

## Overview of Design Tools

- Each stage of the design process is aided by a number of design tools or methods.
- Design teams need to manage team dynamics and the project, and do so in a professional and ethical manner.

### Stage 5: Design Communication

**Design Tools:** Engineering graphics, manufacture, communications

- Engineering graphics (Ch. 9)
- Prototypes, models and proofs of concept (Ch. 10)
- Communicating designs orally and in writing (Ch. 11)

### Prototyping and Proofing the Design (Ch. 10)

- Prototypes, models and proofs of concept (Sec. 10.1)

Prototypes and models are to translate design ideas so that the design concepts can be tested and communicated to the client(s).

- Prototype refers to the first full-scale and functional form of a design. Or the “real thing”;
- Model (or mockup) refers to the representation of a design; A model is usually smaller in size and made of different materials; It can be a paper model, computer model, or physical model;
- Proof of Concept refers to controlled tests in which a particular device or concept can be shown to work as it was designed; Controlled tests are those not conducted in the “real-world” environments.

The reasons of choosing models (over prototypes) are:

- To save time and money;
- To refine the design towards an optimal solution.

More on the various forms of models:

- Descriptive models (that describe how a design is)
  - Scale models
  - 3D models
  - Computer animations
- Predictive model (that predict how a design will behave)
  - Mathematical models
  - Finite element models
  - Computer simulations
  - Scale models

### Communicating Design Orally and in Writing (Ch. 11)

- General guidelines for technical communication (Sec. 11.1)
- Oral presentations (Sec. 11.2)
- The project report (Sec. 11.3)

- Seven principles of technical writing (p. 143)
- Oral presentation outline (pp. 146-147)
- The process of writing a project/technical report (pp. 150-151)
- Rough outline of a report (p. 152)

More on the project report:

- Audience: instructor
- Purpose: is to persuade your instructor that you have followed the design process thoughtfully and that your design solves the problem.
- Tone: should be serious and not frivolous. The tone of your report tells the readers something about you, thus can enhance or undercut your purpose.
- Section heading: should appear on the same page as the body of text that it introduces.
- List (such as list of objectives, list of functions, etc.):
  - Use numbers or bullet to present a list
  - Make sure items on a list are grammatically, parallel.

<p>The key requirements are that the design be:</p> <ul style="list-style-type: none"> <li>• Easy to use</li> <li>• Cleanability</li> <li>• Users can store it under table</li> <li>• Portability</li> <li>• Water resistant</li> </ul> <p>This one is less good. Terrible, even. Terrible!</p>	<p>The key requirements are that the design be:</p> <ul style="list-style-type: none"> <li>• Easy to use</li> <li>• Easy to clean</li> <li>• Storable under table</li> <li>• Portable</li> <li>• Water resistant</li> </ul> <p>This ones good!</p>
---	--

- List cont'd:
  - For a list of more than seven items, create sub-categories so readers can see the logical relationships among the items
- Figure:
  - Label the figure and place the figure number and title (or caption) below the figure;
  - Indicate the source, where applicable;
  - Refer to the figure in the text; such reference should precede the figure and identify the figure by its number;
  - Position the figure as close as possible to its reference in the text.
  - Explain the significance and key points of the figure.
- Example:
- “The proposed design contains three sub-systems (see Figure 2) which are, ... ”
- Table:
  - Label the table and place the table number and title above the table;
  - Indicate the source, where applicable;

- Refer to the table in the text; such reference should precede the table and identify by its number;
- Position the table immediately below the paragraph containing its reference in the text.
- Explain the significance and key points of the table.
- Example: “As Table 11 indicates, ...” or “As the table below indicates, ...”

Table 11: Decision matrix for choosing the preferred design

Source: class notes, Engineering 1112FA, Introduction to Engineering Design, Lakehead University, Sep. – Dec. 2016,

Objectives	Weights	Alternative 1	Alternative 2	Alternative 3
Obj. 1.1	0.09			
Obj. 1.2	0.21			
Obj. 2	0.15			
Obj. 3	0.55			
Total	1			

- Abstract:
  - Brief statements of the problem that led to the project (up to 5 sentences);
  - Brief statement of the purpose and scope of the project (up to 5 sentences);
  - A description of the methodology used to develop the design (up to 5 sentences);
  - A summary of the design and its features and/or benefits. This is the most important part of the abstract and should demonstrate what you have achieved;
  - Brief statements of limitations (or recommended improvements) of the design (2 or 3 sentences).
- Abstract (cont'd):
  - Abstract is not the replace introduction or table of contents.
  - It should be written to stand on its own. That is, without reading the rest of the report, readers should have a good idea of what you have accomplished and the motivations behind the project/design.
  - Figure may be included in the summary of design portion of the abstract.
- References:
  - Cite references within the text, in numerical order according to order of appearance; For example, “it was shown in [1] (or [1,2], or [1-4]) that ... “
  - Listing a textbook under References: see ASME References Guide, (2) and [3] in particular;

- References (cont'd):
  - Listing a website under References:
  - Last name of each author followed by initials, 'Title', year published. [Online] Available: http://website URL. [Accessed: Date of access].
- Example:
- [1] Emarketer.com, 'Social networking reaches nearly one in four around the world', 2014. [Online]. Available: <http://www.emarketer.com/Article/Social-Networking-Reaches-Nearly-One-Four-Around-World/1009976>. [Accessed: 23- Jun-2014].

