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The Society of Automotive Engineers organizes the Formula SAE competitions annually for universities internationally to compete in a series of events. Teams compete in several dynamic tests for the vehicle's handling, performance, and fuel economy, as well as static events that judge the team's assumptions for cost, design, and business elements. This paper explores the application of management structures to the environment that teams experience when they are at competition. The needs of this temporary organization differ from when at a fixed location, such as a university, in terms of objective, norms, and resources and require a different approach. Background research from similar environments, mobilization practices, and management structures provide a baseline for a theory to be applied to how a Formula SAE could operate more efficiently. Interviews of several members of the team enabled specific applications to be created and used at one competition during 2010. These were then reviewed and modified afterward to be more effective for the next event.

Key Words: Temporary Organizations, Management, Organization, Industrial Engineering

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Temporary Organizations: Competition Management for Global Formula Racing

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I understand that my project will become part of the permanent collection of Oregon State University, University Honors College. My signature below authorizes release of my project to any reader upon request.

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Michael A. Warmack, Author

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1. Introduction

1.1 Background

The Society of Automotive Engineers (SAE) organizes the Formula SAE competitions annually for universities internationally to compete in a series of events. Each university team designs and manufactures a unique open-wheeled, formula-style racing car for each year. Teams compete in a series of dynamic tests for the vehicle's handling, performance, and fuel economy, as well as static events that judge the team's assumptions for cost, design, and business elements. The premise of the competition is to see who can design the best vehicle for a fictional company that would like to manufacture the design for the weekend driving enthusiast. Over one hundred universities participate in these Formula SAE events internationally.

The Oregon State University Formula SAE team is a successful team in the competition, placing second in SAE California 2009 and first in Formula Student Austria 2009. The team has grown over the years from a collection of motivated students to being the focal point for several undergraduate senior projects and graduate theses topics. For the 2010 competition season, Oregon State University (OSU) has merged with the Duale Hochschule Baden-Württemberg, Ravensburg at the Friedrichshafen campus (DHBW-R) in Germany to from a unified team under the name Global Formula Racing (GFR). This is the first time that two universities, much less two international schools, have joined together in Formula SAE into a single team. All design, sourcing, manufacturing, and fabrication responsibilities were divided between the two. The final objective of GFR is

to create two identical cars, one for each campus, and compete in six international events. The OSU vehicle will compete at Formula SAE Michigan and Formula SAE California and the DHBW vehicle will compete at Formula Student in England, Formula Student Germany, Formula Student Austria, and Formula SAE Italy.

A lot of effort was put into creating a successful management structure for Global Formula Racing's first year. Some of those measures included regular video conferences between German and American teams, a strong steering committee, and a supply chain management group that would solely focus on how to internationally source the materials needed for both vehicles. Many of the challenges that GFR has faced in their inaugural year are similar to other companies' global manufacturing challenges in terms of planning, logistics, and communication.

What is different about the Formula SAE team structure is that is has a high turnover rate of designers in their senior year of school. After finishing a season by working on a specific vehicle sub-system for their senior design, most members graduate from the university and begin their careers. This annual change results in tribal knowledge being lost with those the move on. Graduate students and the faculty advisor remain to be the best source of knowledge for how the team should operate. Team captains are also an excellent source as they have several years of experience with Formula SAE and address most of the management duties. This year has seen more importance placed on documenting major decisions, designs, and procedures with the intent that it will shorten the learning curve for the following year's senior designers.

Another significant contrast in how the structure of a Formula SAE team differs from an international company is the objective. GFR is designing, manufacturing, and

assembling a vehicle with the intent in competing against other universities rather than releasing a product into the market for sale. Being at competition is much different than organizing the creation of vehicle. The objective changes from creating the vehicle to succeeding in each of the events at competition. There are two classes of graded events: static, which measures the engineering theory, estimated cost, and the business model of the design, and dynamic, where judges grade the vehicle for performance in acceleration, maneuvering, endurance, and fuel economy. Additionally, a significant amount of support is needed for the team while at competition, which usually lasts for four to five days. Support topics include vehicle repair and adjustments, transportation, food, and lodging. Given that a significant amount of the team's effort is in the design and optimization of the car, planning and support for competition is generally prioritized lower. However, more importance should be placed on competition planning because teams are mostly judged on what is seen during events. Planning and defining how Global Formula Racing should manage itself at competition is just as important as when the teams are at their universities. It will take a different approach to management than when at home due to different objectives and limited time and resources available to accomplish their goals.

1.2 Significance

The direct significant and benefit to this paper is to improve the performance of Global Formula Racing at competition by improving their management structure in preparation and in the field. The premier teams within Formula SAE have excellent designs but also have excellent management structures. Team performance is equally as important as vehicle performance. This study will help GFR to continue the traditions of

former OSU and DHBW-R racing teams in being successful at competitions. It is their goal to not be among the elite teams but to be the best of them all. That will require an evolution in management design just as their vehicles have.

Indirectly, there are similar teams in other industries that may benefit from this paper. Groups that must prepare for an event and execute in a short amount of time are very similar to Formula SAE teams at competition. Some of these could be business presentation groups, emergency services, project teams, etc.

1.3 Purpose

The purpose of this paper is to analyze and improve the performance of Global Formula Racing's preparation and execution at SAE competitions. A review of previously published material on related topics will provide a base of information and followed by interviews of team members to highlight past issues at competition as well as suggestions for the future. This information will be analyzed and then applied to how the team operates at the first 2010 SAE competition in Michigan by means of structure, procedures, and tools. Their effectiveness will be reviewed after competition where final recommendations will then be made.

2. Literature Review

2.1 Basic Management Structures

Understanding the fundamental management structures that are in common use today would be an appropriate start in determining if there is a particular structure that would apply to Global Formula Racing at competition. Morse and Babcock's "Managing Engineering and Technology" (2007) is a good entry-level text that is used in undergraduate management studies. The simplest management theory uses "functional departmentation." Breaking up tasks within an organization and assigning specialized personnel is more productive than having a single person responsible for multiple tasks. However, this theory is dependent on having enough responsibilities to be able to effectively utilize a resource. Smaller formula teams may not have enough tasks or resources available to specialize during competitions. Not assigning functional roles may also be appropriate when all of the members have equivalent knowledge about the vehicle and the team. In the case of GFR, the design was based off several sub-teams designing particular systems and working together with other groups. The functional departmentation is already in place before competition and team members have specific knowledge of the sub-system that they control. Because education of the car varies between members, not having responsibilities divided by function in competition would not be effective. When there is a specific system problem, the quickest way to resolve it would be with someone that is experienced with its design.

A controlling element of management structures is the span of control that is present. This defines how many people report to the level above them. Militaries are commonly structured with a span of four: platoons have four squads, companies have

four platoons, etc. (Morse and Babcock, 2007). Narrow spans of control are heavy on supervision of subordinates but are slow in communication. Wide spans on the other hand, are the exact opposite of narrow ones. This requires a span of control that is appropriate for the organization. One applicable condition that can increase the span width without sacrificing necessary supervision is the amount of training of subordinates. In the case of GFR, members that may be very sufficient in suspension design should also understand how the rest of the cars works and interacts. Not only will they be able to comprehend the overall system better, but also be able to perform minor repairs or assist in major ones with another systems specialist. Another applicable element is clearly stating instructions. Having a pre-defined series of tasks frees the manager of explaining exactly what is needed to the subordinate. Checklists and procedures are two vehicles for communicating clear instructions of tasks.

A logical structure for Global Formula Racing would be to use a functionally divide responsibilities. The three areas that have already been discussed are dynamic events, static events, and support roles. Selecting controllers for each of these areas hasn't been identified as a need. There aren't enough tasks in each area for a dedicated manager to be effective, and the team captains already have a role in coordinating between all of the groups. With this size of group, it is important to look at the quantity of responsibilities as well as the degree of differentiation between tasks, and how time-intensive they are. Evaluating these three elements will determine the span of control of subordinates and tasks.

2.2 Parallels to the Film Industry

A film production management structure may be one of the best models that would apply to a Formula SAE team. Beth Bechky (2006) embedded with several film crews to write a paper that looked into the nuances of temporary organizations. She first looked into the way that film production crews were structured and then how the different roles organized together. Teams would use a general structure of organization that is commonly agreed upon but would then negotiate their responsibilities through "enthusiastic thanking and polite admonishing."

Temporary organizations "bring together a group of people who are unfamiliar with one another's skills, but must work interdependently on complex tasks." Global Formula Racing would be a partial exception to this. Groups of members that are with each university are familiar with each other but less-so with the partner university. Because there will be both American and German students at all competitions, it would be reasonable to say that there will be a degree of unfamiliarity that makes the competition environment a temporary organization. Managing this situation using solely traditional methods would be inadequate due to how they are innately governed. Temporary organizations "are governed through networks of relationships rather than by lines of authority." Especially since there is no monetary motivation for participation in competition, mutual respect and a common goal will keep a team structure organized. By not having strict lines of authority, increased flexibility is permitted to members, allowing them to react to the situation even if they are not responsible. What is important to define is a "role structure." Bechky states that allowing negotiation of individual member roles from a basic understanding will promote successful collaboration within a group (2006).

This negotiation is not done formally or even directly. Bechky describes the role development taking place through “enthusiastic thanking and polite admonishing” continuously over the duration of the temporary organization. There are several instances where managers would openly and repeated thank assistants for their work on a task. When a member would not perform as well as expected, the supervisor would correct him or her politely on how to perform the task. The reply was usually apologetic and receptive. The manner of this exchange not only preserves the working relationship but also makes it stronger through acceptance. The author noted that it was “often used by senior crew members to provide role clarification for the junior crew members.” Admonishment should be an important part of the temporary organization when done tactfully. Additionally, tolerance of mistakes is important but should be taken advantage of by correcting the mistake. In both the film industry and at Formula SAE competitions, time is very limited and repeated mistakes will affect performance (Bechky, 2006).

The role structure that Bechky uses to illustrate how film sets are usually managed is very similar to how a Formula team could structure themselves at a competition. Her model is “rather strictly organized by department, with a thin upper hierarchy, and a pool of production assistants at the bottom.” It is structured with the top controllers (director, producer, and director of photography) with department heads below them (i.e. location manager, electrical gaffer, production designer, etc.). The production assistant is noted as having a “more fluid (role)” and there are multiple examples of where production assistants frequently perform tasks in different departments. If this structure were to be directly applied to Formula, the captains would be the top managers with functional roles below them. Some of the functional roles may

have assistants but the remainder of student members at competition would take the role of production assistant. They would be very flexible to needs that are identified by the captains or the functional managers (Bechky, 2006).

The film industry could be an effective model in how Global Formula Racing should define its structure while at competition. An important point when implementing such an organization would be to allow room for members to negotiate their individual responsibilities, especially at the secondary level. The set of students and their individual skills will also vary at each competition and strict lines of authority would most likely hamper performance. Positive reinforcement of work and polite admonishing will improve the working relationship of the team as well as improve its overall effectiveness by correcting mistakes in a supportive manner.

2.3 Suggestions from a Nursing Community Mobilization

There is much research available in the area of what is known as Hastily Formed Networks (Denning, 2006). These are groups that formed quickly from multiple agencies when a disaster happens and traditional response structures fail. Most of these papers reference the incidents of September 11th and Hurricane Katrina, but they are inappropriate for research for this topic. The response time is too short to be used as an example and the nature of emergencies, frankly, have a different set of norms and priorities than those of a racing competition. However, a paper written by a Susan Mace Weeks describing the mobilization of her nursing community during Katrina outlines her experience with the disaster (2007). She outlines a series of best practices on the management and operation of her temporary environment. While some observations are

health-care specific, several key points can be applied to the temporary organization of Formula SAE competition with little extrapolation.

