

## Memorandum

**Date:** January 29, 2008  
**To:** ENG1102 Development Team  
**From:** J.E. Hertel  
**Subject:** Super Mileage Vehicle (SMV) Concept ---- **DRAFT**

**cc:**

MTU is looking to compete in the SAE Super Mileage competition for North America and is requesting your team's design concept to meet the challenge. This memo outlines the general requirements and states the project deliverables needed from your team in order to evaluate your design concepts.

### **Background**

As oil prices rise and environmental problems become more critical, the auto industry is being forced to develop vehicles that take a quantum jump in fuel efficiency. To hasten these developments, the Society of Automotive Engineers (SAE) has challenged engineering schools around the world to compete for efficiency records.

Teams design and build single passenger cars to run on a test track using a precisely measured quantity of gasoline. All teams start with the same engine, a Briggs and Stratton 3.5 HP 09102 Type 1016E1A1001. The rules allow for significant modification of the engine.

Many US schools have responded to the challenge: University of California, Berkley, UCLA, MIT, Penn State, Ivy Tech and Valparaiso to name a few. The winning teams, however, have consistently hailed from Canada: University of British Columbia, Universite' Laval (Quebec) and University du Quebec. The best mileage by a US engineering school in 2006 was 1314 mpg whereas University of British Columbia ran 3145 mpg.

The 2007 competition will be held at the Eaton Corporation Marshall Proving Grounds in Marshall, MI. The competition rules can be found at: <http://www.sae.org/students/superrules.pdf>. A data file with the course distance, direction and elevation segments will be available to your team for use in simulating your vehicle's performance.

You are competing against the other SMV teams in the class based on your design concepts and simulated performance of your design. Your predicted performance will be judged based on the credibility of your work. Criteria such as safety, security, utility, comfort, etc. will be important in all design concepts. However, there is no need to consider either development or product cost at this stage.

## Project

This project needs to move quickly to develop and demonstrate potential concepts. As such, your team's deliverables are needed by dates listed below. Further descriptions of each of these deliverables are found in the attached list.

<u>Deliverable:</u>	<u>Format</u>	<u>Team/Ind.</u>	<u>Due Session:</u>
1. Investigation	memo + enclosures	individ./team	4.2
2. Project Proposal	memo + sketches	team	5.2
3. Physical Concept	UG-NX drawings	individ./team	8.1
4. Hazard Analysis	memo + enclosure	team	8.2
5. Energy Budget	memo + enclosures	team	9.2
6. Program Flowcharts	VISIO drawings	team	11.2
7. Vehicle Simulation Program	Matlab Code	team	12.1/13.2

### **Final Deliverables (DP pts)**

8. Presentation	slides + demonstration	team	14.1
9. Project Book	memo & organized binder	team	14.1

Note: due dates may change as they approach. Check my homework web page for actual dates.

## Project Requirements

Your team will develop one or more SMV concepts, both the **form** (appearance, structure) as well as the **function** (performance). Your design must stay within the SAE 2007 Super Mileage Rules. You will first need to research key areas such as drag, rolling resistance, ergonomics, drive efficiency, steering mechanisms, etc. Although you are not presently doing a detailed design of the vehicle and drive system, you will need to establish the basic functions in order to credibly predict your design's concept.

The vehicle simulation program will allow you to demonstrate the expected performance of your vehicle based on your assumptions. Using Matlab, you will enter data to define the course, weather, driver, and the program will plot the expected vehicle speed as it travels through the course. Three laps of the course will be simulated (as specified in the rules) and your resulting mileage will be calculated.

We look forward to your team's innovative concepts. Please proceed with the investigation phase asap and get back to us with any questions you may have regarding this request.

Encl.

## Project Phases (deliverables)

### 1. Investigation

Before choosing your concept, you need to research relevant vehicle and competition information. Each team member should research a different area relative to SMV's; i.e., aerodynamic drag, rolling resistance, roadway designs, small engines, drive systems, etc. The key information gathered in each area needs to be collected on a **one page sketch** which includes labels and notes. Sketches need to indicate how your information relates to possible SMV concepts. Summarize your findings in a memo and include your sketches as attachments.

Some good sources:

SAE Supermileage site: <http://students.sae.org/competitions/supermileage/>  
U of Toronto 2004 Design Report:  
<http://www.supermileage.skule.ca/documents/2005ThesisReport.pdf>  
Berkeley's SMV website: <http://smv.berkeley.edu/>  
“Bicycling Science” by Wilson and Papadopoulos, MIT Press, 2004

### 2. Project Proposal

Based upon your investigation and first-hand knowledge of SMV's , your team will brainstorm a minimum of 10 possible design concepts. The five “best ideas” will be evaluated in a decision matrix to find the ONE features that will differentiate your concept from other SMV's.

