AN ABSTRACT OF THE THESIS OF

Hillary M. Shoop for the degree of Honors Baccalaureate of Science in Industrial Engineering presented on 24 May 2010. Title: OSU Formula Society of Automotive Engineers: Team Management Structure.

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Dr. Toni L. Doolen

The OSU Society of Automotive Engineers (SAE) is a nonprofit, student-run organization dedicated to enhancing its members' engineering, leadership, communication, and teamwork skills. The OSU Formula SAE team objective is to design, build, and race an autocross style car that competes at annual events worldwide. The purpose of the proposed research is to identify potential improvement opportunities in the OSU Formula SAE team management structure. While SAE is heavily focused on technical mechanical and electrical engineering design, it is generally accepted that it is as much a management competition as it is an engineering design competition. Based on a literature review of company and project management structures, the OSU FSAE team represents a matrix structure where project members report to both a project (team captain) and functional (steering committee) manager.

At least one team member representing each of the management levels was interviewed for this research and asked questions pertaining to successes and problems encountered during project completion. The results from these interviews were coded and evaluated based on categories pertaining to strengths and weaknesses of the matrix management structure. Based on the coded data, the biggest opportunities for improvement in the OSU Formula SAE management structure exist in the areas of technical development, norms and authorities, and team processes.

Key Words: Management Structures, Project Management, Matrix, Industrial Engineering

Corresponding E-mail Address: hshoop@gmail.com

OSU Formula Society of Automotive Engineers: Team Management Structure

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Hillary M. Shoop

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APPROVED:

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Co-Mentor, representing Industrial Engineering

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Co-Mentor, representing Industrial Engineering

_____

Committee Member, representing Industrial Engineering

_____

Head, School of Mechanical, Industrial, and Manufacturing Engineering

_____

Dean, University Honors College

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.

_____

Hillary M. Shoop, Author

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Contents

Tables

1. INTRODUCTION

1.1Background and Significance

The OSU Society of Automotive Engineers (SAE) is a nonprofit, student-run organization dedicated to enhancing engineering, leadership, communication, and teamwork skills of its members. There are many types of student teams involved in SAE, two of which are represented at Oregon State University. Within OSU SAE, the Baja (off-road vehicle) and Formula (street car) teams are each composed of over twenty undergraduate and graduate students. The objective of each of these teams is to design, build, and race effective cars that compete at annual events worldwide.

In the 2010 season, the OSU Formula team collaborated with the German University Duale Hochschule Baden-Württemberg-Ravensburg (DHBW-R). The two universities competed as one team: Global Formula Racing (GFR). The goal was to work together to create a single car design that utilized the knowledge and expertise of students from both schools. The collaboratively developed GFR design was used to manufacture two identical cars—one at the OSU campus in Corvallis, Oregon, USA, and the other at the DHBW-R campus in Friedrichshafen, Baden-Württemberg, Germany. The global collaboration aspect of the project created additional levels of complexity to this already complex project, especially with team management. To build a vehicle worthy of global status at worldwide competitions, effective management of over sixty graduate and undergraduate students between the two universities was crucial.

1.2 Research Topic

This study will focus on management structure of the U.S. portion of the OSU Formula, or Global Formula Racing, team. While SAE is heavily focused on technical

mechanical and electrical engineering design, it is generally accepted that it is as much a management competition as it is an engineering design competition. At each competition there are dynamic events that test the functionality of the car but also static events that test the team's knowledge of the design and manufacturing process. A detailed description of the Formula SAE series, competition rules, and history of SAE at OSU is provided in Chapter 2.

Various levels of leadership currently exist in the OSU Formula management team. There are two levels of upper management: advisory and technical. Advisory management is responsible for broad design and operation decisions. An example of upper management responsibilities include higher level design decisions such as the type of engine and chassis to be used each year. This group is composed of graduate students with extensive experience on OSU Formula teams and competitions. The technical management is composed of the team captains: two undergraduate students with expertise on Formula SAE cars and the authority to make decisions regarding the 2010 design. These technical management members oversee daily design and operation decisions. The final level of management consists of subteam captains. These members are upperclass students that take ownership and responsibility for a certain subsystem of the car and act as a liaison between the upper management and all other student members working on that subsystem.