Weeks coordinated American Red Cross Disaster Health Services in Fort Worth, Texas during Hurricane Katrina, some 550 miles from New Orleans. It was estimated that over 28,000 individuals went through the nursing community during the seven weeks that shelters were established (2007). This put a great strain on the available health care in the region. She was able to recruit volunteer nurses, establish a patient evaluation system, and secure the necessary resources for treatment and care. She wrote this paper with fourteen "lessons" from her experience and six are applicable to any temporary organization.

Lesson One: Be Flexible. During a situation that is not routine, the demands and priorities can change frequently and without notice. Weeks described how she saw health care professionals perform janitorial jobs simply because they needed to get done. A temporary group does not always have the capacity or time to explicitly divide tasks. Time will be limited with this kind of group and driving towards an objective. It is more important to accomplish tasks than to waste time delegating or ignore it all together. There will be many needs at a Formula SAE competition that range from purchasing a replacement part to taking out the trash. Regardless of what normal roles a person has and the nature of the task, everyone should be prepared to be proactive and take care of what needs to get done.

Lesson Two: Preplanning Helps. Weeks recommended that communities to carry kits that would enable a shelter to rapidly prepare for an event. Her area was able to be successful in treating incoming individuals because of the working relationships that she

built with local health care professionals and facilities. She gathered the necessary resources quickly, even without prepared kits. This identifies how it is beneficial to identify and prepare for responding to situations. There are situations that will happen and ones that are likely to happen during competitions. Being prepared in response is essential when there isn't much time to evaluate and respond. This will be discussed later with Known Knowns, Known Unknowns, and Unknown Unknowns.

Lesson Three: Establish a Chain of Command. A traditional management structure has more emphasis of tactical decisions at the base and strategic ones at the top. Weeks quickly realized that she wouldn't be able to do both effectively while being at the shelters. She sought individuals that would be able to perform routine nursing duties so that she could focus on the managing the entire system. A Formula competition may appear as being a series of responsive, tactical decisions, but this will be inefficient in execution. The strategic level of competition is scheduling, logistics, awareness of competitor's strengths, etc. The responsive, skilled individual is important for responding to breakdowns and other tactical situations but does not have a broad vision. A person that can see how different events interact with each other is just as important so a clear, efficient path can be set for the team.

Lesson Four: Systems Thinking. Early in the mobilization stages, it was very difficult for Weeks to effectively evaluate incoming individuals and access essential medial information. She was able to centralize evacuees to determine the level of care that they required and which facility would be most appropriate for them. This central location also provided basic needs such as wash facilities, food, and communication for people to use before moving to another shelter. The objective for a racing competition is

obviously different than a nursing community, but the lesson still applies. Operating as a system, rather than an assortment of individuals, eliminates waste. Making decisions and responding as a group will prevent the waste of underutilized resources. For example, there is a separation between the team camp and the competition event site with only a few cars available for transportation. A few people need to get to competition immediately so they take the last car to the site, not remembering that a driver is needed to bring the car back to the house and drive more. Time is wasted determining where the car is, contacting those that left, and having an important person drive back to the team camp. It will be important to setup time-saving systems to evaluate situations and then respond as a team instead as a group of individuals.

Lesson Five: Communication. Setting up phones in every shelter was the most effective system that Weeks could setup. A large Email distribution was attempted but not effective in reaching all of the individuals because they could not add new volunteers to the group list. There was also a dedicated line setup to the central Emergency Operations Center. This eliminated a lot of the time that it took to reach key personnel in crisis situations. If a group is to move together in unison, they need to be able to talk effectively. Clear, reliable, and simple methods of communication will need to be identified. This also includes visual communication. Good group communication goes beyond one-to-one talking. One-to-many will be important for common questions such as who is needed where, what events are happening next. These questions can often be answered by a bulletin board or other visual aid instead of taking the time to find someone and have them stop what they are doing to answer.

Lesson Six: Establish a Supply Chain. Sourcing medical supplies for the influx of evacuees was critical so that the nursing staff could do their jobs. After acquiring an initial stock of supplies, Weeks was able to create a system of daily needs from each of the shelter. The lists would be pooled together with the most critical ones prioritized. Not an advanced system but adequate for their needs. She also describes in this section how she worked on preventing the loss of materials. Prescriptions were consistently being misplaced or stolen after being issued to an individual and their solution was to issue the drugs with fanny packs. This reduced the waste of material as well as the time required to process the request again. Global Formula Racing will have an internal supply chain when at competition. Having a well-fed crew is essential if they are expected to perform at their best but the majority of the food will be kept at the house with some in the trailer. This will require a supply chain system to be created so that there are not shortages at the event site that require trips to the house or store. Also, a certain amount of extra parts will be on-hand in the trailer but major components will not be. Identifying where these can be found near the event site will be absolutely essential to minimize reaction time. Neither Weeks' nor GFR's supply chains are in a sense traditional but are absolutely critical for success.

Susan Mace Weeks' situation of her mobilization is similar to Global Formula Racing at competition in a sense because they are both temporary organizations that have objectives that are time-sensitive. Her own observations of flexibility, preplanning, chain of command, systems thinking, communication, and supply chains are good points for GFR to use as a foundation to managing themselves at competition. The solutions will

undoubtedly be different that for the nursing mobilization but will have the same underlying concepts.

2.4 Knowns, Known Unknowns, and Unknown Unknowns

It was previously stated that Hastily Formed Networks (HFN) are not similar enough to Formula SAE competitions to be useful. However, Peter J. Denning describes the different types of situations that HFNs must face (2006), and these can be applied to GFR as they can describe the different situations that the team can face. By understanding how incidents affect the team's resources in different ways, they can reduce their impact by preparing for high impact, high probability situations.

The first category is Knowns. They are events that a team realizes will happen and they know how to respond to them quickly. Pre-existing systems are used to address and resolve the issue at hand. These differ from procedure because they are still unplanned events but their likelihood of occurring is nearly guaranteed. Additionally, they also have the option to not respond as the outcome would be undesirable but not incapacitating. An example with a Formula team could be that the vehicle team needs parts or even food but cannot resolve this need on their own. The resolution may be that someone is ready at the pit area to respond once they receive the signal to do so.

The middle grouping of events is Known Unknowns. These consist of likely events with response structures in place. Emergency response examples could be local fires or small earthquakes. They place a higher strain on a responding team due to a more significant impact and uncertainty when the event occurs, and there is also an obligation to respond. An equivalent event that would be a Known Unknown would be a systems

failure on the vehicle. The team will be able to respond and resolve the situation but it is not known if or when something of this nature would happen.

The highest level is the most devastating and stressful on a group. Example events include major natural disasters and terrorist attacks. The response to these is initially unknown and results in the creation of Hastily Formed Networks to address the situation. Other aspects of this situation are genuine surprise and insufficient resources. When responding, the HFN must first determine what the response is before acting upon it. An Unknown Unknown scenario for GFR would be a major failure in the vehicle. There are limited resources at competition sites and if there were a situation where an essential part or system could not be replaced, the car would be unable to run and drop out of the remaining dynamic events.

Understanding the idea behind stratifying these events to the Formula team is important because actions can be taken to reduce their impact. Identifying which situations are most likely to occur and then preparing for them is the first step to be taken, and an additional step would be to expect them to occur at competition. This moves Known Unknowns into the Known category. Unknown unknowns are the most crippling to a team's chance for success at competition, particularly for dynamic events. One way to reduce the probability of these occurring would be to extensively test the vehicle which the resources exist to remedy the problem. Their impact may not be able to be reduced but their likelihood can be through simulation. If a reoccurring event is discovered and a weakness identified, the team has the opportunity to prepare for this and it becomes a Known Unknown. This starts to explore risk management theory, and GFR should note the benefits of continuing research of this in the future.

3. Survey Methodology

3.1 Research Instrument

The formal research instrument for this paper consisted of an interview with predetermined questions. There were five sections to the interview: preliminary, general, dynamic events, static events, support roles, suggestions, and strengths/weaknesses. The first questions in the preliminary section were designed to ease into the interview and determine the interviewee's previous experience with Formula SAE. If the subject had been to a competition previously, then questions about dynamic, static, and support roles would be permitted. These sections had a series of similar questions that would ask about a previous incident, how the team responded, the success, and how they felt about the incident in hindsight. All interviewees were asked the same series of questions about a general incident that they had previously experienced in a temporary environment such as a camping or road trip. This enabled more involvement from first-year students. The objective of these four sections was to identify incidents that could happen during competition. Incidents that happened outside of Formula could still be generalized and extrapolated to apply to competition and allow for this research to be less reactive of what has happened at competition to what could happen. The last two sections, suggestions and strengths/weaknesses, allowed the interviewee to share ideas and opinions about the team that could help recognize areas of opportunity or improvement. This is not intended to be a scientific survey but a tool to generate ideas for improvement and start discussions.

3.2 Institutional Review Board Approval

Due to the involvement of human subjects in the research survey, it was necessary to involve the Oregon State University Institutional Review Board (IRB) to approve the survey questions and methods of research before beginning. The purpose of this is to ensure that human subjects are treated fairly, safely and ethically for the cause of research. All IRB-submitted documents can be found in Appendix A.

3.3 Data Collection Details

The interview process was conducted by explaining the informed consent document, included in Appendix A-6, and answering any questions about consent or the purpose of the project. Subjects were asked questions that were on the interview template about past experiences with and outside of Formula SAE. If a question was elaborated upon that answered other questions, the subject was permitted to do so and the research assistant took notes in the appropriate section.

3.4 Participants

The participants for the research survey were from Oregon State University that were currently or had been members of OSU Formula SAE. The majority of the questions in the survey pertained to information concerning Formula SAE, hence the restriction. However, there were no limitations beyond being at Oregon State and part of the Formula SAE team.

4. Survey Results

Seven members of the Oregon State Formula SAE team were interviewed formally. More would have been preferred, but due to the crashed schedule before the Michigan competition, several key members were unable to commit to an interview. Nevertheless, the interviews returned good information. The interview template can be found in Appendix A-7 and the compiled responses from the interviews can be found in Appendix B.

4.1 Preliminary

The average experience of the seven interviewees was four years and three years when considering the person with ten years experience as an outlier. Ten years was the most experience and one year was the least. All were planning to make it to a SAE competition for the 2010 season and five had been to competition in previous years. Their responses on why they enjoyed being with the team were similar. Many commented that they enjoyed the experience of building a vehicle and going to competition while also recognizing that the SAE program is a valuable engineering teaching tool for future professionals.

4.2 General Experience Results

The non-SAE incident responses were mostly about outdoor trip experiences with one exception of a Boy Scout Eagle Project example. The majority of the incidents were caused by poor planning or not bringing essential items along with the trip. Their responses were reactive to the incident; some decided to attempt to address the situation with skills and materials on-hand and two simply dealt with the situation because it was

not mission-critical. One incident involved a medical emergency where the interviewee became hypothermic due to poor judgment. This was resolved because others on the trip were skilled in identifying and treating the condition. Six of the seven said that better planning beforehand would have prevented or reduced the impact of the incident. The other was a broken radiator on a motor home that could have not been prevented under normal operation.

4.3 Dynamic Event Results

Of the five eligible interviewees (due to previous SAE competition experience) four were part or system failures and another was a vehicle crash. All incidents were different situations that had occurred over the last five years and the system failures were all different parts of the car. One occurred during a dynamic event, two were able to be repaired quickly and did not affect the ability to compete, and the last was successfully repaired but not it time to compete. All interviewees of these four scenarios described that their incident could have been prevented or mitigated by designing for maintainability, extensive testing to identify weak areas, and having materials and resources on-hand to address breakdowns. The fifth incident involved a driver-error crash where the team had to scramble to repair the suspension. The team was successful and responded in a professional manner and didn’t require any changes in their reaction or supporting resources.

