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ORGANIZATION AND MANAGEMENT OF A BAJA SAE COMPETITION TEAM

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ORGANIZACIÓN Y GESTIÓN DE UN EQUIPO DE COMPETICIÓN BAJA SAE

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RESUMEN DEL PROYECTO

La competición Baja SAE, que empezó en 1976, alberga una serie de eventos donde alumnos de varias universidades compiten por el rendimiento de unos vehículos todo terreno que previamente han tenido que diseñar y construir. La competición incluye pruebas de diseño, aceleración, resistencia, etc. El objetivo es competir contra otras universidades con el fin de que una empresa ficticia elija el mejor coche como prototipo para la construcción de un modelo de vehículo del que se construirán un número limitado de unidades para el mercado de consumidores. Existen tres competiciones regionales en los Estados Unidos (una en el Este, otra en el Medio-Oeste y la última en el Oeste, donde el equipo de SDSU competirá) y tres competiciones a nivel internacional (en Corea, Sudáfrica y Brasil). Esta competición ha recibido el generoso patrocinio de Briggs & Stratton quienes, durante más de 25 años, han donado los motores de 10 CV con los que los equipos compiten.

El objetivo de la competición es evaluar el rendimiento y funcionamiento del vehículo en una serie de pruebas estáticas y dinámicas. Las pruebas dinámicas tienen el mayor peso dentro de la competición. Entre estas pruebas se incluyen la de velocidad, tracción, maniobrabilidad, especialidad (diferente para cada competición), suspensión y resistencia (la carrera), que suman un total de 700 puntos sobre los 1000 puntos de la competición. Los 300 puntos restantes son asignados a las pruebas estáticas de diseño y coste. El equipo ganador será aquel que consiga sumar más puntos entre todas las pruebas mencionadas anteriormente.

El desafío de los equipos será no solo diseñar, construir, probar y correr con el vehículo, sino también encontrar y proveer fondos además de gestionar a los miembros del equipo y sus cualidades de forma eficiente para así conseguir un vehículo mejor que el de los competidores que sea capaz de funcionar sobre todo tipo de terrenos. El producto final también tiene que atraer al consumidor en cuanto a

fiabilidad, rendimiento, seguridad y estética. Otros aspectos como la facilidad del mantenimiento también son puntuados en las pruebas de diseño.

El principal objetivo de la competición es ser capaz de construir un prototipo de vehículo que pueda ser utilizado como modelo para fabricar un número limitado de unidades disponibles para el consumidor. De esta manera, la calidad, procesos de fabricación y los costes tienen que tener un peso importante en el diseño, ya que el vehículo ideal debería puntuar entre los primeros puestos en todas las pruebas además de tener un presupuesto bajo. Sin embargo, el principal objetivo de este proyecto es centrarse en la organización y gestión de los recursos del equipo Baja SAE para satisfacer el reglamento de la competición y crear un vehículo competitivo bajo el presupuesto establecido.

Como este vehículo puede ser considerado un producto nuevo que tiene que ser introducido en el mercado, se utilizarán estrategias similares que las compañías usan a la hora de desarrollar nuevos productos. Las tareas de diseño y producción del producto, así como el abastecimiento de las piezas serán complementadas con estrategias de marketing y comunicación para venderlo. Junto con todas estas actividades se realizarán sólidos análisis como el DAFO, la cadena de valor, el análisis de costes o de marketing para poder crear un vehículo mejor que el de la competencia a un precio razonable.

Varios objetivos han sido identificados como los más importantes para este proyecto:

- Objetivo 1: cumplir con el reglamento y los requisitos de la competición, tanto a nivel técnico como a nivel económico
- Objetivo 2: maximizar el potencial del equipo gestionando y asignando diferentes actividades a diferentes miembros del equipo según sus cualidades
- Objetivo 3: promocionar el proyecto y recaudar fondos para realizarlo
- Objetivo 4: superar en rendimiento a la competencia
- Objetivo 5: establecer un modelo para que otros equipos lo puedan utilizar en el futuro

Estos objetivos, junto con los análisis DAFO, la cadena de valor o las cinco fuerzas de Porter ayudarán a definir una clara estrategia a seguir. También se tratarán a lo largo del proyecto planes de acción específicos para implementar dichas estrategias.

Tras el análisis estratégico se incluirá un análisis de los costes derivados de los diferentes procesos de fabricación utilizados para crear el producto.

Como el proyecto está en su fase inicial y el equipo no tiene ingreso alguno por la venta del vehículo, la única forma posible de financiación es mediante patrocinio (no se ha valorado la posibilidad de pedir un préstamo ya que el proyecto es académico y no habrá ningún flujo de caja positivo en el futuro que no provenga de patrocinios). Este proyecto abordará diferentes estrategias para conseguir patrocinadores con un plan de marketing detallado. También se incluirán análisis económicos y financieros para estudiar la viabilidad del proyecto.

Para terminar, se incluirán varias recomendaciones que sirvan a futuros directores de equipos parecidos o a los propios miembros del equipo. El objetivo final de este proyecto es el de crear una guía que futuros equipos puedan utilizar a la hora de empezar y planificar un proyecto parecido.

ORGANIZATION AND MANAGEMENT OF A BAJA SAE COMPETITION TEAM

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PROJECT SUMMARY

Baja SAE is a competition that started in 1976, where university students need to design and fabricate an off-road vehicle in order to compete by the end of the year in a series of events (design, acceleration, endurance race, etc). The goal is to compete against other universities on the design and manufacturing processes of the off-road car to have a fictitious firm accept the best model with the aim of introducing it into the consumer market. There are three regional competitions in the United States (the East, West and Midwest, where the SDSU team will be competing) and other three international events (in Korea, South Africa and Brazil). The competition has received a generous sponsorship from Briggs & Stratton who, for more than 25 years, have been donating registered teams a 10 hp engine.

The competition aim is to evaluate the vehicle's performance in a series of static and dynamic events. The dynamic events count for most part of the overall score. These events include speed, traction, maneuverability, specialty, suspension and endurance race which account for 700 points. On the static side, the cost report and the general vehicle design are taken into account, which account for 300 points of the total 1000 points. The winner of the competition will be the team that gets the higher amount of points from the addition of all the events above mentioned.

The challenge for the teams will not only be designing, building, testing and racing the vehicle, but also to finance the project and manage the team members and their qualifications to achieve a better off-road recreational vehicle able to run through rough terrains. The final product must also attract the customer in terms of reliance, performance, safety and aesthetics. Other aspects such as ease of maintenance will also be considered in the design event.

The main objective of the competition is to be able to build a prototype which could be

used as a model to fabricate a limited number of units available for the consumer market. Thus, quality, fabrication processes and costs must be taken into account, as the ideal competitor would rank among the first in most of the events having a low budget. However, the main objective of this project is to focus on the organization and management of the Baja SAE team's resources in order to comply with the rules for the competition and make a competitive car while meeting the budget.

As the vehicle can be considered a new product that is to be introduced in the market, the team will follow similar strategies that firms use to develop new products. Design and production of the product and parts acquisition will be followed by marketing and communication strategies to sell it. Along with all these important steps, strong analysis such as SWOT, value chain, cost or marketing will be conducted to produce a better vehicle than the competitors at a reasonable cost.

Several objectives have been identified as the main ones for this project:

- 1st: to comply with the rules and requirements of the competition, both at the technical levels and at the budget levels
- 2nd: to maximize the potential of the team by managing and assigning different tasks to the team members
- 3rd: to promote the project and raise funds to execute it
- 4th: to perform better than the competitors
- 5th: to establish a standard for future teams to use as a model

These objectives, together with the SWOT, Value Chain or Porter´s Five Forces analysis will help us define a clear strategy to follow. Action plans to implement this strategies will also be discussed through the project. Following the strategic analysis, a cost analysis will be included to explain the costs associated with the different processes used to manufacture the product.

As the project is at an early stage and the team itself doesn't have any income from sales, the only possible source of finance is sponsorships (the team does not want to ask for a loan as the project is purely academic and will not have any positive cash flows from selling the product). This project will explain different strategies to approach possible sponsors with a successful marketing plan. An economic and financial analysis will also be included to study the viability of the project.

To conclude the project, several recommendations will be given to future project managers and team members. The final objective of the project is to create a guide that future teams can use in order to start and plan a similar project.

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Introduction

1- Introduction

Baja SAE is an international competition where university students need to design, fabricate and race an off-road vehicle. The San Diego State University has launched a new program for their Mechanical Engineering Department Senior Design Program which requires the students to represent the university in a Baja SAE competition. A team of five members was created in order to carry out the project. A heterogeneous mix of skills within the team has motivated a singular and effective design of the vehicle. The continuous support of different sponsors and professionals from the off-road racing community has also had a big impact in the success of this team. The focus of this project is to manage and organize the Baja SAE team of San Diego State University, its resources and members in order to create a successful winning vehicle that is able to beat the competitors while meeting the requirements to compete under the Baja SAE Competition.

1.1- The competition

Mechanical design, as classically taught in engineering has been centered on the application of stress analysis theory. While this theory is important, actual industrial design is generally dependent upon manufacturability, time constraints, and cost constraints as well as stress analysis. With this in mind, the SAE Mini Baja® competition was originated at the University of South Carolina in 1976, under the supervision of Dr. John F. Stephens. Since that time, the competition has grown to become a premier engineering design series. Three Mini Baja® competitions are held annually under the sponsorship of SAE.

In 1976, there were several companies producing a one-man all terrain vehicle retailing for approximately $800. Each of these vehicles was reportedly capable of negotiating very rough terrain with a great deal of reliability and speed. The object of the Mini Baja® competition was to design and fabricate a one-man all terrain vehicle having more than two wheels that will be completely competitive with the manufactured versions from the standpoint of safety, appearance, design, performance, and cost. In simplest terms, “design the most competitive vehicle for the least cost.”

Since 1976, Briggs and Stratton has been donating to each team a similar 10 hp engine which cannot be modified by the teams. Thus, all the teams should have similar performance in terms of power. The main areas in which the teams will have to work on and compete against each other will be the design and manufacturing of the chassis, the suspension and the drive train.

The first competition, in 1976, held at the University of South Carolina and Fort Jackson included ten participating universities. In 1978, the competition was split into three different events, the East, the West and the Midwest competitions. The competition soon became widely famous and by 1985 there were around 50 teams competing in each of the competitions (East, West and Midwest). It was not until 1995 that the competition would have its first international event in Brazil. In the following year, other international competitions were established in Korea and South Africa. All these competitions have remained active until the present, changing each year the university that holds the event.

The 2011 San Diego State University will compete in the Midwest competition, held in Pittsburg, Kansas from the 26^{th} to the 29^{th} of May 2011. One hundred teams from all over the US will participate in this competition this year.

It is not the first time students from San Diego State University participate in such an event. Back in 2005 and 2010 groups of students completed the competition finishing among the 25 first teams. This is a very good result taking into consideration that the university has been unable to provide financial support or even a place where to build the vehicle. Thus, the students have had to plan ahead and look for fabrication sites outside of campus. One of the objectives of this year's team is to start a SDSU Baja club under the umbrella of the SAE Club to promote the competition and encourage younger engineers to join the project at an early stage so that they can compete in their junior years and learn from the experience for following years.

1.2- Requirements

The project must start with a clear and comprehensible reading of the 2011 Collegiate Design Series Baja SAE Rules which can be found at http://www.sae.org/students/mbrules.pdf. This rules book will determine most of the requirements the final design will have to comply with, most of them in terms of size and safety. The most important part of the rules book for the design of the prototype is the one in which the technical requirements are specified.

Most of the rules have been included to ensure a safe competition with little probabilities of getting the users of the vehicle or the people around it harmed. Such rules include the design of a strong rolling cage for the chassis or the design of a towing hitch point to be used in case of an accident. There is another set of rules that will specify the maximum and minimum dimensions of the different elements of the car. This part is crucial for the design of the chassis and the assembly of all the subsystems. The last set of technical requirements is focused on the prohibition of enhancing the performance of the engine to ensure that all the teams are running with the same 10 bhp Briggs and Stratton engine.

All these rules must be taken into account very seriously through the design and fabrication processes, first as guidelines and then as must follow rules, as the first event in the competition will be the safety inspection, where judges will check whether each of these rules is met in the car design. It is important to say that due to the complexity and the amount of technical rules very few teams are successful in the technical inspection the first time they try to. There is a technical inspection period to repair or modify certain characteristics of the vehicle that do not pass this technical inspection on the first attempt. Failing to do so during this period would mean the disqualification from the competition and the team would not be able to participate in any other static or dynamic event.

1.3- Static and dynamic events

For the competition, students must assume that a fictitious industrial company has asked them to create a prototype of an off-road car that will be evaluated together with other prototypes from different teams. The potential customers for such product will be off-road lovers that take the car out on weekends. Thus, the car must have good acceleration, power, brakes and performance in general, while keeping the cost low, an easy maintenance and being safe to drive. As the prototype needs to be sold to the general public, other factors such as aesthetics, comfort and the use of standard parts will be taken into account. The challenge for the teams will be to design and manufacture the prototype that best suits the technical requirements at a low cost. Each design will be compared to those of its competitors to determine which car is the best one.

The cars will be evaluated in a series of static and dynamic events which are weighted in order to come with a final score for each vehicle. Following are the different events and the maximum number of points that can be achieved in each of the events.

STATIC EVENTS (300 POINTS)	POINTS
Design Report	75
Design Evaluation	125
Cost Report	15
Prototype Cost	85
DYNAMIC EVENTS (700 POINTS)	
Acceleration	75
Hill Climb or Traction	75
Land Maneuverability	75
Suspension	75
Endurance	400
TOTAL	1000

Table 1.1 Static and dynamic events

All Baja SAE vehicles must pass the technical inspection before they are permitted to operate under power. The inspection will determine if the vehicle satisfies the requirements of the Baja SAE rules. If vehicles are not ready for technical inspection when they arrive at the inspection site, they will be sent away. Any vehicle may be re-inspected at any time during the competition and correction of any non-compliance will be required. (Adapted from the Baja SAE rules)

The technical inspection consists of 3 different parts as follows:

Engine inspection and governor setting- Governor Setting Check: Briggs & Stratton Technical Representatives will set the governors of all vehicles. Each vehicle engine must be inspected by Briggs and Stratton technical staff that will:

1-Confirm its compliance with the rules and

2-Set the governor to the specified rpm (3800 rpm).

Technical Inspection: Each vehicle will be inspected to determine if it complies with the requirements and restrictions of the Baja SAE rules. This inspection will include an examination of the driver's equipment including helmet and arm restraints, a test of driver exit time and to ensure that all drivers meet the requirements of the rules. During this inspection the team will have to present several documents that prove the quality and strength of the frame material and the roll cage.

Kill switch and dynamic break testing: Both the internal and cockpit kill switches will be tested for functionality. If both switches pass the test then the vehicle will be dynamically brake tested. Each vehicle must demonstrate its ability to lock all four wheels and come to rest in an approximately straight line after acceleration run specified by the inspectors.

1.3.1- Static events

1.3.1.1- Engineering Design Event (200 points)

Design Report: The design report should clearly explain the engineering and design process that was used in developing each system of the team´s Baja SAE vehicle. The process for each system could include: Objectives, customer requirements, alternatives considered, improvements over last year´s design, the results of design calculations, stress analysis, testing, etc.

Design evaluation: will involve two steps. The first step will be the initial design judging of all vehicles. After initial judging is complete and the design evaluation scores recorded, the top cars (number determined by SAE and the organizers) will move onto Design Finals, where the top teams will gain some bonus points. During the design evaluation, team members are expected to fully explain and discuss all aspects of their vehicle´s design and the rationale behind their design decisions.

The design points are awarded in the following areas:

Design Category	**Points**
Originality, Innovation, Craftsmanship	31.25
Suspension, Steering, Brakes	31.25
Structural Design, Operator Confort, Mass Production	31.25
Powertrain, Serviceability	31.25
Total	**125**

Table 1.2 Design points

1.3.1.2 – Cost Event (100 points)

Cost consists of two related sections: Cost Report and Prototype Cost. The cost report provides all the background information to verify the entire vehicle's actual cost. The prototype cost is the actual cost and the points related thereto. The prototype cost points (85 points) will be calculated as follows:

$$Prototype\ Cost = 85\ points \times \frac{C_{max} - C_{yours}}{C_{max} - C_{low}}$$

where:

C_{yours} is the vehicle cost

C_{low} is the lowest vehicle cost

C_{max} is the highest vehicle cost

Chapter 3 will cover the results of the cost analysis.

1.3.2 – Dynamic Events

The dynamic events are intended to determine how the Baja SAE vehicles perform under a variety of conditions.

1.3.2.1 – Acceleration (75 points)

The acceleration event is designed to measure each vehicle´s ability to come up to speed quickly from a standing start. Acceleration is measured as the time to complete a 30.48m (100ft) or 45.72m (150ft) flat, straight course from a standing start. The course surface varies from pavement to loose dirt.

The following equation will be used for the acceleration score:

$$Acceleration\ Score = 75\ points \times \frac{T_{longest} - T_{yours}}{T_{longest} - T_{shortest}}$$

where:

$T_{shortest}$ is the fastest time by any vehicle

T_{yours} is the time for the vehicle to be scored

$T_{longest}$ is the lesser of: a) slowest time by any vehicle; b) $2.5T_{shortest}$

1.3.2.2 – Hill Climb or Traction Event (75 points)

The Hill Climb Event is designed to measure each vehicle´s ability to transmit excess (climbing) force to the ground. If local terrain does not support a significant Hill Climb, a Traction Event may be substituted, usually involving pulling an excess load. This event tests the vehicle´s relative ability to climb an incline from a standing start or pull a designated object, e.g. "eliminator skid", vehicle, or chain, along a flat surface. If a vehicle cannot complete the course and get a time, it will be scored on the distance that it travels before stopping.

The score of this event will depend on the number of vehicles, if any, that complete the course. There can be three different situations:

a) All teams succeed in completing the specified distance of the course, then the score will be based on the time that has taken each team to complete it:

$$Traction\ score = 75\ points \times \frac{T_{longest} - T_{yours}}{T_{longest} - T_{shortes}}$$

where:

$T_{shortest}$ is the fastest time by any vehicle

T_{yours} is the time for the vehicle to be scored

$T_{longest}$ is the lesser of: a) slowest time by any vehicle; b) $2.5T_{shortest}$

b) None of the teams succeed in completing the specified distance of the course, then the score will be based on the distance that each vehicle travelled:

$$Traction\ Score = 75\ points \times \frac{D_{yours} - D_{shortest}}{D_{longest} - D_{shortest}}$$

where:

$D_{shortest}$ is the shortest distance travelled by any vehicle

D_{yours} is the distance travelled by the vehicle to be scored

$D_{longest}$ is the longest distance travelled by any vehicle

c) some of the vehicles succeed in completing the specified distance of the course and some don't. If at least one vehicle climbs the hill or makes a full pull and others do not, then the vehicles going the full distance (Group I) will be scored based on time and vehicles that fail to climb the hill or make a full pull (Group II) will be scored based on distance.