The goal of this research was to identify areas of the management structure that, if improved, could potentially increase the overall performance of the SAE teams. A literature review was conducted to analyze current management structures in other organizations. These structures were defined and the strengths and weaknesses of each structure were assessed. Interviews of OSU Formula SAE management team members were then conducted and used to identify strengths and weaknesses of the existing team structure. The data were

coded based on categories derived from hypotheses created for the study. The researcher hypothesized that the following impacts of project completion were potential areas for improvement opportunity: formal communication, informal communication, norms and authorities, resource availability, attitudes and perceptions, technical development, and processes. After coded, the data were analyzed and potential management structure improvement areas were identified.

2. LITERATURE REVIEW

2.1 Organization Structure

According to Kerzner (1979), organizations can be classified into three different groups depending on the factors that drive group organization. Traditional and product organizational structures are classic constructs, however, Kerzner identified the matrix organization as an important third form, especially considering the need for modern organizations to be "dynamic in nature." Organizations "must be capable of rapid reconstructing should environmental conditions dictate" (Kerzner, p. 37). A review of literature was completed to more carefully characterize and define each of these organizational structures and is described next.

2.1.1 Project-Driven Organization

In project-driven structures, everything is centered around the project. The project or program manager is in direct control of all elements needed to conduct each project. According to Morse and Babcock (2007), project-driven structures tend to be highly appealing to "large, long-duration projects, especially those that are very complex, involve a number of different organizations, and require advancing the state of technology" (p. 346). Kerzner (1979) argues that this system is more effective when project work is continuous. A continuous flow of projects minimizes conflict by maintaining drive and focus. The project manager has complete control over project scope, schedule, and resources and is also responsible for performance reviews.

2.1.2 Functional

In functional organizations, "projects exist merely to support the product lines or functional lines" (Morse and Babcock, 2007, p.346). The focus in this type of organization is on the most profitable products. Resources are assigned based on profitability. Divisions of labor

are based on functional areas, which are created at the top level of the organization. Projects still exist, and project managers are chosen based on their expertise with the individual topics. Project managers, however, generally do not have direct authority over the majority of the team when teams are composed of people from different functional groups. All workers are ultimately accountable to a functional manager.

2.1.3 Matrix

Matrix organizations combine project and functional organization structures. Newman, Summer, and Warren (1972) describe the objective of a matrix organization is to "(1) ensure the coordinated, focused attention that [unique and complicated] projects require and (2) at the same time retain the benefits of specialized expertise and capabilities that only functional departments can provide" (p. 104). To achieve these objectives, individuals are accountable at both the project and functional level in a matrix organization. A project manager is assigned to each individual project and decides the scope and schedule of the project as well as the resources needed to complete the project. Functional managers also play a critical role. This person allocates the time of employees with specialized functional abilities and is responsible for the quality of work done by these specialists.

In his discussion of general project management, the system Lock (1984) describes a matrix organizational form. The frequent selection process of an engineering project manager is described: "The engineer is doubling two roles, exercising a direct line-supervision authority in controlling and guiding his engineering or drawing team, whilst acting in a staff role when attempting to influence the other departments which are engaged in his project" (Lock, p. 8). This description suggests that even when an overall organization structure is unknown, a matrix approach to project management is most likely to occur. This is due to the necessity of gaining

expertise on projects from specialized employees and the desire to maintain a standard organizational structure.

2.2 Organization Structure Strengths and Weaknesses

Each of the three project structures described above have specific strengths and weaknesses. In order to analyze these attributes in terms of strength and weaknesses for each organizational structure type relevant to the OSU Formula SAE team management structure, a table was created. Each table categorizes the strengths and weaknesses of each of the three structures by impactful characteristics of OSU Formula SAE project completion. See Tables 2.1-2.3. These categories were determined based on methods indicated by Miles and Huberman (1984) for creating codes for analyzing qualitative data. Further explanation of codes can be found in Chapter 3.