Your team will then submit a proposal to develop your concept:

**Format** - memo to 1102 instructor

**Executive statement** - what this memo is about and why it is written

**Background** - list the project objectives & target market

- cite portions of your investigation
- format and paste your Evaluation Matrix into the proposal and briefly explain the alternative concepts

**Proposal** - describe the basic concept and function(s) of your recommended design.

- include a hand sketch which shows your concept and some of the features.
- explain how you plan to model the physical components so others can see what it will look like
- explain how you plan to predict the performance of the vehicle

**Management Plan** - state the project leader and various roles of the team members

- attach a Gantt Chart to show the task breakdown and who is responsible for each task

**Closing** - request approval to proceed with the project.

### **3. 3-D Solid Model**

Create a 3-D model of your SMV using UG-NX. This will be an assembly of parts shown in 3-D space to best illustrate your overall design. Each team member will model a component or sub-assembly related to the vehicle. In addition, each team member needs to produce a detailed drawing of a single component..

The component chosen for detailing must have “significant geometry”; i.e., no simple blocks or cylinders, must contain at least 10 dimensions. The drawing must follow basic dimensioning conventions (refer to Sorby 3-D Visualization). The drawing must have a border and title block with Part Name, Date, **Designer**, Course, Section and Team Number.

Specific printouts needed (minimum requirement for a four person team is seven printouts):

- two overall views (shaded or line) showing vehicle outside appearance
- one overall view showing vehicle key components with labels indicating component names
- one detail drawing per team member (as specified above).

### **4. Hazard Analysis**

Perform a Hazard Analysis on your design concept based on the methods described in class (reference Dale Anderson’s article, <http://www2.latech.edu/~dalea/instruction/hazards.pdf>). Use a spreadsheet to create your hazard analysis table.

Attach your Hazard Analysis to a cover memo summarizing your findings, conclusions and recommendations regarding the safety of your design concepts.

### **5. Energy Budget**

Energy sources and sinks need to be clearly established in order to predict your SMV's performance and optimize the design. The energy source will be one gallon of ISO 100 Octane gasoline. Energy sinks will typically be aerodynamic drag, rolling resistance, drive efficiency and bearing friction.

Document your assumptions in a spreadsheet that clearly defines your units and calculates the vehicle’s steady-state speed (assume straight and level roadway for this deliverable). Summarize your findings in a memo with the spreadsheet analysis as an attachment.

### **6. Simulation Program Flowchart**

Using VISIO Tech, create a flowchart that shows how you can input driver, weather and course data; predict vehicle speed over the course; and output the results. This is the prelude to your actual simulation program. Your program will be structured based on this flowchart.

Minimum required features:

- Prompt setup data for demonstration (driver data, course data, weather data)
- Initialize course and plot an elevation view.
- Calculate vehicle velocity as it travels through the course
- Plot the vehicle velocity along the course
- Printout a summary of the trip including final MPG

Submit a printout of your flowchart. No memo is required for this deliverable.

## **7. Vehicle Simulation Program**

Using Matlab, your team will write code to demonstrate the SMV performance. The code must be written in a format like the ones used in class (i.e., structured, proper header information, indented, commented). When the program runs, it will show messages to the user prompting them through the demo setup and vehicle operation (i.e. "Start Vehicle"). The program needs to use the vehicle parameters together with Eaton test course data file in order to calculate the vehicle's acceleration, velocity and position as a function of time. The program will also display a summary of average lap speed and vehicle mileage.

Your code needs to include the minimum required features (as stated in 7 above) and be structured using at least two (2) function calls.

## **8. Presentation**

Your team will present your design concept to the class (and instructors). UG-NX models will be used to create Powerpoint slides showing your physical design, features and performance. You will also do a real-time demonstration of your predicted performance using Matlab. The audience may ask questions and request that you demonstrate certain features in your program and try to make it (or your vehicle) crash.

The presentation must be 6 minutes +/- 15 seconds with an additional 2 minutes for questions.

## **9. Project Book**

Project books (or Job Books) are used by engineers to document the various phases of a design (concept through final design). This allows other engineers to understand the design and troubleshoot or modify a design. If good documentation is produced as you work through the design steps, the Project Book requires minimal time to assemble.

A "Memo of Transmittal" will be included with the project book to summarize the project deliverables, results and conclusions.

Your project book will be a collection of all project documentation (all previous deliverables - **corrected and improved as needed**). The book should be an example of your team's best work; i.e., even though you received 10/10 as a deliverable, the bar is raised for the project book. The first document in the book should be a cover memo to give a brief background of your project, brief description of what's in the book (short, indented paragraph for each section) and reference any additional materials included at the back. All of the material will be organized neatly in a 3 ring binder with tabs to delineate each section.