Group I – Teams that make the full distance will be scored

$$Traction\ Score = 75\ points \times \frac{T_{shortest}}{T_{yours}}$$

where:

$T_{shortest}$ is the fastest time by any vehicle

T_{yours} is the time for the vehicle to be scored

Group II – Teams that do not make the full distance will be scored by the following:

$$Traction\ Score = (lowest\ score\ from\ Group\ I) \times \frac{D_{yours}}{D_{course}}$$

where:

D_{yours} is the distance travelled by the vehicle to be scored

D_{course} is the distance from start line to finish line

1.3.2.3 – Maneuverability Event (75 points)

The maneuverability event is designed to assess each vehicle´s handling ability over a typical Baja terrain. The course may consist of a variety of challenges at the organizer´s option, possibly including tight turns, pylon maneuvers, ruts and bumps, drop-offs, sand, rocks, gullies, logs, and inclines. Only vehicles that complete the maneuverability course within a time not exceeding 2.5 times that of the fastest vehicle will receive a score.

Maneuverability scoring is based on the vehicle´s time through the course:

$$Maneuverability\ Score = 75\ points \times \frac{T_{longest} - T_{yours}}{T_{longest} - T_{shortest}}$$

where:

$T_{shortest}$ is the fastest time by any vehicle

T_{yours} is the time for the vehicle to be scored

$T_{longest}$ is the is the lesser of: a) slowest time by any vehicle; b) $2.5T_{shortest}$

1.3.2.4 – Specialty Event: Suspension (75 points)

The Suspension event is designed to test the measure the resistance and the suitability of the suspension systems of the vehicles.

Suspension scoring is measured by the time it takes the vehicles to complete the suspension course:

$$Suspension\ Score = 75\ points \times \frac{T_{longest} - T_{yours}}{T_{longest} - T_{shortest}}$$

where:

$T_{shortest}$ is the fastest time by any vehicle

T_{yours} is the time for the vehicle to be scored

$T_{longest}$ is the is the lesser of: a) slowest time by any vehicle; b) $2.5T_{shortest}$

1.3.2.5 – Endurance (400 points)

The endurance event assesses each vehicle´s ability to operate continuously and at speed over rough terrain containing obstacles in any weather conditions. Endurance may be run for either time or distance. Endurance events for time usually run for four (4) hours. Endurance events for distance continue until at least one car has gone the specified distance.

Endurance may be run as either (A) a single four (4) hour race, (B) a predetermined and published distance, or as (C) elimination heats followed by a final in which the total time of one elimination heat plus the final is 4 hours. The organizer (with approval from SAE) will announce the structure of the event prior to the start.

The team that completes the distance of the competition first, or the greatest distance in the time set for the competition will be declared winner. The endurance event score is determined by (a) the number of laps each team completes during the endurance final (scored laps) and (b) the finish order of teams at the end of the event (finish order), which will influence in the number of bonus points given to the cars that have finished with the same number of completed laps.

The endurance scoring is based on the number of laps the vehicle competes in the allowed time:

$$Endurance\ Score = 400\ points \times \frac{L_{yours} - L_{lowest}}{L_{highest} - L_{lowest}}$$

where:

$L_{highest}$ is the highest number of laps completed by any vehicle

L_{yours} is the number of laps completed by the vehicle to be scored

L_{lowest} is the lowest number of laps completed by any vehicle

All these rules have been adapted from the rule book 2011 Collegiate Design Series Baja SAE Rules.

1.4 – Project Goals

The goal of the 2010 – 2011 San Diego State University Baja SAE team is to compete and win the 2011 Baja SAE Kansas competition. To that end the team has designed and manufactured a competitive vehicle that is able to succeed in all the kinds of events that concern this competition. A group of 5 students and several academic and professional advisors has worked for more than 9 months to complete this project within the time limits of the competition. Several subprojects have aroused for a better organization of the team such that each member will focus more on one or two of the following: Chassis, Drive train, Suspension, Steering, Braking, and Electrical Systems. This project will be focused on the organization and management of the team's resources, both tangible (financing, materials, etc.) and intangible (human knowledge).

The project will consist of five differentiated parts: I. Planning: a strategic analysis and planning will be conducted to design and control the different tasks to be accomplished. II. Cost analysis: including the design of a budget, the control of the costs of the vehicle, etc. III. Marketing plan: search and contact of possible sponsor firms, design of a sponsorship package to attract new sponsors, design of a communication strategy to promote the project through the team website and different engineering events and presentations. IV. Economic and financial analysis: income and cash flow statements to check the viability of the project.

It is also the desire of the team and its sponsors to create the foundations of a San Diego State University Baja SAE Club which will operate under the umbrella of the SDSU SAE Club.

The different objectives can be listed as follows:

Objective 1: to design the strategic plan of the Baja SAE team for the coming year

- Strategic Analysis
- Strategic Planning
- Implementation

Objective 2: Cost Analysis

- Create a realistic budget for the design, procurement and manufacture processes of a Baja SAE vehicle
- Control the different costs of these processes
- Create a cost clear and transparent cost report, both for the competition and to show the sponsorship

Objective 3: Marketing Plan

- Product definition
- Different sponsorship types
- Communication and Website design

Objective 4: Financial plan

- Search of different forms of financing to conduct the project
- Market research for possible sponsors interested in the off-road competition environment
- Create individual sponsorship packages to present the possible sponsors

Objective 5: Set the basis to create a club that continues with the Baja SAE team tradition during the coming years.

- Deal with the paperwork to create a San Diego State University Baja SAE club that continues with the competition spirit
- Create a guide (this project) that helps future teams get organized and succeed in their future projects

1.5 – The car: Design and construction of the different subsystems

The whole process of designing and building the car took a huge effort from 5 team members since beginning of September 2010 to the end of May 2011, when the competition was held. The fall semester of 2010 was spent reading and understanding the rules, as well as designing the different subsystems and elements that would be needed to purchase for the construction of the vehicle. The construction of the vehicle did not start until mid December when the tubing for the chassis was received by one of the sponsors. It was not until mid May that the car would be finished and ready to start testing it, allowing two weeks before the competition to test it and repair it.

1.5.1 – Chassis

The design of the chassis was highly constrained by the rule book. Many of the safety rules had a direct impact on the design of the chassis, as it is the most important subsystem regarding the driver's safety. The chassis was designed with the SolidWorks 3D CAD software, which also allows conducting the necessary FEA analysis to check the safety of the design under different load/stress situations.

The chassis' premier function is to allow safe vehicle operation and more importantly protection of the driver. It is the most integral part of the vehicle because it interacts with every system of the vehicle. Close communication with team members designing the suspension and drive train was required. The main objective of the chassis is to accomplish the functions while fulfilling the Baja SAE parameters. The features the team focused the chassis design on were the safety of the driver, the ease of transportation and maintenance, cost, quality, and weight.

SDSU Baja designed and manufactured the vehicle chassis, precisely following the Baja SAE Rules (henceforth know as “The Rules”), with primary importance given to the factors of safety, comfort, affordability, manufacturability, durability and performance.

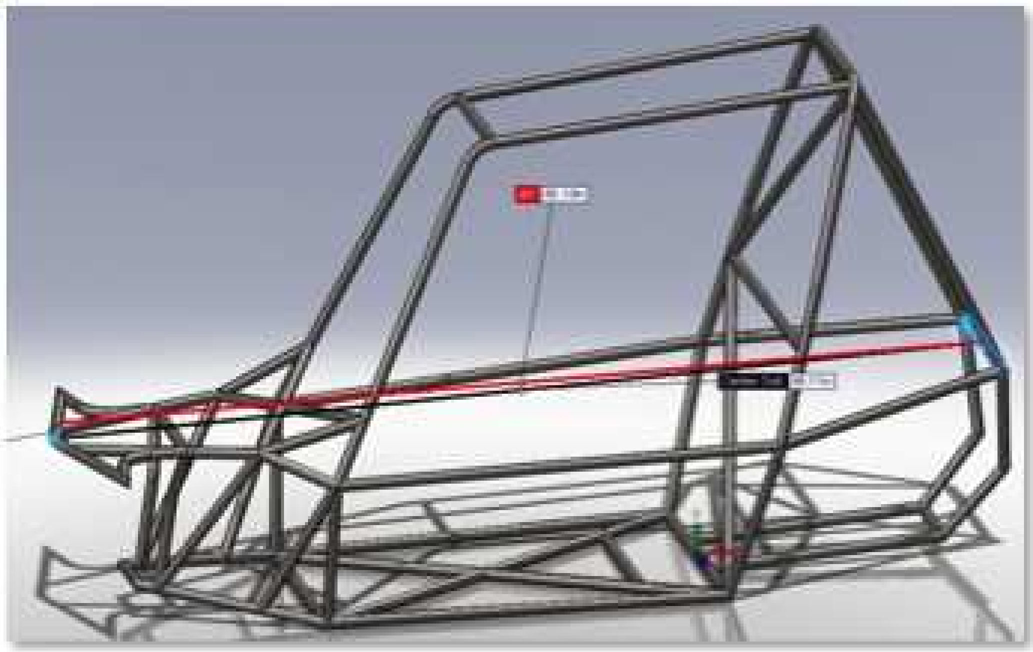


Figure 1.1: Complete build of the Chassis designed in SolidWorks

Figure 1.2: Complete build of the Chassis

The vehicle's chassis was designed in such a way to ensure the driver could comfortably operate the vehicle during the competition. The seat was angled back at an angle of 18 degrees, to the vertical, so that driver would not have to sit straight up. This results in a more relaxed seating position, and less stress on the driver's legs, buttocks, and back. The five-point Crow Industries harness system effectively protects the driver while in operation. Its attachment points on the chassis feel natural to the driver. The Rules' design requirement was to ensure the vehicle was "capable of carrying one (1) person 190 cm (6 feet, 3 inches) tall weighing 113 kg (250 lbs)." The acceleration and brake pedals are at a relaxed distance from the seat so as to ensure the driver's legs is not restricted nor over extended. The steering wheel is in an ergonomic position that feels normal to the driver. It is placed at a point that allows the driver a sufficient view of the vehicle's surroundings. The kill switch in the cockpit is mounted on the left side of the vehicle and is easy to access. The chassis also protects the driver in the event of a rollover.

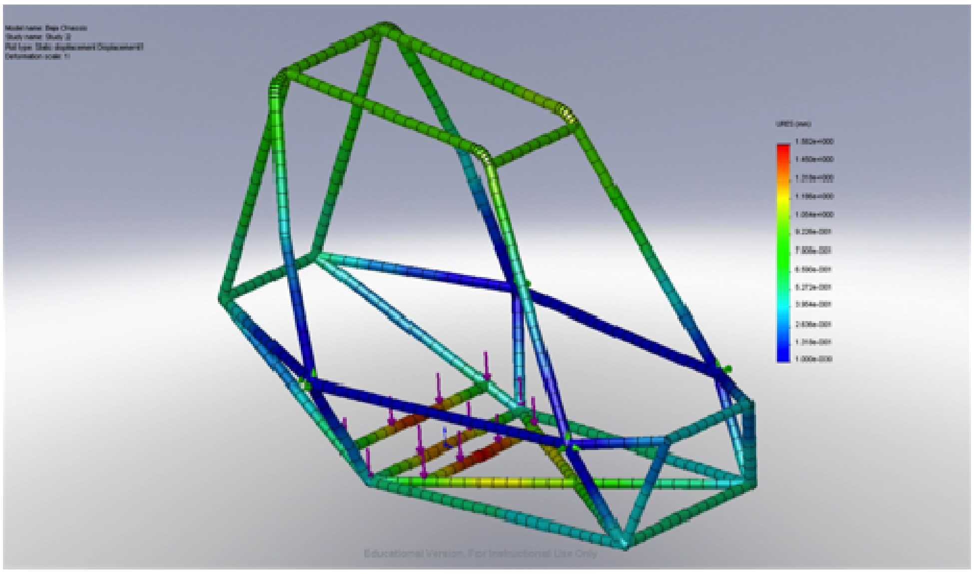


Figure 1.3: 4130 CRMO Steel Chassis: under strain static load

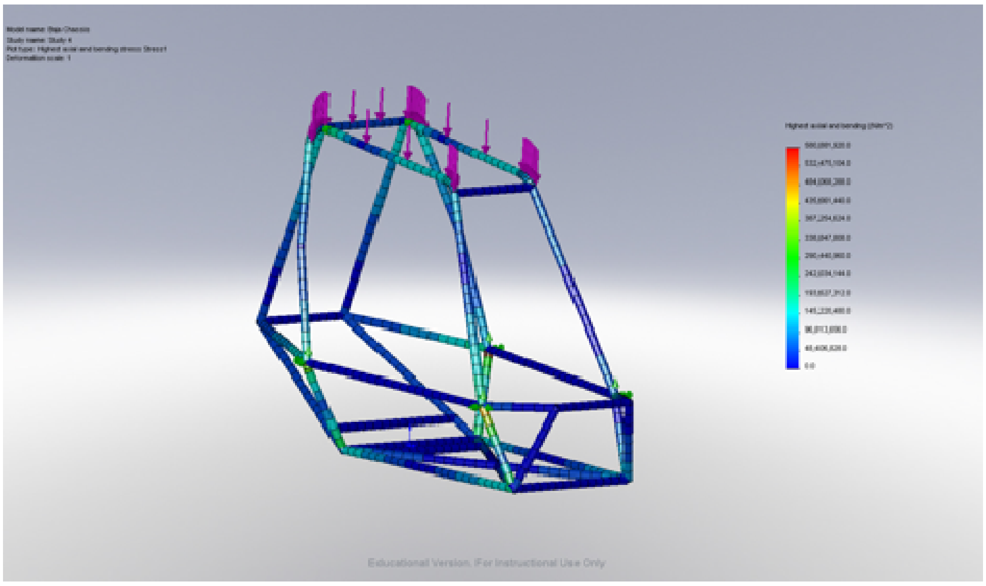


Figure 1.4: 4130 CRMO Steel Chassis: Highest Axial and Bending Stress in Rollover

1.5.2 – Drive train

The drive train is comprised of a standard issue Briggs and Stratton 10 horsepower engine. For the competition there may be no type of modification to the engine. From there, various combinations of drive trains can be combined.

For the current competition year, the use of a Continuously Variable Transmission (CVT) and a FNR transaxle will be used. The CVTech CVT will be used. This CVT has a 0.43:1 ratio and will allow for a step-less change between an infinite number of gear ratios between maximum and minimum values. Because the driving shaft is able to maintain a constant angular velocity over a range of output velocities the vehicle is able to get superior fuel efficiency as well as more usable power. In addition, this year's vehicle will be using a Dana H-12 Transaxle. This is a significant improvement upon previous years. The transaxle has a 13:1 Ratio and has the ability to go Forward, Neutral, and Reverse. Subsequently, a variety of combinations of CVTech CVT models and tire sizes have been included in the Table 1.3.

	CVTech	Comet 790	Comet 790	Comet 780	Comet 780
21 inch Tires	Option 1	Option 2	Option 3	Option 4	Option 5
Engine RPMS	3800.00	3800.00	3800.00	3800.00	3800.00
High	0.43	0.50	0.50	0.70	0.70
Low	3.00	3.30	3.30	3.70	3.70
FGR	13.00	13.00	10.15	13.00	10.15
Tire Diameter (in)	21.00	21.00	21.00	21.00	21.00
Tire Circumference (ft.) (TC)	5.50	5.50	5.50	5.50	5.50
Final Gear Ratio	5.59	6.50	5.08	9.10	7.11
ER/FS=DJR	8837.21	7600.00	7600.00	5428.57	5428.57
DJR/FGR=RAR	679.79	584.62	748.77	417.58	534.83
RAR*TC=FT/MIN	3737.32	3214.09	4116.57	2295.78	2940.41
FT/MIN*0.01136=CMPH	42.46	36.51	46.76	26.08	33.40
Actual Top speed (MPH)	39.06	33.59	43.02	23.99	30.73
ER/FS=DJR	1266.67	1151.52	1151.52	1027.03	1027.03
DJR/FGR=RAR	97.44	88.58	113.45	79.00	101.18
RAR*TC=FT/MIN	535.68	486.98	623.72	434.34	556.29
FT/MIN*0.01136=CMPH	6.09	5.53	7.09	4.93	6.32
Max	565.50	622.05	485.68	697.45	544.55
Min	81.06	94.25	73.59	131.95	103.02
Ground Max	323.14	355.46	277.53	398.54	311.17
Ground Min	46.32	53.86	42.05	75.40	58.87
Force at Ground Max (N)	1437.41	1581.15	1234.52	1772.81	1384.15
Mass (kg)	276.00	276.00	276.00	276.00	276.00
Acceleration (m/s^2)	5.21	5.73	4.47	6.42	5.02

Table 1.3: Gear Calculations for various combinations of CVTs for 21-inch tires

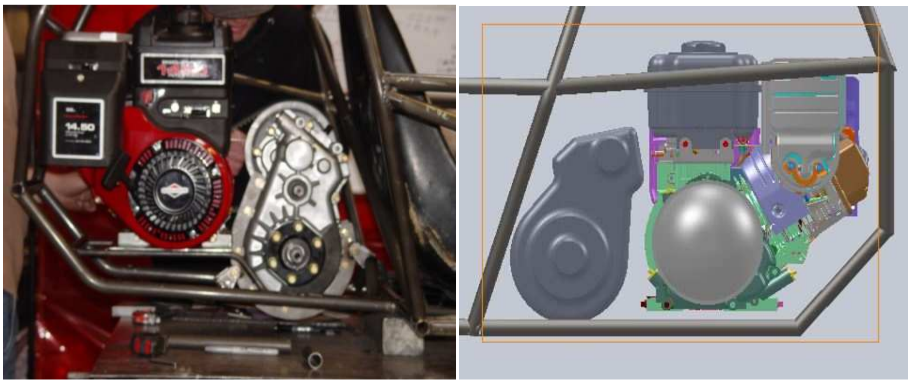


Figure 1.5, 1.6: Actual vs. Modeled Drive train Configuration

1.5.3 – Suspension

The main thing kept in mind when designing the front suspension was to have enough suspension travel to handle the competitive terrain yet is compatible with the frame design. A dual wishbone configuration was chosen, which is comprised of upper and lower control arms. Throughout the design of the suspension, the team focused on the ease of manufacture of the design, as well as the ability to make bolt on replacement parts. All of the components within the suspension were designed to be made using fixtures to hold the pivot points and supporting tubes in place while being welded. This increases repeatability of suspension arms during manufacture. Another design feature that simplified the manufacturing process is that the suspension arms are designed to be useable on either the left of right side of the vehicle (with the exception of the shock mount on the rear arm, which was made using a fixture and welded on at a later time.).