	STRENGTHS	WEAKNESSES
PROJECT		
Resources	Can maintain expertise on a project w/o sharing key personnel (2)	Inefficient use of specialists (1)
		Tendency to retain personnel on project long after needed (2)
Process	Good training ground for general management (2)	Lack of career continuity and opportunities for personnel (2)
Norms & Authority	Provide complete line of authority (2)	
	Participants work directly for project manager (2)	
	Upper management more time free time for executive decision making (2)	
Attitudes & Perceptions	participants demonstrate loyalty with better product identification (2)	
Communication	Single point for customer contact (1)	
	Rapid reaction time possible (1)	
	Simpler project communication (1)	
	Strong communication channels (2)	
Technical development		Uncertain technical direction (1)
		Poor cross feed of technical information between projects (1)
		Technology suffers because project focus is lacking (2)
Schedule	Good schedule (1)	
	More flexibility in determining tradeoffs (2)	
Scope	More flexibility in determining tradeoffs (2)	
Cost	Good cost control (1)	
	More flexibility in determining tradeoffs (2)	
Team Dynamics		

Table 2.1: Strengths & Weaknesses of Project-Driven Organizations

	STRENGTHS	WEAKNESSES
FUNCTIONAL		
Resources	Efficient use of technical personnel (1)	Slower work force
	Flexibility in the use of manpower (2)	
Process	Career opportunity & growth for technical personnel (1)	
	Provides continuity in the functional disciplines (policies, procedures, etc.) (2)	
Norms & Authority	Good control over personnel (2)	Weak project authority (1)
		No one person in charge of whole project (2)
		Does not provide project-oriented emphasis (2)
Attitudes & Perceptions	Good stability, security, & morale (1)	Decisions normally favor strongest functional group (2)
		Motivation and innovation decreased (2)
Communication	Channels are vertical and well established (2)	Weak customer interface (1)
		Poor horizontal communication (1)
		Additional lead time required to approve decisions (2)
Technical development	Good technology transfer between projects (1)	Ideas tend to be functionally oriented w/ little regard for on-going projects (2)
	Better technical control (2)	
Schedule	Flexibility (1)	
Scope		
Cost	Easier budgeting and cost control (2)	
Team Dynamics	Good stability, security, & morale (1)	

Table 2.2: Strengths and Weaknesses of Functional Organizations

	STRENGTHS	WEAKNESSES
MATRIX		
Resources	Project manager maintains max project control over resources (2)	
Process	Policies and procedures set up independently for each project (2)	More time initially needed to define policies and procedures (2)
Norms & Authority	Functional organization exists primarily as support for the project (2)	Often relationship between project and functional managers is not clear (1)
Attitudes & Perceptions		Functional managers may be biased according to their priorities (2)
Communication	Rapid responses possible to changes (2)	Matrix response time at company level slow (2)
Technical development	Strong technical base developed because people can be shared (2)	
Schedule	Better balance (2)	
Scope	Better balance (2)	
Cost	Cost minimized because key people can be shared (2)	Company-wide it is not as cost effective because of redundancy (2)
	Better balance (2)	
Team Dynamics		Balance of power between functional & project teams must be watched (2)

Table 2.3: Strengths and Weaknesses of a Matrix Organization

Attributes annotated with a (1) were taken from Morse and Babcock (2007). Attributes annotated with a (2) were adopted from Kerzner (1979). Because matrix organizations are theoretically a combination of the strengths of both project and functional organizations, the weaknesses associated with matrix organizations reflect more subjective issues related to maintaining balance between the individual structures.

2.3 Society of Automotive Engineers

The Society of Automotive Engineers (SAE) is an international organization dedicated to enhancing mobility technology across many fields. The society was created out of a desire to have "free exchange of ideas" in order to enhance automobile knowledge amongst automobile business leaders. (SAE International Abridged History) In 1905, SAE was founded by Peter Heldt and Horace Swetland, two prominent figures in the automobile magazine industry, with Andrew Riker and Henry Ford acting as president and vice president respectively. Today SAE International has over 121,000 members and twelve different collegiate design competitions that each attract more than 4500 students from 500 universities on six continents.

2.3.1 Formula Society of Automotive Engineers

The Formula Society of Automotive Engineers (Formula SAE) is one of the collegiate design competitions operating under the umbrella of the parent SAE organization. It was started in 1978 to promote student engineering careers by offering an environment to enhance all aspects of engineering skills (Formula SAE Website). The concept of the competition reflects the underlying goal to provide students with diverse opportunities in an engineering related project (Formula SAE History, 2010):

> The concept behind Formula SAE is that a fictional manufacturing company has contracted a design team to develop a small Formula-style race car. The prototype race car is to be evaluated for its potential as a production item. The target marketing group

for the race car is the non-professional weekend autocross racer. Each student team designs, builds and tests a prototype based on a series of rules whose purpose is both to ensure onsite event operations and promote clever problem solving.

