Basics of CAD/CAE/CAM Software

25.353 Lecture Series

Prof. Gary Wang
Dept. of Mech. and Manufg. Engr.
University of Manitoba

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

Database

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

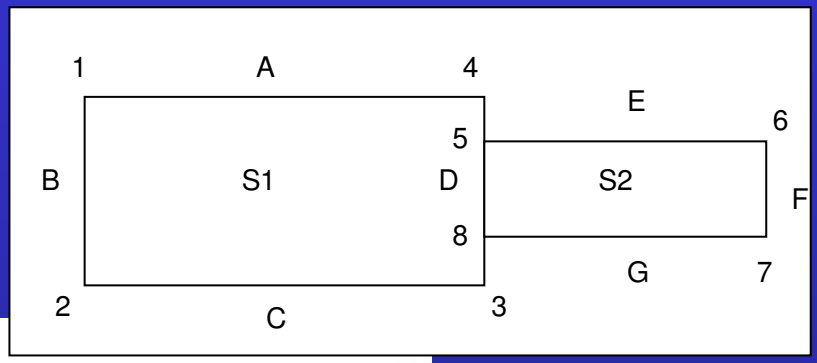
- Eliminate redundancy.
- Enforce standards which eliminate data conversion, which reduces cost.
- Apply security restrictions and accessibility to authorized users.
- Maintain integrity.
- Balance conflicting requirements.

Database

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

Relational Database

- Slow response
- Large memory
- Easy adaptability



Point	x	y
1	x_1	y_1
2	x_2	y_2
3	x_3	y_3
4	x_4	y_4
5	x_5	y_5
6	x_6	y_6
7	x_7	y_7
8	x_8	y_8

Relation POINT

Line	Start point	End point
A	1	4
B	1	2
C	2	3
D	3	4
E	5	6
F	6	7
G	7	8

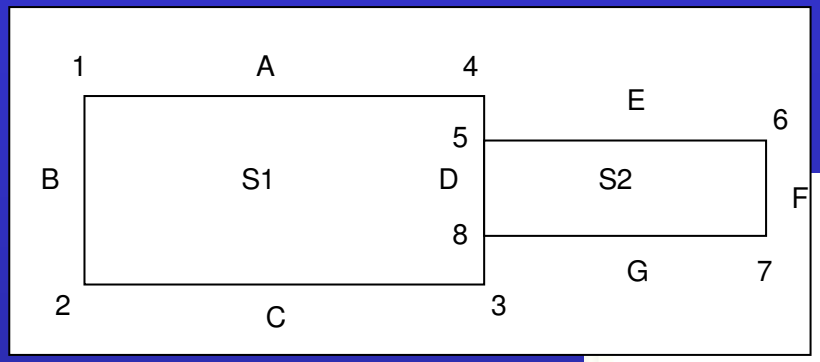
Relation LINE/CURVE

Surface	Line/ curve	Type
1	A	Line
	B	Line
	C	Line
	D	Line
2	E	Line
	F	Line
	G	Line
	D	Line

