AN EXAMPLE FORMAT FOR DESIGN PROJECT REPORTS
[ADAPTED FROM ASME GUIDELINES FOR STUDENT DESIGN COMPETITION]

TITLE
(TIMES NEW ROMAN, 12, BOLD)

Team Name (Times New Roman, 12)

First Author (Times New Roman, 12)
Second Author (Times New Roman, 12)
Third Author (Times New Roman, 12)
...continue to list all authors / team members

Date (Times New Roman, 12)

Abstract (Times New Roman, 12, justified, placed on title page)
The report should start with an abstract of approximately 100 words, summarizing the objective, contents, results, and conclusions of the report as specifically as possible.
The heading of the Abstract should be italic. Update the abstract as more sections of the report are competed.

[Note: The **purpose** of the design report is to describe and justify the final design (or for the intermediate reports the current status of the design). The **audience** is primarily decision makers (technical and business project managers) in your company and internal technical staff. The **style** (based on guidelines in Style Guide [Shipley and Associates, 1987] and Write to the Top [DiGregorio, 1995] should follow these guidelines:

1) Take the active voice (use first person nouns and direct, forceful verbs);
2) Use pronouns when recommending something, drawing conclusions, or conveying decisions;
3) Write the way you talk - make it easy for the reader to get your point;
4) Keep most sentences and paragraphs short.

Formatting Guidelines: The entire body text of the report should be Times New Roman, 12, with 1 inch margins. Major headings should be numbered consecutively, 1.0, 2.0, 3.0, etc, typed in bold face with a font size of 16. Sub-headings should be numbered consecutively, 1.1, 1.2, etc, typed in bold face with a font size of 14. Finally, sub-sub-headings should also be numbered consecutively, 1.1.1, 1.1.2, etc., typed in bold face with a size 12 font face. It is not recommended to go beyond three levels of headings.

1.0 Introduction (Times New Roman 16, Bold, left)

Use the introduction section to provide some background information on the overall design problem domain. This introductory information should come from your literature search – Library, Internet, trade magazines, etc. Key points to cover:

- Set the **context**: Help the reader understand general information about the problem or need area, including any necessary definitions, statistics, etc. Use pictures and visual images as much as possible.
- Explain the **purpose**: why is this work important?
- Set the **scope**: How far can you or will you go to solve the problem?
- State the **objectives**: In short statements or a bullet list, identify the specific objectives of your work - things that can be assessed at the end of the project to determine if you were successful.

Important Note: All sources that are not your own ideas must be referenced.

For your reports, please use the *parenthetical references: author-date system.* A sample reference list addressing each of the five main types of information sources is given at end. These include: websites (Swanson, 1999), journals (Muriru and Daewoo, 2002), books (Zacharia and Daudi, 2001), conference proceedings (Peters et al., 2001) and patents (Wen-Cheng, 1994). For more information on ethical standards for publications (for the example of ASME journals), see http://journaltool.asme.org/Help/AuthorHelp/WebHelp/JournalsHelp.htm#Guidelines/Ethical_Standards.htm.

1.1 Initial Needs Statement (Times New Roman, 14, left)

Provide a brief paragraph describing the initial needs statement – the needs statement itself is usually given to the design team. Please also include some initial discussion of the need statement, linked to the introductory material.

2.0 Customer Needs Assessment

This section describes the iterative FOCUS process for defining the customer (360 degree perspective), developing appropriate interview and observation guides, collecting data, and converting it to customer requirements statements (customer needs). Please show/describe the iterative nature of the process to illustrate how the project was impacted by customer input. This section should include descriptive text and several tables and figures, including:

1. An initial customer needs list obtained from interviews and observations (refer to Table 1). Note that all table captions are placed on *top* of the tables. Please note that all tables are numbered consecutively. **Please make sure that a table is not split between two pages.** Move the table to a location where it can fit. If the table is too big to fit, split the table into two separate tables.
2. A table listing the hierarchal design objective list, that has been augmented with constraints and functions (refer to Table 2). Note that the constraints and functions are formatted differently for easy identification.
3. Include the most relevant copy of your interview guide and observation guide in the Appendix, and reference it from this section.