This concept enforces the fact that the SAE competitions are not purely based on technical engineering talent. Due to the complex nature of the Formula SAE project, effective management plays a crucial role in successful teams.

2.3.2 Rules & Competitions

There are many rules in Formula SAE that govern how the car and teams operate during competitions. These rules vary from restrictions on engine type and fuel to how students behave at competition (Formula SAE Website). The Formula SAE competitions are structured to highlight both the performance of team cars as well as knowledge of the student members. Within a competition, there are two different types of events: static and dynamic. A breakdown of the different events and their associated competition points can be found in Table 2.4.

Static Events:	
Presentation	75
Engineering Design	150
Cost Analysis	100
Dynamic Events:	
Acceleration	75
Skid-Pad	50
Autocross	150
Fuel Economy	100
Endurance	300
Total Points 1,000	

Table 2.4: Formula SAE Competition Point Breakdown

The static events test each team's knowledge of the design, cost, and practical business feasibility of their vehicle. There are three static events: design, cost, and presentation. The design event seeks to test technical knowledge of all student members by questioning the reasoning behind each car's design. Design event judges ask questions ranging from technical

components to broad vehicle dynamic concepts. The cost event is similar but with respect to manufacturability of the vehicle. Cost event judges evaluate and test students on the actual manufacturing processes involved in creating each car as well as their knowledge of best practice manufacturing techniques and cost saving methods. Finally, the presentation event is an opportunity for students to create and present a comprehensive business case that convinces the executives of a corporation (event judges) that the team's design best meets the demands of the amateur, weekend competition market and that it can be profitably manufactured and marketed.

The dynamic events test the physical capability of each team's car. The acceleration event evaluates the car's acceleration in a straight line on flat pavement over a distance of 75m. The objective of the skid-pad event is to measure the car's cornering ability on a flat surface while making a constant-radius turn. The objective of the autocross event is to evaluate the car's maneuverability and handling qualities on a tight course without the hindrance of competing cars. The autocross course will combine the performance features of acceleration, braking, and cornering into one event. The car's fuel economy will be measured in conjunction with the Endurance Event. The fuel economy shows how well the car has been tuned for the competition. This is a compromise event because the fuel economy score and endurance score will be calculated from the same heat. No refueling is allowed during an endurance heat. The Endurance Event is designed to evaluate the overall performance of the car and to test the car's durability and reliability.

2.3.3 OSU Formula SAE

At Oregon State University (OSU), the Society of Automotive Engineers is one of the largest student-run organizations on campus. It is largely comprised of mechanical engineering students, but all disciplines are welcome to participate. The tradition of Formula SAE at OSU

started in 1987. The first car was built during this year but did not compete. In 1996, OSU successfully competed its first Formula vehicle at the Formula SAE West competition in California. Since that year, the team has had a successful history of completing cars each year.

2.3.4 Management Structure

Based on the management system described in Chapter 1, the management structure that best describes the current OSU Formula SAE team is matrix. Team members report both to a subsystem captain for individual project work as well as to overall team advisors for general team functionality. Although Formula SAE can be seen as an individual project itself, the OSU team was considered an organization with projects defined by each subsystem. Each year, the team builds a new 'product' that has similar yet evolving features based on previous designs. To determine which areas in the matrix structure present the greatest opportunity for improvement, interviews of team members were conducted, and the results of the analysis of the interviews are summarized in the next three chapters.

3. METHODOLOGY

3.1 IRB Approval

Since human participants participated in the interviews, approval from the Oregon State University Institutional Review Board (IRB) was required. Obtaining IRB approval ensures that human participants are not harmed as a result of a research project. The complete IRB application is included in Appendix A.

3.2 Participants

Student members of the Oregon State University (OSU) Society of Automotive Engineers (SAE) were the participants asked to participate in the interviews. Because the study's purpose was to analyze management operations, student members with management roles were targeted. In order to determine which students met this condition, an email was sent to the OSU SAE faculty advisor (see Appendix B). The faculty advisor then contacted the researcher and a meeting was held with the OSU SAE faculty advisor. The faculty advisor provided a list of students with management roles at various levels of the organization. This list was used to generate an e-mail distribution list. The faculty advisor then sent out an email informing these students about the study and the interviews (see Appendix C). If interested, the students were asked to contact the researcher to participate.