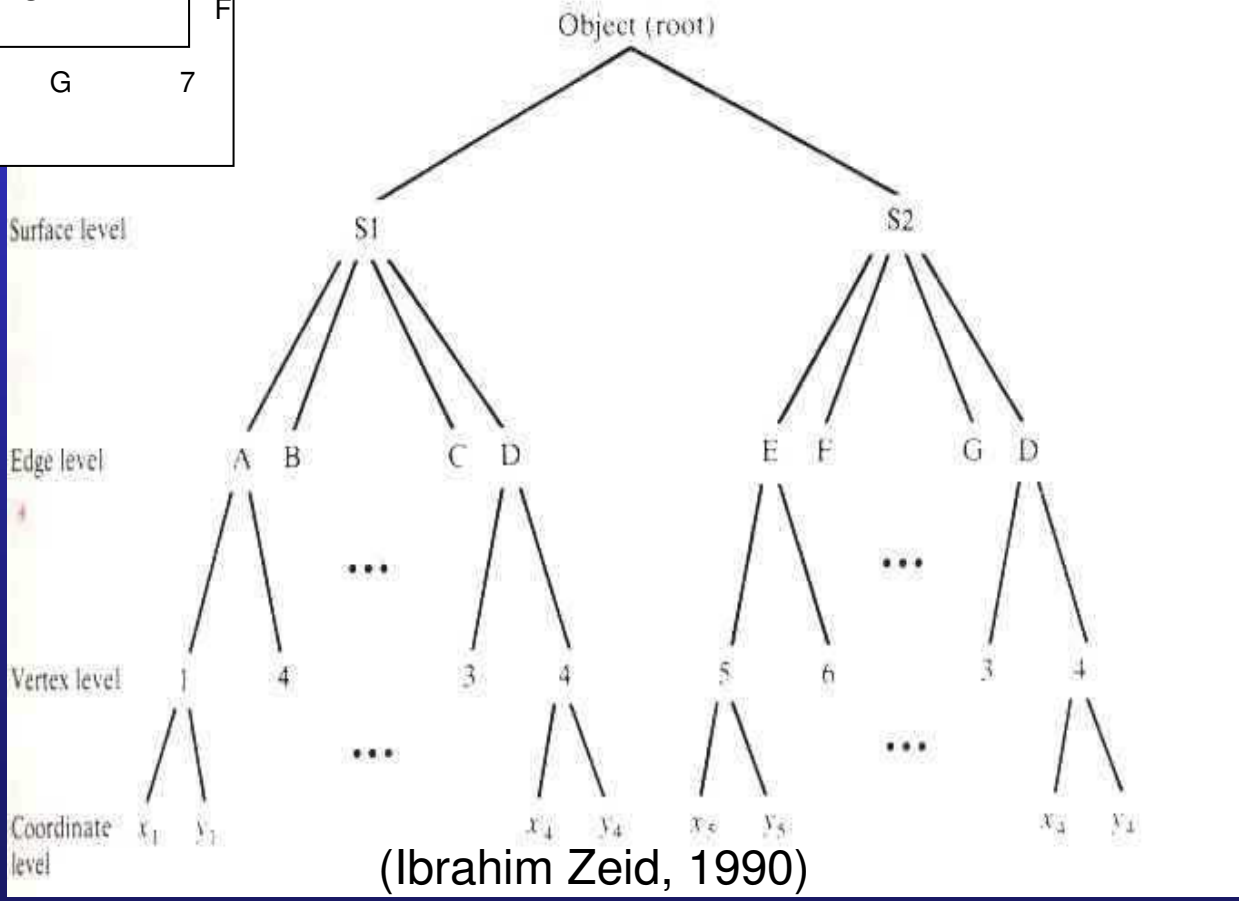
Relation SURFACE

(Ibrahim Zeid, 1990)

Hierarchical Database

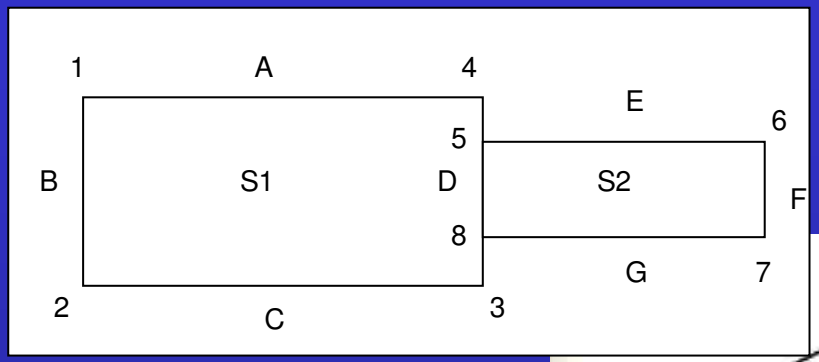


- 1 : n association
- Rather rigid data access
- Redundant data structure and inflexible to restructure

