Knowledge Based Agents: KB-CAD Integration

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Introduction

• **CAD (Computer Aided Design).** “computer-based tools that assist engineers, architects and other design professionals in their design activities”

• Embedding knowledge-based design applications into CAD systems helps improve their capability and performance
Application of the knowledge-based system in design review

- Example?
Frame Work

• This paper evaluates results of six years of research in developing and implementing knowledge-based design applications in CAD systems.

• A knowledge-based systems tool was embedded in three commercial CAD systems using a special integration software program. This software is called Stonerule
Why AI?

• History record for future need - like design modification.
• Supporting explanation to help and convince user.
• Release developer, knowledge engineer, from must-know programming.
• Efficient use of OO, not all programming language support OO.
• Reuse of inference engine, CAD interface, and knowledge base.
• Help maintenance and avoid spaghetti code.
• Experts can learn to add rules to the KB themselves - English like.
Smart CAD Applications

• Design review
  - The knowledge-based system’s rules specify the conditions that must be fulfilled.

• Automated design

• Design advice

• Concurrent engineering facilitator
The knowledge-based engineering application of the embedded system
Objectives and requirements

- Use of existing systems and tools.
- Applications programming interfaces.
- Transparency of applications.
- Incorporation of user-defined programs.
- Continual knowledge base access.
- Independent development of the knowledge-based systems applications.
Implementation

• CAD software
  - Dassault Systemes’ Catia and Cadam, and Pro/Engineer by Parametric Technology
  - no modifications or alterations to the existing systems
  - CAD system to be used without the knowledge-base when desired
Implementation (cont.)

• The systems shell
  - (called Trinzie’s Aion Development System, AionDS)
  - Preferred over over Lisp- or Prolog-based shell
  1- the systems shell must operate directly on the native CAD geometry
  2- The shell must be compact enough
Implementation (cont.)

• The knowledge base
  - design rules derived from corporate policies, procedures, and experience, including the heuristics of expert designers
  - relationships between strictly geometric parameters, or relationships between geometric and non-geometric parameters
Integration

• (Stunerule) Structure:
  - The communication mechanism between the knowledge-based systems shell and the CAD system
  - Module 1 Links into the CAD system, Invoke KB and interact with user
  - Module 2, Libraries to handle Inter-process Communication.
  - KB interface Programs, directly access the KB systems shell
Virtual Geometry Environment (Shell side)

- The VGE module consists of a set of class libraries that embed the CAD system’s API calls within the objects.
- To create or read geometry, the knowledge base developer simply refers to a library of geometric elements available within the knowledge-based systems engine.
Virtual Geometry Environment (Cont.)

• This library can be continually expanded and contains primitive parametric and associative geometric elements (spheres, cylinders, cones, cubes, and so on)

• Complex parametric associative geometric objects are made up of multiple primitives.
Virtual Geometry Environment (Cont.)

- OO representation will allow all object properties in coordinator classes (methods to read, draw, ...) to be inherited by the geometry and process classes.
- Conceptually, this architecture allows one knowledge base to be used with any CAD system (as long as the interface software exists)
Operation

• KB system invoking
  - During a CAD session, the user can invoke an embedded knowledge-based systems function in exactly the same manner as any other CAD function.
  - If the knowledge base requires information during its execution, the inferencing process is interrupted and the needed information is obtained by one of the following methods:
Operation (Cont.)

• by a search of the geometry and attributes of the CAD model;
• by an automated query to an external database using, for example, Structured Query Language (SQL);
• by reading the geometry or attributes of an object in the CAD model interactively selected or specified by the user; or
• by querying the user directly for the information (user sourcing).
Operation (Cont.)

1: select task
2: load task
3: query context
4: process input
5: require additional input
6: input
7: optimal solutions
8: select solution
9: generate model
Operation (Cont.)

• Integration software Role:
  - When required, the integration software handles the user interface to communicate information to the CAD user.
  - For user sourcing, the integration software displays an English language query (prompt) on the CAD screen.
  - The integration software also provides communications for intermediate results and messages, and for the explanatory facility of the knowledge-based systems engine.
Challenges

- **Interpreting Object Structure**
  - Either CAD provides feature-based model and objects recognition, or the KB should apply pattern matching and feat. extraction.
  - correspondence between the knowledge base’s logical or symbolic reasoning, and the geometric reasoning
  - capabilities of geometric reasoning lag behind those of symbolic logic
  - So, knowledge must be expressed linguistically or symbolically, as there is no other language in which to express it
Challenges (Cont.)

• Geometric knowledge acquisition
  
  - It would be highly desirable, however, to develop a graphical language for inputting design knowledge through the CAD interface as geometry and geometrical relationships.

  - The modification of the design does not automatically flow back into the rule modifications that originally created it, one time change?
• Thank You

• Questions?