3.3 Research Instrument

A qualitative interview protocol was created to use in identifying key areas for improvement in OSU SAE management operations (see Appendix E). The first two pages of the interview informed participants about the purpose of the study, the structure of the interview, and made it very clear that participation was voluntary. Participants were asked to sign a form to confirm voluntary participation (see Appendix D).

The interview structure was based on suggested protocol by John W. Creswell (1994). For interviews, Creswell recommends to "ask one or two grand tour questions followed by no more than five to seven subquestions" (Creswell, 1994). Grand tour questions are general questions developed to encourage individual thought processes related to the targeted topic to emerge. The subquestions then attempt to solicit more details regarding the grand tour question responses. This research used this method and included three sets of grand tour questions, each followed by three or four subquestions.

Although the study's purpose was to identify problem areas in management operations, it was also important to identify successful processes in order to develop a starting point from which to improve. To achieve this, the first two grand tour questions of the interview asked the participant to recall a time when he or she encountered a problem in the daily operations of the team, but the third grand tour question asked the participant to recall a recent success. In addition, a fourth grand tour question asked the participant to recall a time when a change in operation was attempted but failed. This question was important to discover how the organization tried to create change in the past.

The subquestions attempted to uncover more details about the events. All grand tour questions were followed by subquestions asking about the timeline of each event and the effects on project scope, cost, team dynamics, and/or schedule. For the two grand tour questions focusing on problematic events, a subquestion was included to determine what was done, if anything, to remedy the situation. The grand tour question that focused on a successful experience included a subquestion to determine if the event was repeated. Finally, the grand tour question regarding the failure of an attempted change included additional subquestions to

determine exactly why the implementation was unsuccessful and what was done, if anything, to remedy the situation.

3.4 Data Collection Details

The interview was administered to nine student members of the OSU SAE team. After each interviewee voluntary contacted the researcher to participate in the study, a time was scheduled for them to meet with the researcher. The researcher and interviewee met in locations that allowed anonymity to be maintained for the study. During each interview, the researcher wrote answers from each question down by hand on a hard copy of the interview questions. In order to be able to connect each interview to the interviewee if necessary, the name of each participant was written on the top of each of their interviews. After each interview, these documents were kept in a locked drawer. After all interviews were complete, the researcher transcribed the written results of the interview into an electronic form that can be found in Appendix E.

3.5 Analysis Details

To analyze the data, codes were used that were derived from the project impact categories created to analyze strengths and weaknesses of organization structures in Chapter 2. See Table 3.1. A code is "an abbreviation or symbol applied to a segment of words—most often a sentence or paragraph of transcribed field notes—in order to classify the words" (Miles and Huberman, 1984, p. 56). Codes are created based on "research questions, hypotheses, key concepts, or important themes" (p.56). For this research, the following codes were created:

CODE	ABBR.	DESCRIPTION
Formal Communication Channels	CF	Communication through formal means such as scheduled meetings and formalized written methods (e.g. letters).
Informal Communication Channels	CI	Communication through informal means such as unscheduled meetings and informal written methods (e.g. email).
Norms & Authorities	NA	Established practices and authoritative figures that govern daily team operations.
Resource Availability	RA	Resources such as humans, money, equipment, or material used to complete the project.
Attitudes and Perceptions	AP	Subjective ideas and general opinions on how the project is completed.
Technical Development	TD	Physical progression of project completion.
Processes	P	Practices by which the project is completed and the organization is run.

Table 3.1: Code Abbreviations and Descriptions

These codes were developed by the researcher to indicate the hypothesized areas in which the OSU Formula SAE team could present areas for improvement in management structure.

The transcribed interview results were printed and analyzed based on the codes. The researcher looked at each question from each interviewee individually. The general code topic for each of the questions was determined first. For example, if the answer's main theme related to the car's technical development, that question was labeled with a 'TD'. The remaining portions of each question were then labeled based on the code to which the content corresponded. After the codes were determined for all data, each coded piece of data was analyzed to determine whether or not it had a positive or negative impact on car completion. The complete set of these coding results can be found in Appendix E.