Comments regarding what the team has done well in the past with dynamic events include double-checking the vehicle before leaving the pit, being first in line for events and on-site, having team meetings, and continuing the lightweight design concept.

4.4 Static Event Results

One interviewee could not think of any incident involving a static event, two described the same event, and the other two described different situations where items were forgotten for the presentation. Two described an incident at 2009 California where the front suspension failed a few minutes before it was announced that the team would compete in the semi-finals for design. Nobody was prepared or expecting to make it to this level of design, especially with the vehicle in its current state. The team scrambled to bring all of the presentation materials together and placed the car on a cart which they brought into the design semi-final. The team was successful in this stage of design and made it to the finals. One interviewee commented that better preparation for static events would help in reactive situations. The other stated that the team should prepare for all stages of the design competition and assume that they would make semis and then finals. The other incidents described forgotten materials (USB drive with business presentation, background information for presentation) and their responses were to send runners back to the pit area to retrieve the necessary items. Both interviewees stated that having a checklist for each event would prevent forgotten items. One of them recognized that items would always be forgotten and that someone should be ready to respond by running to the pit if necessary.

Comments regarding success in static events include rehearsing and preparing well, posting a schedule for the team for all to see, basing all of the design theory from the lightweight concept, and having the motivation and attitude to deliver results when it mattered most.

4.5 Support Role Results

Three interviewees described when parts were needed to be purchased off-site for repairs. One talked about food support and another was a situation where an essential item was needed for tech inspection with the resolution of a checklist for inspection. Regarding off-site part purchases, two of the situations were specific parts that we essential to the vehicle but were not included in the trailer. Both persons commented that it could have been prevented if there were an inventory of spares in the trailer. The third situation was more of a communication issue. A team member had taken a vehicle from the competition site to pick up food for the team when a situation occurred that required an off-site part to be purchased. The driver did not have his cell phone on and was unaware that the team's priorities had changed until he returned to the site. Reminding team members to charge phones every night and have them audible during the day was a possible solution. Having two vehicle options at competition was another. Better food management may have also prevented this by having it organized and pre-purchased. One interviewee commented that it is hard to perform well when there aren't many food choices due to nobody taking on the responsibility or doing a poor job.

Responses to asking about support role successes were mostly met with suggestions about the team could do better. One interviewee also stated that he couldn't think of any successes for the support of the team and that a lack of planning was common. However, having team members willing to run back to the pits and organizing international shipping were some positive observations.

4.6 Suggestions Results

Five of the seven suggestions for dynamic events were regarding more testing time on the vehicle before competition. Testing is the only way that life cycles of parts can be measured and problems identified before being at competition. Direct support to the vehicle was also repeatedly mentioned with specific examples of the chase cart being organized with necessary vehicle and driver equipment and that those most experienced in vehicle repair are ready to do so. All team members were also suggested to be flexible for any task that could come up. Other comments were to make sure that the drivers were in the best condition possible before driving by having enough food, water, shelter, and a positive environment around them. A more defined role structure was also suggested.

Ideas for static events were generally about more preparation for each of the events. This was extended by some to say that static events, particularly design, are team ventures and that everyone should be aware of basic vehicle concepts, who specializes in each topic, and resist the urge to improvise when asked challenging questions. Meeting as a team the night before to discuss clothing and prepare was also suggested.

There were several different suggestions for team support. Better preparation and time management was essential to thoroughly prepare for the entire event. The team has had a reputation of not having any slack time with deadlines or missing them altogether. Communication was also highlighted as being essential before and during competition. Cell phones are a primary source of communication but there are also radios available. Both need to be prepared and utilized effectively. Better food management was mentioned again. Having a dedicated person allows them to focus on what the team needs and not be disrupted by vehicle or event demands that could shift priorities. One

interviewee also commented that the crew and drivers at different events wouldn't receive food or drink until they returned to the pit where it was common that the majority of the food was eaten. Food needed to be reserved or run out to the dynamic team after a certain amount of time. Other suggestions included generally willingness to perform tasks, a designated "gopher" for parts, and a cheering section during dynamic events.

4.7 Strengths and Weaknesses Results

Nearly all of the interviewees said that the single greatest strength of the team was the dedication and drive that everyone puts into the team. Everyone wants to see success. They also commented that the team works together well, even in adversity or disagreement. The knowledge base that everyone brings to the team is also vast and many incidents have been resolved from understanding the systems in addition to the commitment to competing. One person said that OSU Formula is 95% better organized than the other Formula SAE teams. However, he did recognize that the last five percent is exponentially harder and what separates the most elite teams.

All of the responses to where Formula SAE can improve the most were unique with several underlying themes. Team organization can always be improved but there was a particular nod to competition roles being defined better. There were several general team comments such as having more accurate advanced materials modeling, better project management, furthering communication improvements between American and German counterparts, and more team building activities. Other observations that pertained to competition were more individual responsibility, finding tasks for all members at competition, leveling the work distribution, and having enough chairs, especially for drivers and members that work in the dynamic areas.

5. Analysis and Application for SAE Michigan 2010

There are several themes that the interviews highlight. Generally, preparation has the greatest impact in preventing incidents from occurring in the first place and mitigating them when they do happen. In the general and static sections there were several comments about how essential items were missing or an issue could have been avoided by planning ahead. While the causes of forgotten items or poor planning were not within the scope of the interview, direct observation helps connect causes to results. Working directly with the team is essential to refine any tools that may be applied or find issues in competition management. Informal discussions with experienced members repeatedly stated that competition management was frequently "ad hoc" and reactive. This tendency could explain why events in the past have been poorly planned. Resolving issues at competition with limited resources results in more stress and time are needed. Denning's paper on Knowns, Known Unknowns, and Unknown Unknowns has been already discussed on how the severity of events can be mitigated. Through testing, weaknesses in the car can be identified and resolved. If they cannot be resolved, the breakdown event can be anticipated with essential materials and skills. The document created to reduce the probability of missing material or a tool was a trailer checklist (Appendix C). Experienced members of the team helped write down the essential elements that were needed in the competition trailer. This was posted inside the trailer for others to see as well as be modified if something was missing.

Static and support roles will have less catastrophic events because they involve less complex systems. Preparation is still very important. Missing items were the most frequently mentioned issue with static events, and there is a need here to ensure that

nothing is forgotten. A checklist could be an appropriate tool but may be too passive to be effective. Those that are in charge of the static events will be focusing on their presentations and not necessarily on the details of what they need to bring. Through the informal discussions with experienced members, the role of an equipment manager for static events was created. They would work with those responsible for each static event to ensure that the necessary items went to the event. Responsibility for each event also needed to be defined, and thus, static event leads were created. They would be the primary presenters for each event and have the knowledge of what they needed to be successful.

The discussions on how static events could be structured then led to more breakdowns of needs in the team at competition. The dynamic team also has supplies that they carry with them on a cart as they travel to different events with the vehicle, and the need for another equipment manager was identified here. Similar to how the need for static leaders was determined, there were other responsibilities with regard to dynamic areas that could be covered. These positions were the vehicle and pit managers. The first would be the champion of the vehicle and make sure that it would be ready for competitions and events. The second was a commander of sorts. They would be experienced and be able to recognize what the team needed to do and how to react to situations.

Support roles were more difficult to define due to a lack of previous definition within the team. A list of support needs was created to determine where the lines of responsibility could logically be drawn. This list included weather, transportation, house/camp management, off-site purchases, blogging/media, on-site food and drink,

runners to/from the pit, communication, and general labor. This list was discussed with the team captains and through their experience, several new roles were created: house/camp manager, off-site drivers, on-site food manager, and a dynamic food assistant. Other roles that were essential to the competition such as photographers, photo spotters, and drivers were also defined in this informal meeting. Table One shows the different roles discussed with their responsibilities.

Role	**Responsibilities**
Pit Manager	Manages the pit area on site Includes: repairs, identifying situations and responses Match available people and resources to tasks Evaluates and responds to the needs of dynamic and static teams Schedules and monitors when and where the vehicle and teams need to be on-site Responsible for communication on-site Monitors weather and track conditions
Vehicle Manager	Is with the vehicle at all times, including pits, dynamic, and static events Ensures that it is ready for competitions Delivers the vehicle to competition sites on time Communicates with pit manager location and needs of the vehicle Holds one of the dynamic passes Work with MOTEC diagnostics
Dynamic Equipment Manager	Usually with the Vehicle Manager in dynamic areas Responsible for all equipment that will be required for dynamic events Includes: driver's equipment and parts cart Work with the MOTEC diagnostics
Static Equipment Manager	Responsible for equipment that is needed for static events Needs to be at all static events Communicates with each static event leader for needed equipment
Cost Event Leader	Champions the Cost Event Identifies and guides people needed for Cost Event Communicates with Static Equip. Manager for needed equipment
Design Event Leader	Champions the Design Event Identifies and guides people needed for Design Event Communicates with Static Equip. Manager for needed equipment
Presentation Event Leader	Champions the Presentation Event Identifies and guides people needed for Presentation Event Communicates with Static Equip. Manager for needed equipment
Photographer/ Media	Attends required photographer meeting on-site Photograph dynamic events Coordinate with spotter Abide by photography rules at all times Monitor and add to team blog

Spotter for Photographer	Attends required photographer meeting on-site Accompany photographer whenever in dynamic area Abide by photography rules at all times Help with blog if needed
Competition Drivers	Compete in dynamic events Work with DEM to ensure all driver equipment is accounted for Communicate with Vehicle Manager on how vehicle is performing
House Manager	Responsible for needs of the off-site house/camp Manages house meals, works with daily cooks Coordinates with Pit Manager for food scheduling and transport between house/site Coordinates with On-Site Food Head for lunch/snacks/additional meals on-site
On-Site Food Lead	Responsible for food, drink, and waste for team on-site Ensures that there is enough food for team as long as they are on-site Coordinates with House Manager for supplies from house Works with Dynamic Food Runner to get food to members inside dynamic area
Dynamic Food Assistant (Multiple)	Works with On-Site Food Lead to get food to members inside dynamic area Not a fixed role, but at least one person needs to be identified at pit
Off-Site Drivers and Purchasers (Multiple)	Not a fixed role, but at least one person needs to be available at any time Drives vans in-between house and site Makes trips off-site for supplies, parts, etc. Needs to be able to legally drive Comfortable with responding quickly Ability to purchase goods and reimbursed at a later time

Table One: Role Descriptions for Michigan

The structure in Table One is similar to what was described in Bechky's observations of a film company's management structure. This is a structure where a few controlling leaders are on the top, several functional managers are in the middle (sometimes with specialized assistants), and production assistants are on the bottom with informal reporting lines. In this proposed structure, the pit manager is on top, various event managers are in the middle with assistants, and the rest of the team is available for work where it is needed.

Communication is an important topic to address and has been mentioned both in Weeks' nursing paper as well as in the interviews with team members. Cell phones have been and will remain a common communication tool that most of the team uses at

competition. An identified breakdown of this system was that not all phone numbers were known or accessible at competition. This could result in a delay in reaching someone that is necessary to resolve a situation, such as an example from an interview where a driver could not be reached. Compiling a roster ahead of time with phone numbers and posting it in visible locations will mitigate this risk. Additionally, the team should also be in the practice of charging their phones every night and being aware of the ringer settings. There may be some occasions where phones need to be turned off (design competition) but may be forgotten afterwards. There are also two-way radios available to the team. This is a good resource when on-site and should be placed with the dynamic team, the pit, and other groups that are at individual events. An advantage of radios over cell phones is that they should be location-based rather than person-based. If the pit needs to be contacted, it would be faster to use a radio rather than a cell and try to find an individual. Other forms of communication that will be explored are using white boards in the trailer to display important information such as major events for the day and having team meetings every night.