#### From ASME.org:

**Text Citation.** Within the text, references should be cited in numerical order according to their order of appearance. The numbered reference citation should be enclosed in brackets.

#### Example

It was shown by Prusa [1] that the width of the plume decreases under these conditions.

In the case of two citations, the numbers should be separated by a comma [1,2]. In the case of more than two reference citations, the numbers should be separated by a dash [5-7].

**List of References.** References to original sources for cited material should be listed together at the end of the paper; footnotes should not be used for this purpose. References should be arranged in numerical order according to their order of appearance within the text.

(1) Reference to journal articles and papers in serial publications should include:

- last name of each author followed by their initials
- year of publication
- full title of the cited article in quotes, title capitalization
- full name of the publication in which it appears
- volume number (if any) in boldface (Do not include the abbreviation, "Vol.")
- issue number (if any) in parentheses (Do not include the abbreviation, "No.")
- inclusive page numbers of the cited article (include "pp.")

(2) Reference to textbooks and monographs should include:

- last name of each author followed by their initials
- year of publication
- full title of the publication in italics
- publisher
- city of publication
- inclusive page numbers of the work being cited (include "pp.")
- chapter number (if any) at the end of the citation following the abbreviation, "Chap."

(3) Reference to individual conference papers, papers in compiled conference proceedings, or any other collection of works by numerous authors should include:

- last name of each author followed by their initials
- year of publication
- full title of the cited paper in quotes, title capitalization
- individual paper number (if any)
- full title of the publication in italics
- initials followed by last name of editors (if any), followed by the abbreviation, "eds."
- publisher
- city of publication
- volume number (if any) in boldface if a single number, include, "Vol." if part of larger identifier (e.g., "PVP-Vol. 254")

- inclusive page numbers of the work being cited (include “pp.”)

(4) Reference to theses and technical reports should include:

- last name of each author followed by their initials
- year of publication
- full title in quotes, title capitalization
- report number (if any)
- publisher or institution name, city

### **Sample References**

- [1] Ning, X., and Lovell, M. R., 2002, “On the Sliding Friction Characteristics of Unidirectional Continuous FRP Composites,” *ASME J. Tribol.*, 124(1), pp. 5-13.
- [2] Barnes, M., 2001, “Stresses in Solenoids,” *J. Appl. Phys.*, 48(5), pp. 2000–2008.
- [3] Jones, J., 2000, *Contact Mechanics*, Cambridge University Press, Cambridge, UK, Chap. 6.
- [4] Lee, Y., Korpela, S. A., and Horne, R. N., 1982, “Structure of Multi-Cellular Natural Convection in a Tall Vertical Annulus,” *Proc. 7th International Heat Transfer Conference*, U. Grigul et al., eds., Hemisphere, Washington, DC, 2, pp. 221–226.
- [5] Hashish, M., 2000, “600 MPa Waterjet Technology Development,” *High Pressure Technology*, PVP-Vol. 406, pp. 135-140.
- [6] Watson, D. W., 1997, “Thermodynamic Analysis,” *ASME Paper No. 97-GT-288*.
- [7] Tung, C. Y., 1982, “Evaporative Heat Transfer in the Contact Line of a Mixture,” Ph.D. thesis, Rensselaer Polytechnic Institute, Troy, NY.
- [8] Kwon, O. K., and Pletcher, R. H., 1981, “Prediction of the Incompressible Flow Over A Rearward-Facing Step,” *Technical Report No. HTL-26, CFD-4*, Iowa State Univ., Ames, IA.
- [9] Smith, R., 2002, “Conformal Lubricated Contact of Cylindrical Surfaces Involved in a Non-Steady Motion,” Ph.D. thesis, <http://www.cas.phys.unm.edu/rsmith/homepage.html>

- **Common mistakes:**

- There is no space between a number and its’ unit. For example, it should read 100 N instead of 100N.
- Inappropriate prefixes are used for decimal multiples; For example, is it k (not K) for 1000. Therefore, it is 1 km; not 1 Km, and not 1 KM.
- Only imperial unit it used. For example, instead of 50 ln, it should read 222 N (50 lb).