In addition to analysis based on codes, the data was analyzed based on four aspects of overall project completion: schedule, scope, cost, and team dynamics. Each interview question had a subquestion pertaining to the potential effect the topic had on the each of the previously

mentioned project attributes. The same general topic for each question was used when assessing correlation to these attributes.

4. Research Findings

The results of coded data were analyzed to determine opportunities for improvement in the OSU Formula SAE management structure. After the data were coded, the code frequencies were counted and assessed. These results were analyzed based on the impacts of project completion (codes), overall project attributes (cost, schedule, scope, dynamics), and relatedness to strengths and weaknesses of the matrix management structure.

4.1 Code Results

The results of the coding process are summarized in Tables 4.1 and 4.2. Table 4.1 summarized the number of text segments where a negative relationship between two characteristics was identified. Table 4.2 summarized the number of text segments where a positive relationship between two characteristics was identified.

(-)

	CF	**CI**	**NA**	**RA**	**AP**	**TD**	**P**
CF		1	2			1	
CI	3		2		3		2
NA	2			3	7	2	3
RA						1	
AP		1					
TD	1	6	7	12	10		4
P	5		1	3		1	

Table 4.1: Coded Data Negative Correlations

(+)

	CF	CI	NA	RA	AP	TD	P
CF			1	1	1	2	1
CI	2						1
NA					1		1
RA							
AP		2	1				1
TD	1	2	5	2	2		2
P							

Table 4.2: Coded Data Positive Correlations

The rows of the tables represent the overall theme of response. The columns of the tables represent responses to each portion of each response as related to the overall topic. For the majority of questions, the response themes related to technical development of the car. This is evident from the larger number of responses in the technical development (TD) row of each table. Table 4.1 represents negative relationships in responses. If the overall theme of the answer was determined to have a negative impact on project completion, and the piece of data also had a negative impact on project completion, that piece of data was counted as a negative relationship. If the overall theme of the response was determined to have a positive impact on project completion, and the piece of data also had a positive impact on project completion, that response was counted as a positive relationship. Finally, if the overall theme of the response had a negative impact on project completion, but the response had a positive impact on project completion, that piece of data was counted as a positive relationship. This final type of relationship (negative overall impact but positive individual impact) was used to identify opportunities for individual actions and people to overcome obstacles in project completion.

4.1.1 Evaluation of Negative Correlations

From Tables 4.1 and 4.2, it can be seen that there are several combinations of codes that occur at a much larger frequency than others. In the negative relationship table, combinations with larger frequencies were the areas with the biggest opportunities for improvement. The most commonly occurring relationships were within technical development. The largest numbers of negative relationships occurred with (1) resource availability, (2) attitudes and perceptions, (3) norms and authority, and (4) informal communication. Examples of these relationships are summarized in Table 4.3.

Correlation	Example from Interview Results
TD-RA **TD-NA**	"The interviewee was told by a member of management that a certain part should be completed a certain way. A different member of management said that the parts should be completed the way they had been in the past first and then completed the new way after the old way was done. Time constrictions made it impossible to complete the part BOTH ways, so the part was completed the old way."
TD-AP **TD-CI**	"One of the team leaders wanted a certain part made. The team leader asked the interviewee to complete tasks to incorporate the part but a different team leader didn't want him to do that because it wouldn't be a good use of time. They all argued for an hour and then went back to the car to figure out that they didn't need the part anyways."

Table 4.3: Technical Development Correlations

Both of the examples provided in Table 4.3 demonstrated a general trend of upper management to openly disagree on methods in which team members should complete tasks. In terms of management structure, this trend is common for matrix management structures when roles of functional and project managers are unclear. Based on the management structure

strengths and weaknesses discussed in Chapter 2, technical development was not a major weak area for matrix management structures because matrix organizations are generally able to share key technical personnel and critical resources between projects. This indicated that the four categories of resources availability, norms/authorities, attitudes/perceptions, and informal communication were interfering with effective project completion.

The next most frequent negative relationships were found to occur between norms/authorities and attitudes/perceptions, and processes and formal communication. Table 4.4 provides examples from the interviews of these relationships.

Correlation	Example from Interview Results
NA-AP	"Old ways of operating seem to be the hard set ways. This is the only way we do it, and we don't need to waste time figuring out a different way to do it."
P-CF	"Training of new team members, especially new seniors for design projects is inadequate. The goal was to get new members familiar with the car and other members through weekly Monday meetings and car info sessions. Not all new members were caught up to speed in time."

