Basics of CAD/CAE/CAM Software

25.353 Lecture Series

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Outline

• Common features of CAD tools
• Database and Database Management System (DBMS)
• Current market
• Selection of software tools
Common Features

- written in a standard programming language.
- hardware-independent.
- quality, speed, and ease of information retrieval are determined by its database structure and data management system.
- some semantics or user interface system for operation commands
- an interactive programming tool
- import/export various formats of CAD/CAM files.
- After all, they are based on the same fundamental CAD/CAM algorithms and techniques.
Database and Data Management System (DBMS)
-- Core to a CAD/CAM system
An organized collection of graphical and non-graphical data stored on secondary storage in the computer.
Database Requirement

A CAD/CAE/CAM database should support:

- Engineering applications from conceptual design to manufacturing operations
- Dynamic modification and extension of the database and its associativity
- The iterative nature of design
- Design versions and levels of detail
- Concurrent and multiple users
- Temporary database support
- Free design sequence
- Easy access
Desired Database Features

• Associativity
  – various data forms and applications

• Centralization
  – same data form, various use in one application

• Integration
  – support various applications of the geometric model
Advantages of Centralized Database

- Eliminate redundancy.
- Enforce standards which eliminate data conversion, which reduces cost.
- Apply security restrictions and accessibility to authorized users.
- Maintain integrity.
- Balance conflicting requirements.
Database

- Record-Based Database
  - Relational Database
  - Hierarchical Database
  - Network Database
- Object-Oriented Database
Relational Database

- Slow response
- Large memory
- Easy adaptability

(Ibrahim Zeid, 1990)
Hierarchical Database

- 1 : n association
- Rather rigid data access
- Redundant data structure and inflexible to restructure

(Ibrahim Zeid, 1990)
Network Database

- Allows m:n association between records
- Multiple data accesses allowed and reduced redundancy.
- Complex data structure
- Difficult to implement and restructure

(Ibrahim Zeid, 1990)
Object-Oriented Database

- **Object**: It is the basic modeling unit in object-oriented models.
- **Attributes**: intrinsic properties of the object or describe its relationship with other objects.
- **Method**: execution of methods can change attributes values and produce outputs.
- **Message**: method is invoked by a client by sending a message to the object.
- **Class**: Objects with their common behavior and attribute types.

Class name: 2D-surface
Attributes: upper left corner
length
height
Method: translate

**Inheritance**: A class can inherit attributes and method from another class.
Object-oriented Database

- data hidden
- abstract data model
- object defines attributes and associated actions

Object-oriented database seems the ideal one for CAD/CAE/CAM application.
Hybrid database may also be useful.
Database Management System (DBMS)
Database Management System (DBMS)

- Data Directory
- Access/Security Control
- Transaction Processing

Database Management System

Users

Application Programs

Database
Comparison of DBMS in CAD and in Business

<table>
<thead>
<tr>
<th></th>
<th>Conventional DBMS</th>
<th>DBMS in CAD/CAM</th>
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</thead>
<tbody>
<tr>
<td>Data type</td>
<td>Most alpha-numeric</td>
<td>Alpha-numeric and graphics</td>
</tr>
<tr>
<td>Number of data types</td>
<td>Few</td>
<td>Large</td>
</tr>
<tr>
<td>Data relations</td>
<td>simple</td>
<td>Complex</td>
</tr>
<tr>
<td>Data feature</td>
<td>Stable</td>
<td>dynamic</td>
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Quick Questions

• Most CAD/CAM packages can be run on a similar hardware platform such as PC and UNIX workstations.
• Different CAD/CAM packages use fundamentally different geometric modeling techniques.
• Generally, the data structure and the DBMS of a CAD/CAM directly influences its performance.
• A CAD/CAM system’s DBMS is required to manage a variety of data types and dynamically update information.
• The drawback of the relational database structure is that it requires substantial sorting and thus slows down the system response.
• The most important characteristic of CAD/CAM is its desired fully 3D, associative, decentralized, and integrated database.
CAD/CAE/CAM Software Market

• A wide range of scope and capabilities
• Popular vendors:
  – CAD/CAM: Pro/Engineer, IDEAS, UNIGRAPHICS, CATIA
  – CAD alone: AutoCAD, Mechanical Desktop, SolidWorks, SolidEdge, CADKEY
  – CAM alone: MasterCAM, Varimetrix
  – FEA: Nastran, Patran, Marc, Dytran, WorkModel FEA (the first five are from Mechanical Solutions Corporation), Algor, Ansys, Pro/Mechanica (included in Pro/E), Abaqus, CFX
Some Sites

- [http://caddprimer.com/](http://caddprimer.com/): educational
- [http://cadsystems.com/](http://cadsystems.com/): commercial, can get numerous small and free CAD tools
Mechanical Engineering Sites

Source: “CAD in the Mechanical Engineering Sector” from CADDigest.com, Summer 2003. (UK)
A Glimpse of Price

- Autodesk Inventor (approx. $3,000 if you already have autoCAD)
- Pro/ENGINEER Foundation Advantage $4,995 (Full license price much higher)
- Solid Edge V.6 $5,000
- SolidWorks 2005 $4,995

Software Selection

- Is it for personal or professional use?
- Select a program compatible with programs used by your clients and consultants
- Review how many customization features a program offers
- Decide between a brand name and any workable program
- Find out if the dealer offers technical support
- Ask if the dealer offers free or low-cost updates of the program
- Find exactly what you need and match the needs with a program
Users of CAD/CAE/CAM Software

• Software operators (most of us)
• Application programmer (customizing the software, often called “secondary development”. Often engineers in a manufacturing company – no access the source code.)
• Software developer (access the source code – vendor company)
Learning Curve

- Knowledge gained
- Confusion zone
- Mastering the system
- Further training
- Initial training period
- Time
- Mastering the system
Summary

- Common features of CAD software
- Database and data management systems (DBMS)
- Misc.
  - Application modules
  - Current software market
  - Learning curve
  - Software selection