For the front and rear suspension of the vehicle, it was decided to use a double wishbone design similar to what can be found on many modern dune buggies and off-road race cars. The decision to utilize this style front suspension also allowed for the use of a program called *Racing by the Numbers*, by Mitchel Software, to aid in the design phases of the suspension systems. This program is able to plot all the pivot points in the front suspension and cycle it to analyze the resulting geometry. This program helps to speed up the design as the suspension points can be tweaked easily and quickly in order to generate desirable suspension geometry. After the location of the pivot points were set, the next step was to create solid models of the suspension arms using *SolidWorks*, and then perform FEA on them using *SolidWorks Simulation.*

The many hours spent working in the computer aided design and analysis stage resulted in unequal lengths of the front a-arms. That is, the upper control arm is shorter than the lower control arm. The difference in control arm length results in a varying tire camber angle throughout the wheel travel. At static ride height, the camber angle is negative one degree, at full droop it is negative 5 degrees, and at full compression, the camber angle is negative 3 degrees. By forcing the camber angle to change throughout travel, tire scrub can be minimized. Minimal tire scrub is advantageous, as it allows the suspension to work more freely as well as decreasing the rolling resistance over rough and uneven terrain. Figure 1.7 shows an exaggerated example of camber change throughout wheel travel, resulting in zero tire scrub. This drastic amount of camber change is not ideal, as it applies very high stresses on the tire hub and spindle components. A compromise must be made to achieve a minimum amount of tire scrub, while maintaining an acceptable camber angle. The end result of the design is 19 mm (0.75 inches) of tire scrub, with a maximum camber angle of negative 5 degrees throughout ten inches of wheel travel.

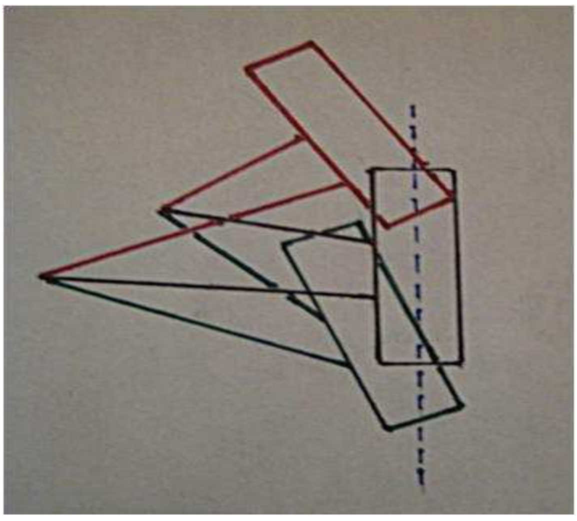


Figure 1.7: Camber angle change through wheel travel

In addition, the suspension geometry is a bit skewed because the inner pivot points are not parallel with the centerline of the chassis. The rear pivot points of both the upper and lower arms are located downward and outward of the forward pivots. The reason they are located outward was to provide increased foot room, which would allow the driver's seating position to be moved forward, decreasing the overall wheel base of the vehicle, and increasing its handling in tight cornering situations. The benefit of the lower placement of the rear pivot points is that it sets the suspension at a declined angle, which allows the suspension to work better in "nose heavy" landings, which are common in Mini Baja vehicles due to their relatively short wheel base and lack of horsepower to carry the front end over jumps. Because of the nonparallel pivot points, it was decided that urethane bushings could not be easily mounted, and they would wear too rapidly. Instead, the decision was made to use spherical heim joints at all of the suspension pivot points, as they would allow for the misalignment needed in the design. This decision increased the initial cost of the vehicle, but will reduce the long term cost, as the heims will last much longer than the urethane-bushing alternative.

Figure 1.8: Front suspension upper and lower A-arms

The A-arms were fabricated using 1.00-inch outer diameter chromoly steel tubing. The lower arms have a wall thickness of 0.095-inches for strength; this is due to the fact that it will be taking in more stress. The upper arms were constructed with

0.065-inch wall thickness. The arms are connected with heim joints to the frame and spindles. The lower arms are where the shocks will be mounted. The amount of achievable travel came out to 8.00 inches, which is what was expected in the design.


Figure 1.9: (Left) Front suspension upper and lower A-arms connected to the frame

Figure 1.10: (Right) Illustration of the amount of upward travel

Another important aspect of the front suspension was the design of the upright. Which ideally for off road racing aspect the front caster would need to be close to zero. For the design the caster angle is 10 degrees, which allowed optimal suspension cycle while maintaining proper directional stability. The upright went through four redesigns. Two designs called for aluminum and the other two mild steel plates. The finish product was a compilation of previous designs in the form of a 3D jigsaw puzzle.

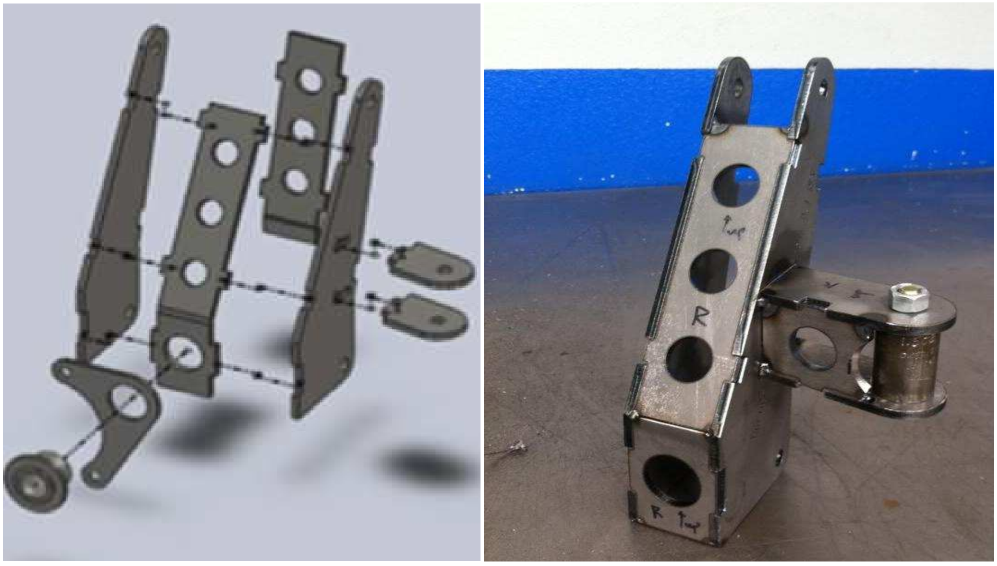


Figure 1.11, 1.12: (Left) Exploded view of Spindle Assembly (Right) Fabricated Spindle

The shocks that will be used in the front, as well as the rear, are custom made from Walker Evans. The shocks have Eibach 100 lb/in coils. This spring rate was selected by utilizing an online spring selection program. The program works by computing spring rate using several inputs provided by the user. These input values include: total vehicle and driver weight, front to rear weight ratio, unsprung weight at each corner, shock travel length, and wheel travel length. Vehicle scales were used to determine the vehicle weights. By putting a scale under each wheel of the fully assembled vehicle, the scales were able to tell us the weight at each corner as well as the total weight. To determine un-sprung weights, vehicle scales were again used. This time, the springs were removed from the coil-over, and the chassis was supported by jack stands. The scales were placed under the wheel, this time only registering the weight of the wheels and arms, as they hung from the supported chassis.

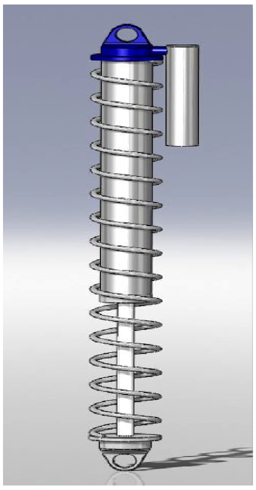


Figure 1.13, 1.14: (Left) Solid Modeled Shock (Right) Custom Walker Evan Shocks

1.5.4 – Steering

Throughout the design of the steering system, the team focused on several numbers such as Bump steer, steering angle, and Ackerman angle; all of which are important in proper steering geometry. For the purpose of this build, the team decided to utilize a manual rack and pinion steering box to convert the rotational movement of the steering shaft into lateral translation of the tie rods and steering arms. Due to the time and labor constraints of this build, the team decided to buy a rack and pinion rather than designing and building it. The team chose the Desert Karts rack and pinion, which had 11 inches of travel with a 12:1 ratio, shown in Figure 1.15.

Figure 1.15: DesertKarts 11" Steering Rack and Pinion

The turning radius of a vehicle is the amount of room required for a vehicle to make a 180-degree turn. That is to say, if a vehicle's turning radius is decreased, it is able to make tighter turns, and in turn is more maneuverable in tight driving conditions. One thing the team did to minimize the turning radius of the vehicle was maximized the angle that the wheels are able to turn left or right. To maximize this angle, the team used a larger outer heim joint on the upper and lower arms than were needed strength wise. Because larger heim joints were used, higher misalignment spacers were able to be utilized making for a greater turning angle.

The Ackerman angle refers to the fact that when a four-wheel vehicle is turning, the inner and outer wheels actually turn in a different radius. The outer wheel travels through a much larger and more gradual turn than the inner tire. Proper steering geometry will correct for this, by taking into account the Ackerman angle theory and the inner tire will turn a few more degrees than the outer tire in a turn. This variation in turning angle from one tire to another can be accomplished by correct placement of the outer steering pivot points. The simplest was to account for Ackerman angle is to draw a construction line from the center of the rear axle through the steering axis and extend it forward a couple inches. To have proper Ackerman steering angle, the outer tie rod pivots must lie somewhere on this line. That is, if the car was designed to be rear steer, the tie rod pivots would be inside the steering axis, and in the team's situation, with a steering system mounted in front of the spindle, the outer tie rod pivots will lay outside the steering axis.

Figure 1.16: View of the front A-arms and tie-rods

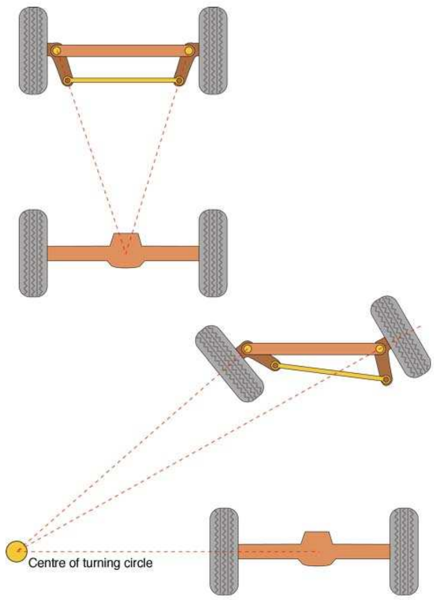


Figure 1.17: Ackerman geometry diagram

Bump steer refers to the idea that the direction that the tires are pointed can change as the suspension is cycled upward or downward. Bump steer is highly undesirable in a vehicle as it results in unpredictable handling characteristics in rough and bumpy terrain. Bump steer can be minimized with proper tie rod length and placement. When designing the steering system, it was found that the stock locations of the tie rod mounts on the rack the team chose would result in too long of tie rods, which would ultimately result in excessive bump steer. To compensate for the narrow mount point locations on the rack, a “dog bone” was designed, which would bolt to the stock locations on the rack, and move the pivots outward to a desired location. In the case of an unequal length a-arm system, it is important for the tie rod length to be between the length of the upper and lower arms.

1.5.5 – Safety

There are three main features that keep the driver safe from injury during operation of the vehicle: Fire Safety, Restraints, and Kill Switches.

For fire safety the team designed a firewall made of 1.27 mm (0.05 inch) thick 3003 aluminum sheets that keeps the drivers compartment separated from the drive-train area. By Baja SAE rules the firewall must not allow any fuel to enter the driver’s compartment as well as keep the driver separated for a potential drive-train fire. The reason the team chose 3003 aluminum compared to the popular 6061 aluminum was that the 3003 was easier to work and cheaper. An example of how it was easier to work with was when adding brake folds and rolling beads creases the softer 3003 aluminum deformed much easier that the harder 6061 aluminum. The other fire safety feature is a mounted fire extinguisher easily accessible to the driver as well as to an outside person.

The second feature that keep the vehicle’s driver safe fall under the category of driver restraints; these include a particular headrest, style and size of seat belt and arm extension limiters. The headrest protects the driver from whiplash in the event that the car is “rear ended,” it limits the rearward motion of the head. The minimum thickness and material per Baja SAE rules are a cushion of SFI 45.2 foam no thinner than 50.4 mm (2 inches) thick. The next driver restraint protection is the use of a 76.2 mm (3 inch) wide nylon five-point seat belt with a non-cam latching mechanism. This style of belt limits the driver's body from motion excessive motion in all relevant directions. The team chose to use the Crow Industries brand belt as it met all of the specifications and was competitively priced. As for arm extension limiters the team also chose to purchase those from Crow Industries as they were compatible with the chosen five-point seat belt system and were also competitively priced.

Kill Switches – The main features that keep other drivers and spectators safe are the two easily accessible kill switches. One switch is easily within reach of the vehicle driver and the other in easily accessible to an outside person. In the event that the vehicle gets a stuck throttle or there is a release of fuel operation of one of these switches can safely neutralize the situation.

2

Strategic analysis and plan

2 – Strategic analysis and plan

The SDSU Baja team must work together as a company developing a new product that needs to be presented in front of a jury (a fictitious company). A very important tool for every company developing a new product is to create an effective strategic plan that can be followed for the next year or so, not only until the competition takes place, but also after it finishes with a follow up plan.

The first thing that needs to be accomplished when creating a company or team is to identify its mission. Some questions need to be answered before moving on: Why does a team need to be created? Or, what are the goals as a team? Such questions will help identify the mission of the team.

For a team plan to be strategically coherent all organizational vision, mission statements and strategic objectives must follow the same direction. The natural steps to achieve successful strategic actions are: strategic analysis, strategic formulation and strategic implementation.

On the first part, the strategic analysis, the situation of the team must be considered both internally (the team itself) and externally (within the industry, its competitors…). Both the firm's intellectual and tangible assets will be considered in this analysis.

The second part will be dedicated to designing and formulating strategies that will lead to the desired outcomes. These strategies should be formulated at different levels: business level strategies, corporate level strategies and entrepreneurial strategies.

The last part of this chapter will explain different ways of implementing the above mentioned strategies at the different levels and some ways of controlling that such strategies are being followed by all the team members. The chapter will end with an overview of how good leadership skills can help in the performance of the team. Some ethical issues will also be covered as part of the strategic plan.

This structure follows the traditional view of strategic management which consists of the analysis, decisions, and actions an organization or team undertakes in order to create and sustain competitive advantages. In the team's situation, those competitive advantages are the ones that will make us successful in the competition against the other teams.

There are four main key attributes to the strategic management of a team:

- Directs the team toward overall goals and objectives: as the team is quite small, it is easy to align team goals with individual goals. Being a small team also helps having a tighter control over the team members.
- Includes multiple stakeholders in decision making: there are different stakeholders that can influence in the decision making process of the project. Not only the team members, but also some of the main sponsors (very experience in the off-road competition environment, mechanics, academics from the Mechanical Engineering Department of the San Diego State University, the competition requirements from the Society of Automotive Engineers SAE, etc. Probably the main influence that the team has received when making decisions through the different steps of the design, fabrication and testing of the car has been from the members of last year's team.
- Needs to incorporate short-term and long-term perspectives: team leaders must maintain both a vision for the future of the team as well as a focus on its present operating needs. Thus, short-term objectives must be designed to fit into a clear long-term strategy (finish the car before the competition starts and outperform the rivals).

- Recognizes the trade-offs between efficiency and effectiveness: effectiveness can be seen as tailoring actions to the needs of a team or "doing the right thing" while efficiency means performing actions at a low cost relative to a benchmark or "doing things right". This trade-off has been present through the whole process of designing and building a car, as the team had to maintain a low budget (both because the lower the cost of the car, the more points the team will get in the cost event, and because of the limited financing) while creating a competitive car.

A difference between intended strategy and realized strategy must also be noted. Intended strategies are those in which team decisions are determined only by analysis, while decisions for realized strategies are determined not only by analysis, but also by unforeseen environmental developments, unanticipated resource constraints, or changes in team preferences. The final realized strategy of any team is thus a combination of deliberate and emergent strategies.

Figure 2.1: Intended vs. Realized Strategies

2.1 – Strategic analysis

It consists of the advance work that must be done in order to effectively formulate and implement strategies. The final bottom line of the strategic analysis is to determine the team's goals and objectives in order to channel the efforts. These goals are also useful by providing a means of allocating resources.

Before the goals are determined, both the external and the internal environment of the team need to be analyzed.

2.1.1 – Analyzing the external environment

In order to analyze the external environment of the team, a thorough analysis of both the general environment and the competitive environment must be done.

2.1.1.1 – The general environment

The general environment is composed of factors that can have dramatic effects on a team's strategy. The team or organization has usually little ability to predict trends and events in the general environment and even less ability to control them.

The general environment can be divided into six main segments: demographic, socio-cultural, political/legal, technological, economic and global. The industry of automotive competition, however, will not be affected by all these segments. The main segments that will influence directly or indirectly the Baja SAE project will be:

- Technological segment: developments in technology lead to new products and services and improve how they are produced and delivered to the end user. A very important technological development that has shaped the automotive competition industry in the last decades has been the computer-aided design (CAD) and the computer-aided manufacturing (CAM) softwares. Many of the parts that were used in the car were fabricated using laser cut technology or CNC machines which start with the design of the parts with CAD software. The creativity of the teams also plays a key role in this segment, as products from different industries can be used to build this kind of off-road vehicles. For example, the team used a golf kart gear box and different components from other off-road vehicles. Another important technological improvement can be the development of light weight, resistant materials, as the component that weights most from the car is the main body, which is usually made of 4130 chromoly steel. This material is used because of its low cost, its strength properties and its easiness of handling. However, if another material such as aluminum were to be used, the body would be lighter having the same resistance. However this is much more expensive and difficult to manage. Another technological component that would have an impact on the hypothetical mass production of the vehicle would be the increase in productivity rates thanks to automated or semi-automated production processes.

- Economic segment: the economy has an impact on all industries, from suppliers of raw materials to manufacturers of finished goods and services. Key economic indicators include interest rates, unemployment rates, the Consumer Price Index, etc. The main source of finance of most teams in these competitions is each team's home university. That can be a problem when the home university has a very low budget. San Diego State University receives funds from the state of California and from private investors that are allocated to different research programs and projects. However, due to the economic recess of the last few years, the university is having more and more trouble to allocate the limited funds. That is why the project started with no financial help from the university at first. Private sponsors had to be contacted to receive funds to start the project. However, many private sponsors that would have been happy to help under good economic conditions were unable to provide any funds due, again, to the economic recess.

2.1.1.2 – The competitive environment. Porter's Five Forces Model of Industry Competition

The nature of competition in this industry, as well as the performance of the teams, is often more directly influenced by the developments in the competitive environment, as the general environment affects most teams in the same way. The competitive environment consists of many factors that are particularly relevant to a team's strategy. Porter's Five Forces Model of Industry Competition will be used to assess the effects of each of these forces in the performance of SDSU Baja SAE team in the competition.