Table 1. Initial Customer Needs List Obtained from Interviews and Observations (Times New Roman, 12, Bold, Centered)

Portable
Easy of load on and off the truck
Able to fit through standard doorway
Safe
Easy to Load and Unload Tires
Flexible
Protection from cutting devices
Minimal debris
Adaptable to a wide range of tire sizes
Cut side walls and tread
Fast cutting operation
Small cycle time between each tire
Durable
Low Noise
Debris contained
Retails under $6,000
Easy to operate
Light
Small footprint
Easy maintenance
Relatively maintenance free
Collapsible

Table 2. Hierarchal Customer Needs List (With Weighting factors)
(Times New Roman, 12, Bold, Centered)

1. Portable (0.22)
1.1 Easy of load on and off the truck
1.2 Light
F.1 Collapsible
C.1 Small footprint
C.2 Able to fit through standard doorway
2. User friendly (0.49)
2.1 Low Noise
2.2 Safe
F.1 Protection from cutting devices
F.2 Debris contained
2.3 Easy to Load and Unload Tires
2.4 Minimal debris
2.5 Fast cutting operation
2.6 Small cycle time between each tire
2.7 Easy to operate
3. Flexible (0.08)
3.1 Adaptable to a wide range of tire sizes
F.4 Cut side walls and tread
4. Durable (0.22)
4.1 Easy Maintenance
4.2 Relatively maintenance free
C. 3 Retails under $6,000

2.1 Weighting of Customer Needs

This section should begin with a brief introduction on the importance of weighting, and then provide a description and/or tables that show how the weights were calculated. The resources for making decisions discussed in class would be a good tool to use here. Figure 1 illustrates the use of one method, the Analytical Hierarchy Process (AHP), to create a weighted hierarchal customer needs list. It is very important to include figures and tables to show how the decisions were made, not just what the decisions are.

Like tables, all figures are numbered consecutively. Unlike tables, however, figure captions are typically placed at the bottom of the figure. This section should build on and make reference to the weighted hierarchal customer needs list.

	Portable	User Fr.	Flexible	Durable	Total	Weighting
Portable	1.00	0.33	3.00	1.00	5.33	0.22
User Fl.	3.00	1.00	5.00	3.00	12.00	0.49
Flexible	0.33	0.20	1.00	0.33	1.87	0.08
Durable	1.00	0.33	3.00	1.00	5.33	0.22

Figure 1. Example of AHP Pair wise Comparison Chart to Determine Weighting for Main Objective Categories

3.0 Revised Needs Statement and Target Specifications

Using the initial problem statement and the knowledge gathered from the customer needs, describe a revised needs statement that provides a more concise description of the design problem.

Clearly define the target specifications and the design criteria that define the problem (generated from the customer requirements and engineering standards). Include the initial justification for the specifications and the metrics (how "meeting the specs" will be measured), referring to customer requirements and benchmarking results as appropriate. Also describe how the specifications were checked with the customer to ensure they meet their needs.

4.0 External Search

This section should include information gathered from numerous sources about the design problem and the product, process, or system that is at the center of the design problem. Focus primarily on the information that is pertinent to the revised needs statement and target specifications. Sources should include library, internet, magazines, patents, observations of actual products, discussions with "experts", etc.

You should also perform a patent search to determine the key technologies used in similar designs. Focus on utility patents (looking at function) and not cosmetic patents (focusing on artistic design).

Evaluate the patents and information sources, and clearly state what impact they have on the development of your project.

Also, summarize your business opportunity, and make reference to your "Business Opportunity Statement" in the Appendix.