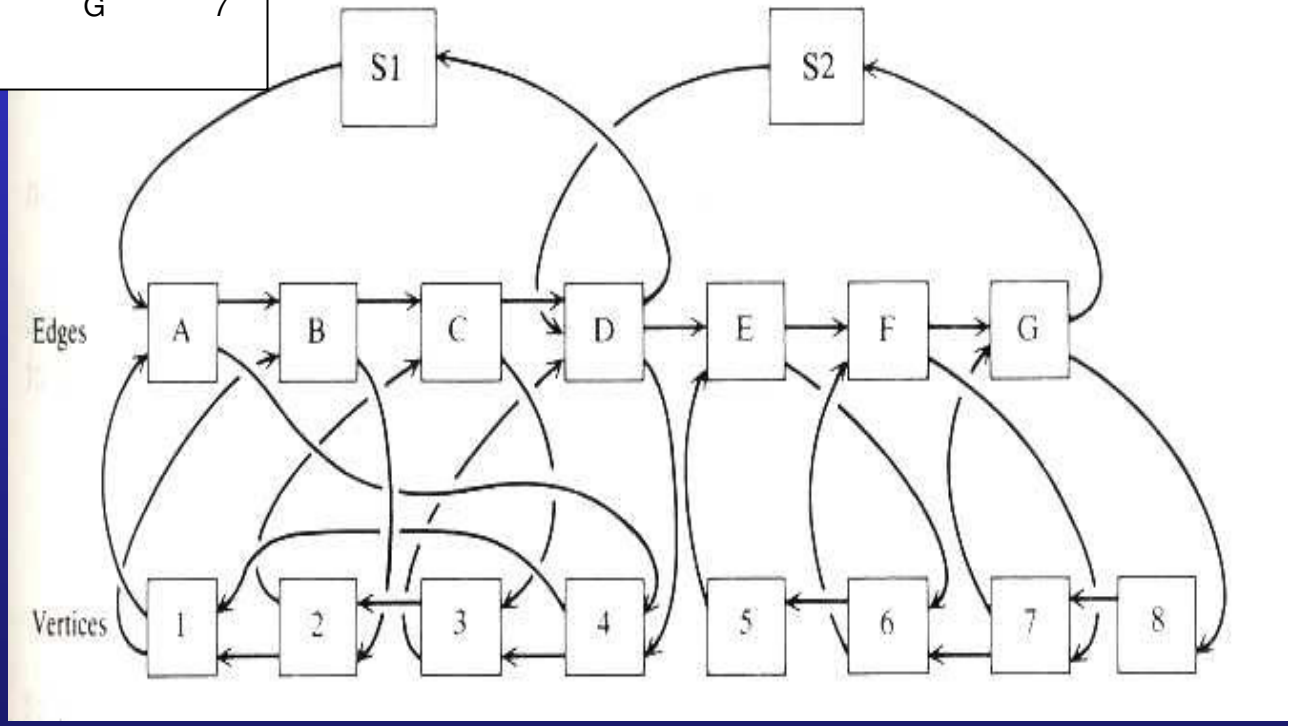


(Ibrahim Zeid, 1990)

Network Database



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

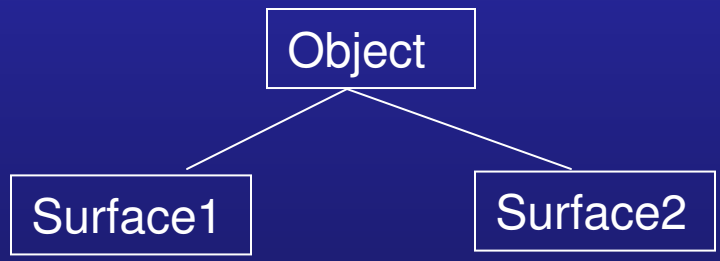


(Ibrahim Zeid, 1990)

