Web-enabled model-based CAD for design

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Computer-aided design (CAD) applications have been widely used in the construction industry as a tool to aid architectural design, to visualize the physical appearance of a building, and to specify design details for construction processes. This paper describes and demonstrates web-enabled model-based CAD applications, conceptually represented in Figure 1, that could act as a service hub and communication tool for building design, analysis, and construction management.

Current CAD programs are mostly standalone. Increasingly innovative ways of exploiting the Internet is giving rise to potentially new ways of designing and managing constructed facilities. The Internet has been leveraged to build an environment that connects distributed CAD software clients to a centralized product data server for collaborative design (Fuh and Li, 2005; Han et al., 1999; Zhuang and Chen, 2000). In this paper, we demonstrate the use of the Internet technologies to explore and retrieve information available on the web, and to integrate distributed applications as web-based services within CAD programs. For example, technologies are now available to enable a designer to ‘pull’ an object (e.g. door, window, chair, etc.) over the web and directly drop them into a CAD design. These technologies not only allow designers to create and change a design easily and quickly, but also enhance the communication among the designers, manufacturers and suppliers within the construction industry.

Traditionally, a design is drawn using a combination of geometric entities such as lines, planes, and volumes. This geometry-based approach is now evolving to an object-oriented model-based approach, in which each design object (e.g. door, wall, slab) has its properties and semantics (Eastman et al., 2008). The sets of properties affect the operations on the object in a model-based CAD software application. The object properties and semantics can also be manipulated by other software applications and can further be utilized throughout the project life cycle. Application programming interfaces (APIs) in CAD software can be used to facilitate the management and exchange of the object information. Therefore, a CAD application can become a service hub for acquiring and capturing design and project information.

![Figure 1. Web-enabled model-based CAD applications](image-url)
This paper presents three scenarios to show the potential of web-enabled model-based CAD in the design and construction processes, using both Autodesk Architectural Desktop (ADT) and Google Sketchup. The first scenario demonstrates the usage of CAD programs to perform configuration design by directly interacting with the web and online information through web browsers and a CAD software plug-in namely SpecifiCAD. Leveraging Autodesk i-drop technology and the drag-and-drop capability of Sketchup interface, architects can conveniently bring design components from online catalogs to CAD software programs. Interaction with the web is also allowed inside CAD programs to provide customized information. Creation and modification of architectural designs are therefore facilitated.

The second scenario illustrates the evaluation of design alternatives according to energy and carbon emission simulation and analysis results, provided by using a Sketchup plug-in that links to the Integrated Environmental Solutions (IES) software packages. The building information in CAD models is extracted and used for the analyses. With web-enabled configuration design and model-based building performance analysis, sustainable building design can be performed more quickly and easily.

The third scenario shows the utilization of the entity information from CAD models to facilitate project planning and control with suppliers. In this example, the Autodesk ADT CAD model is supported by schedule information which is connected to project management applications. Project manager can submit query to inquire building information and to view only the building components involved in specific tasks or in a specified period. Project manager can also access the schedule information and invoke supplier’s web services within ADT for material delivery management.

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