4.1 Benchmarking

This section should identify all commercially available products, processes, or systems that attempt to address all or a significant part of the needs statement that your project is addressing. Create a benchmarking table that compares numerous applicable features. Note that not all

systems will have all features. The results should be prefaced with an introductory paragraph and then neatly summarized in a table (see Table 4). In tables, you may reduce the font size to 10 point to allow inclusion of more information per table. Recall a single table should not be split over multiple pages.

This section might also include:

1. Figures/pictures of the benchmarked products, systems (if available)
2. Tables listing specs and metrics for benchmarked products, including their performance with respect to the target specifications (if applicable)
3. Sketches clearly indicating dimensions and all relevant features that could be of use in your design. For example, the number, size and location of screw holes.

Table 4. Benchmarking of Products

Feature	Systems 1	System 2	System 3	System 4
Size				
Weight				
Cost				
Flexibility				
And so on…….				

See the "Intro to Target Specifications" presentation for more information on benchmarking products and metrics. As in the other sections, show some details that illustrate project development but focus on the information that is pertinent to the revised needs statement and target specifications.

4.2 Applicable Patents

Each team member should provide at least one applicable patent, and write an evaluation that describes what impact this patent or the ideas therein have on the development of your project. The overall section must describe the results of a thorough patent search in your product area.

4.3 Applicable Standards

Search governmental and industry sources for applicable standards, rules, regulations, etc., and record them here. Make sure to consider health and safety, environmental regulations, governmental policies, etc. Also evaluate them and state what impact they have on the development of your project.

4.4 Applicable Constraints

Determine what internal (space, budget, expertise,…) and external (market, environment, health and safety,…) constraints are applicable and record them here. Also evaluate them and state what impact they have on the development of your project.

4.5 Business Opportunity

Include a short overview here, and reference the Business Opportunity Statement which should be included in the Appendix. Guidelines for the statement are in http://www.ent.ohiou.edu/~me470/SnrDesign06_07/me470/Businessopportunitystatement.htm .

5.0 Concept Generation

In this section describe the processes used to generate creative alternative conceptual designs and do an initial screen for feasibility. Document numerous (≥3) feasible alternatives, and discuss the continuing influence of the customer in the design process.

5.1 Problem Clarification

Use tools and analytical models to clarify the problem, such as the "Power Flow" Model for Design Concepts, the black-box model or the energy-material-signal model (EMS).

5.2 Concept Generation

Briefly describe the process used for concept generation, making note of processes used to enhance creativity and to maximize the number of different system-level and subsystem-level concepts considered. For concept generation various techniques can be used (e.g., brainstorming, C-sketch, TRIZ, etc.). A morphological chart (Figure 2) may help to organize subsystem concepts for each function.

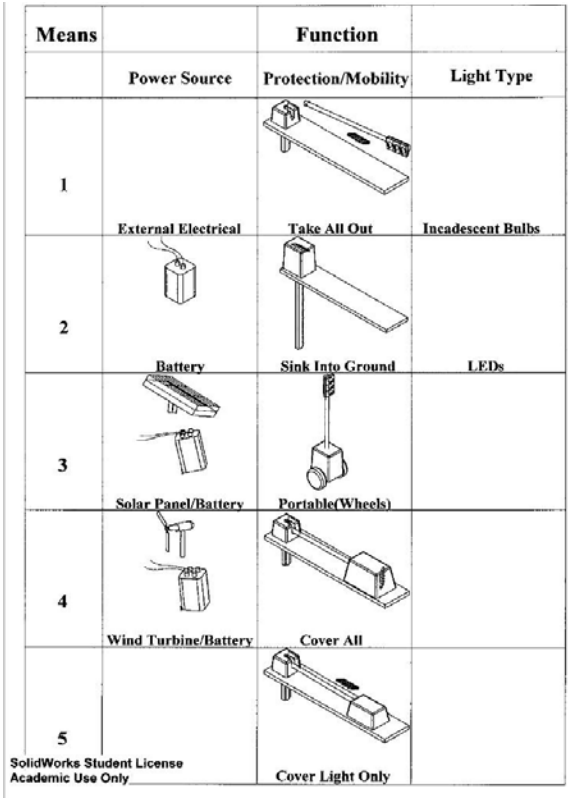

Figure 2. Morphological chart

Include sufficient detail to show the important results of the concept generation process, including (as applicable) brainstorming lists, mind-mapping charts, affinity diagrams, sketches/drawings of concepts (hand sketches or CAD drawings approximately scaled, including users in operating position(s)), etc.