A visible schedule also improves team communication. All students have access to student handbooks for each event online and a few hard copies are given to each team. The master event schedule is in this document. In order to improve this, the schedule was taken into a MS Excel document and customized to the team's particular deadlines (cost, design, and presentation scheduled times). Significant events were color-coded to indicate if they were mandatory meetings (i.e. driver's meetings), dynamic, or static events. A column showing required personnel was also added as a reminder. These

schedules are to be posted in visible locations in the trailer. The schedule for Michigan 2010 can be seen in Appendix D.

Breakdowns in the vehicle can be prevented but all risk cannot be eliminated. There will still be incidents that require the team to react and all of the necessary equipment may or may not be on-site. If there is a need to travel off-site, someone on the team needs to identify what is needed and then research where it could be purchased near the site. Another tool was created to eliminate this step that already documents local resources that the team may need over the course of the competition. This wasn't limited to the needs of the vehicle; grocery and department stores were included in addition to nearby Honda dealers and auto parts shops with their phone numbers, physical addresses, and distances from the competition site and from the house listed. The Honda dealers (the vehicle engine is from a Honda motorcycle) were also contacted to see what kind of spare parts that they had at their stores. This document can be found in Appendix E.

Improving the food management was a repeated topic in the interviews as well as from informal discussions with the team. Being well fed and hydrated can significantly affect a person's performance and cooperation within the team. California 2009 was used as an example of how there wasn't a designated person taking care of food for the whole team. Food was bought daily from local fast food vendors and was expensive, complicated to reimburse, and not healthy. Michigan would have two people in charge of food at the competition. One was the on-site food manager and the other was the house manager. They would work together to determine what was needed every day so that the team would have enough food, drinks, and snacks for hunger and hydration to not be an issue. Breakfast and lunch were similarly served in the sense that food was easily

accessible for team members to come and go when they needed it or had time. Breakfast was planned to consist of breads, cereals, fruits, and yogurt. Lunches had the elements to make sandwiches from peanut butter, meats, and cheeses, with chips and other snacks supplementing them. Drinks were also important and various powdered mixes were bought and planned to be stocked throughout the week. It was commented in the interviews that the dynamic team sometimes didn't get enough food or drink because they weren't usually at the pit when food was made or delivered. This will be addressed by having people run pre-made sandwiches to the dynamic team so that they can continue to participate in the events while being fed.

The dinner for each of the nights were designed to be filling and match with how much time would be available to cook. For example, a more time-intensive meal of Chicken a la King was planned for the night before design presentation. It was thought that the team would mostly be preparing for the event at the house and allow for a more complex meal to happen. Conversely, a burrito bar with minimal cooking was planned for the following day after design semi-finals could take place and run late. Desserts were also planned as a treat for the team to keep morale up. Another addition was having easy-to-make snacks that someone could immediately cook after returning from the competition site. This would control the team's hunger while the main dinner was being made.

The different tools and structures that were discussed and implemented before the Michigan competition address the basic needs of Formula SAE competition management. Having a structure helps divide responsibilities so that forgetting important items (documents, parts) or functions (food, transportation) is minimized. Communication,

scheduling, researching local resources, and food management were the major items that would have the most impact on how effectively the group functioned in their temporary environment. How well they functioned in the field will be reviewed and changes will be made if necessary to improve them for the SAE California competition.

6. Observations from Michigan

The management structure met mixed success. Static and support roles were well defined and fulfilled. It was beneficial to have static event leads, static equipment managers, and those responsible with food visible so people knew who to go if they had questions. Another reason for success in these areas was that it was unprecedented to have structure. This was the first impression of the team of having support roles fulfilled and was accepted. The dynamic team structure had already been defined by team members from previous competitions. It was more difficult to implement the vehicle manager and pit manager structure because of this. Those that have a lot of knowledge in the vehicle including the drivers, sub-team designers, captains, and grad students usually travel with the vehicle and cart. Someone still remains at the pit but they are usually someone that doesn't have as much influence on the team as a captain does. It isn't what was originally stated in the role descriptions but it still works. The original structure will be tweaked to find a balance between new theory and existing structure. Because a lot of the team travels with the vehicle and there is a significant collective knowledge, there may not be a need for a designated vehicle manager or require the dynamic equipment manager be experienced in MOTEC but rather just the general equipment. Other observations for role definitions:

- The team captain performed most of the blog updates, the photographer supported him with the best daily pictures
- Multiple photographers were allowed in the Endurance Event
- Spotters for photographers are not very formalized, anyone can be one
- The dynamic food runner does not need to be a specific position, food can be run by anybody but the on-site food manager should be aware of the dynamic team's needs
- Off-site drivers don't need to be designated but do need to be known and carry a working cell phone

- Cooking was mostly done by house manager and on-site food manager, will be addressed in detail later, possible new role

The major vehicle breakdown for the event occurred Thursday morning as the team was practicing and waiting for track conditions to improve before participating in the acceleration and skid-pad events. The vehicle was in the practice area when an oil hose popped off its fitting and started leaking oil into the bottom of the chassis. The team immediately brought the car out of the practice area and then placed it on the stands. There weren't any paper towels on the cart to soak up the oil so the team asked other teams nearby. Another member called back to the pit to have them run a roll of towels to the practice area. The team was working very quickly because the dynamic events in the morning were going to close in an hour and a half. It was determined that more oil was needed to replace what was lost. Another call was made to the pits to run some oil to the vehicle, but those working on the car weren't sure if the one container that was left would be enough. One member was designated to use the document with local resource information to find the specialty oil that the vehicle needed. After the oil was found, another person was sent to pick several bottles up and returned within an hour. The situation was resolved with the oil on hand and the team had enough time to compete in both of the dynamic events for the morning.

This incident showed a few areas for improvement and a success. The dynamic equipment managers had not been able to work on organizing the cart so that everything was on it when needed. Those that had been asked to do so also had other responsibilities with working on the car. When given a finite amount of time, they chose working on the car rather than prepping the chase cart. This is understandable and a more appropriate person for dynamic manager would be someone that can take the time to prepping the

cart. A tool to help them would be to create a checklist for the cart that is reviewed before leaving the pit. The success of this situation was the response structure. Communication traveled from the dynamic team to the pit explaining what was needed for the car and was delivered quickly. The off-site resources list was also helpful in minimizing the time needed in finding specialty oil. While the outside oil was not necessary in this case, it could have been the difference in making it to the dynamic events or not. As stated earlier, the local resources document was a success and should be used for future competitions. It should be further improved and include maps from the competition site to form a booklet that is stored in the trailer. One weakness of the execution of this process was that the document was required that it be accessed on the internet as well as directions to each of the locations. Researching and printing a hard copy further refines this tool.

While it was identified that a cart checklist would be an important resource, the trailer checklist was not used for preparation to the event. The trailer at competition has a degree of organization but not to the point where tools can be instantly identified and accessed. It is a major project that needs to be addressed by more than a simple checklist. It will be refined for use in California but more effort should be placed with a cart checklist as it is low-hanging fruit situation.

The schedule document seemed to be a success at competition. It was posted just inside both doors to the trailer alongside the rosters. Direct improvements to their use may be to use larger font so that they are more easily read, but the color coding was effective in showing significant events. An adjustment made on-site was that the day's major events were written on a whiteboard so that they were more visible. To

complement the schedule, several digital clocks should be posted in visible locations to help the team keep track of time.

There were no major incidents involving communication breakdowns. The cell phone lists were deployed and may have been used a few times to reach some members. There weren't any daily reminders to charge phones, and while there wasn't a critical situation, a few phones died during the day. A nightly team checklist may need to be created to serve as a preventative reminder. The two-way radios were mostly used for the German member who did not have cell phones. It was good having a contingent form of communication on-site. The California competition will have few, if any, members that don't have a cell phone and is an opportunity to formalize the use of radios. One should always be at the pit and one with the support cart. They may not need to be physically attached, but they should have a designated spot where they are accessible.

On-site food was very successful in meeting the needs of the team. A table was dedicated to food and kept on the side of the trailer so that members could access it easily. The selection consisted of snacks such as pretzels, chips, fruit, candy, and drinks. The available drinks were juice at first and then powdered drinks after they were consumed. Some breakfast foods such as bagels and some yogurt and placed out at the beginning of the day and then replaced with sliced bread and sandwich materials around lunch. Having a refrigerator in the trailer was important in keeping perishable foods on-site. There were several times were sandwiches were pre-made and then run out to the dynamic team. Having enough disposable plates, cups, and utensils for the team was also essential to its success.

Michigan is somewhat unique because of the team's access to a vacation house. Most of the other events will be in camping situations with different resources. Nevertheless, the same concepts should apply. The food success at the house was more mixed. Breakfast took a bit of a learning curve to determine the best selection for team members to come into the kitchen and grab what they needed. There was usually an hour available between waking up the team and having to leave for the site. It seemed that the best method for breakfast was to set out different food items next to the appliance or dishes needed and have individuals choose. For example, coffee and juice near cups, bread and bagels with jam and cream cheese next to the toaster, and cereal next to milk and bowls. There was one occasion where oatmeal was made for the entire team. It was important to use multiple stove burners in order to cook a significant amount within the time allowed.

Dinner had a few good choices and a few that needed to be improved on. The successes were meals that could be cooked quickly such as spaghetti, burritos, sausages, and burgers. The team returned to the house late and was very tired. Keeping a hungry team up waiting for food isn't good for team dynamics or staying rested. Meals that take multiple people and more time can be successful but it is important that they have enough time to prepare before the team returns back to the house or camp. Another advantage of quick cooking is being able to quickly run a second batch if the first is eaten. There was one meal that took a long time to cook and wasn't enough for the team. That situation should be avoided to keep the team happy. Dessert is a nice treat to include after meals. Time, hunger, mood, and the day's accomplishments should be taken into account when deciding if cooking dessert is worth the extra effort.

One issue with cooking that will need to be addressed is that most of the cooking and clean up was done by a few people. This can be a delicate matter due to the unleveled workload on-site and the assumed seniority of individuals within the team. Some members work very hard during the day due to their knowledge of the car and there is an innate ranking within the team. These are both realistic team dynamics that cannot be changed. However, the kitchen tasks still need to be leveled more than they were at Michigan. An assignment system for each day should be made before each the trip begins and be enforced by those the captains and other influential members.

An unexpected addition to the pit area was a speaker for playing music. It was utilized well for background working music as well as some play time. Both help the team work together better and it should be encouraged at future events.

7. Conclusions

Winning the overall SAE Michigan competition was a huge accomplishment from many different people's efforts. By no means did the competition management structure suggested in this paper win the competition but it was an essential element that complemented the other strengths of the team. The major incident of the event was handled effectively with the help of the support structure. Food management was significantly improved from past competitions and helped the team perform at its best. There are several areas that need improvement for the next competition in order to be even more effective. All tools and processes should be continuously improved after each competition as different incidents occurs as various weaknesses and strengths are found.

In addition to the management tools that were created through this paper, the studies selected in the literature review should provide focus for future teams. The film industry structure seems to be an effective model for Formula SAE teams. As it is developed further and becomes accepted within the team, introducing the attitudes and dynamics that Bechky describes would a good direction to move in (2006). Weeks' reflective work with her nursing mobilization has several points that future competition management tools should use as reference. Again, those are flexibility, preplanning, chain of command, systems thinking, communication, and supply chain (Weeks, 2007).

Addressing Knowns, Known Unknowns, and Unknown Unknowns (Denning, 2006) may informally be occurring within the team. Testing remains the primary method to determine the weaknesses of the vehicle while they can still be resolved before competition. As previously discusses, testing can shift catastrophic events to being manageable when the team knows how to react to them. This reduces the overall risk

factor when at competition and inversely increases the chance for success. Another element of testing that isn't as always discussed is that it is team practice. Especially with travelling to a testing location such as Dallesport, the team is forces to work together and react to incident away from the shop, university, and home. Testing here creates a similar temporary organization as to the one at competition. There wasn't much testing before Michigan 2010 but is highly encouraged for future events and seasons. Furthering research in risk management to explore different situations that the team might face and resolutions would be beneficial. It would be a major project to take on.

