ENGINEERING COMMUNICATION
-- DRAWINGS

ME 482 Senior Design II
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based on a presentation by Dr. Z. Song
Engineering Drawing

- A form of visual communication
- Common **language** of engineering
- A method of transferring **ALL** needed information from **design** into **manufacture**

- **Effective and efficient** way to communicate:
  - Engineering requirements (Customer ➔ Engineer)
  - Proposals (Engineer ➔ Customer)
  - **Design intent** (Engineer ➔ Manufacture)
  - Instructions (Engineer ➔ User)
Design Intent

- **Purpose:** Building intelligence into the model
- **Governs how features are** intended **to be related with each other**
- **With good design intent, models can be updated almost effortlessly**

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“… a detailed explanation of the ideas, concepts, and criteria that are defined by the Owner to be important; … even when you have a full geometric description of an object you may NOT know why something is designed to be like it is.”

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- **Example 1:** A CAD model from reverse engineering a 3D laser scanner
  - No, does not contain any information about their design intent
  - Not a record of relationship between sub-parts or a construction sequence

- **Example 2:** Transferring a model from one CAD system into another
  - Maybe, often does not transfer design intent
  - May result in approximate models due to different model representations and tolerance systems.
Legal Contracts

Engineering drawings are legal contracts
- If the product is wrong, manufacturer is protected from liability as long as he/she has faithfully executed the drawing instructions.

• Creation and maintenance of engineering drawings are, and should be, expensive and time consuming
• Drawings should communicate all the needed information about "what is wanted"
• No ambiguity
• Not open to interpretation
Early Engineering Drawing Pioneers

- Leonardo da Vinci (1452 - 1519)
  - Created pictorial drawings
  - Without dimensions

- Leon Battista Alberti (1404 - 1472)
  - Needs for geometry in drawing
  - Drawings with multiple views

- René Descartes (1596 - 1650)
  - Invented Cartesian coordinate system
  - Founder of analytic geometry
Evolution of Engineering Drawing

• Pre-industrial revolution
  – Parts from hand sketches and drawings

• Post-industrial revolution (19\textsuperscript{th})
  – Interchangeability became important
  – Requires accurate drawing
  – Engineering drawing evolves rapidly

• From hand practice to CAD (1960 – 21st)
Types of Engineering Drawing

- Cartographic
- Electrical
- Electronics
- Civil
- Architectural
- HVAC
- Landscape
- Mechanical

Tools for communication
Requires worldwide, standardized drafting practices
Engineering Drawing Standards

• Standards provide rules for specification and interpretation
• Standardization aids internationalization
• ANSI (ASME) vs. ISO

• Drawing Concepts Overview
  – Isometric Drawing
  – Multiview (Orthographic) Drawing
  – Sectioning
  – Dimensioning
Isometric Drawing

• Any engineering drawing should show everything
• A complete understanding of the object should be possible from the drawing

E.E. Blanco et al.

Wikipedia.org
Multiview (Orthographic) Projection

- Orthographic projection: System for drawing and dimensioning complex three-dimensional items
- From 3D designs to 2D drawings
- First-angle vs. third-angle projections
How many views?

• Does it have to be three?

Six principal viewing planes:
  – Front, top, right-side, left-side, bottom, rear

• Need as many views as are required to fully described the object
Auxiliary Views

• Parts with surface(s) not parallel to any of the six principal viewing planes

• Allow for inclined planes (and any other significant features) to be projected in their true size and shape
Sectioning and Section Views

- Used when interior details cannot be seen from the outside

- Half section views
Dimensioning

- A dimension is for **size** and **position**
- Different kinds: Linear, aligned, angular, radius/diameter, reference etc.
Rules for Dimensioning

- **Accuracy**: correct values must be given.
- **Clearness**: dimensions must be placed in appropriate positions.
- **Completeness**: nothing must be left out, and nothing duplicated.
- **Readability**: the appropriate line quality must be used for legibility.
- Put in exactly as many dimensions as are necessary for the craftsperson to make it - no more, no less.

- **No redundant dimensions**
  - clutter the drawing
  - often lead to conflicts when tolerance allowances can be added differently
CAD

• It’s not a computer game!
• Suppose to facilitate the expression of design intent

Common CAD Software Manufacturers
• Alibre, Inc.
• Ashlar-Vellum
• Autodesk, Inc.
• Bentley Systems, Inc.
• Dassault Systèmes
• Google Inc.
• GRAPHISOFT
• IMSI/Design, LLC
• Intergraph
• IronCAD
• Kubotek Corporation
• Parametric Technology Corporation
• Siemens Corporation
The Engineering Design Process
(Integrated with CAE)
Common CAD Formats

- 2-D Drawings
- 3-D Wireframe Model
- 3-D Surface Model
- 3-D Solid Model
Surface Modeling Techniques

- Polygon

- Non-uniform rational basic spline (NURBS)
Creating Surfaces

- Direct surface modeling
- Procedural surface modeling

EXTRUDE

SWEEP

LOFT

BOUNDARY PATCH
Conclusions

• Engineering drawing is a vital form of communication

• Engineering drawings are legal documents

• Key is to capture design intent

• Should contain all vital information for production

• CAD software should only facilitate instead of replace design