Include some discussion of features that may serve as "delighters" - unique or unexpected features that could distinguish your product.

5.3 Initial Screening for Feasibility and Effectiveness

Describe the method of concept screening (for possible methods, see http://www.ent.ohiou.edu/~me470/SnrDesign05_06/me470/Conceptselection_MITmodified.pdf) Include appropriate evaluation of the alternatives to judge feasibility relative to the specifications and criteria. Document the feasibility of numerous ($\geq$3) feasible alternatives.

6. Concept Selection

6.1 Data and Calculations for Feasibility and Effectiveness Analysis

Include appropriate Free Body Diagrams (FBD), calculations, simulations, research and other analysis that can be used to more rigorously judge feasibility and effectiveness relative to the specifications and criteria. For example, a vehicle design project would require numerous FBDs, with calculations that show the power requirements to achieve the max speed specification, the torque requirements for the acceleration and gradeability specifications, the energy storage requirements (amp-hour capacity for batteries, fuel tank size,...) for the range specification, etc.

6.2 Concept Screening

Describe and show the results of processes used to get feedback from the "customer" with respect to your concepts, the process used to screen the concepts (system-level and subsystem-level if appropriate) and definitions of what feasibility and effectiveness mean with respect to the concept screening, the results (with justification) of the concept screening including how concepts were combined and refined.

6.3 Concept Development, Scoring and Selection

Describe the process used to develop and evaluate the final concepts, and describe in detail the concept selected for further refinement, including detailed sketches with the user in operating position(s). See the Concept Evaluation and Selection Presentation for more information. Remember that the goal is not selection but development of the best concept, so combining and refining concepts is highly encouraged. Concept scoring is normally done with Pugh Charts (or other decision-making tools). Explain the scoring method used in the decision matrix. Show detailed feasibility and effectiveness analysis for the selected concept relative to all design specifications.

7.0 Final Design

Discuss details of the design refinement process and the final detailed design. Start with a system level description that flows down to the subsystem and component level.

The project must include both thermal and mechanical design aspects, so make sure that both aspects of your project are described.

It is suggested that you use FMEA to organize the discussion of how the critical design areas were identified and what methods were used to develop a safe and effective final design. Describe how you did the FMEA and what the results were, and make reference to actual FMEA worksheets included in the appendix.
Show highlights of the key analysis that was done to justify design decisions, and include the results and conclusions from the analysis in the body of the report (place the details of any significant analysis in the appendix).

For all significant design decisions (items identified by FMEA to be important decisions), provide clear and complete justification that includes all aspects of the decision (to demonstrate that a good design process was followed to achieve a good decision).

Acceptable / Supported decisions include most of the following considerations

Considerations	In-Process (Design Refinement) Level	Completed Decision Level
Impacts / Effects (First, do no harm. Immediate and long term, intended and unintended, local and global impacts of products and production on the environment and society)	Considered for the overall project, and is impacting production and part-level decisions.	All aspects considered and hard choices and tradeoffs are made as required to limit impacts.
Professional and ethical standards (Decision and Justification show good judgment and integrity)	Demonstrates a commitment to professional standards.	Demonstrates a commitment to professional standards.
Function (Research, precedent and vendor info show it should meet the design specifications)	Complete and up-to-date	Complete and up-to-date
FMEA (A failure modes and effects analysis or similar technique is properly used to evaluate the overall system failure modes and hazards and to prioritize risks and focus the design effort.	All Hazards identified and most significant items evaluated.	All significant hazards evaluated and RPNs decreased to acceptable values.