Another project that would improve the effectiveness at competition would be to organize and sustain order in the trailer. A lot of incident responses depend on parts, material, and tools from the trailer. Having those items accessible could provide the few minutes that the team needs to compete.

Global Formula Racing came into their first competition with force and returned home with the first place trophy. A lot of effort has been put into the team, the design, and the vehicle, but it doesn't mean much if the team cannot execute at competition. Competition management of this temporary organization is the lens that focuses the team to the best performance. The highest levels of racing require flawless team execution and this paper encourages GFR to embrace these ideas as part of the evolution of team excellence.

Works Cited

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Appendices

Appendix A-1: IRB Documents – Notification of Exemption

Institutional Review Board • Office of Research Integrity
B308 Kerr Administration Building, Corvallis, Oregon 97331-2140
Tel 541-737-8008 | Fax 541-737-3093 | IRB@oregonstate.edu
http://oregonstate.edu/research/ori/humansubjects.htm

NOTIFICATION OF EXEMPTION

May 27, 2010

Principal Investigator:	Robert Pasch	Department:	Mechanical, Industrial, and Manufacturing Engineering
Study Team Members:	N/A		
Student Researcher:	Michael Warmack		
Study Number:	4587		
Study Title:	Best Management Practices in Temporary Environments		
Funding Source:	None		
Submission Type:	Initial Application received 03/18/10		
Review Category:	Exempt	Category Number:	2

The above referenced study was reviewed by the OSU Institutional Review Board (IRB) and has determined that it is exempt from full board review. You may proceed with the research described in the protocol.

Expiration Date: 04/19/11
Annual continuing review applications are due at least 30 days prior to expiration date

Documents included in this review:

- ☒ Protocol
- ☒ Consent forms
- ☐ Assent forms
- ☐ Grant/contract
- ☒ Recruiting tools
- ☒ Test instruments
- ☐ Attachment A: Radiation
- ☐ Letters of support
- ☐ External IRB approvals
- ☐ Translated documents
- ☐ Attachment B: Human materials
- ☐ Other:

☐ Project revisions:

Principal Investigator responsibilities:

- Amendments to this study that impact the requirements for review must be reviewed prior to initiating the change. Please contact the IRB Office if you have questions about planned amendments.
- To ensure that changes to this research project have not altered the review category[1], the Principal Investigator must complete a brief renewal application on an annual basis. Submit a continuing review application or final report to the IRB for review at least four weeks prior to the expiration date. Failure to submit a continuing review application prior to the expiration date will result in termination of the research, discontinuation of enrolled participants, and the submission of a new application to the IRB.
- All study team members should be kept informed of the status of the research.
- Reports of unanticipated problems involving risks to participants or others must be submitted to the IRB within three calendar days.

If you have any questions, please contact the IRB Office at IRB@oregonstate.edu or by phone at (541) 737-8008.

[1] Review categories include exempt, expedited, and full board.

Appendix A-2: IRB Documents – Initial Application

Institutional Review Board • Office of Research Integrity
B308 Kerr Administration Building, Corvallis, Oregon 97331-2140
Tel 541-737-8008 | Fax 541-737-3093 | IRB@oregonstate.edu
http://oregonstate.edu/research/ori/humansubjects.htm

INITIAL APPLICATION
Study Number: Assigned by Office

Study Title:	Best Management Practices in Temporary Environments		
Principal Investigator:	Dr. Robert Paasch		
email address:	paasch@engr.oregonstate.edu	Telephone:	1.541.737.7019
College, Center, or Institute:	Engineering		
If "other", indicate college:			
Department:	Other		
If "other", indicate department:	Mechanical, Industrial, and Manufacturing Engineering		

Please email the completed application and all relevant attachments to IRB@oregonstate.edu

- File names for all attachments should include the last name of the Principal Investigator, document title, and version date. For example: Smith_Protocol_10272009.doc
- All attachments should include the last name of the Principal Investigator, document title, version date, and page number.
- Signature page must be mailed, faxed, or scanned and emailed to the IRB.

1. **In one paragraph or less, state your primary research question:** The purpose of this research is to identify and quantify potential problems, challenges, and opportunities in the OSU Society of Automotive Engineers Formula team with a focus on their management structure at competition. The goal is to identify what improvements would be most beneficial to the SAE teams to potentially improve their success at competition.

2. **Anticipated Level of Review**
   See Review Level Determination form at http://oregonstate.edu/research/ori/forms/IRBreview.doc

   ☒ Exempt
   ☐ Expedited
   ☐ Full Board

3. **Sources of Support for this project (pending or awarded)**

   ☐ Internal Funding Source: _____
   ☐ External Funding Source: _____
   ☐ Source of material, equipment, drugs, supplements, or devices: _____
   ☒ None of the above

   If funded, submit a copy of the grant or contract. If award is pending, submit as a project revision if and when funding or material is awarded.

4. **Ethics and Compliance Training**

Institutional Review Board • Office of Research Integrity
B308 Kerr Administration Building, Corvallis, Oregon 97331-2140
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http://oregonstate.edu/research/ori/humansubjects.htm

INITIAL APPLICATION
Study Number: Assigned by Office

All study team members involved in this project must receive training in the ethical use of human participants in research. Please refer to the Education Requirement Policy at: http://oregonstate.edu/research/ori/humansubjects.htm

Study Team Member(s)	Role in Project	email Address	Ethics Training Completed
Dr. Robert Paasch	Principal Investigator	paasch@engr.oregonstate.edu	☒ Yes ☐ No
Michael Warmack	Student Researcher	warmackm@onid.orst.edu	☒ Yes ☐ No
	Student Researcher		☐ Yes ☐ No
	Student Researcher		☐ Yes ☐ No
	Student Researcher		☐ Yes ☐ No
	Student Researcher		☐ Yes ☐ No
	Student Researcher		☐ Yes ☐ No
	Student Researcher		☐ Yes ☐ No

5. Risk/Benefit Assessment for adults and/or children

Minimal risk: The probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

Adults	Children
☒ Minimal risk	☐ Minimal risk
☐ Greater than minimal risk	☐ Greater than minimal risk, but holds prospect of direct benefit to subjects
	☐ Greater than minimal risk; no prospect of direct benefit to subjects but likely to yield generalizable knowledge about the subject's disorder or condition
	☐ Research not otherwise approvable but presents an opportunity to understand, prevent, or alleviate a serious problem affecting the health or welfare of the subjects

6. Subject Population

Total number (not a range) of subjects that will be enrolled over the life of the study: 50

Participant age range (check all that apply):

☐ 0-7: include parental consent form, unless seeking waiver

☐ 8-17: include assent form and parental consent, unless seeking waiver

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INITIAL APPLICATION
Study Number: Assigned by Office

☒ ≥18: include consent document or oral consent guide, unless seeking waiver of consent

Populations who may enroll in this research, even if they are not the target population (check all that apply):

☐ Adults lacking capacity to consent
☐ Pregnant women and fetuses
☐ Children in foster care or wards of the state
☐ OSU Students or employees
☐ Prisoners *(ineligible for exempt review)*

☐ Non-English speakers: If non-English speakers will be enrolled, provide details below regarding qualifications of the translator(s) and of the research staff or student(s) obtaining consent in a language other than English: _____

7. If the research involves any of the following, check the appropriate box

☐	Study of existing data	*Data must be "on the shelf" prior to conception of current study in order to be considered existing*
☐	Audio or video recording	*Consent document must indicate whether recording is optional or a required study activity. If optional, include an opt-in/opt-out section for subjects to initial*
☐	Deception	*Requires full board review*
☐	Radiation	*Complete attachment A. IRB will forward submission to Radiation Safety*
☐	Human biological materials	*Complete attachment B. IRB will forward submission to Biosafety*
☐	Microorganisms or Recombinant DNA	*IRB will forward submission to Biosafety*
☐	Sending or receiving biological materials	*Contact Technology Transfer regarding the potential need for a Material Transfer Agreement (541)737-4437*
☐	Using Chemical Carcinogens	*List of applicable chemicals: http://oregonstate.edu/ehs/carclist IRB will forward to Chemical Safety*
☒	Waiver of documentation (signature) of informed consent	*Include justification in protocol. See IRB website for INSTRUCTIONS FOR ORAL OF ALTERNATIVE CONSENT PROCESS*
☐	Waiver of informed consent	*Include justification in protocol*
☐	Translated documents	*Include material in English and translated into a language spoken by participants*

8. Research and/or recruitment sites

☐ If multi-center study, list all participating academic institution(s): _____
Submit IRB approvals from other sites
☐ Attached
☐ Pending

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B308 Kerr Administration Building, Corvallis, Oregon 97331-2140
Tel 541-737-8008 | Fax 541-737-3093 | IRB@oregonstate.edu
http://oregonstate.edu/research/ori/humansubjects.htm

INITIAL APPLICATION
Study Number: Assigned by Office

☐ List all sites of research and/or recruitment. For example, schools, medical centers, tribal reservations, international sites, listservs, Registrars, etc.

Name(s) of other research site(s): N/A
Provide letter(s) of support from appropriate authority at each site

Name(s) of other recruitment site(s): N/A
If recruitment method involves more than an advertisement (newspaper classified, flier, listserv email), provide letter(s) of support from appropriate authority

9. Attachments *(check all that apply)*:

☒ Protocol (required)	☐ Grant application or funding contract
☐ Consent Document(s)	☒ Recruiting tools (e.g., ad copy, flyers, letters)
☐ Assent Document(s)	☒ Test instruments (e.g., questionnaires, surveys)
☐ Attachment A: Radiation	☐ Material(s) in other languages
☐ Attachment B: Human Materials	☐ External IRB Approvals

☐ Letters of support from external research sites

☒ Other: Oral Consent Guide

10. Will the study need to be registered with ClinicalTrials.gov?

☐ **Yes** Applicable* Clinical Trials:

Trials of Drugs and Biologics: Controlled clinical investigations of a product subject to FDA regulation, other than Phase I investigations
Trials of Devices: Controlled trials with health outcomes of devices subject to FDA regulation, other than small feasibility studies and pediatric postmarket surveillance
**NIH encourages registration of ALL trials whether required under the law or not.*
http://grants.nih.gov/grants/guide/notice-files/NOT-OD-08-014.html

☒ **No**

11. Conflict of Interest:

Federal Guidelines require assurances that there are no conflicts of interest in research projects that could affect the welfare of human subjects. If this study presents a potential conflict of interest, additional information will need to be provided to the IRB.

Examples of potential conflicts of interest in research involving human subjects may include, but are not limited to:

- A researcher or family member participates in research on a technology, process or product owned by a business in which the faculty member holds a financial interest.
- A researcher participates in research on a technology, process or product developed by that researcher.

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- A researcher or family member has a financial or other business interest in an entity which is supplying funding, materials, products, or equipment for the current research project.
- A researcher or family member serves on the Board of Directors of a business which is supplying funding, materials, products, or equipment for the current research project.
- A researcher receives consulting income from an entity that is funding the current research project.

Does any member of the study team, or any of their family members, have a financial or other business interest in the source(s) of funding, materials, or equipment related to this research study?

☒ No
☐ Yes – Please describe: _____

By signing below, I certify that the information contained in this application is accurate and complete. I understand that research involving human participants, including recruitment, may not begin until full approval has been granted by the IRB.

Name of Principal Investigator: _____

Signature_____ Date_____
Principal Investigator

The signature page must be received by the IRB before review of the application will begin.