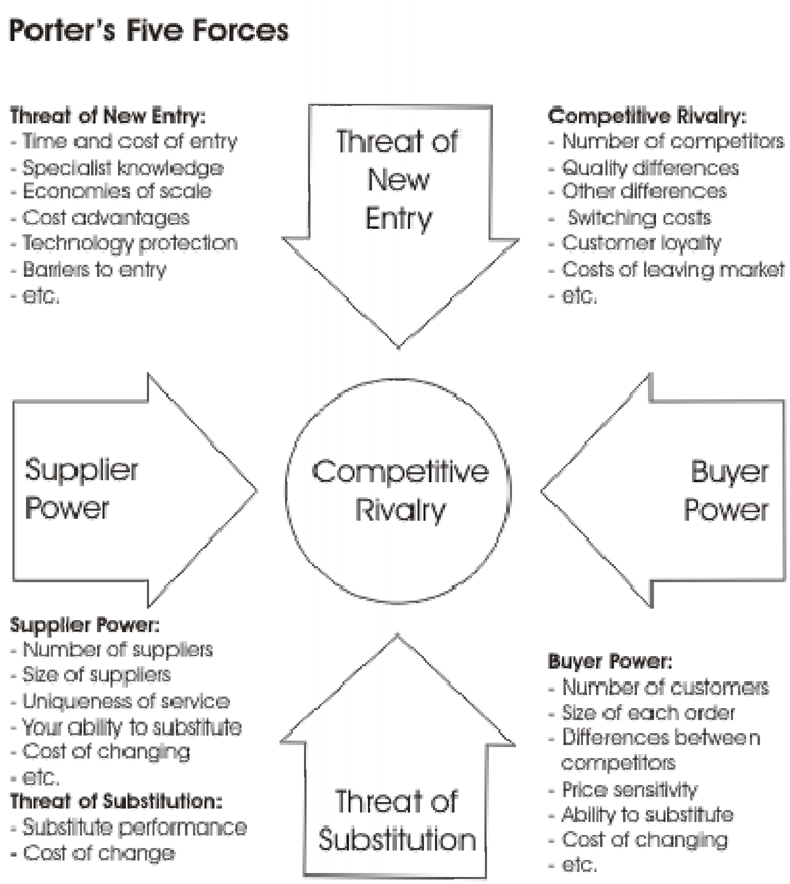


Figure 2.2: Porter's Five Forces

The industry that the Porter's Five Forces Model will assess here is the Baja SAE competition industry. In this model, Porter identifies each of the possible forces that can limit the team's ability to compete or be profitable in the given market. In the team's situation, profitability can be measured as the performance of the team's vehicle in the competition. This model helps managers assess how to improve the organization or team's competitive position against each of the five forces. Each of these forces will be assessed individually:

- The threat of new entrants: refers to the possibility that the profits of established organizations in the industry may be eroded by new competitors. The extent of the threat depends on existing barriers to entry and the combined reactions from existing competitors. A new entrant can be any team that has not competed in previous years. There are different sources of entry barriers. The first and most important one is that teams can use vehicles from past competitions as long as they change at least 30% of the design of the vehicle. Thus, many traditional teams focus on improving a specific subsystem that might not have worked as planned in a past competition, but still keep all the other subsystems that worked properly. In this sense, the amount of work that must be completed before the competition by new entrants is much bigger than the work done by traditional teams. However, at the competition site, traditional teams will have a strong competition among each other, but they are usually happy to help new and inexperienced teams. The capital requirements are also a big barrier of entry, as traditional teams will need lower budgets (to modify their existing cars) than new entrants, who need to build their car from scratch. To sum up, the main entry barrier will be the learning curve that traditional teams gain year after year. There are other barriers to entry in other industries such as economies of scale, product differentiation, switching costs or access to distribution channels; however, those don't have a significant influence in the Baja SAE competition industry.
- The bargaining power of buyers: buyers threaten an industry by forcing down prices, bargaining for higher quality or more services, and playing

competitors against each other. A buyer group is powerful when it is concentrated or purchases large volumes relative to seller sales, when the products it purchases from the industry are standard or undifferentiated, when the buyer faces few switching costs or when it earns low profits. In this competition, the buyer has a very powerful bargaining position, as it is the only buyer for the industry (remember that the buyer, or jury, is a fictitious company that will select the best performing car with the lowest budget. That is why product differentiation, as well as performance and a low cost for the car production are all very important in this competition. It is also very important to understand the needs of the target market, as all competitors will be focusing on fulfilling the buyer’s needs. This can be achieved by fully understanding the rules and regulations of each year’s competition.

- The bargaining power of suppliers: suppliers can exert bargaining power over participants in an industry by threatening to raise prices or reduce the quality of purchased goods and services. Suppliers are powerful when they supply to a segmented industry. The Baja SAE competition is a segmented industry, with a limited number of suppliers. Thus, suppliers can exert a big influence on the prices. Several items such as the kill switches are required to compete in the events, and there is only one supplier of those items. Thus, the supplier could raise prices and the buyers (teams) would have no option but to buy it from them. This is also an example of how a supplier can have a lot of bargaining power when the product is an important or necessary input to the buyer. When considering supplier power, there is usually a focus on suppliers of raw materials, equipment, machinery, and associated services, such as supply of labor.
- The threat of substitute product and services: this means the competition of firms within an industry with industries producing substitute products or services. The competitors in this industry do not have to worry about the competition with substitute products or services as there are none.
- The intensity of rivalry among competitors in an industry: firms and organizations use tactics such as price competition, advertising battles,

product introductions, and increase customer service or warranties. Intense rivalry is the result of several factors such as having numerous or equally balanced competitors, a slow industry growth, lack of differentiation or high exit barriers. In the competition, the intensity of rivalry is high due to the amount of teams competing each year (around 100). Teams can choose to differentiate in any of the different events (design, cost, endurance…) being aware of the tradeoffs between the different events (for example, a vehicle manufactured with low cost, low quality parts might not finish the endurance race).

It is worth mentioning how the Internet has affected the five competitive forces by speeding up the process of acquiring supplies or by connecting suppliers to end users without intermediaries.

2.1.2 The team's internal environment

The internal analysis of a firm helps to understand why some firms outperform other direct competitors. It also provides the tools to identify the key factors that make some teams outperform others in any competition. There are different frameworks that give an idea of the internal situation of a team. The first one is the traditional value-chain analysis developed by Michael Porter. The second framework that will be used to assess the internal environment of the team is the resource-based view of the team.

2.1.2.1 – Value-chain analysis

Value-chain analysis views the organization or team as a sequential process of value-creating activities. It is useful for understanding the building blocks of competitive advantage. Value is the amount that buyers are willing to pay for what a firm provides them. For the project, the team needs to understand the needs of the potential buyer of the product and create a high quality car that does not exceed the value the customer is willing to pay. Creating value for buyers that exceeds the cost of production (the margin) is a key concept used in analyzing a firm's competitive position.

There are two different categories of activities. First, five primary activities (inbound logistics, operations, outbound logistics, marketing and sales, and service) contribute to the physical creation of the product or service, its sale and transfer to the buyer, and its service after sale. Second, support activities (procurement, technology development, human resource management, and general administration) that add value by themselves or through important relationships with both primary and other support activities.

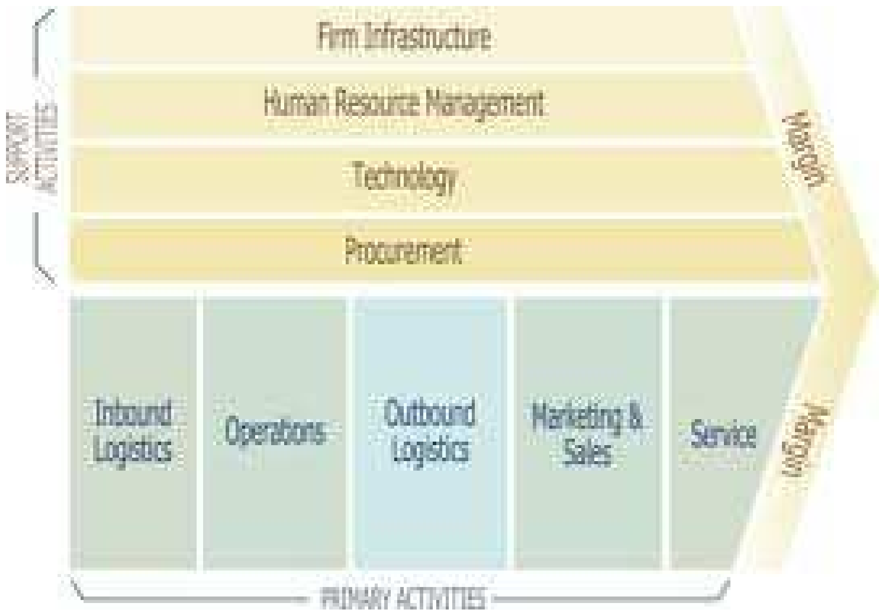


Figure 2.3: Value-chain analysis. Primary and support activities

The value-chain analysis can also be used in a broader context incorporating the value chains of all the subjects that are included in the overall supply chain and distribution channels in which the product participates. The value that the end user will pay will be the cost of producing the product plus all the margins from the raw materials suppliers, the product developers and the distributors. From the management point of view, if the team wants to get a larger portion of the total margin, it only has two possible options: buy cheaper from the suppliers or increase the selling price. In the case of this competition, none of these possibilities is recommended as the team has little bargaining power over suppliers (as explained in the Porter's Five Forces of Competition section) and the final price to which the team would sold the car is not considered, but only the final cost of producing it.

Primary activities are more related to the technical side of manufacturing a product and include:

- Inbound logistics: associated with receiving, storing and distributing inputs to the product such as material handling or inventory control. Having an ordered warehouse of the materials purchased to build the vehicle helped reducing the costs of ordering materials that were not needed and finding the required metals easily.
- Operations: associated with transforming inputs into the final product form, such as machining, assembling, and testing. Luckily, most of the operations were performed in a machine shop of one of the sponsors with cutting edge industrial machines and tools that were very useful in the process of manufacturing. The easy access to most of the hardware needed also helped. Outsourcing some of the operations such as small parts machining (laser cut), TIG welding, etc. to sponsors from the industry was very helpful.
- Outbound logistics: associated with collecting, storing and distributing the product to buyers. The only outbound logistics activity related to the project was towing the car with a trailer from San Diego, California to Pittsburg, Kansas, where the competition is taking place. Due to the size of the product, and the distance involved, towing the vehicle was the only affordable option.
- Marketing and sales: associated with purchases of products and services by end users and the inducements used to get them to make purchases. Also used to draw investors to get the financial support needed for the project. There is

a chapter used to describe the promotion and advertising ideas used in the project to attract potential sponsors.

- Service: providing service to enhance or maintain the value of the product, such as installation, repair, training, parts supply, and product adjustment. The juries from the competition take into account the number of standard parts used in the vehicle and the easiness of service for each of the parts in the design event.

Secondary activities are those which are important to the functioning of the team but whose performance does not directly influence the final product and include:

- Procurement: purchasing inputs used in the project's value chain (raw materials, hardware, parts, etc.) An important improvement the team did in this area was to decrease the number of business days since the team ordered the parts designs to the company that would laser cut those parts for us, from four to one or two. Being a prototype, many of the designs of the parts would be done day by day, according to the specific needs of the subsystems the team was working on, so changing from four days to receive the parts to one or two days did have an important effect speeding up the manufacturing process.
- Technology development: every value activity needs technology. The range of technologies used in this project is very broad, from CAD and CAM software, to CNC machining, different welding methods, etc.
- Human resource management: recruiting, hiring, training, development and compensation of all types of personnel. Although the SDSU Baja SAE project has not dealt with any of these activities, an important effort has been made so that the tradition of competing continues year by year, by promoting the project in several university related activities together with the engineering department.
- General administration: encompassing general management, planning,

finance, accounting, etc. It supports the entire value chain and not individual activities. A strong leadership can also make a positive impact on an organization's success.

Competitive advantages can appear not only in individual activities that outperform rivals, but also in the interrelationships that appear among activities within the organization, or within the organization and other organizations that are part of the project's value chain.

2.1.2.2 – Resource-based view of the team

The resource-based view (RBV) of an organization or team is the perspective that teams' competitive advantages are due to the creation of strategic resources that are valuable, rare, costly to imitate, and costly to substitute. The RBV is a very useful framework for gaining insights as to why some competitors are more profitable than others. In the competition, this can be measured as the efficiency of some teams allocating their resources as opposed to the inefficiency of others (who have a bigger budget but create a lower quality vehicle).

There are three key types of resources that teams possess: tangible resources, intangible resources, and organizational capabilities. A central theme of the resource-based view of the team is that competitive advantages are created (and sustained) through bundling of several resources in unique combinations.

- Tangible resources: assets which are relatively easy to identify. They include physical (machine plant, equipment, machinery provided by the team's main sponsor) and financial assets (cash and the ability to borrow funds) that the team uses to create value for its customers. The team's strategic planning process, as well as the patents (if the team had developed any), are also considered tangible resources. The team's financial resources, although limited, have been enough to continue working on the project to the end of the competition.

- Intangible resources: organizational assets that are difficult to identify and account for such as human resources, innovation resources, and reputation resources. The experience and capabilities of the team members (mainly mechanical engineers), and their managerial skills should be taken into account. Since this year is the first one in which the school has been a little concerned about this competition, the team members only come from an engineering background. However, it would be very beneficial for the team to have some members from different backgrounds such as business management or finance to deal with all the non-technical events of the competition such as the budget control or the cost report. It is the goal of the team members to expand the participation in the team to other departments outside engineering for future years. Even though the team does not have a good reputation in the history of the competition, the team's main sponsor, The Corky McMillin Companies, who has been kind enough to support both financially and letting us use their racing team shop, has a very well know and reputable racing team in the Baja racing competition industry.
- Organizational capabilities: the competencies and skills a team uses to transform inputs into outputs. In other words, the team's capacity to deploy tangible and intangible resources over time. Product development capabilities or innovation processes are examples of organizational capabilities. Being a new and small team, such capabilities are very difficult to be the team's basis for competitive advantage.

Resources alone are not a basis for competitive advantage, nor are advantages sustainable over time. For a resource to provide a firm with the potential for a sustainable competitive advantage, it must have four attributes. First, the resource must be valuable, in the sense that it exploits opportunities or neutralizes threats in the firm's environment. Second, it must be rare among the firm's current and potential competitors. Third, the resource must be difficult for competitors to imitate (being physically unique, having a complex path dependency development, etc.). Fourth, the resource must have no strategically equivalent substitutes.

Is a resource or capability…				
Valuable?	Rare?	Difficult to imitate?	Without substitutes?	Implications for competitiveness?
No	No	No	No	Competitive disadvantage
Yes	No	No	No	Competitive parity
Yes	Yes	No	No	Temporary competitive advantage
Yes	Yes	Yes	Yes	Sustainable competitive advantage

Figure 2.4: Criteria for sustainable competitive advantage and strategic implications

2.1.3 – SWOT analysis

A very popular method of analyzing both firm and industry (internal and external) conditions is SWOT analysis. SWOT stands for strengths, weaknesses, opportunities, and threats. It provides a basic listing of conditions both inside and surrounding the organization.

The strengths and weaknesses portion of SWOT refers to the internal conditions of the organization (where the team excels, strengths, and where it may lack competitors, weaknesses). Opportunities and threats are environmental conditions external to the organization. These could be factors either in the general environment or in the competitive environment.

The general idea of SWOT analysis is that the team should:

- Build on its strengths
- Try to remedy the weaknesses or work around them
- Take advantage of the opportunities presented by the environment
- Protect the firm from the threats

Considering the factors mentioned in the external and internal analysis, the SDSU Baja SAE Team SWOT analysis points the following:

Strengths:

- Mechanical engineering team members with different set of skills
- Passion for cars and racing competition
- Industry support from the very beginning
- Free access to a state-of-the-art machine shop
- Many local businesses into off-road competition
- Determination to succeed

The SDSU Baja SAE Team is composed by five senior mechanical engineering students from San Diego State University and Universidad Pontificia de Comillas. The different technical backgrounds enriched the team's skills and capabilities. Having some local students also helped contacting most of the sponsors, who were very interested in supporting the project from the beginning. All the team members volunteered to participate in the program, knowing the amount of effort and time it would take to finish such a project. Their determination to finish the project kept the team united until the very end, exceeding both their sponsors and teachers' expectations.

Southern California, due to the amount of desert areas around it, has a very important off-road tradition. This helped the team contact many of the potential sponsors that would help the team get parts and products at discount prices, or even for free. The cost of the project without their support would have been too high for any individual sponsor to put up with. The support from the team's main sponsor, The Corky McMillin Companies, and the free access granted to their Racing Team machine shop gave the team and invaluable advantage, without which, the project would probably not have been completed on time with such quality.

All these characteristics are presented as strengths compared to the other teams in the competition, that might not have such a support from the industry, or as nice facilities as the SDSU Baja SAE Team used to build their vehicle. All the above mentioned strengths could be sum up into two main ones: human workforce and industry support.

Weaknesses:

- Small team
- Little experience in the competition industry
- Little university support
- Start project from scratch
- Limited budget
- Part time dedication to the project

Even though the project team was supposed to be composed of at least eight senior mechanical engineering students, only five students volunteered for the program. The small size of the team and the inexperience of all the team members in similar competitions did slow down the design and production of the prototype. Even though most of the ideas applied in the competition industry had been covered in the engineering programs studied by the team members, it takes more than studying for a course to apply those concepts in real life.

From the beginning of the project, the university seemed very interested in being represented by this group of students. However, they never showed support, nor financial, nor providing a space where to build the car, until the very last month before the competition when they saw the car at an advanced stage of its construction and thought it was time for them to support financially the project, giving the team some money the team members had advance in order to finish the project. For future reference, after considering the pros and cons of building the car at the university or outside in a private shop, the ideal location to build a car would have been at a spot in the university close to the machine shop from the university's engineering department.

A very important disadvantage the team was facing was that it had to build a car from scratch. Most teams in the competition rebuild old cars and improve them (the rules specify that at least 30% of the car's design or fabrication must be new, compared to the old model). Even thought SDSU had presented a car last year, this vehicle had been financed by the team members, and was owned by them. That is why the team was not able to use any of their parts or designs. However they did help this year's team with their invaluable advice.

The project started with a very limited budget of $2,500 (given by the team's main sponsor The Corky McMillin Companies) to start with, which was extended one month before the project to $4,000 thanks to the contribution of the university. This budget is not enough to build such a car. That is the reason why the team had to look for other sponsors in the industry who could provide parts at a discounted price, or for free. This situation limited the products that the team could afford and use, which also limited the performance of the vehicle.

The last weakness of the team was the limited amount of time the team members could expend in the machine shop building the car (which turned out to be most of their free time). All the team members were close to graduation, but had either part-time jobs or other subjects, or both.

Opportunities:

- Begin a SDSU Baja SAE Club
- Impress both the school and the sponsors with the team's performance
- Create a competitive prototype for future teams' reference
- Learn from the experience for future career opportunities
- Industry contacts

The first three opportunities go hand in hand. For the university team to become competitive, the performance in this year's competition must be excellent. This will help future teams improve certain parts of the car that need to be redesigned (such as the rear end of the car which is too heavy) and get more sponsors to upgrade some of the lower quality parts. This would also encourage the university to provide a spot where the manufacturing activities could be done.

The idea of beginning a university club would benefit the team as not only senior students would participate in the design and manufacturing processes, but also other students from junior years, or even students from other majors who are interested would have a role in the team. Forming a club would also mean achieving a better organizational design, having a president, vice-president and a more controlled budget. This structure would help sophomore and junior students get in touch with the project years before their senior year, learning from the experience and applying the learnt concepts in their final year project, passing them to future generations. Other engineering students, as well as business or finance students will be welcomed to join this club.