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.**

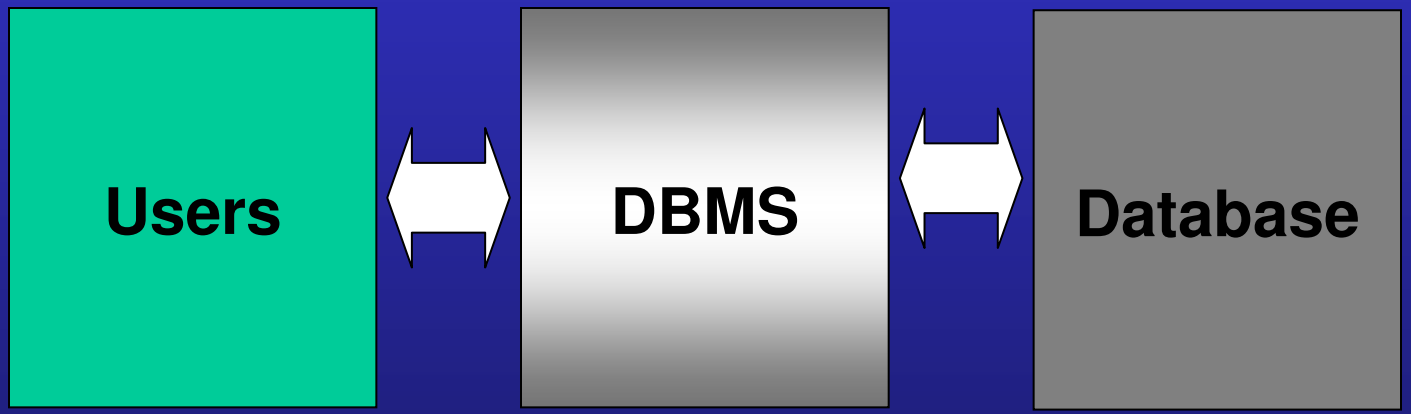
Object-oriented Database

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

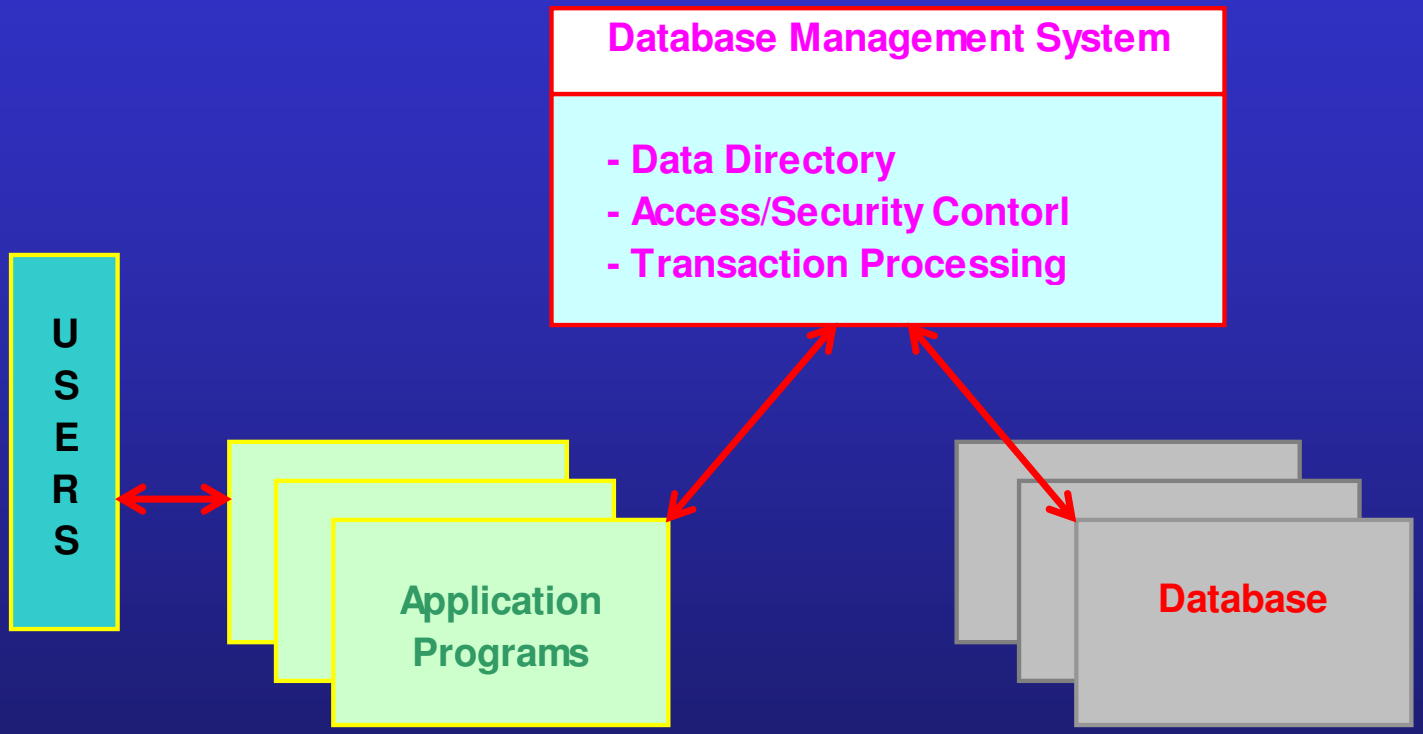
Object-oriented database seems the ideal one for CAD/CAE/CAM application.

Hybrid database may also be useful.