The signature page may be:

- **sent via mail to B308 Kerr**
- **faxed to the IRB at (541) 737-3093 or,**
- **scanned and sent via email**

Appendix A-3: IRB Documents – Protocol

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RESEARCH PROTOCOL

15 March 2010

1. **Protocol Title:** Best Management Practices in Temporary Environments

PERSONNEL

2. **Principal Investigator:** Dr. Robert Paasch, Associate Professor, School of MIME, OSU
3. **Student Researcher:** Michael Warmack, Industrial Engineering Student, OSU
4. **Co-investigator:** None
5. **Study Staff:** None
6. **Investigator Qualifications:** The principal investigator is an associate professor in the School of Mechanical, Industrial, and Manufacturing Engineering at Oregon State University. Dr. Paasch has had much experience in academia and industry that have given him the insight in effective ways for identifying opportunities for improvement in a system. He has also been involved in several Honors thesis projects as a mentor.
7. **Student Training and Oversight:** The student researcher is an undergraduate student in industrial engineering with industry experience through the university MECOP program. There will be constant communication between the principal investigator and the student researcher through email and weekly status meetings. No extended absences are planned at this time, but in such of an event, oversight will be transferred to another professor within the School of MIME that is familiar with the research.

DESCRIPTION OF RESEARCH

8. **Description of Research:** The purpose of this research is to identify and quantify potential problems, challenges, and opportunities in the OSU Society of Automotive Engineers Formula team with a focus on their management structure at competition. The goal is to identify what improvements would be most beneficial to the SAE team to possibly improve their success at competition. By interviewing current SAE members, comparing different responses, and quantifying all responses together, opportunities for improvement may possibily be visible. These results will be compared to industry best practices and published in a thesis for the University Honors College (UHC), presented for an Honors review board, and displayed at the UHC thesis fair in May 2010.
9. **Background Justification:** The OSU Society of Automotive Engineers (SAE) is a nonprofit, student-run organization that designs, manufactures, tests and competes with a Formula-style race car. The competition environment is much different than the fixed structure of day-to-day activities at Oregon State. An effective field management structure is important so that the team can perform well at events and respond to situations that affect their success. Previously, most of the management at competitions is reactive to situations, and a proactive approach would be an improvement.
10. **Subject Population and Recruitment**

- The participant population will be members of the Oregon State Society of Automotive

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engineers.

- Up to fifty (50) individuals will participate to the study.
- The team captains for OSU SAE will be notified of the study and asked to participate. They will also be asked to communicate with all members of OSU SAE notifying them of this research opportunity with the attached email script. Members can voluntarily respond by contacting the student investigator. The student researcher will schedule interviews based on the interviewee's convenience.
- Privacy will be protected by limiting knowledge of participation to the research team only.

11. Consent Process

- A waiver of documentation (signature) of informed consent will be sought for this study. This is based off the second cause for waiver that the IRB permits:

  > *That the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context.*

  There are no foreseeable risks to participants, and it is common in industry for internal research on opportunities for improvement not to require documentation of consent during interviews. These reasons meet the second cause for waiver quoted above.

- Consent will be available to participants twice before the interview is conducted. The first will be during the notification of this opportunity. The Informed Consent Document (attached) will be attached to the email script that OSU SAE team captains will be asked to communicate with all members and referenced in the email script. The second opportunity will be at the interview but before any questions are asked. Participants will be shown the Informed Consent Document and any questions about the process will be answered. Only after this then the interview will proceed and they the participant can skip questions or stop at any point. They will have the opportunity to keep the Informed Consent Document for their personal use so they can contact the student researcher or the IRB at any point after the interview is conducted.

12. Eligibility Screening: Any OSU SAE member is welcome to voluntarily participate and there will be no screening of subjects.

13. Methods and Procedures

i. Identify Participants: SAE members will be notified of the research opportunity through the team captains. If they choose to participate, they can contact the student researcher.

ii. Schedule Interviews: Interviews will be scheduled based on availability of each individual member. No interviews will interfere with the work or school requirements of the participants.

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iii. Conduct Interviews: All information collected throughout the interview sessions will be recorded on paper interview templates, which contain the interview questions. A copy of the questions will be available for the interviewee to keep, upon request. The interview templates are included as an attachment.

iv. Analyze Data: Analysis of the data will begin by typing interview data and sorting into appropriate management categories. The data will then be coded in order to determine common themes and potential problem sources. Coded data will not be linked directly to participants.

14. **Compensation:** There will be no compensation for participating in the study.

15. **Cost:** There will be no costs associated with the study.

16. **Anonymity or Confidentiality**

- Knowledge of interview participation will be limited to the research team. No record will be kept of participation. Email responses will be destroyed at the termination of the study.
- The paper interview template (attached) will not contain any personal information that could identify any participant.
- Confidentiality of the information provided during this research study will be kept confidential to the extent permitted by law.
- After research is collected and quantified, participant responses will be retained in a paper format in a locked storage cabinet for at least three years post study termination. Digital copies of the typed up responses will be placed onto a data media format and placed in the locked storage cabinet. Digital files on hard drives will be destroyed at the end of the study.

17. **Risks:** There are no foreseeable risks to participation. No additional advantages or disadvantages will result from participation. Those who choose not to participate in the data collection will be thanked and will not be contacted again for this study.

18. **Benefits:** Participants may directly benefit from the study. It is expected that the results will be available for 2010 competitions and will possibly improve the performance of the team during this and future seasons.

19. **Assessment of Risk-to-Benefit ratio:** There no foreseeable risks and potentially significant benefits. Therefore, the benefits outweigh the risks.

Appendix A-4: IRB Documents – Captain Recruitment Script

Recruitment Script for Team Captains

Project Title: Best Management Practices in Temporary Environments
Principal Investigator: Dr. Robert Paasch, Assoc. Prof., School of MIME, Oregon State University
Student Investigator: Michael Warmack, Engineering Student, Oregon State University

My name is Michael Warmack and I am a student at Oregon State University. I am beginning a research project with your student organization: the Society of Automotive Engineers, Formula (FSAE). I would like to conduct interviews with team members that would approximately take thirty (30) minutes. During these interviews I will ask several questions about past incidents at competitions where team members needed to react to situations. I will focus on dynamic and static events and support roles.

For your involvement in this research, I would provide you with a summary of the results from these interviews along with some recommendations based on my research. In addition, I would provide you with a summary of my overall findings.

If you are interested in participating in this research, please contact me at warmackm@onid.orst.edu. I will then send a script to that you can email to the members of FSAE at Oregon State. It will provide details how they can contact me if they wish to volunteer for this research opportunity.

Thank you for your time.

Appendix A-5: IRB Documents – Interview Recruitment Script

Recruitment Script for Interviews

Project Title: Best Management Practices in Temporary Environments
Principal Investigator: Dr. Robert Paasch, Assoc. Prof., School of MIME, Oregon State University
Student Investigator: Michael Warmack, Engineering Student, Oregon State University

My name is Michael Warmack and a student at Oregon State University. I am beginning a research project with your student organization: the Society of Automotive Engineers, Formula (FSAE).

You are invited to participate in a research study that will focus on identifying potential areas for improvement in management structure at competitions. The research will be gathered through interviews with team members such as yourself. This could potentially improve the performance of FSAE at events. This research will be published for use in the University Honors College (UHC), presented for an Honors review board, and displayed at the UHC thesis fair in May 2010.

If you are interesting in participating, the interview would approximately take thirty (30) minutes that we can schedule at your convenience. Attached to this email is the "Informed Consent Document" that describes the study and your rights as a research subject if you choose to volunteer. Would you be willing to participate?

Thank you for your time. Please contact me at warmackm@onid.orst.edu with a day and time that would work for you if you are willing to participate

Appendix A-6: IRB Documents – Informed Consent Document

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INFORMED CONSENT DOCUMENT

Project Title: Best Management Practices in Temporary Environments
Principal Investigator: Dr. Robert Paasch, Associate Professor, School of MIME, Oregon State University
Student Investigator: Michael Warmack, Industrial Engineering Student, Oregon State University

PURPOSE OF THE STUDY

The purpose of this research is to identify and quantify potential problems, challenges, and opportunities in the OSU Society of Automotive Engineers Formula team with a focus on their management structure at competition. The goal is to identify what improvements would be most beneficial to the SAE team to possibly improve their success at competition.

PURPOSE OF THIS DOCUMENT

This document gives you the information you will need to help you decide whether to be in the study or not. Please read the form carefully. You may ask any questions about the research, the possible risks and benefits, your rights as a volunteer, and anything else that is not clear. When all of your questions have been answered, you can decide if you want to be in this study or not.

PERSONS RESPONSIBLE FOR STUDY

The study and interviews will be conducted by the student researcher, Michael Warmack, and under the guidance of the principal investigator, Dr. Robert Paasch.

THE PURPOSE OF THE RESEARCH

The purpose of this research is to interview Oregon State Society of Automotive Engineers Formula team members and quantify past challenges at competitions and ideas that may be useful for upcoming competitions. Your answers will be compared to other responses to determine trends and possibly identify how OSU SAE could improve their success at competition.

THE NATURE OF PARTICIPATION

You will participate in an interview. If you agree to participate, it will approximately take thirty (30) minutes to complete. In the event that we reach thirty minutes and not all questions have been asked, you have the option to continue for any length of time that you are willing to commit.

ACCESSIBILITY TO INDIVIDUAL INTERVIEWS

The information you provide during this research study will be kept confidential to the extent permitted by law. Special precautions have been established to protect the confidentiality of your responses. Only

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the research personnel at Oregon State University will have knowledge of your participation in this study. If the results of this project are published your identity will not be made public.

POTENTIAL RISKS WITH PARTICIPATION

There are no foreseeable risks in participation.

POTENTIAL BENEFITS WITH PARTICIPATION

The collected information will be able to highlight common challenges for OSU SAE at competitions. These results will be considered with other research in the project and recommendations will be made to the Formula SAE team. It is expected that these suggestions will be available for competitions during the 2010 season and possibly improve performance.

VOLUNTARY PARTICIPATION

If you decide to take part in the study, it should be because you want to volunteer. You can stop at any time during the study, and you are also free to skip any question that you would prefer not to answer. If you choose to withdraw from this project before it ends, the researchers may keep information collected about you and this information may be included in study reports.

WHOM TO CONTACT WITH QUESTIONS OR CONCERNS

If you have any questions about this research project, please contact: Michael Warmack at 971.227.1442 or warmackm@onid.orst.edu.

If you have questions about your rights as a participant, please contact the Oregon State University Institutional Review Board (IRB) Human Protections Administrator, at (541) 737-8008 or by email at IRB@oregonstate.edu.

ORAL CONSENT

By agreeing to participate in this study, it will be considered that you have provided consent.

Appendix A-7: IRB Documents – Interview Template

Interview Template

Project Title: Best Management Practices in Temporary Environments
Principal Investigator: Dr. Robert Paasch, Assoc. Prof., School of MIME, Oregon State University
Student Investigator: Michael Warmack, Engineering Student, Oregon State University

Thank you for agreeing to participate in this interview. As discussed earlier, we will be discussing opportunities for improvement for the SAE Formula team at competition. Before we begin, please review the Informed Consent Document and ask any questions that you may have about the process.

You may keep the guide for your records as well as a copy of these questions.

I will be asking a series of questions about specific situations and events. I would like you to be as specific as you can about these events. Additional questions will ask if you have any ideas for improvement at competition. This interview will approximately take thirty (30) minutes. In the event that we reach thirty minutes and not all questions have been asked, you have the option to continue for any length of time that you are willing to commit.

(Preliminary Section)

How long have you been involved with the SAE team?

What do you most like about being a part of SAE Formula?

Will you be able to go to at least one SAE competition this year?