The project is in itself a huge opportunity for the team members to expand their career opportunities. Activities as important as budget control, teamwork, etc. are very valuable for an engineer's career perspective.

Having the support of the McMillin Racing team has opened many doors to the team members by getting in touch through them with other potential sponsors who were also related to the off-road competition industry.

Threats:

- Much more experienced universities as competitors
- Not enough financial support
- Burnout of team members
- Fail to comply with the rules and regulations of the competition

The team's main threats are other teams that have a long history competing in similar events. Such teams include Université Laval, Rochester Institute of Technology, Cornell University, etc. These universities have been developing their prototypes for the last couple of years, having very strong and light vehicles. This means a huge advantage over the team and other new teams. The goal of SDSU Baja SAE team is to become as competitive as them in the next year or so.

The next two threats would have had a very negative impact on the team and could have risked the attendance of the team to the competition. The lack of financial support has been a major concern among the team members as some wanted to contribute with their own money to finish the project, while others did not have the financial resources to do so. Luckily, none of the team members quit the project at its middle stage, where most of the financial and technical problems arose. This could have had a devastating effect on the other team members.

The last threat the team will have to face is the security and rules inspection before competing. This inspection could have the team been expelled from the competition if not meeting all the requirements.

It is important to bear in mind that SWOT analysis has a few limitations that will be explained here:

- It is just a starting point for discussion. SWOT cannot show how to get competitive advantage. It is not an end in itself.
- A team's strengths or capabilities may not enable it to achieve a competitive advantage.
- SWOT's focus on the external environment is too narrow. Analysts may fail to identify changes in the industry, suppliers, etc.
- SWOT analysis only gives a picture of a moving target.

As a conclusion, it is important to say that SWOT analysis is a very important tool to start a strategic analysis, but it does not help developing competitive advantages that can be sustained over time.

2.1.4 – The team's goals

A hierarchy of goals exists in every team or organization. This hierarchy includes its vision, mission, and strategic objectives.

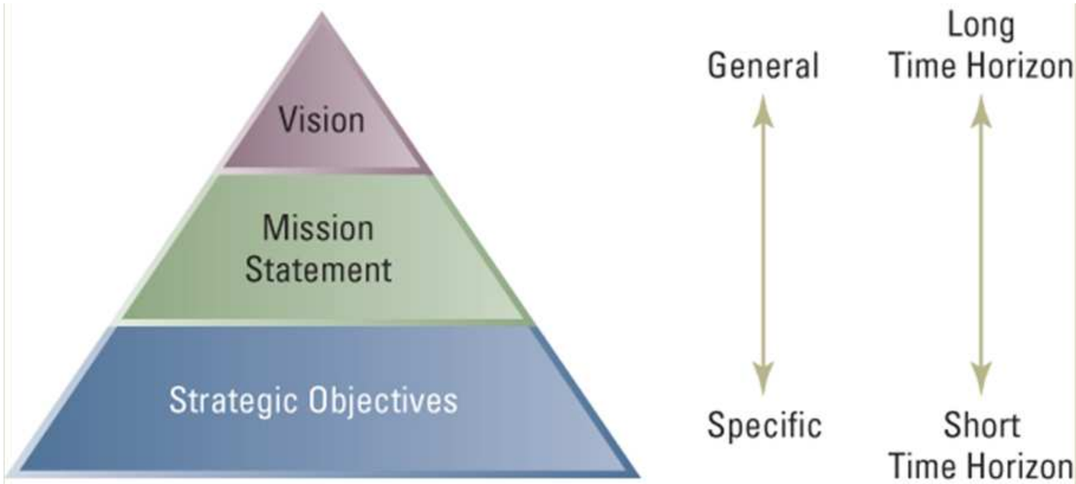


Figure 2.5: Hierarchy of Goals

2.1.4.1 – The team's vision

The vision must be an organizational or team goal that evokes powerful and compelling mental images. It must be massively inspiring, overarching and long term. As a team leader, having only a vision is not enough. A plan to implement it is also needed in order to succeed.

"Our vision is to take the SDSU Baja SAE team to the very top of the Baja SAE competitions". Even though this may not sound realistic when the SDSU Baja SAE team has competed in just two previous, non consecutive, events, it definitely creates a powerful image and evokes a sense of competitiveness within the team members. It may seem a little vague as it doesn't really say when this vision will be fulfilled; however, it may be beneficial to have a long term vision that can be used over the years. In the case of the SDSU Baja SAE team, the objective of the team is very precise, win every year the competition. Thus, even though the vision must be more general, it still needs to be narrow enough. A general vision is more helpful for diversified companies that compete in more than one industry.

2.1.4.2 – The team’s mission statement

Together with the vision, the team must also identify their mission statement. A team’s mission statement differs from its vision in that it provides both the purpose of the team, its scope of operations, and the basis of its competitive advantage.

“The SDSU Baja SAE team is committed to improve their Baja designs and performance by building on the legacy of previous years’ experience, climbing to the very top of the competition positions every year”. This statement is far more specific than the vision, and it provides both the purpose of the team, score high in the Baja SAE competitions, as well as the basis of its competitive advantage, improving previous years’ models.

2.1.4.3 – The team’s strategic objectives

The last step is to define the strategic objectives which must have certain characteristics. They must be:

- Measurable: there must be at least one indicator that measures progress fulfilling the objective
- Specific: providing a clear message of what needs to be accomplished
- Appropriate: must be consistent with the mission and the vision of the team
- Realistic: must be an achievable target given the organization’s capabilities and opportunities in the environment
- Timely: there needs to be a time frame for accomplishing the objective

When strategic objectives follow the above criteria, they help channel team members toward common goals. This helps the team concentrate and conserve valuable resources and work collectively in a more timely manner

Challenging objectives can help motivate and inspire team members throughout the team to higher levels of commitment and effort. Individuals work harder when they are striving toward specific goals instead of being asked simply to do their best. There is always the potential for different parts of an organization to pursue their own goals rather than overall team goals. Thus, meaningful objectives help to resolve conflicts when they arise. They also provide a yardstick for rewards and incentives.

Having determined the characteristics these goals must have, the SDSU Baja SAE strategic objectives will be now presented:

- Objective 1: to comply with the rules and regulations stated in the 2011 Baja SAE Rules.
- Objective 2: to obtain enough financial resources to make the necessary investments while maintaining a healthy cash-flow.
- Objective 3: work as a company and feel proud of being part of it.
- Objective 4: differentiate both in efficiency and efficacy from the competitors.
- Objective 5: finish all the 2011 Baja SAE events within the top 20 teams.
- Objective 6: make sure the younger students from SDSU continue with the SDSU Baja SAE team tradition the following year.

All the objectives meet the requirements established in terms of specificity, measurability, etc.

2.2 – Strategic formulation

To achieve the above mentioned strategic objectives, the following strategies have been formulated:

Objective 1: to comply with the rules and regulations stated in the 2011 Baja SAE Rules.

- Raise the team member's awareness about the importance of totally understanding the rules and regulations of the competition.
- Master the 2011 Baja SAE Rules.
- Design and build the vehicle according to the rules' restrictions and the customer's needs

Objective 2: to obtain enough financial resources to make the necessary investments while maintaining a healthy cash-flow.

- Achieve support from the university
- Look for potential industry related businesses who might be interested in sponsoring the project.
- Allocate wisely the funds and control the costs.

Objective 3: work as a company and feel proud of being part of it.

- Structure the tasks for each team member.
- Foster a good working environment.
- Promote a fluent communication among the team members and with other project stakeholders.

Objective 4: differentiate both in efficiency and efficacy from the competitors.

- Create a detailed project plan and outline.
- Meet all the deadlines.

Objective 5: finish all the 2011 Baja SAE events within the top 20 teams.

- Build a fast and strong car.
- Design learning from last year team's caveats.

Objective 6: make sure the younger students from SDSU continue with the SDSU Baja SAE team tradition the following year.

- Start a SDSU Baja SAE Club where younger students can commit with the project at an early stage and ensure continuity.
- Promote the new club.

2.3 – Strategic implementation

Each of the strategies mentioned will be transformed into action plans:

Objective 1: to comply with the rules and regulations stated in the 2011 Baja SAE Rules.

- Raise the team member's awareness about the importance of totally understanding the rules and regulations of the competition.
    - Distribute the 2011 Baja SAE Rules among the team members
    - Look for examples where universities had been disqualified for not complying with the rules

- Master the 2011 Baja SAE Rules.
    - Study the rules individually before having group meeting to

discuss with the other group members.

- Discuss for clarification with last year's team members.
- If doubts still arise, write an email to the Baja SAE Rules Committee.

- Design and build the vehicle according to the rules' restrictions, the customer's needs, and the expected budget.
    - Identify which rules influence each member's subsystem and have a profound knowledge of them.
    - Allocate a budget to each of the vehicle's subsystems.
    - Optimize the resources analyzing in each situation whether it is more convenient to fabricate or to buy the part.

Objective 2: to obtain enough financial resources to make the necessary investments while maintaining a healthy cash-flow.

- Achieve support from the university
    - Invite both the Dean of the Engineering Department and the Head of the Mechanical Engineering Department to the machine shop once the vehicle is at an advance stage of construction.
    - Create a detailed sponsorship package for the university explaining how they could help the project and show it to them.
    - Bring some support messages from the industry to exert more pressure on the school.

- Look for potential industry related businesses who might be interested in sponsoring the project.
    - Analyze the market to identify potential sponsors from the off-road competition industry.

- Create a tailored sponsorship package for each of the potential sponsors explaining how they could contribute to the project.
- Visit first those sponsor who are more determined to contribute (to encourage those who are less determined by showing them a list of the sponsor companies to date).
- Look for ways to advertize the project both in the university and other publications.

- Allocate wisely the funds and control the costs.
    - Create separate budgets for each of the subsystems and allocate initial funds accordingly.

Objective 3: work as a company and feel proud of being part of it.

- Structure the tasks for each team member.
    - Divide the project into the different subsystems that compose it.
    - Allocate each of the subsystems to one or several team members according to their skills and background.
    - Balance the workload of each team member.

- Foster a good working environment.
    - Organize team building activities outside the project's scope.
    - Encourage both flexibility and respect among team members.

- Promote a fluent communication among the team members and with other project stakeholders.
    - Organize periodical team meetings to follow the project's progress.

- Organize punctual meetings with sponsors to give updates of the project's progress.
- Create a "Google" group to speed up communication among team members and share common documents.
- Create a team's web page.

Objective 4: differentiate both in efficiency and efficacy from the competitors.

- Create a detailed project plan and outline
    - Study of the sequence of tasks that need to be accomplished.
    - Design a Gantt chart to limit and control the time spent in each of the tasks and minimize the gaps between tasks.

- Meet all the deadlines.
    - Estimate the length of each of the tasks that compose the project.
    - Design concrete action plans that are obtainable and with a distributed working load among the team members.

Objective 5: finish all the 2011 Baja SAE events within the top 20 teams.

- Build a strong, fast car.
    - Prioritize strength vs. speed.
    - Design according to the race track's characteristics.
    - Design for a high torque on the lower gear end.

- Design learning from last year team's caveats.
    - Include a differential slip.
    - Shorten the wheel base length.

- Improve torque on the low gear ratio.

Objective 6: make sure the younger students from SDSU continue with the SDSU Baja SAE team tradition the following year.

- Start a SDSU Baja SAE Club. where younger students can commit with the project at an early stage and ensure continuity.
    - Talk to the Mechanical Engineering Department.
    - Create an independent club or a club under the already existing SAE Club.
    - Evaluate pros and cons of each option.

- Promote the new club.
    - Visit junior classrooms and encourage young students to join the club.
    - Create an action plan for the events where the team can attend at the beginning of Fall 2011 Semester.

3

Cost analysis

3 – Cost analysis

The objective of the cost report is to report the cost value (suggested retail price) of the items selected to build the car. The objective is not to report the cheapest price that an item can be purchased. For example, if two schools are using the same CVT they both should be reporting the same price, even though they might have purchased them for different prices, since both schools get the same value from the CVT.

The cost report should serve as two functions, (1) a bill of materials for the car, and (2) it should help equalize teams that choose to use items of high value with teams that use items of low value.

In industry it is very important to look at the design and performance, as well as cost. Cost is the key driving force to many design decisions. If shocks are selected that cost $4000, the team should understand it will lose points in cost, but it might improve the score in the dynamic events.

The cost report consists of a three level bill of materials with standardized summaries in the 13 major cost areas. The three levels consist of:

- Level 1 is the “Summary Cost” worksheet. This worksheet gives the jury a general idea of the costs of all the subsystems of the car and the total cost of the car.
- Level 2 is the group of 13 Form “A” worksheets. These worksheets are meant to include the costs of all the elements purchased to build the car (Material cost) and the costs of transforming or handling those elements (Labor cost) in order to make the car.
- Level 3 is the group of 13 Form “B” worksheets. These worksheets are meant to include only the costs of transforming or handling the elements included in the Forms A to actually make the car. These costs will be included in the

Forms A under the Labor cost label.

The cost report included in this project gives just a first picture of the actual cost of the car. This is due to timing issues. There is an initial cost report due on April 4th 2011, which is the one included in this project. There is a second cost report which also includes all the costs incurred from April 4th to May 26th, the day the competition starts. However, those numbers have not been included in the cost report presented below.

A cost guide is provided by the organizers where the elements that are usually needed to build such a vehicle are organized into categories, the 13 categories that have been mentioned above. The 13 categories and its components are:

- Engine: Engine, Choke, Accelerator, Pedal Cables, Fuel Tank, Splash shields, Spill prevention.
- Transmission: Gearbox, Hydraulic Clutches, Torque Conv., Shift Mechanisms
- Drive Train: Belts, Gears, Chains, Drive Shafts, Bearings, Sprockets, Axles, Chain guards.
- Steering: Steering Wheel, Bearings, Shafts, Gears, Tie Rods, Bushings.
- Suspension: A Arms, Spindles, Shock, Rod Ends, Ball Joints.
- Frame: Structural Members, Roll Cage, Mounts, Firewall, Seat.
- Body: Outer Covering, Fenders, Skid Plates.
- Brakes: Mech/Hyd. Components, Pedals, Lines, Fittings, Fluid.
- Safety Equipment: Guards, Padding, Fire Extinguisher, Safety Harness.
- Electrical: Kill Switch, Battery, Cables, Wiring, Lights.
- Fasteners: Nuts, Bolts, Rivets, Zip Ties.
- Miscellaneous: Transponder, Paint, Trim.
- Event: Tires/Rims, Flotation, and any other items that will be used at the event only.

There are also two tables provided by the organizers of the event to standardize the cost of both materials and labor that are included in the car. That way all teams will be using similar prices for the materials used as well as for the processes used to transform those materials into the final product.

Material Cost Table			Density
Mild Steel, e.g. 1010, 1025	$ 1,00	/lb	0.284 lb/in³
Alloy Steel, e.g. 4130, ChroMoly	$ 2,00	/lb	0.284 lb/in³
Aluminum	$ 5,00	/lb	0.0975 lb/in³
Mag	$ 9,00	/lb	0.0648 lb/in³
Non-graphite composites	$ 40,00	/lb	-
Graphite-based composites	$ 100,00	/lb	-
Lexan	$ 15,00	/lb	0.043 lb/in³
Brass	$ 10,00	/lb	0.316 lb/in³
Copper	$ 10,00	/lb	0.324 lb/in³
Kevlar	$ 50,00	/lb	0.0524 lb/in³
Plastic	provide cost documentation from mcmastercarr		
Fiberglass	provide cost documentation from mcmastercarr		

Table 3.1: Material costs

Operations Cost Table		
Labor (all other activities)	$ 35,00	/hour
CNC Machine (time)	$ 70,00	/hour
Computer-aided labor (water jet cutting, etc)	$ 70,00	/hour
Welds	$ 0,35	/in
Saw/Tube Cuts	$ 0,40	/in
Tube Bends	$ 0,75	/bend
Non-metallic cutting	$ 0,20	/in
Radiusing tube ends	$ 0,75	/end
Drilled holes	$ 0,35	/hole
Reemed hole	$ 0,35	/hole
Tapping holes	$ 0,35	/hole
Sheet Metal Shearing	$ 0,20	/cut
Sheet Metal Punching	$ 0,20	/hole
Sheet Metal Bends	$ 0,05	/bend
Sheet metal stampings (process cost only)	$ 0,05	/sq in
Sand castings (process cost only)	$ 3,00	/lb
Die castings (process cost only)	$ 4,00	/lb
Investment Castings (process cost only)	$ 8,00	/lb
Thermal forming (process cost only)	$ 4,00	/lb
Plastic Injection (process cost only)	$ 2,75	/lb

Table 3.2: Operation costs

3.1 – Summary cost

As the Table 3.3 shows, the total cost of the car, up to April 4th 2011, summed a total of $7,024.69. Some important and costly elements such as the tires that were purchased for the race are not included in this analysis. Nor are the costs associated to the travel to the competition site.

Table 3.3 Summary costs

Sect #	Item	Description	Subassembly Costs		Vehicle Assembly Labor		Subtotal		Cost Adj. Form	Adjustment	Judges
			Material	Labor	Time(min)	Cost	Material	Labor			Adjusted Cost
1	Engine		$513,95	$8,75	30	$17,50	$513,95	$26,25			$540,20
2	Transmission		$267,83	$0,00	10	$5,83	$267,83	$5,83			$273,66
3	Drive Train		$1.200,00	$0,00	45	$26,25	$1.200,00	$26,25			$1.226,25
4	Steering		$703,46	$14,99	60	$35,00	$703,46	$49,99			$753,45
5	Suspension		$1.739,66	$95,26	90	$52,50	$1.739,66	$147,76			$1.887,42
6	Frame		$331,22	$603,48			$331,22	$603,48			$934,70
7	Body		$0,00	$0,00		$0,00	$0,00	$0,00			$0,00
8	Brakes		$816,27	$0,00	60	$35,00	$816,27	$35,00			$851,27
9	Safety Equipment		$129,52	$0,00	30	$17,50	$129,52	$17,50			$147,02
10	Electrical Equipment		$0,00	$0,00		$0,00	$0,00	$0,00			$0,00
11	Fasteners		$149,97			$0,00	$149,97	$0,00			$149,97
12	Miscellaneous		$252,00	$0,00	15	$8,75	$252,00	$8,75			$260,75
13	BIR Event		$0,00	$0,00		$0,00	$0,00	$0,00			$0,00
14	KAN Event		$0,00	$0,00		$0,00	$0,00	$0,00			$0,00
15	ILL Event		$0,00	$0,00		$0,00	$0,00	$0,00			$0,00
		BIR Total:	$ 6.103,88	$ 722,48		$ 198,33	$ 6.103,88	$ 920,81			$7.024,69
		KAN Total:	$ 6.103,88	$ 722,48		$ 198,33	$ 6.103,88	$ 920,81			$7.024,69
		ILL Total:	$ 6.103,88	$ 722,48		$ 198,33	$ 6.103,88	$ 920,81			$7.024,69

3.2 – Costs of each subsystem

These are all the Forms A for the different subsystems. Note that not all the subsystems had been purchased by April 4th so just the ones that had some items will be included here. It is also important to mention that the Forms B are just meant to compute the cost of manufacturing processes that are included in Forms A as Labor cost, so they will not be included here.

