Contents

- Definitions of CAD/CAM/CAE
- Product development
 - Practical example
- Design models
- Hardware components
 - I/O devices
 - Graphics display
 - Vector-refresh
 - Raster

Product Cycle (CAD/CAM/CAE)



Computer-Aided Design

- Technology concerned with the use of computer systems to assist in the creation, modification, analysis, and optimization of a design
 - Computer graphics and an application program facilitating engineering functions in the design process
 - From geometric tools to manipulate shapes to customized application programs (analysis and optimization)
 - Most basic role: define the geometry of design
 - Important components: computer-aided drafting system and geometric modeling system

Computer-Aided Manufacturing

- Technology concerned with the use of computer systems to plan, manage, and control of manufacturing operations
 - Most mature area: NC(Numerical Control)
 - Robot programming for material handling, welding, assembling, etc.
 - Process planning
 - Group Technology
 - Feature recognition of feature based modeling
 - MRP(Material Requirement Planning)
 - Rapid Prototyping
 - Stereolithography
 - Selective Laser Sintering
 - Fused Deposition



CAM: Example



- Technology concerned with the use of computer systems to analyze CAD geometry, allowing the designer to simulate and study how the product will behave so that the design can be refined and optimized
 - Kinematic program, large-displacement dynamic analysis, etc.
 - Most widely used method of computer analysis: FEM
 - Stress, deformation, heat transfer, fluid flow, magnetic field, continuous field problem
 - Pre-processor: construction of the abstract model and generation of the finite elements
 - Post-processor: visualization of results
 - Design optimization

CAE: Example



CAD/CAM/CAE Systems - 7

Example: Cellular Phone (CAD)



Solid Model

Example: Cellular Phone (CAE)



Finite Element Analysis Model



Stress Distribution



Boundary Conditions



Fill-time Distribution

Example: Cellular Phone (RP/CAD)



Physical Prototype



Part Drawing

Example: Cellular Phone (CAD)

Injection Mold Design

- Core plate
- Cavity plate
- Side cores



- Mold base
- Ejector pins
- Cooling channels



Example: Cellular Phone (CAM)



NC Tool Path to machine mold

Computer-Integrated Manufacturing (CIM)



생산공정의 디지털화 (Digital Manufacturing)

• CAD/CAE/CAM과 같은 컴퓨터에 의한 디지털 정보기술 을 개발, 설계, 제조, 검사 등의 생산 프로세스에 활용



Kinds of Design Models

- Product development models
 - Generic product knowledge (design process models)
 - Product models (geometric & non-geometric)
 - Generic mfg process models (with physics-based and economic models)
 - Factory models (specific instances)
- Non-geometric models
 - wiring schematics
 - hydraulic piping diagrams
 - flowcharts
 - graph-based models

Different Design Models of Same Component



Some Non-geometric Models



Hydraulic Components

Control System Flowchart

CAD vs. System Modeling

| | CAD Modeling | System Modeling |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Model | detailed 3D assembly model, complete with electric components, standard mechanical parts, wire harnesses and manufacturing information | schematic (mostly 2D) representing the data flow, input-output relationship and component hierarchy that depict the inner workings of a vehicle, plane, robot, plant or another complex system |
| Input | wall thickness, extrusion lengths, trim angles and other values that define the geometry of the design (geometric values and component shapes) | fan speed, valve modulation, temperature and power |
| Simulation | studying how stress, pressure and forces would affect the integrity of the design (mechanical behaviors) | computing the effects of varying inputs on the overall structure of the design |

CAD vs. System Modeling: Component



3D Geometric Model







CAD/CAM/CAE Systems - 19

CAD vs. System Modeling: Vehicle



CAD/CAM/CAE Systems - 20

Components of CAD/CAM/CAE Systems



Input Devices (1)

- To locate points and lines: cross-hair cursors on the screen
- To select menu items
- To manipulate parts of constructed images







Mouse

Data tablet with a puck and a stylus

Space ball

Input Devices (2)

Digitizer



Touch-sensitive screens



Lightpen



- Image scanner
- Joysticks, trackball

Output Devices



I/O Devices for Virtual Reality

- Graphics display changes dynamically in response to body motion
 - Headset (provides Window), Glove
- Haptic technology
 - 컴퓨터의 기능 가운데 촉각과 힘, 운동감 등을 느끼게 하는 기술



Graphics Display Devices

- Memory requirement
 - Method of refresh Display Vector Raster Storage Refresh Color CRT Flat panel tube CRT Mono-Color chrome Liquid Gas Electrocrystal plasma luminescent

ullet

Vector-Refresh Graphic Device



Raster Graphic Device (1)

- Introduced in the mid 1970s
- Based on TV Technology
- Main type of graphic device
 - High performance-to-price-ratio
- Scanning pattern for refresh or frame buffer
 - Need scan conversion or rasterization
 - Implemented at the hardware level
 - A point plotting device
 - XY matrix of dots
 - Pixels "pointillist" method
 - Need to address each pixel individually

Raster Graphic Device (2)



CAD/CAM/CAE Systems - 29

Colors of 3 Bit Planes (Frame Buffers)



| Black | 0 | 0 | 0 |
|---------|---|---|---|
| Red | 1 | 0 | 0 |
| Green | 0 | 1 | 0 |
| Blue | 0 | 0 | 1 |
| Yellow | 1 | 1 | 0 |
| Cyan | 0 | 1 | 1 |
| Magenta | 1 | 0 | 1 |
| White | 1 | 1 | 1 |



Color Raster Graphic Device

Distribution of phosphors for RGB colors







Aliasing Effect

- Highlights pixels in the proximity of the line
- "Stair-stepped" appearance of diagonal lines
- Reduce the problem using various intensity levels to blend the edges of lines



Comparisons

- Vector Refresh Displays
- Advantages
 - Low persistent phosphor with refreshing
 - Useful in representing dynamic motion
 - Produce a bright and clear picture
 - Have a high resolution
- Disadvantages
 - High cost
 - No capability of filling area with color

- Raster Scan Display
- Advantages
 - Inexpensive
 - Bright pictures
 - Color
 - Dynamic motion
 - Independent on picture complexity
- Disadvantages
 - Large amounts of storage requirement
 - Aliasing Effect