Have you been to an SAE competition before?

If *Yes: Proceed with all following sections.*

If No: Skip Sections 2, 3, and 4

(Section 1) Please think of an event that is not part of SAE Formula that you had to plan and execute. This could be a camping trip, a road trip, a student event, etc.

Can you recall and describe an event where an unexpected incident required yourself or others to react?

Can you please describe the situation?

How did you or others respond to the situation?

Were you successful in resolving the situation?

What would you done differently or what would have been helpful if this situation happened again?

(Section 2a) Formula SAE goes to several competitions every year with their finished car. The dynamic or moving events that you can earn points in are: acceleration, skid pad, autocross, fuel economy, and endurance.

Can you recall and describe an incident at a dynamic event where an unexpected situation required the team or yourself to react?

Can you please describe the situation?

How did the team or you respond to the situation?

Were you successful in resolving the situation?

What would you done differently or what would have been helpful if this situation happened again?

(Section 2b) Is there anything is particular at competition that you have experienced and felt it increased success in dynamic events and can you explain what that is and why?

(Section 3a) There are also static events at competitions and include: business presentation, engineering design, and cost analysis. Combined, they are worth over 30% of the competition score.

Can you recall and describe an event at a static event where an unexpected incident required the team or yourself to react?

Can you please describe the situation?

How did the team or you respond to the situation?

Were you successful in resolving the situation?

What would you done differently or what would have been helpful if this situation happened again?

(Section 3b) Is there anything is particular at competition that you have experienced and felt it increased success in static events and can you explain what that is and why?

(Section 4a) Dynamic and static events directly affect the competition score. Other indirect effects are how the team supports each other when not competing. Some examples of team support are: transportation, food, off-site trips for supplies, communication – both visual and verbal, etc.

Can you recall and describe an event in a support role where an unexpected incident required the team or yourself to react?

Can you please describe the situation?

How did the team or you respond to the situation?

Were you successful in resolving the situation?

What would you done differently or what would have been helpful if this situation happened again?

(Section 4b) Is there anything is particular at competition that you have experienced and felt it increased success of the support role and can you explain what that is and why?

(Section 5) Do you have any suggestions that you feel would increase the success that the team has in dynamic events?

Do you have any suggestions that you feel would increase the success that the team has in static events?

Do you have any suggestions that you feel would increase the success that the team has in a support role?

(Section 6) What do you think is the team's greatest strength at competition and can you explain why?

What do you see as an area of improvement for the team at competition and can you explain why?

Appendix B: Interview Responses

Preliminary Section

How long have you been involved with the SAE team?

1 Two years
2 Five years
3 Four years
4 One year
5 Three years
6 Three years
7 Ten years

What do you like most about being part of SAE Formula?

1 Building a race car
2 Going to competition
3 Practical experience in solving issues
4 Prepares for engineering job
5 Working on car, learning, being part of the team
6 Real engineering, see other cars at competition, trade experiences
7 Winning; supporting the development of engineers

Will you be able to go to at least one SAE competition this year?

1 Yes
2 Yes
3 Yes
4 Yes
5 Yes
6 Yes
7 Yes

Have you been to an SAE competition before?

1 Yes
2 Yes
3 No
4 No
5 Yes
6 Yes
7 Yes

General Experience Section

Can you recall and describe an event where an unexpected incident required yourself or others to react?

1 Broke a raft on a trip
2 Rafting the Grand Canyon
3 Eagle Project building a dock off a house
4 Camping trip
5 Camping trip
6 Long-distance hike
7 Hunting trip

Can you describe the situation?

1 Ripped a valve off
2 Short on beer, too much food
3 Plan was based off conditions that changed as well as changes to actual design
4 Split responsibilities among group and some didn't fulfill their needs such as bringing fire equipment; rained
5 Motor home overheated and broke down; radiator cap popped
6 No research of trail, couldn't find any trail; tents leaked at night
7 Hunting trip; tried to carry out a elk late on exposed ridge with no food and water; became hypothermic

How did you or others respond to the situation?

1 Borrowed parts from other groups, repaired on shore
2 Dealt with it
3 Modified design based off the material on-hand
4 Looked at all available items on-hand, used lighter flint and body spray to start fire
5 Cooled down, refilled radiator and recapped
6 Dealt with it but eventually left
7 Others in group recognized hypothermia and responded with appropriate first aid

Were you successful in resolving the situation?

1 Yes
2 Yes
3 Yes
4 Yes
5 Yes
6 No
7 Yes

What would you done differently or what would have been helpful if this situation happened again?

1. Have spare parts with group, check spares before trip
2. Bring more food
3. More frequent communication with customer; more direct communication
4. Personally brought the equipment
5. Nothing
6. Prepare ahead of time, contingencies, emergency contact info, better general planning
7. Prepared better for day, re-evaluate when situation changed

Dynamic Event Section

Can you recall and describe an incident at dynamic event where an unexpected situation required the team or yourself to react?

1. Suspension failure
2. 2006. Starting clutch failure
3. N/A
4. N/A
5. Couldn't pass brake test at 2009 FSG
6. 2008. Car had low oil pressure while in line for Autocross
7. 2005 Baja. Major accident and damage to front suspension

Can you describe the situation?

1. Suspension mount failed and a-arms buckled
2. Clutch failed on Friday of events
3. N/A
4. N/A
5. Engine blew before event and may have spilled fluid onto brake rotor. Couldn't lock axle with brakes
6. Oil pump failed; custom part had never failed
7. Inexperienced driver took first jump aggressively and damaged front right suspension.

How did you or others respond to the situation?

1. Evaluated situation; repaired on-site overnight; bought necessary material
2. Rolled to pits and decided to pull engine and cut chassis to get to the part
3. N/A
4. N/A
5. Troubleshoot problem; changed brake bias, cleaned brake cylinder, cleaned rotor, replaced rotor, and talked to other teams for parts.
6. Repaired part
7. Team reacted instantly to repair bent a-arms and tie rods. No blame placed on driver.

Were you successful in resolving the situation?

1 Yes
2 Yes
3 N/A
4 N/A
5 Yes
6 Mixed, successful repair but event closed before car could run
7 Yes

What would you done differently or what would have been helpful if this situation happened again?

1 More testing to identify issue beforehand
2 Serviceability in design
3 N/A
4 N/A
5 Design bigger rotors and multiple brake pistons; don't shortcut with repairs; have supplies on-hand; have knowledge to repair
6 Design for maintainability
7 No changes

Is there anything in particular at competition that you have experienced and felt it increased success in dynamic events and can you explain what that is and why?

1 Continuing the lightweight car concept
2 Double-check everything on car
3 N/A
4 N/A
5 Team meeting at the end of day to review and prepare for the next; first in line for events
6 Being at events and on-site first as a team
7 N/A

Static Event Section

Can you recall and describe an incident at static event where an unexpected situation required the team or yourself to react?

1 No
2 Forgetting something for presentations
3 N/A
4 N/A
5 CA 2009, car was broken when announced that team made it to design semi-finals
6 CA 2009, car was damaged for semi-finals
7 CA 2009, background forgotten for presentation judges

Can you describe the situation?

1 N/A
2 USB w/ slide show for presentation; wax paper for design
3 N/A
4 N/A
5 Team wasn't expecting to be in design semis, especially with broken car.
6 Team wasn't expecting to be in design semis, especially with broken car.
7 Background was forgotten to give to judges

How did you or others respond to the situation?

1 N/A
2 Sent runner to pit to get items
3 N/A
4 N/A
5 Scrambled to bring everything together for design semis
6 Scrambled to bring everything together for design semis
7 One presenter excused themselves and ran back to pit to retrieve information

Were you successful in resolving the situation?

1 N/A
2 Yes
3 N/A
4 N/A
5 Yes
6 Yes
7 Yes

What would you done differently or what would have been helpful if this situation happened again?

1 N/A
2 More organization
3 N/A
4 N/A
5 Prepare for all levels of design
6 Better preparation
7 Checklist for presentation; have response team ready

Is there anything in particular at competition that you have experienced and felt it increased success in static events and can you explain what that is and why?

1 Rehearsal and preparation for events
2 Posted schedule for OSU and other top teams
3 N/A

4 N/A
5 Able to deliver when it matters the most; shear will of wanting to succeed
6 Everything is related to the lightweight design theory
7 N/A

Support Roles Section

Can you recall and describe an incident in a support role where an unexpected situation required the team or yourself to react?

1 Needing supplies
2 Food on-site
3 N/A
4 N/A
5 Running off-site for car parts
6 Tech inspection needed something in particular but was forgotten
7 Needed to find parts off-site, vehicle was being used for food and driver couldn't be contacted

Can you describe the situation?

1 Suspension broke and needed to go out and find the necessary parts.
2 No one was in charge of food and those that were assigned on-site performed poorly
3 N/A
4 N/A
5 Needed fuel pump for engine, didn't have spare
6 Forgotten item at tech inspection
7 Priorities changed and vehicle resource and driver were unable to be contacted so that they could respond appropriately

How did you or others respond to the situation?

1 Someone went out at night and found what was needed.
2 No response
3 N/A
4 N/A
5 Team member negotiated part off a floor model at a dealer
6 Had someone run back to pit to grab necessary items
7 Had to wait until driver came back to pit to go back and find parts

Were you successful in resolving the situation?

1 Yes
2 No
3 N/A
4 N/A
5 Yes

6 Yes
7 No

What would you done differently or what would have been helpful if this situation happened again?

1 Standardized list of spares based on past needs
2 Have designated person, plan food beforehand
3 N/A
4 N/A
5 Run an inventory of parts in trailer
6 Have designated runner
7 Have cell phones charged, on, and with person; remind team everyday to do so; have two vehicles ready to travel

Is there anything in particular at competition that you have experienced and felt it increased success in a support role and can you explain what that is and why?

1 No. Often a lack of planning and going off-schedule
2 Parts runners to dynamic areas
3 N/A
4 N/A
5 Organized shipping in its own bins between international events, labeling, bill of material; grouping together and executing when it's time
6 Good driver support: food, water, umbrella
7 N/A

Suggestions Section

Do you have any suggestions that you feel would increase the success that the team has in dynamic events?

1 Additional time for testing
2 Testing
3 People with design experience are ready to act during dynamic events
4 Testing, well-defined comp schedule, roles, material, car setup and prep; fans for cooling engine
5 Push cart is organized w/ parts and driver gear; be flexible and ready
6 Testing; have tuning settings on-hand at event
7 Test, tune, prep. Car and driver are in perfect condition; watch weather for strategic decisions

Do you have any suggestions that you feel would increase the success that the team has in static events?

1 More preparation, time, and resources available for reports
2 N/A

3 All members have basic understanding of car and general automotive knowledge
4 Schedule roles, prepare visuals and demos, props; people know what to wear; huddle/pep-talk on key points
5 Preparing beforehand; rehearse; good visuals; don't improvise - say what you know, aim for semis to show-off more knowledge
6 Integrate whole team together at design; use design mistakes as engineering examples
7 More preparation for cost event and real scenario

Do you have any suggestions that you feel would increase the success that the team has in a support role?

1 Better prep and organization of parts before leaving; better time management up to leaving for competition
2 Willingness
3 Have someone dedicated to food; cheering section at dynamic
4 Preparation and organization; communication with home base and able to communicate with everybody; identify people that are able to drive
5 Define roles early and communicate/execute well; be organized
6 Have a "gopher" that can get parts. Check communication equipment beforehand; food support
7 Better food management; feed dynamic team and mission critical members; hydration

Strengths and Weaknesses Section

What do you think the team's greatest strength is at competition and can you explain why?

1 First in line for everything and the ability to react quickly
2 We're competitive and dedicated
3 Team works together well
4 Organization and preparation
5 Always able to deliver, no matter what the situation; getting work done
6 Vast combined knowledge; strong drive
7 Better organization than 95% of teams

What do you see as an area of improvement for the team at competition and can you explain why?