- Engine

Engine Subsystem Form A

Item	Category	Description	Purchased	Fabricated	Vendor	Quantity	Material Cost	Labor Cost	Extended Material Cost	Extended Labor Cost	Extended Total
1	Engine		X		Briggs & Stratton	1			$0,00	$0,00	$0,00
2	Engine		X		Briggs & Stratton	1	$450,00		$450,00	$0,00	$450,00
3	Throttle Cable		X		Home Depot	1	$2,00		$2,00	$0,00	$2,00
4	Throttle Pedal	CNC Side Foot Rest	X		Race Ready	1	$38,00		$38,00	$0,00	$38,00
5	Other	Throttle Cable Cover	X		Summit Racing	1	$23,95		$23,95	$0,00	$23,95
		Subsystem Assembly Time (min)	15		Subsystem Assy Cost					$8,75	$8,75
		Totals							$513,95	$8,75	$513,95
									Total:		$522,70

Table 3.4: Engine costs

- Transmission

Transmission Subsystem Form A

Item	Category	Description	Purchased	Fabricated	Vendor	Quantity	Material Cost	Labor Cost	Extended Material Cost	Extended Labor Cost	Extended Total
1	Other	Dual Pulley CVT	X		CVTech	1	$236,11		$236,11	$0,00	$236,11
2	CVT belt		X		CVTech	2	$15,86		$31,72	$0,00	$31,72
		Subsystem Assembly Time (min)	0		Subsystem Assy Cost					$0,00	$0,00
		Totals							$267,83	$0,00	$267,83
									Total:		$267,83

Table 3.5: Transmission costs

- Drive train

Drive Subsystem Form A

Item	Category	Description	Purchased	Fabricated	Vendor	Quantity	Material Cost	Labor Cost	Extended Material Cost	Extended Labor Cost	Extended Total
1	Axle	LSD Transaxle FNR	X		Dana-Spicer	1	$1.200,00		$1.200,00	$0,00	$1.200,00
		Subsystem Assembly Time (min)	0		Subsystem Assy Cost					$0,00	$0,00
		Totals							$1.200,00	$0,00	1.200,00
									Total:		1.200,00

Table 3.6: Drive train costs

- Steering

Steering Subsystem Form A

Item	Category	Description	Purchased	Fabricated	Vendor	Quantity	Material Cost	Labor Cost	Extended Material Cost	Extended Labor Cost	Extended Total
1	Steering Wheel	Grant/12 1/2 in. dia.	X		Auto-Zone	1	$36,99		$36,99	$0,00	$36,99
2	Shafts	Splined Shaft	X		Fiber Tech	1	$11,70		$11,70	$0,00	$11,70
3	Shafts	Steering Shaft		X		1	$1,62	$4,29	$1,62	$4,29	$5,91
4	U-Joint	Spline Slip U-Joint	X		Fiber Tech	2	$35,39		$70,78	$0,00	$70,78
5	Rack & Pinion	11" Rack and Pinion	X		DesertKarts	1	$103,79		$103,79	$0,00	$103,79
6	Spindles	Front Spindles		X		2	$72,40		$144,80	$0,00	$144,80
7	Tie Rods	Tie Rods		X		2	$5,50	$4,25	$11,00	$8,50	$19,50
8	Ball Joints	1/2" Heim RHT	X		Summit Racing	2	$11,95		$23,90	$0,00	$23,90
9	Ball Joints	1/2" Heim LHT	X		Summit Racing	2	$11,95		$23,90	$0,00	$23,90
10	Bushings	1/2-3/8 misalign spacers	X		Ballistic Fabrication	4	$6,99		$27,96	$0,00	$27,96
11	Bushings	Urathane steering shaft bushin	X		Off Road Warehouse	2	$2,99		$5,98	$0,00	$5,98
12	Other	Aluminum Retaining Rings		X		2	$0,52	$1,10	$1,04	$2,20	$3,24
13	Spindles	Rear Spindles		X		2	$120,00		$240,00	$0,00	$240,00
		Subsystem Assembly Time (min)	0		Subsystem Assy Cost					$0,00	$0,00
		Totals							$703,46	$14,99	$718,45
									Total:		$718,45

Table 3.7: Steering costs

- Suspension

Suspension Subsystem Form A

Item	Category	Description	Purchased	Fabricated	Vendor	Quantity	Material Cost	Labor Cost	Extended Material Cost	Extended Labor Cost	Extended Total
1	A-arm	Front Upper Arm		X		2	$21,70	$12,54	$43,40	$25,08	$68,48
2	A-arm	Front Lower Arm		X		2	$18,97	$8,55	$37,94	$17,10	$55,04
3	Rod Ends	5/8" Heims	X		Summit Racing	12	$11,95		$143,40	$0,00	$143,40
4	Bushings	Heim Spacers	X		Fibre Tech	20	$4,75		$95,00	$0,00	$95,00
5	Bushings	High Misalignment Spacers	X		Ballistic Fabrication	8	$7,99		$63,92	$0,00	$63,92
6	Shock	Walker Evans Shocks	X		Walker Evans	4	$310,00		$1.240,00	$0,00	1.240,00
7	A-arm	Rear Upper Arm		X		2	$33,00	$14,00	$66,00	$28,00	$94,00
8	A-arm	Rear Lower Arm		X		2	$25,00	$12,54	$50,00	$25,08	$75,08

Subsystem Assembly Time (min)	0	Subsystem Assy Cost		$0,00	$0,00
Totals			$1.739,66	$95,26	1.834,92
			Total:		1.834,92

Table 3.8: Suspension costs

- Frame

Frame Subsystem Form A

Item	Category	Description	Purchased	Fabricated	Vendor	Quantity	Material Cost	Labor Cost	Extended Material Cost	Extended Labor Cost	Extended Total
1	Complete Roll Cage			X		1	$136,72	$230,15	$136,72	$230,15	$366,87
2	Suspension mounts	Front Suspension Mounts		X		1	$3,01	$80,40	$3,01	$80,40	$83,41
3	Suspension mounts	Rear Suspension Mounts		X		1	$4,15	$80,85	$4,15	$80,85	$85,00
4	Seat Mounts	Seat Mount		X		1	$3,49	$26,30	$3,49	$26,30	$29,79
5	Brake mounts	Pedal Assembly Mount		X		1	$1,36	$13,95	$1,36	$13,95	$15,31
6	Misc. mounts	Skid Plate Mounts		X		1	$2,39	$18,35	$2,39	$18,35	$20,74
7	Transmission mounts	Engine Mount		X		1	$7,21	$29,05	$7,21	$29,05	$36,26
8	Transmission mounts	Pillow Bearing and Front Center Hub		X		1	$5,82	$36,93	$5,82	$36,93	$42,75
9	Seat	Fiberglass seat	X		Fiber Tech	1	$122,78		$122,78	$0,00	$122,78
10	Transmission mounts	Transaxle Mounting Bracket		X	Pro Comp	1	$44,29	$35,00	$44,29	$35,00	$79,29

Subsystem Assembly Time (min)	90	Subsystem Assy Cost		$52,50	$52,50
Totals			$331,22	$603,48	$882,20
			Total:		$934,70

Table 3.9: Frame costs

- Brakes

Brakes Subsystem Form A

Item	Category	Description	Purchased	Fabricated	Vendor	Quantity	Material Cost	Labor Cost	Extended Material Cost	Extended Labor Cost	Extended Total
1	Other	Caliper Mount Bolt Honda PN:	X		Veys Powersports	2	$2,53		$5,06	$0,00	$5,06
2	Brake Pads	Front Pad Set PN: FA84X	X		Veys Powersports	2	$28,39		$56,78	$0,00	$56,78
3	Other	Honda 400-EX Front Assembly	X		GDH Racing	1	$192,14		$192,14	$0,00	$192,14
4	Brake Pads	Rear Honda PN: 06435-HP6-A(	X		Veys Powersports	1	$40,95		$40,95	$0,00	$40,95
5	Brake Calipers	Rear Assembly Honda PN: 431	X		Veys Powersports	1	$196,18		$196,18	$0,00	$196,18
6	Other	Front Disk Bolts Honda PN: 90	X		Babbitts Sports Center	6	$3,99		$23,94	$0,00	$23,94
7	Brake Pedal	Assembly CNC PN: Series 204	X		Hawkins Speed Shop	1	$116,99		$116,99	$0,00	$116,99
8	Brake Lines	60" US Line PN:360	X		Fiber Tech	3	$7,39		$22,17	$0,00	$22,17
9	Brake Lines	30" Straight #3 PN:3130	X		Fiber Tech	2	$14,92		$29,84	$0,00	$29,84
10	Brake Lines	9" -03 Hose PN:3109	X		Fiber Tech	1	$10,00		$10,00	$0,00	$10,00
11	Other	Brake Light Switch PN:881	X		Fiber Tech	1	$14,99		$14,99	$0,00	$14,99
12	Brake Fittings	3/16 Union T PN:130333	X		Fiber Tech	1	$3,98		$3,98	$0,00	$3,98
13	Brake Fittings	3/16x1/8 Elbow PN:122320	X		Fiber Tech	2	$2,80		$5,60	$0,00	$5,60
14	Brake Fittings	3/16x3/16 Nut PN:121003	X		Fiber Tech	4	$0,88		$3,52	$0,00	$3,52
15	Brake Fittings	(-3) to 3/16 Fitting PN:7236	X		Fiber Tech	3	$4,95		$14,85	$0,00	$14,85
16	Brake Fittings	(-03) 3/8 Banjo PN:997603	X		Fiber Tech	3	$6,49		$19,47	$0,00	$19,47
17	Other	10MMx1.25 PN:9920332	X		Fiber Tech	1	$3,00		$3,00	$0,00	$3,00
18	Other	Brake Clip PN:W72	X		Fiber Tech	2	$1,60		$3,20	$0,00	$3,20
19	Other	Long Brake Li PN:04-114A	X		Fiber Tech	3	$1,17		$3,51	$0,00	$3,51
20	Brake Rotor	Rear Honda PN: 43251-HP6-A(	X		Veys Powersports	1	$39,00		$39,00	$0,00	$39,00
21	Other	Rear Disk Bolt Honda PN:9011	X		Veys Powersports	5	$2,22		$11,10	$0,00	$11,10

Subsystem Assembly Time (min)	0	Subsystem Assy Cost		$0,00	$0,00
Totals			$816,27	$0,00	$816,27
			Total:		$816,27

Table 3.10: Brakes costs

- Safety equipment

Safety Equipment Subsystem Form A

Item	Category	Description	Purchased	Fabricated	Vendor	Quantity	Material Cost	Labor Cost	Extended Material Cost	Extended Labor Cost	Extended Total
1	Seat Belts	5 point, latch seat belts	X		Crow Enterprizes	1	$95,94		$95,94	$0,00	$95,94
2	Other	Arm Restraints	X		Crow Enterprizes	1	$33,58		$33,58	$0,00	$33,58

Subsystem Assembly Time (min)	0	Subsystem Assy Cost		$0,00	$0,00
Totals			$129,52	$0,00	$129,52
			Total:		$129,52

Table 3.11: Safety equipment costs

- Fasteners

Fasteners Subsystem Form A

Item	Category	Description	Purchased	Fabricated	Vendor	Quantity	Material Cost	Labor Cost	Extended Material Cost	Extended Labor Cost	Extended Total
1	Bolts	3/8 X 2 grade 8 (pack of 25)	X			1	$7,79		$7,79	$0,00	$7,79
2	Bolts	3/8 X 2.5 grade 8 pack of 5	X			1	$6,95		$6,95	$0,00	$6,95
3	Bolts	3/8 X3 Grade 8	X			6	$1,19		$7,14	$0,00	$7,14
4	Bolts	3/8 X4 Grade 8	X			6	$1,49		$8,94	$0,00	$8,94
5	Washers	3/8 (box of 100)	X			1	$5,77		$5,77	$0,00	$5,77
6	Nuts	3/8 nylock (pack of 20)	X			4	$3,06		$12,24	$0,00	$12,24
7	Bolts	1/2 X 3 Grade 8	X			8	$1,35		$10,80	$0,00	$10,80
8	Bolts	1/2 X 8 Grade 8	X			2	$2,49		$4,98	$0,00	$4,98
9	Washers	1/2 inch (Pack of 25)	X			1	$4,98		$4,98	$0,00	$4,98
10	Nuts	1/2 nylock (pack of 10)	X			1	$3,28		$3,28	$0,00	$3,28
11	Bolts	7/16 X 2.5	X			2	$1,19		$2,38	$0,00	$2,38
12	Bolts	7/16 X1	X			2	$0,98		$1,96	$0,00	$1,96
13	Washers	7/16 inch	X			6	$0,19		$1,14	$0,00	$1,14
14	Nuts	7/16 nylock	X			2	$0,30		$0,60	$0,00	$0,60
15	Bolts	1/4 X 1/2 grade 8 box of (100)	X			1	$8,00		$8,00	$0,00	$8,00
16	Bolts	1/4 X 1 grade 8 (box of 100)	X			1	$9,63		$9,63	$0,00	$9,63
17	Nuts	1/4 Mechanical lock (box of 25)	X			5	$3,28		$16,40	$0,00	$16,40
18	Washers	1/4 inch box of 100	X			2	$4,30		$8,60	$0,00	$8,60
19	Bolts	# 10 X 1/2 (Pack of 10)	X			2	$1,49		$2,98	$0,00	$2,98
20	Washers	#10 (pack of 25)	X			2	$1,49		$2,98	$0,00	$2,98
21	Nuts	#10 nylock (pack of 10)	X			2	$1,49		$2,98	$0,00	$2,98
22	Zip Ties	Zip ties	X			1	$5,99		$5,99	$0,00	$5,99
23	Safety Wire	1 spool	X			1	$3,99		$3,99	$0,00	$3,99
24	Cotter pin	pack of 4	X			2	$0,35		$0,70	$0,00	$0,70
25	Snap ring	rear bearing carrier (pack of 1(	X			1	$8,77		$8,77	$0,00	$8,77
		Subsystem Assembly Time (min)	0		Subsystem Assy Cost					$0,00	$0,00
		Totals							$149,97	$0,00	$149,97
									Total:		$149,97

Table 3.12: Fasteners costs

- Miscellaneous

Miscellaneous Items Form A

Item	Category	Description	Purchased	Fabricated	Vendor	Quantity	Material Cost	Labor Cost	Extended Material Cost	Extended Labor Cost	Extended Total
1	Transponder		X		My Laps MX	1	$252,00		$252,00	$0,00	$252,00
		Subsystem Assembly Time (min)	0		Subsystem Assy Cost					$0,00	$0,00
		Totals							$252,00	$0,00	$252,00
									Total:		$252,00

Table 3.13: Miscellaneous costs

4

Marketing plan

4 – Marketing plan

4.1 – Marketing analysis

Assessing the potential market for new products is a key to every product success. As managers of a new product thorough analysis needs to be conducted in order to determine whether the product has the potential to turn the market around, or whether it will fail to attract customers due to market conditions. Thus, market analysis should be seen as an investment and not so much as an expense.

When facing the introduction of a new product to the market, managers have two options: introduce it or not. However, this decision involves many tradeoffs and risks. That is where market research and analysis adds important information and reduces considerably the potential risks of product failure.

Our market research will not be focused on whether the product will succeed or not (as the team will create the prototype no matter what), but on the needs of the customer which will be translated into technical specifications of the prototype to meet those needs.

The marketing analysis will also be focused on looking for potential project sponsors who might be able to finance part of the project.

Based on the strategic plan described previously, and taking into account the strengths and weaknesses of the project, as well as the opportunities and threats identified, a marketing plan will be designed in order to enhance the project strengths and the opportunities given by the market, as well as protect ourselves from the weaknesses and from the threats of the competitive environment.

4.1.1 – Identification of potential customers

The prototype will be designed and manufactured to compete against another 100 similar prototypes from which only one of them will be chosen by the jury of the competition to be produce at a large scale. The potential or target customers of these vehicles will be off-road recreation fans.

Due to this scheme, both the manufacturing company and the end user will have to be taken into account when designing and manufacturing the vehicle. The basic characteristics that the end customer is looking for in the vehicle are performance, safety, design and cost. However, to these characteristics, it also needs to be added the standardization of the different manufacturing processes involved in the project which will make it more attractive to the fictitious manufacturing company.

Below is a table with the needs of the end customers and the technical interpretation of it:

Customer Statement	**Interpreted need**
I want a nice car	The vehicle is esthetically pleasant
I want an efficient vehicle	Performance of the vehicle is optimum
I want the vehicle not to break	The vehicle is reliable
I would like to fix the vehicle on my own	The vehicle is easy to maintain
I want the car to meet the SAE specifications	The vehicle has a maximum width of 64 in and length of 108 in
I want my vehicle to be versatile	The vehicle can operate over rough terrain
I want my vehicle to pass over any kind of obstacle	The vehicle has ground clearance sufficient to clear obstacles

I want a reliable engine	The vehicle has a proven 10 hp Briggs & Stratton gas engine
I don't want my vehicle to spin its tires on gravel or sand	The vehicle has traction to navigate through rough terrain
I want to be able to tow my vehicle	The vehicle has safe hitch points both on the front and rear
My vehicle should be able to stand punishment	The vehicle is rugged
I want to be safe if the vehicle flips over	Roll cage adequately protects the driver
I don't want the frame to break	Frame is made of strong material
I want to be able to switch my vehicle off in case of an emergency	Vehicle has two kill switches at locations accessible to driver and pit crew
I want to be harnessed safely to the vehicle	Vehicle is equipped with proper five strap system harness
I want to be able to stop	Vehicle has hydraulic breaks that can lock all four wheels
I want my hands and feet to be safe around belts and tight spaces	Vehicle has appropriate panels and guards
I want a vehicle that takes off fast	Vehicle has good acceleration
I want to be able to pull objects with my vehicle	Vehicle has good torque for pulling
I want to be able to control my vehicle under every situation	Vehicle is maneuverable
I am too tall for a normal Baja car	Vehicle fits a wide range of people
I don't want to feel the high engine temperature when I'm driving	Vehicle has a heat shield between the driver and the engine

I don't want to be changing gear all the time	The vehicle has a Continuously Variable Transmission (CVT)

Table 4.1: Customer needs and technical interpretation

4.2 – Marketing plan

4.2.1 – The Marketing Mix and 4 Ps

Marketing is often defined as "*putting the right product in the right place, at the right price, at the right time*". This means that the product has to meet the potential customers' needs, be sold where they are going to see it, when they want to buy it at a price that is balanced with the value they are going to get from it. However, all these Ps need to succeed. If any of those elements fails, then the whole product can fail. This model was first expressed by E J McCarthy in 1960.

The Four Ps are:

- Product
- Place
- Price
- Promotion

To address each of these variables, it is easier to answer a set of questions standard questions:

4.2.1.1 – Product

- What does the customer want from the product? What needs does it satisfy?

What features does it have to meet these needs? The answers to these questions can be found above in the customer statements and interpreted needs table.