Design Analysis (Sufficient and Correct Analysis for part sizing and material selection to avoid failure; Simulations demonstrate performance of major subsystems in critical operating modes.)	All critical load cases and failure locations identified and analysis completed and validated for most critical locations. Simulations begun with estimated parameters.	Analysis completed and validated for all critical locations. Simulation completed with experimentally validated parameters.
Safety (All aspects of project and product safety considered continuously throughout the design process. Design for Safety terminology & approach used.)	Design for safety on a system level is complete. Examples of avoidance and protection are presented.	A comprehensive approach is documented that shows reduction of all hazards (product and production) to low risk.
Economics / Value (Cost/benefit analysis is used to evaluate value, not just immediate cost. A vendor selection process is followed and documented.)	Most significant items have been analyzed for value and a process is used for vendor selection.	All significant items have been analyzed for value. Good vendor selection process.
Customer (360 degree Customer Input solicited, evaluated and appropriately used.)	Significant input has been incorporated from various external and internal customers	Usability, marketability and other customer input incorporated from all significant external and internal customers
DFMA (All aspects of Manufacturing and Assembly Considered, including manufacturability of design features, use of manufacturing features, machinability of materials,…)	Manufacturability and assembly of most significant items has been analyzed and improved to appropriate levels.	Manufacturability and assembly of all significant items has been analyzed and improved to appropriate levels.
Testing (Mock-ups and experiments used for information and validation)	Most mock-ups complete and used appropriately for product development. Other tests are planned.	Mock-ups and tests were used appropriately for numerous aspects of product development.
Other (Creativity and initiative are evident in the decision process**;** Good **planning and organizing** are demonstrated, including use of **decision making tools** [Pareto analysis, decision matrices and other prioritizing and organizing tools]; Impacts on design criteria are considered)	Some other considerations are evident.	Most other considerations are evident.

7.1 How does it work?

In the best way you can, please explain how your design works. Focus on system-level operational details (how the user would operate the system), but include some technical information that describes how the product actually works. Include instructions for maintenance and service, and any assembly steps that must be completed by the customer. This section should be understandable to the target customer, and should be able to serve as product literature (operating manual).

7.2 How is it manufactured and assembled, and what does it cost?

In either a narrative or step-by-step style, discuss the manufacturability and cost of the final design:

- A reasonably detailed manufacturing and assembly plan (with pictures and/or figures) must be developed that details how the product will be manufactured (in lots of 5000/yr) and that estimates the per unit production cost (including labor, materials, overhead,...) at that production volume. [Use the recommended cost estimation procedure discussed in class, or an equivalent method]
- The material, material condition, manufacturing method, surface finish, and tolerances must be specified for the most significant components and justified based on Design for Manufacturing and Assembly principles. Provide some explanation in this section for the tolerances specified in the drawings, and how the dimensions fully control the important part features, and how manufacturing considerations are represented in the drawings.

- **Design Drawings, Parts List and Bill of Materials**

Include in this section, or in an Appendix or design project file referenced from this section, the assembly-level and part-level drawings that summarize and communicate your design. Please provide a set of drawings with sufficient detail to control manufacture and assembly of the final design (i.e. the drawing set could be sent to a manufacturing shop for the final design to be produced). For this project, assembly and subassembly drawings and parts lists should be complete, but it is acceptable to focus on the most significant part-level drawings (but at least one per team member) to do a good job fully dimensioning and tolerancing them. The assembly drawings should show all parts (purchased and manufactured) with part numbers, and the parts list should identify all parts. The assembly drawing should also include all assembly-level dimensions.

Note that detailed drawings are not required for components/subassemblies that are purchased and not modified prior to assembly. These are specified in the parts list and shown with key dimensions to scale in the subassembly/assembly drawings. Supply the best possible purchase information (vendor/part #/part description) for purchased items.