1 Better identification of support roles at competition
2 Take responsibility, find work to be done
3 Working together with German/American counterparts; communication on collaborative efforts; team building/involvement/non-work activities/motivations; realistic deadlines
4 Communication and organization
5 Preparation and organization

6	More accurate modeling of advance materials and physical testing; take advantage of mistakes; communication; clear vision of events; bring in people that aren't knowledgeable
7	People are competition that do not have tasks get in the way, find a role for everybody; uneven work distribution, not enough chairs

Appendix C: Trailer Checklist Example

☐	Trailer Toolbox Item
	Socket set, standard
	Socket set, metric
	Spare M8 socket
	Ratchet set
	Wrench set, standard
	Wrench set, metric
	Spare M8 wrench
	Drill bit set, metric
	1/4" drill bit
	Cordless drill
	Drill charger
	Drill battery
	Masking tape
	Duck tape
	Electrical tape
	Helicoil kit, 1/4-28
	Helicoil kit, M5
	Helicoil kit, M6
	Helicoil kit, M8
	C-Clamps, Assorted
	Screwdriver set, Phillips
	Vice grips, Assorted
	Calipers
	Allen wrench set, standard
	Allen wrench set, metric
	Needlenose pliers
	Dikes
	Safety wire
	Safety wire pliers
	Lock-Tite, Red

☐	Other Items
	Air compressor
	Air hose
	Air tank
	Bulk nitrogen
	SCUBA nitrogen
	Arbor press
	Generator
	Battery chargers (2)
	Extension cords, minimum 200 feet
	Power strips (4)
	Folding tables (2)
	Small red toolbox
	Tire pressure gauge, red toolbox
	Wheel nut wrench, red toolbox
	Allen wrench set, standard, red toolbox
	Allen wrench set, metric, red toolbox
	Mobile composites lab (small oven, small vacuum pump)
	sheet metal
	canopy/awning
	Electrical repair kit
	Timing kit
	Oil
	Brake degreaser
	Funnel

Appendix D: Michigan Schedule

Legend: **Mandatory Meeting**
Static Event
Dynamic Event

Time	Event	Location	People Needed			
TUESDAY, MAY 11						
6:30 - 10:00 p.m.	Early Registration	Brooklyn Super 8 Motel	As many as possible			
WEDNESDAY, MAY 12						
8:00 a.m.	Site Opens					
8:00 a.m. - 4:30 p.m.	Registration Open	G1				
1:00 p.m.	**Tech Inspection "Take-a-Number" and Safety Check opens**	**G2 - Enter SE Corner**	**Dynamic Mgr**	**Plus one support**		
2:00 p.m. - 7:00 p.m.	Tech Inspection opens	G2 - Enter SW Corner	Vehicle Mgr	Dynamic Mgr	Jeff (with gear)	One add'l allowed
3:00 p.m. - 7:00 p.m.	Scale Opens	G1 Drive Through	Vehicle Mgr	Dynamic Mgr	Some in Support	
5:30 p.m.	Welcome Ceremony	Main Tent				
7:00 p.m.	Tech Inspect and Scale close					
7:30 p.m.	Official Closing of the Site					
8:00 p.m.	EVERYONE MUST BE OFF-SITE					
THURSDAY, MAY 13						
7:30 a.m.	Site Opens					
8:30 a.m. - 5:00 p.m.	Fuel Station Opens	Outside G1	Vehicle Mgr	Support		
8:15 a.m.	**Drivers' Meeting (Brake & Noise)**	**Main Tent**	**Bill Murray**			
8:30 a.m. - 9:15 a.m.	**Design Presentation, 1st Round**	**G3 - Bay E**	**Chris Patton**	**Most of Team**		
9:00 a.m. - 5:00 p.m.	Tilt/Noise/Brake Open	Outside G2	Vehicle Mgr	Dynamic Mgr	Jeff (Tilt)	Bill (Brake)
10:30 a.m. - 11:00 a.m.	**Business Presentation**	**Suites - Bay E**	**Hillary**	**Tate**	**Static Mgr**	
12:00 p.m. - 1:00 p.m.	LUNCH BREAK	Main Tent				
2:00 p.m. - 2:30 p.m.	**Cost Presentation**	**G3 - Bay J**	**Bryan**	**Jeff**	**Static Mgr**	
5:00 p.m.	Fuel and Tilt/Noise/Brake Close					
5:00 p.m. - 5:30 p.m.	Presentation Judge Debrief	Suites				
5:00 p.m.	Push Bar finalist teams announced					
6:00 p.m.	Design Semi-Finalists Announced					
6:00 p.m.	**Drivers' Meeting (Acceleration & Skid-Pad Events)**	**Main Tent**	**Chris Patton**	**Trevor**	**Jeff**	
6:30 p.m.	**Design Semi-Finals**	**G3**	**Chris Patton**	**9 others for design**	**Static Mgr**	
7:30 p.m.	Official Closing of the Site					
8:00 p.m.	EVERYONE MUST BE OFF-SITE (excluding Design Semi)					
10:00 p.m.	Semi-finalist Teams Released from Design Semi-Finals					
10:30 p.m.	All Design Semi-finalists & Judges must Exit MIS					

		Legend:	Mandatory Meeting				
			Static Event				
			Dynamic Event				
Time	**Event**	**Location**	**People Needed**				
FRIDAY, MAY 14							
7:30 a.m.	Site Opens						
8:00 a.m. - 5:00 p.m.	Fuel Station opens	Outside G1	Vehicle Mgr	Support			
9:00 a.m. - 12:30 p.m.	Acceleration and Skidpad Events Open	Dynamic Area	Vehicle Mgr	Dynamic Mgr	Chris	Trevor	Jeff
9:30 a.m.	Presentation Seminar	G1					
12:00 p.m. - 5:30 p.m.	Design Event Feedback (By Appointment)	G3					
12:30 p.m.	Acceleration and Skidpad Events Close						
12:30 p.m.	LUNCH BREAK	Main Tent					
1:15 p.m.	**Drivers' Meeting (Autocross)**	**Main Tent**	**Bill**	**Matthias**			
2:00 p.m. - 5:00 p.m.	Autocross Event Open	Dynamic Area	Vehicle Mgr	Dynamic Mgr	Bill	Matthias	
5:30 p.m.	Staging for Panoramic Photograph (Tentative on weather)						
6:15 p.m.	**Drivers' Meeting (Endurance, Fuel Economy)**	**Main Tent**	**Bill**	**Matthias**			
7:00 p.m.	Friday Award Ceremony (After Drivers' Meeting)	Main Tent					
7:30 p.m.	Official Closing of the Site						
8:00 p.m.	EVERYONE MUST BE OFF-SITE						
SATURDAY, MAY 15							
7:30 a.m.	Site Opens						
8:00 a.m. - 5:00 p.m.	Fuel Station opens	Outside G1	Vehicle Mgr	Support			
9:00 a.m.	Endurance Opens for Group 1	Dynamic Area					
11:30 a.m.	Endurance Line Closes for Group 1						
Noon. - 2:00 p.m.	Design Event Feedback (By Appointment)	G3					
12:00 p.m.	LUNCH BREAK	Main Tent					
1:15 p.m.	Design Finalists Start Endurance	Dynamic Area	Vehicle Mgr	Dynamic Mgr	Bill	Matthias	
1:45 p.m.	Endurance Opens for Group 2	Dynamic Area					
3:00 p.m. - 5:00 p.m.	**Design Finals**	**G3**	**Chris Patton**	**Static Mgr**	**Most of Team**		
3:30 p.m.	Endurance Line Closes for Group 2 (earlier if no cars in line)						
6:30 p.m.	Design Review	G3					
8:00 p.m.	Final Award Ceremony	Main Tent					
10:30 p.m.	Official Closing of the Site						
11:30 p.m.	EVERYONE MUST BE OFF-SITE						

Appendix E: Michigan Local Resources Document

Local Resources for SAE Michigan
Rental House is at 9880 W Ferndale Dr, Manitou Beach, MI 49253
Michigan International Speedway (MIS) is at 12626 U.S. 12, Brooklyn, MI 49230

Categories:
1. Moto 1, "Dave"
2. Honda Parts Dealers
3. Other Local Auto Parts
4. Grocery, Etc.
5. Local Hospitals

If something breaks, call this guy
Moto 1 - "Dave"
9934 US 223
Adrian, MI 49221
(517) 467-9311 (Shop)
(517) 442-4421 (Cell)
- Usually open 9-6 daily, okay with cell calls
- Races motorcycles, personally owns a similar engine, has 'hard' parts
- 5.9 mi from house
- 11.6 mi from MIS

Honda Parts Dealers
Town & Country Sports Center, Inc.
US 12 & US 127
Cement City, MI 49233
(517)547-3333
- Mon-Fri 10:00AM-6:00PM
- Sat 10:00AM-3:00PM
- Sun 12:00PM-4:00PM
- 7.5 mi from house
- 6.3 mi from MIS

Dexter's Motors
3804 S Adrian Hwy
Adrian, MI 49221-9294
(517)263-6050
- Mon 9:00AM-6:00PM
- Tue-Thu 9:00AM-5:00PM
- Fri 9:00AM-6:00PM
- Sat 9:00AM-3:00PM
- Sun Closed
- 16.5 mi from house
- 22.1 mi from MIS

Nicholson's
4405 Jackson Rd
Ann Arbor, MI 48103-1892
(734)769-9815

- Mon Closed
- Tue-Fri 10:00AM-7:00PM
- Sat 10:00AM-5:00PM
- Sun Closed
- 52 mi from house
- 40.6 mi from MIS

Other Local Auto Parts

Napa Auto Parts/ Brooklyn Auto Supply
10412 N Main St.
Brooklyn, MI 49230
(517) 592-2137

- Mon-Fri 8a-5:30p
- Sat 8a-2p
- 12.8 mi from house
- 5 mi from MIS

Speedway Auto Parts
11563 Brooklyn Road
Brooklyn, MI 49230
(517) 592-3244

- Mon-Fri 8a-6p
- Sat 8a-4p
- Sun 9a-3p
- 13.4 mi from house
- 5.6 mi from MIS

Brooklyn Ford
10405 N. Brooklyn Rd
Brooklyn, MI 49230
(866) 353-6973

- Mon-Fri 8a-5p
- 14 mi from house
- 6.2 mi from MIS

Grocery, Etc.

Country Market
11301 Brooklyn Road
Brooklyn, MI 49230
(517) 592-4040
- Daily 6am to Midnight
- 13.7 mi from house
- 5.9 mi from MIS

Wal-Mart Supercenter
1601 U.S. 223
Adrian, MI 49221
(517) 265-9771
- Daily 8a-10p
- 16.3 mi from house
- 21.9 mi from MIS

Meijer
217 U.S. 223
Adrian, MI 49221
(517) 265-7820
- 24 Hours
- 17.5 mi from house
- 21.3 mi from MIS

Kroger
3021 East Michigan Avenue
Jackson, MI
(517) 787-4982
- Daily 7a-11p
- 22.8 mi from house
- 21.5 mi from MIS

Costco
3405 West Central Avenue
Toledo, OH 43606
(419) 381-5000
- Mon-Fri 11a-8:30p
- Sat 9:30a-6p
- Sun 10a-6p
- 47.8 mi from house
- 53.6 mi from MIS

Local Hospitals

Allegiance Health
205 North East Avenue
Jackson, MI 49201
(517) 788-4800
- 24.3 mi from house
- 23 mi from MIS

Bixby Medical Center
818 Riverside Avenue
Adrian, MI 49221
(517) 265-0900
- 14.7 mi from house
- 20.3 mi from MIS