- How and where will the customer use it? The customer will use the product as a way to disconnect with daily life and taking it to off-road sites where it is best to be used.
- What does it look like? How will consumers experience it? The design must be attractive, with a competition-like decoration. Not only the visual effects but also its sound effects are important to the user. The customer will have the experience of running a vehicle with the engine closely situated to the driver's seat, enhancing the competition experience with the sound of the engine.
- What size, colors, and so on should it be? The size must be within the limits of the competition requirements (64 in wide, 108 in long) while the color can be chosen by the team. The size is slightly smaller than the maximum width (62 in) while the length was quite shorter (around 90 in). The car is designed to accommodate comfortably a wide range of different customer sizes. A combination of two colors (chassis and body panels) is recommended, being black the most used color for the chassis as it can dissimulate imperfections on the welds. A combination of colors that evoke the represented university's colors is also advisable.
- What is it to be called? The name of the prototype must be similar in structure to other names given to race cars in different competitions. It must also allow for continuity for next models to be named in similar forms. The prototype was named AOR-02.
- How is it branded? The vehicle is to be branded as an off-road recreational vehicle, easy to handle and for a diverse public. Both safe and fun to take out for a ride with friends or family.
- How is it differentiated versus your competitors? The car has been designed to stand very tough terrain conditions. Thus, a big emphasis has been made to make it strong. This, however, has influenced the weight of the vehicle,

making it more robust than the competitors', but with the correct gear ratio and continuously variable transmission the vehicle still gets very good torque on the lower gears and is designed to run at a maximum speed of around 40 mph, which adequate for the types of terrain it is supposed to run on.

4.2.1.2 – Place

- Where do buyers look for your product? Buyers will look for the product on off-road magazines, off-road recreational shops and probably through the internet in specialized web sites. However, the most direct customer is the fictitious company that is going to chose among the 100 prototypes, which will all be done on the site of the competition.
- If they look in a store, what kind? A specialist boutique or in a supermarket, or both? As said above, end customers would most likely look for the product either in a catalog or in a special off-road shop. However, more and more customers are likely to make initial an initial search and product comparison over the internet, so an online presence is a must these days.
- How can the right distribution channels be accessed? This is not a concern for the team as it is not the objective to actually manufacture more units of the prototype. However, the most convenient way to distribute the product to the end consumer would probably be through local off-road retail shops.

The main objective of the SDSU Baja Team is to impress the jury of the competition. Thus, many other sales concerns such as whether to attend trade fairs or create online submissions to sell the product are irrelevant at this point of the project.

4.2.1.3 – Price

- What is the value of the product to the buyer? As the cost analysis shows, the approximate cost of manufacturing the prototype is around $7,000. This is an expensive price if it is compared to other off-road leisure vehicles that are available in the market. However, this price reflects the cost for building the prototype, which is always higher than the one of manufacturing the product due to the experience curve and other economies of scale.

- It is also important to determine whether the customer is price sensitive. Will a small decrease in price increase market share? Or will a small increase in the price be imperceptible by the customer and thus give the manufacturer a higher margin? Although the fictitious manufacturer will be quite price sensitive, the end user will not be very price sensitive, as this recreation is an expensive hobby, and the buyer needs to account for expensive products, maintenance, and related services.
- Special offers can be made in order to encourage or stimulate potential customers to buy the product. Related services such as insurance or maintenance services can be offered as a package with the product.
- Even though the price is in the average of the competition prices (other Baja SAE vehicles), these are quite overpriced compared to other similar off-road vehicles that can be found in the market such as the Polaris Ranger RZR 800 (which is at a retail price of around $12,000 but has a much better engine of 53 hp and seats 2 people).

4.2.1.4 – Promotion

Here is where the team has more room to differentiate from its competitors, as most of the characteristics from product, place and promotion are restricted by the competition and its rules. Promotion will be the “P” where teams differentiate the most from each other.

- Where and when can the team get across its marketing messages to the target market? During the past few years, communication channels have developed enormously to the point that they reach almost everyone in the developed world at all times. This means an incredible advantage for the promotion of the product, as it is much easier and precise to reach potential customers than it was ten years ago. The internet brings forward a huge number of promotion possibilities such as advertising in off-road specialized blogs, clubs' websites, etc.

- Will the team reach their audience by advertising in the press, or on TV, or radio, or on billboards? Through PR? On the Internet? The purpose of the team was to promote the project during the fall semester of 2010 while the design of the car was being conducted. The objective of the promotion was to inform possible sponsors about the project and explain in which ways they could help. Due to the simplicity of the project, and the lack of local competition that could be going for the same sponsors, the promotion method was quite simple and straight-forward. Even though a few posters where place on the Mechanical Engineering Department's billboards, most of the promotion packages, or sponsorship packages, were delivered in person to the potential sponsor, following a discussion about the project, its characteristics, financial needs, etc.
- A different but effective way to promote the project was by using the opportunities that San Diego State University offered its final year design projects to be presented to the public. This included the final presentations of both the design and the manufacturing processes of the projects (fall 2010 and spring 2011 semesters respectively) and other activities organized by the school where professionals and alumni from the school would visit the facilities and the projects in which the school was involved. This didn't only help the 2011 SDSU Baja SAE team but will hopefully help the next generations of teams.
- The timing of the promotions is also important. First, initial and motivated sponsors need to help shape the project, and once the project is midway, then other not so motivated sponsors are easier to convince, as they can see the progress that has been done and have a better idea where their money will be invested.

In one of the three national competitions (Illinois), there is one presentation event where the team members need to introduce their prototype to the jury. Not only the design is important in this event, but also the technical features, improvements over precious years' models, etc. It is important to note that the target audience here is the jury of the competition, and thus the management team of the fictitious company that would produce the winning vehicle at a large scale. This presentation only accounts for 5% of the total points given in the competition.

Most of the events in the competition are designed to reflect the real challenges many firms in the automotive industry face when launching a new product. The presentation event can be compared to preparing and training a skilled sales force in real life.

The cheapest and most effective way to promote the project in the local media will be through publicity, which is composed by every piece of information that appears in social media, not as a paid advertising, but as articles, critics, or comments of the project. The main difference between publicity and advertising is that the later one will almost always be paid. As the team's budget is too limited, there will be no option but to focus on publicity.

Even though most of the publicity the project will get will be through school and local papers' articles, the team will try that all the information presented gives a beneficial image of the team and its project. One of the objectives of the publicity is also to mention to the public the actual sponsors and their contributions, which is precisely what the team can offer them in exchange of their financing.

The main media for publicity will be both local newspapers and magazines.

- Local newspapers

  - Daily Aztec (San Diego State University daily newspaper)
  - Diario San Diego
  - El Latino
  - San Diego Business Journal
  - San Diego Globe
  - San Diego Reader
  - San Diego Union Tribune

- Off-road magazines

  - San Diego Off Road Magazine
  - Four Wheeler
  - Off-Road Adventures Magazines
  - Dirt Sports Magazine
  - Dusty Times

4.2.2 – Sponsorship

One of the objectives of this project (Objective 2) is to obtain enough financial resources to make the necessary investments while maintaining a healthy cash-flow. To that end, a marketing plan will be designed focusing on the attraction of potential investors and sponsors. Other teams from more prestigious universities receive 100% financing from their respective engineering departments. However, the engineering department from San Diego State University had a very limited budget and only provided the team $1,500 at the last stage of the project.

A previous analysis of last year's project sponsors will help identify many of the potential sponsors for the project. There will be two different types of sponsors.

The first type (Type A) will hopefully provide the team with enough cash to purchase most of the parts needed to complete the project. These companies do not need to be related anyhow to the off-road competition industry. Their main motivation to finance the project will be to support the San Diego State University projects.

The second type (Type B) of sponsoring company will be those who provide the team with parts or materials needed to complete the vehicle at a lower cost than the retail price or for free. These companies are usually related somehow to the off-road competition industry or the off-road leisure industry.

List of potential Type A sponsors:

- Jack in the Box (founder and CEO are SDSU Alumni)
- Rubio's Fresh Mexican Grill (founder is SDSU Alumni)
- Costco (founder and CEO is SDSU Alumni)
- The Corky McMillin Companies (CEO is SDSU Alumni and off-road passionate)

The type B sponsors will be organized into the different subsystems where they will be able to provide parts or materials. The companies approached were all local as the team needs to compete against other teams for sponsorships and it would be harder to compete for bigger, national sponsors.

- Chassis and body

  - Competitive Metals

- Industrial Metal Supply Co
- Sun Sheet Metal San Diego

• Drive train

  - Briggs & Stratton
  - Dana Holding Corporation
  - CVTech Group

• Suspension

  - FOX Racing Shox
  - Walker Evans Racing
  - Off Road Warehouse (ORW)

• Steering

  - Off Road Warehouse (ORW)

• Seat and Safety

  - MasterCraft Safety

All these companies can support the project providing parts and materials at a discount or even for free. If it had not been for the help and support of some of these companies, the end product would have cost a much higher price. Other local business related to the San Diego State University were also approached but were not interested in funding the project.

A sponsorship package was designed to inform potential sponsors about the project and ask them for support. The sponsorship package can be found on Annex A.

The different sponsorship levels were designed so as to accommodate all sponsors necessities. The most important rewards that companies receive from their sponsorship is the publicity the project gives them by appearing in different events such as the competition, senior project shows, Engineering Department Board meetings with the industry, etc. A sticker of the company will also be included in the body of the vehicle. The size and the location of the sticker will depend on the contribution of each sponsor to the project.

The team understands that not every business can afford sponsoring or financing the same amount of money for the project. Thus it is a must to differentiate between the "big" sponsors who have contributed with more than $2,500 or $3,000 and deserve a bigger sticker on a more visible place in the vehicle's body. That is the reason why the different sponsorship options have been designed, depending on the amount of money, or the value of the parts or materials, that has been received.

- Honorary Member (up to $249)
- Preferred Sponsor ($250 to $499)
- Bronze Sponsor ($500 to $999)
- Silver Sponsor ($1,000 to $2,499)
- Gold Sponsor ($2,500 to $5,000)

The sponsors need to understand that no matter how big their contribution is, the vehicle's owner will be San Diego State University as it will pass it on to the next generation SDSU Baja SAE Team so that they can use it as a model and modify it.

4.2.3 – Web page

The main objective of the web page is to promote the project. On the one hand, it serves the team as a platform to communicate periodically with the sponsors to show them the progress of the project and what remains undone. On the other hand, it can also be used to attract new sponsors. As seen in chapter 2, considering the value chain analysis of the team, the design and maintenance of the web page would fall under Technology Development as a Support Activity, which does not have a direct impact on the creation of the product, but, in this case, helps raisin funds and maintaining relationships with the sponsors.

The target audience of the web page will be not only the general public who is interested in the project, but also some industry experts who will consider sponsoring the team. Thus, the contents must be quite specific but also easy to approach by non engineers.

The web page will be structured into three different sections: Home, About and Sponsorship. The first section, Home, will show the sponsors and general public the progress of the project. It is here where team members will upload both pictures and comments on the challenges that the team is facing at the moment or through the year. Other documents such as the CAD designs or the posters about the project designed for the Senior Project Subject will also be included in this section, which will also be used as the page that will appear when opening the web page.

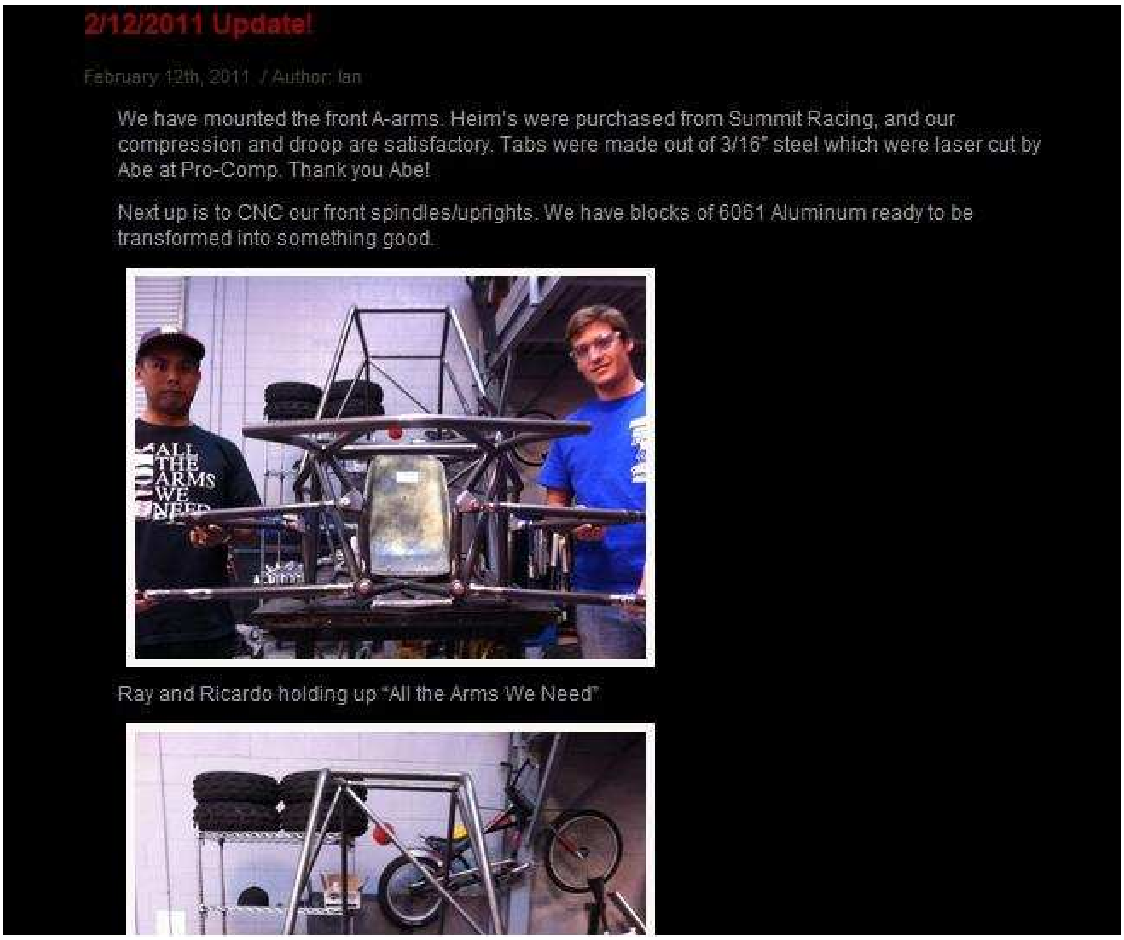
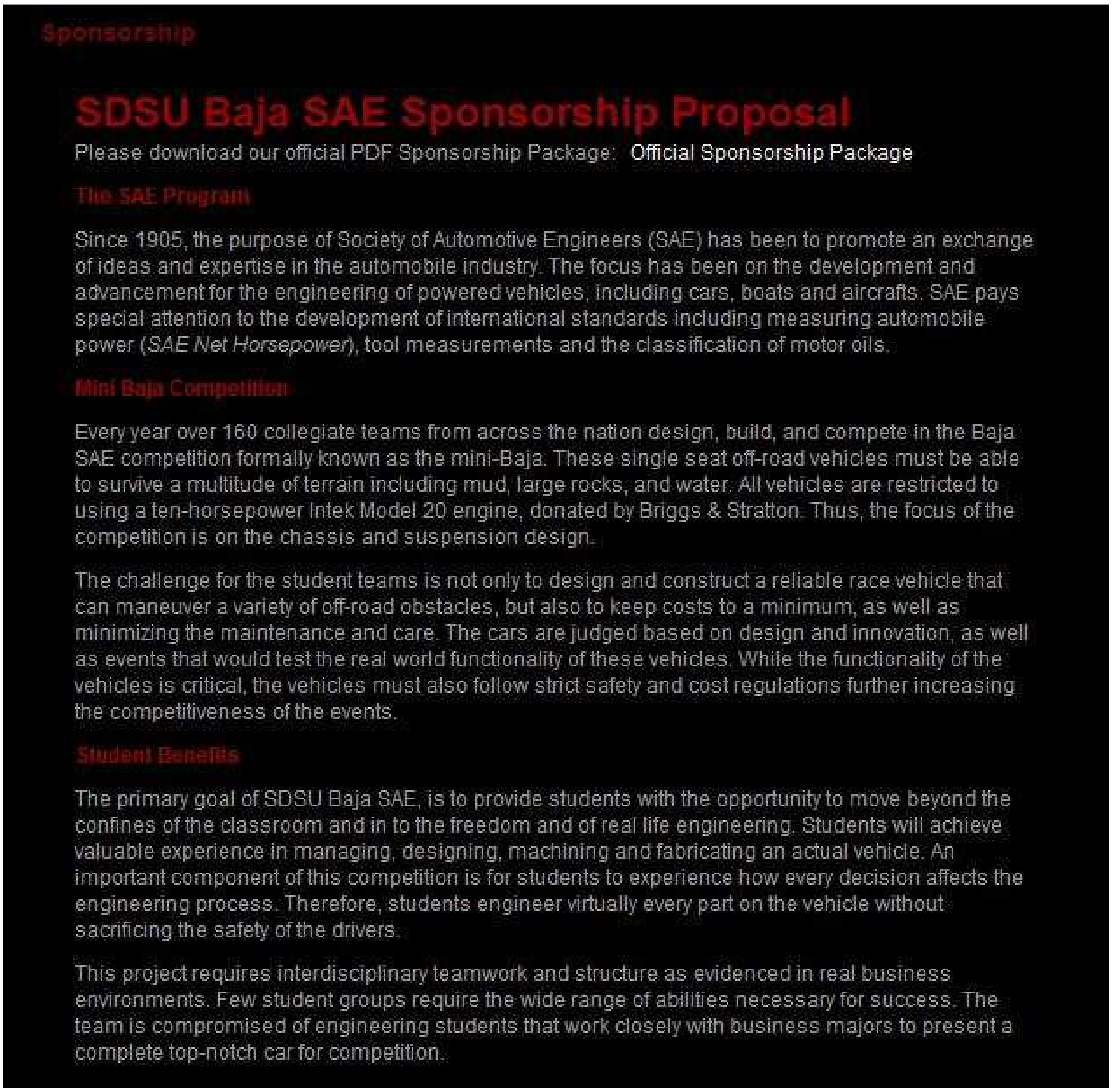


Figure 4.1: Update on the Home section of the webpage

The second section will give a little background on the project and on the team members as well. It will be called the About section and it is thought to give the visitor who shows interest by navigating through the page a little more information that it is not included in the home section.

Figure 4.2: Introduction picture and About section of the web page

The last section is dedicated to Sponsorship where people or firms that are interested in funding the project can read through the sponsorship package that the team would usually send potential sponsors. Here, not only more details about the competition are explained, but also information about the project deadlines, the budget, etc.


Sponsorship

SDSU Baja SAE Sponsorship Proposal

Please download our official PDF Sponsorship Package: Official Sponsorship Package

The SAE Program

Since 1905, the purpose of Society of Automotive Engineers (SAE) has been to promote an exchange of ideas and expertise in the automobile industry. The focus has been on the development and advancement for the engineering of powered vehicles, including cars, boats and aircrafts. SAE pays special attention to the development of international standards including measuring automobile power (*SAE Net Horsepower*), tool measurements and the classification of motor oils.