Database Management System (DBMS)



Database Management System (DBMS)



Comparison of DBMS in CAD and in Business

	Conventional DBMS	DBMS in CAD/CAM
Data type	Most alpha-numeric	Alpha-numeric and graphics
Number of data types	Few	Large
Data relations	simple	Complex
Data feature	Stable	dynamic

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.

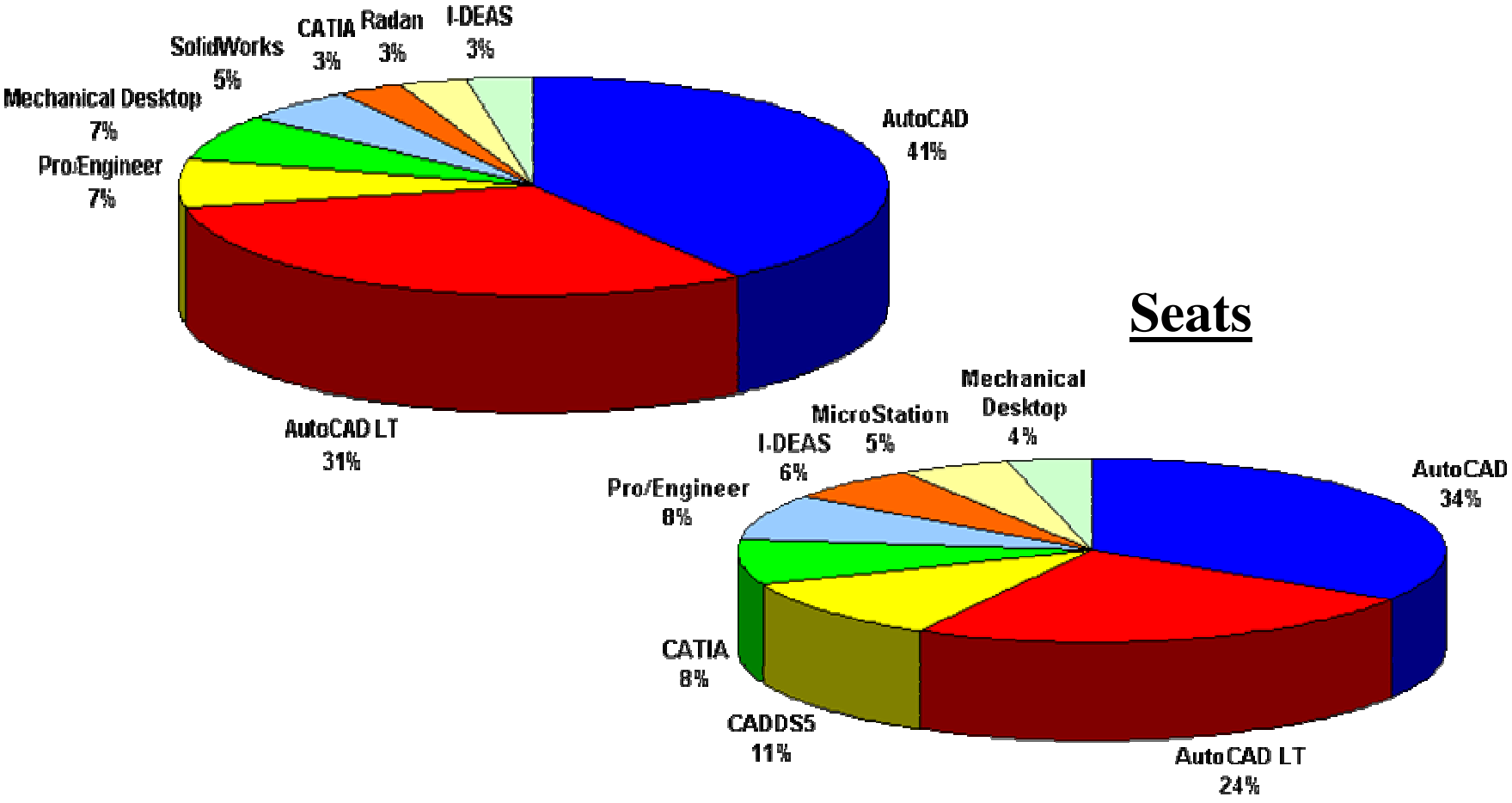
CAD/CAE/CAM Software Market

- 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 fist five are from Mechanical Solutions Corporation), Algor, Ansys, Pro/Mechanica (included in Pro/E), Abaqus, CFX