  - Modification drawings are required for purchased parts that require some manufacturing prior to assembly.
  - Do not draw details of standard hardware like nuts, bolts, washers, castors, computers, etc.; just specify them in the Bill of Materials.

The bill of materials lists:
1) Materials and their specifications (sizes and quantity) necessary to manufacture parts and 2) Off-the-shelf hardware. It may include weights and costs.

Typical Bill of Materials

No.	Part	Qty	Description	Weight	Cost
1	Leg	8 ft	3" nom. x 0.216" wall, Sch 40, Wrought Steel, Seamless	60.6 lb	$_
2	Pin	4	0.25" dia. x 2" long, 303 Stainless Stl, Cold Drawn	0.04 lb	$_
3	Bed	1	18" x 24" x 0.032" Aluminum 1100 sheet	1.38 lb	$_
:	:	:	:	:	:

Note: A design project file compiles the drawings and vendor info and all related information, organized by subsystem and part number/part name. It is not a "formal" document like a report, but more like an expanded design notebook organized according to the parts in the assembly. Using a binder with identification tabs is recommended.

7.4 Design validation through test results and operating experience

Explain the tests that were used to validate the performance, usability, safety, and other features of your design, including for each test: 1) the need for information (what you needed to know), 2) the design of the test (to control certain factors) and the test apparatus (if required), 3) the metrics (the targets for what needs to be measured or observed), 4) the measurement system, 5) the results, and 6) lessons learned and design changes.

Also, discuss the continuing influence of the customer in the design process.

8.0 Conclusions

Did your project meet the objective (to design a good solution to the business opportunity and respond to the original needs statement)? Part of the conclusion section should include a specifications table, showing all specification requirements vs. actual values for the final design. Using the performance relative to specs along with performance relative to the design criteria, address the true value of your design. Make sure to highlight the "delighters" and the truly unique features you have added to your design.

Also remember to include info on:

- Environmental: The design (and any fuels or power sources) should be evaluated for total environmental impact, including concerns related to energy use, emissions, and total life cycle issues (environmental impacts of production methods [hazardous materials?] and product retirement [longevity and recyclability])
- Political: Identify existing government policies that are supportive of the project.

[Note that the following part of the conclusion section will be done individually as part of the executive summary. There is no need to include it in the team report.]
This is a technical report, not a sales brochure, so make sure to be brutally honest in your appraisal

of the overall design and its state of readiness for production.

- Clearly state whether or not you believe the project should be continued or cancelled (based on your improved understanding of the market, the production costs, and the overall impact that producing this design is likely to have relative to addressing the original needs statement (the current energy situation). Justify your recommendation.
- If it should be continued but is not ready for production, clearly state (in specific actions, not generalities) what needs to be done to reach the "production-ready" state, and attempt to place a schedule and budget on the remaining work.

References (Times New Roman, 16, Bold)

Note: That for the author-date system, references are listed in alphabetical order.

Muriru, P.K. and Daewoo, R., "Prediction of the Heat Transfer Characteristics of a Multi-Flame Injector'", Combustion and Flame, vol. 100, no. 2, pp. 123-135, 2002.

Peters, L., Johnson, M., and Davidson, K., "A Novel Approach to Four-Bar Synthesis'", *10th ASME Design Automation Conference*, pp. 234-250, Pittsburgh, PA, 2001.

Swanson Inc., "Online Users Manual for ANSYS 5.0", *http://www.ansys.com/ manual*, viewed on March 1999.

Wen-Cheng, C., "Electric Bicycle'", US Patent no. 5,368,122, November 29, 1994.

Zacharia, M. and Daudi, P.K., The Effect of Multi-materials on Conventional Finite Element Formulations, New York: Wiley and Sons, 2001.

Appendices

Must include

- FMEA Worksheets
- Individual DFMA focus areas

Other things that should likely be included

- Example Calculations
- FEA details and plots of loads, boundary conditions and results. Include mesh convergence studies, validation calculations, etc.
- Manufacturing drawings
- Customer surveys
- Cost worksheets