Mini Baja Competition

Every year over 160 collegiate teams from across the nation design, build, and compete in the Baja SAE competition formally known as the mini-Baja. These single seat off-road vehicles must be able to survive a multitude of terrain including mud, large rocks, and water. All vehicles are restricted to using a ten-horsepower Intek Model 20 engine, donated by Briggs & Stratton. Thus, the focus of the competition is on the chassis and suspension design.

The challenge for the student teams is not only to design and construct a reliable race vehicle that can maneuver a variety of off-road obstacles, but also to keep costs to a minimum, as well as minimizing the maintenance and care. The cars are judged based on design and innovation, as well as events that would test the real world functionality of these vehicles. While the functionality of the vehicles is critical, the vehicles must also follow strict safety and cost regulations further increasing the competitiveness of the events.

Student Benefits

The primary goal of SDSU Baja SAE, is to provide students with the opportunity to move beyond the confines of the classroom and in to the freedom and of real life engineering. Students will achieve valuable experience in managing, designing, machining and fabricating an actual vehicle. An important component of this competition is for students to experience how every decision affects the engineering process. Therefore, students engineer virtually every part on the vehicle without sacrificing the safety of the drivers.

This project requires interdisciplinary teamwork and structure as evidenced in real business environments. Few student groups require the wide range of abilities necessary for success. The team is compromised of engineering students that work closely with business majors to present a complete top-notch car for competition.

Figure 4.3: Sponsorship section of the web page

The format of the web page is quite conventional. In every section there is a header with the logos of the main sponsors and an image of last year's SDSU Baja Team car racing at their competition. The logo of the university was also included in the header.

Most of the text is written in white over a black background, highlighting the titles in red which creates a combination that reminds to the official colors of the San Diego State University, black and red.

Apart from the sponsors' logos there are also links to the sponsors' websites on the right side of all the sections. This might be the way in which the companies get most pops from. It also helps the visitors learn about the business of the sponsors.

The software used to design the web page is WordPress which is a simple and free tool that can give very good results.

There are several easy steps to make an easy and attractive web site:

- The first page has an enormous impact on the potential client or sponsor. That is why its design needs to be precise. It should have a prominent title, with a few pictures and some explanatory paragraphs. It must give a first and attractive snap shot of what the project is.
- Navigation between the different pages must be simple. At every moment, the user must know in which section he is and how to go to a different section. In the SDSU Baja SAE Team website, the user can access the different links to the pages both at the top and at the right side of every page.
- The web page must have two basic functions: first, it must be a means of fluid communication with the sponsors and academics linked to the project. Thus it must have an information role. Second, it must also attract new sponsors and give them the means of contacting the team, through the website or giving information on how to contact.
- Information about the benefits of sponsoring the project should also be included. Under the Sponsorship section, the team explains the potential investors the estimated budget and the actions that will be followed in order to promote not only the project but also its sponsors.
- Something that would have helped convinced new sponsors, but that was not included in the web page, would have been a letter from the team's main sponsor remarking the progress and commitment to the project. This would have helped attract new sponsors to the project.

- Another feature that should have included but wasn't would have been to give the possibility to the users to subscribe to a weekly email list to where the team members would send information about the progress of the project, future events and presentations, challenges that are being faced. That way, their contact with the project will not be limited to the moment where they visit the web page, but also have a friendly reminder every week.

5

Conclusions and recommendations

5 – Conclusions and recommendations

The vehicle was finished shortly before the beginning of the competition, and was not tested until one and a half weeks before the departure date. This testing period should have been at least three weeks long to allow for possible changes in the configuration for a better performance. However, the team did not have enough time to do so. Luckily the final model did comply with the security inspection and was able to compete.

Figure 5.1: Final product

5.1 – Competition results

The results of the SDSU Baja SAE team in the 2011 Kansas competition were not as good as the team would have liked them to be, but still acceptable for such a limited and small team (only five people). The table 5.1 shows the results of each competition event.

Event (points)	Rank	Points
Cost (100)	96	0
Design (200)	40	79
Acceleration (75)	45	58,28
Maneuverability (75)	36	5,81
Pull (75)	9	68,77
Suspension (75)	34	33,31
Endurance (400)	35	216,22
Total (1000)	**45**	**461,39**

Table 5.1: Points awarded by event

The performance of the team in the static events could have been much better, had the team had more time to prepare for the competition. The main goal of the team was to finish the endurance race (the event that awarded most points). This bottom line also helped the team's vehicle score points on the dynamic events.

Analyzing the points awarded and the total point distribution, some conclusions can be drawn.

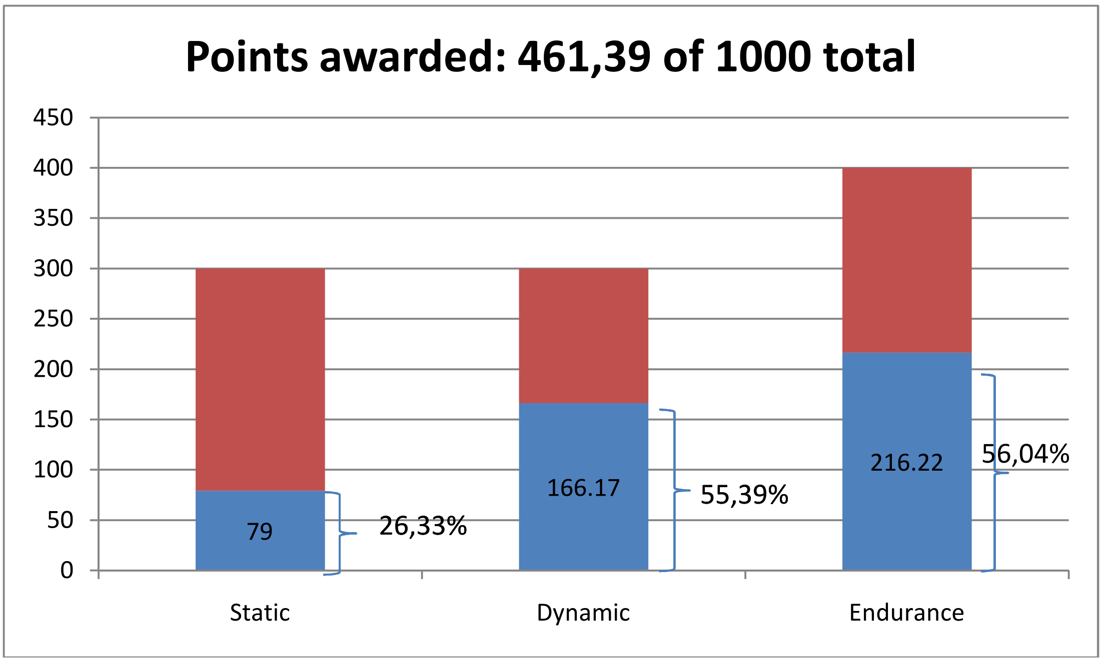


Figure 5.2: Points awarded

First, the performance on the static events (design and cost) happened to be very weak. Had the team scored around 50% of the points in these events, the actual ranking in the competition would have gone up 10 positions to 35th. The main reason behind this score is that no points were awarded for the cost report. This is due to the fact that no cost report was submitted before the competition because the team was 100% occupied the last weeks finishing and tuning the car.

The other main drawback from the competition was that the team was not able to finish the endurance race. After 3,5 hours racing (out of 4 hours that the race lasts) the vehicle crashed into a concrete post braking one of the front shocks, making it impossible for the team to repair it and continue racing in the remaining 30 minutes. However, even though the team did not finish the race, it ranked on the 35th position, which means that less than one third of the teams competing actually finished the race. This can give an idea of the hardness of this event.

Overall, the team and the sponsors were satisfied with the performance of the vehicle, which will be still running after changing the front shock. It is important to mention the 9th position the team got in the pull event, which can be explained by the accuracy of the selection of the gear ratio, transmission, and size of tires.

Figure 5.3: Car after the race

5.2 – Time management

Name	NIC	IAN	RAY	JENSEN	RICARDO
Subsystems	Chasis (1)	Drivetrain (2)		Steering (4)	
		Suspension (3)		Wheels, brakes & hubs (5)	
				Pedals (6)	
Timing (4weeks/month)					
Nov	Get sponsorships for materials and parts (get a cheap price)				
	Get a concept design with the parts we have ordered				
	Receive parts – Redesign subsystems with real measurements				
	Check all designs fit together – Final design				
Dec	Design presentation – Deadline to receive all parts of our car				
	2 week gap to improve or correct final design				
Jan	Get familiarized with the parts and start assembly process				
	Build (1)	Assembly (2)		Assembly (4, 5 & 6)	
Feb					
		Assembly (3)	Electric circuit (7), seat, safety...		
Mar					
	2 week gap to solve unexpected problems				
Apr	Put subsystems together – ASSEMBLY TIME				
May	TEST				
	COMPETITION				

Figure 5.4: Tentative deadlines

The main mistakes while designing an accurate project timeline were:

- The construction of the chassis had to be finished before the team could start working on the suspension and other subsystems, as the team had to work around space and structural problems due to the chassis configuration. Thanks to the time the team spent during the Christmas break to start working on the chassis, it was finished before mid-February, when the team started working on both the front suspension and the drive train.
- Wheels, brakes and hubs, as well as pedals and electric are all easy and adaptable subsystems that can work around the harder subsystems

(suspension, steering, drive train, and chassis), thus their design and fabrication must be left for the very end of the project.

- The rear suspension subsystem was left to the end of the project as there were many security elements around the drive train that would come in between the drive train and the rear suspension. Thus, the team had to come with a non conventional J-arms design to work around all the elements in the rear end of the vehicle. Even though it did work and gave the rear wheels enough travel, it would have been desirable to account for all those security items in the design process so as to have a clear idea of the options when the manufacturing time comes.

5.3 – Financial resources

One major problem that most teams face is the lack of financing for their projects. This problem was especially important in the SDSU Baja SAE team as none of the team members had had precious experience on any kind of similar competitions. Moreover, the team did not have a real financial plan. Whenever the team had funds from sponsors, these would be used. But when those funds were spent, the team members' own money had to be invested in the project.

It is important for future teams to have a clear idea of not only how much money they are going to get from sponsors, but also when they are going to get it, in order to have a healthy cash flow and avoid putting their own money into the project. The first important financial deadline is the team registration for the competition, which needs to be done by the beginning of October. This registration cost is $1,000 and the teams need to be prepared for this early cost.

The sooner the teams get their funds, the sooner they can start ordering parts and materials. Having the parts at an early stage can help the team members visualize the designed configuration and correct any mistakes that have not been taken into account on the CAD models. If the team fails to do so, and receives the parts at a later stage of the project, it risks having to change some features or configurations where the team has spent many hours on.

5.4 – Baja SAE Club

It is very important for the team to have some kind of continuity. As mentioned before in this document, the project would not have been finished, or would have been finished in a very poorly manner, if the team had not had the support and advice from last year's team members.

It is desirable that those in charge of the project have had previous experience on similar projects. That is why the idea of forming a club, where not only senior students participate, but also juniors and sophomores who will learn from the seniors in order to apply that knowledge in the future years when they need to lead the project.

As the previous year's vehicles can be used up to a 70% of its design, experienced team members who have worked on that design will know what to improve from year to year, and will be able to guide new team members into the tasks to be accomplished.

It is also desirable to have different backgrounds among the team members, as a business or finance student would be very useful in keeping track of the financial statements of the firm, give the team members an idea on the funds available, etc. A marketing student could also be very helpful in helping the team design sponsorship packages or attract new sponsors, contact with the media, and promote the project in the school and local fairs.

The best way to achieve such a professional team is by connecting everyone through a school club. In San Diego State University, a Baja SAE Club could not be started as there was already a SAE Club, who works on the Formula SAE competition every year. However, there have been negotiations to create a Baja SAE Team under the SAE Club umbrella, which will also make it easier to contact sponsors through the university.

Junior students from the Mechanical Engineering and other departments have joined the team helping with little tasks and learning the challenges faced with the processes of design and manufacturing a Baja type vehicle. This will mean invaluable experience to them when they decide to start a similar project on their own.

5.5 – Assessment of goals achieved

It is important to analyze to what extent the goals that were defined at an early stage of the project have been achieved.

- **Objective 1: to comply with the rules and regulations stated in the 2011 Baja SAE Rules.** The car passed the technical inspection with no apparent problems, so all the rules and regulations had been applied correctly. Success rate: 100%.
- **Objective 2: to obtain enough financial resources to make the necessary investments while maintaining a healthy cash-flow.** The team was not able to raise funds at the very beginning of the project so each member had to pay $200 of their own money to pay for the registration ($1,000). However, at a later stage, the team was able to raise enough funds to finish the project and participate in the competition (more than $5,000). Success rate: 80%.
- **Objective 3: work as a company and feel proud of being part of it.** The team made a great effort distributing the workload among the team members,

according to their experience and background. This effort implied a great trust among the team members, which contributed to the generation of a competitive vehicle. However, the team did not plan ahead with enough time to finish all the tasks such as the cost report. Success rate: 90%.

- **Objective 4: differentiate both in efficiency and efficacy from the competitors.** The success rate of this goal can be measure both by the ranking position at the end of the competition and the number of members in each team. SDSU Baja SAE Team created a very competitive vehicle, from scratch, in barely 8 months, with limited financial resources and only 5 team members. The biggest teams are formed by 10 to 15 team members. Thus, the SDSU Baja SAE Team did differentiate both in efficiency and efficacy by building a competitive vehicle with very limited resources. Success rate: 90%.
- **Objective 5: finish all the 2011 Baja SAE events within the top 20 teams.** Although this objective may sound a little arrogant now that the competition is over and the results have been announced, it did help the team aim for the top. Success rate: 40%.
- **Objective 6: make sure the younger students from SDSU continue with the SDSU Baja SAE team tradition the following year.** The SDSU Baja SAE team members have been in close contact with several junior students who have joined both the design and manufacturing processes of the car, not only to help this year's project, but also to learn and apply that knowledge when they decide to face the project on their own. Several students expressed their desired to continue with the Baja project the following years. Success rate: 90%.

If all the previous objectives are of similar importance to the project (it is assumed so), the **average success rate for the project is: 81.6%**.

Annexes

Annex A: Sponsorship Package

SDSU Baja SAE

Sponsorship Proposal

The SAE Program

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This project requires interdisciplinary teamwork and structure as evidenced in real business environments. Few student groups require the wide range of abilities necessary for success. The team is compromised of engineering students that work closely with business majors to present a complete top-notch car for competition.

Budget and Sponsorships

As a student run project, we rely on private and corporate sponsorship to fund the design and production of the SDSU Baja SAE vehicle. In order to complete the project and achieve a high level of competitiveness, we must raise approximately $7,500 by the end of 2010.

As a sponsor, you become affiliated with an internationally known engineering association, SAE, while advancing the education and development of SDSU Baja SAE members. Additionally, you have the opportunity to work with motivated and aspiring student engineers.

Team Timeline

Our competition will be held May 26-29, 2011 in Pittsburg, Kansas. The design phase takes place during the Fall 2010 semester and construction begins during the Spring 2011 semester. In order to have ample time for testing, our estimated date of completion is April 30 2011. After testing is completed, a complete tear down is scheduled and the car will be prepped for paint and final assembly.

Advertisement

Throughout the build time we will have periodic updates on both our website sdsubaja.com and on youtube.com to show our progress and to acknowledge our sponsors. Furthermore, group members are also affiliated with other student organizations on campus such as ASME, SHPE, and FSAE. As members of these organizations we are able to advertise at their weekly and bi-weekly student meetings. Additionally, as soon as we acquire sufficient sponsorship, we will produce and sell T-shirts with sponsoring company's logos.

Competition Information

Location: Pittsburg, Kansas
Distance: 1,534 mi (from SDSU)
When: May 26 – 29, 2011
Host: Pittsburg State University
http://students.sae.org/competitions/bajasae/

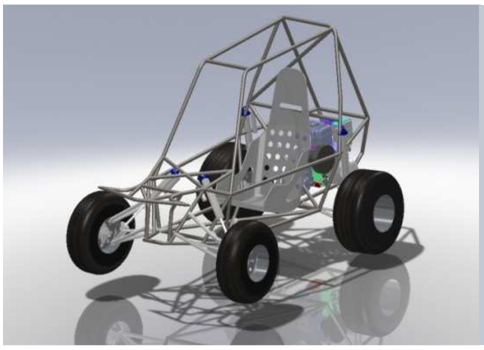
Timeline (Effective 04/01/2011)

- Finish Front Suspension: 04/04/2011
- Finish Steering Components: 04/04/2011
- Install Master Cylinder and Lines: 04/08/2011
- Install Throttle Pedal Assembly: 04/08/2011
- Finish Rear Suspension: 04/15/2011
- Finish Rear Brakes: 04/15/2011
- Send Out Rear Axles: 04/15/2011
- Finish Body Paneling: 04/22/2011
- Install All Safety Components: 04/25/2011
- Miscellaneous: 04/29/2011
- Complete Build: 05/06/2011

Cost Break Down

CVT Transmission:	$100
Engine:	$150
Safety Equipment:	$150
Fasteners:	$150
Frame:	$200
Body:	$250
Steering:	$500
Miscellaneous:	$500
Brakes:	$1000
Tires/Wheels:	$1000
Registration:	$1000
Travel:	$1000
Suspension:	$1500
Estimated Total:	$7500

CAD Designs



Current Progress




What We Still Need

- Dual Circuit Master Cylinder
    - CNC 5/8” Bore Diameter with Pedal Assembly
- Hydraulic Brake Lines And Connections
- Throttle Pedal Assembly And Cable
- Body Panel Tabs
- Safety Equipment
    - Helmet, Neck Brace, Seatbelts
- Steering Wheel

Sponsorship Levels

SDSU-SAE Honorary Member – Up to $249

1. Ad on sponsor board
2. Linked add on www.sdsubaja.com

SDSU-SAE Preferred Sponsor – $250 - $499

1. Ad on sponsor board
2. Team photo and Appreciation Letter
3. Vinyl logo on topside panel (Up to 2"x4")
4. Linked add on www.sdsubaja.com

SDSU-SAE Bronze Sponsor – $500 - $999

1. Ad on sponsor board
2. Team photo plaque
3. Vinyl logos on side panel (Up to 3"x6")
4. Linked add on www.sdsubaja.com

SDSU-SAE Silver Sponsor – $1,000 - $2,499

1. Ad on sponsor board
2. Team photo plaque
3. Logo on team trailer
4. Vinyl logos on top of side panel (Up to 4"x8")
5. Linked add on www.sdsubaja.com

SDSU-SAE Gold Sponsor – $2,500 to $4,999

1. Ad on sponsor board
2. Team photo plaque
3. Logo on team trailer
4. Test drive Baja car summer 2011
5. Vinyl logos featured prominently on side panels (up to 5"x10")
6. Linked add on www.sdsubaja.com

Material Sponsor

SDSU-SAE will gladly accept your material contribution. We can use resources such as a travel vehicle and trailer, accommodations, engine fluids, tires, team attire, etc.

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If you have any questions please contact Dr. Monte Mehrabadi (faculty Advisor) at (619) 594-2450 or by e-mail at mehrabadi@mail.sdsu.edu