process that has been pioneered by Frank Gehry and his partners and collaborators, and that has enabled the efficient design and construction of such innovative projects as the Bilbao Guggenheim Museum (Figure 14-7) and the Conde-Nast cafeteria interior (Figure 14-8), strikingly illustrates this. The exploration of design ideas begins with the production of quick sketches and three-dimensional physical models. As the design converges, physical models are digitized to create corresponding digital models—particularly of