Some Sites

- http://caddprimer.com/: educational
- http://cadsystems.com/: commercial, can get numerous small and free CAD tools
- http://www.cad-cam-cae.com/index.htm: news and some tutorials
- http://dmoz.org/Computers/CAD_and_CAM/PTC_Pro_Engineer/: all about Pro/E
- http://www.umanitoba.ca/faculties/engineering/mech_and_ind/prof/wang/index_files/25.353/indexf_files/Links353.htm: course collections
- http://www.journeyed.com/itemDetail.asp?T1=88294903: student version

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**

Sept 13, 2004, “CAD For The Budget-Conscious”, by Paul Teague from DesignNews.com

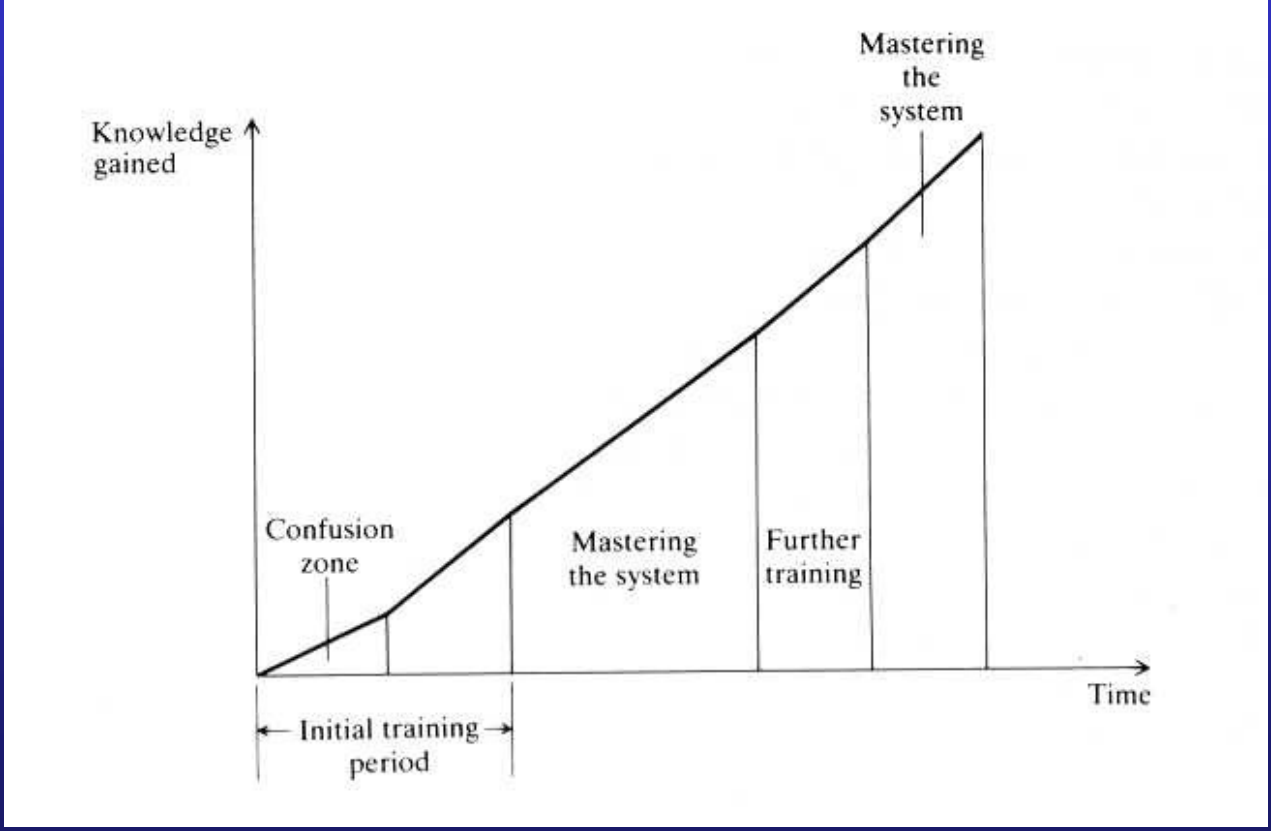
Software Selection

- 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



Summary

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