Table 4.4: Norms/Authorities and Processes Correlations

Norms and authorities as related to the roles of functional managers are a strength of matrix organizations. Functional managers exist to support the project work. The weakness of norms and authorities in matrix structures occurs when the relationship between project and functional managers is unclear as alluded to in the technical development discussion. Again, there is potential that attitudes and perceptions were interfering with effective project completion. In the category of processes, the strength for matrix structures involves the ability to set up policies and

procedures independently for each project. Formal communication methods were potentially impeding effective process execution in positive progress toward project completion.

4.1.2 Evaluation of Positive Correlations

Although there were many opportunities for improvement within technical development, especially corresponding to norms and authorities, there were also several positive examples the relationship between these two categories. A good example from an interview occurred in the technical development of a certain subassembly:

> "The interviewee came up with rough idea [based on research done on existing designs] and talked with a team leader to figure out if it was mechanically feasible. By working with the team leader, it saved a lot of time for testing. It has proven to be more reliable than they could have hoped for."

Examples such as these suggested that working effectively with team leaders to more efficiently complete project tasks was a common occurrence despite evidence that this was also an opportunity for improvement.

4.2 Overall Project Attributes Analysis

In order to assess how each of the negatively relationships affected the overall project attributes of schedule, scope, cost, and team dynamics, an additional numerical analysis was completed. In each interview question, there was a subquestion asking about the effect of each scenario on project schedule, scope, cost, and team dynamics. The frequency at which each of these attributes occurred within answers is summarized in Table 4.5.

	Schedule	Cost	Scope	Team Dynamics
CF	1		1	
CI				2
NA	4		3	4
RA	3			2
AP				
TD	6	2		7
P	3	1	2	1
TOTAL	**17**	**3**	**6**	**16**

Table 4.5: Frequency of Overall Project Attributes

It is evident from Table 4.5 that schedule and team dynamics were the most frequently affected project attributes. When looking at Table 4.5, it can be seen that all three most frequently occurring codes (technical development, norms/authorities, and processes) are strongly associated with changes in schedule and team dynamics.

5. Recommendations and Conclusion

After analyzing the coded interview results, there were several clear opportunities for improvement within the current OSU Formula SAE management structure. On a large scale, project schedule and team dynamics were the two biggest improvement opportunities, and these areas were most negatively affected by technical development, norms and authorities, and processes.

5.1 Opportunity for Improvement: Technical Development

According to literature review of matrix structure strengths and weaknesses, technical development is a strength of matrix organizations, because technical resources can be more easily shared between projects. Based on observation of the SAE organization, this was true. There were many excellent technical resources within upper and middle level management. It was then necessary to identify why this area also provided multiple opportunities for improvement.

In order improve technical development, there are several key aspects on which to focus. These are resource allocation, norms and authorities, attitudes and perceptions, and informal communication. After analyzing these aspects and the strengths and weaknesses of a matrix management structure, there are several ways in which technical development can be improved. Resource allocation is theoretically a strength of matrix structures because project managers can maintain the maximum project control over resources. Based on the interview results, it is apparent that conflict exists between functional (steering committee) and project (captains) management. This trend also ties into the weaknesses of matrix structures in terms of norms/authorities where the relationship between functional and project managers is unclear, and attitudes/perceptions where functional managers may be biased according to their priorities.

These observations suggest that unclear roles and authorities of project and functional managers may negatively impact team performance.

5.2 Opportunity for Improvement: Processes and Norms/Authorities

Processes and norms/authorities are two additional attributes of team structure that have potential for improvement. These areas are difficult to define in terms of management *structure*. Based on the analysis, formal team communication had a negative impact on how processes were being effectively used to complete the project. The weakness of processes in matrix organizations indicates that the same formal communication methods are not always effective for all project teams. This suggests that an opportunity for improvement of the SAE team is the organization of how individual project teams complete tasks. It is possible that project teams can be organized differently in order to create more effective formal communication channels for individual teams.

For norms/authorities, the biggest strength in achieving project completion for a matrix organization is the fact that functional managers exist primarily as project support. Again, this ties back into the issue of norms/authorities causing difficulties in the technical development area of project completion. After observation of the SAE team and interviews with the team members, it was evident that functional managers did not exist primarily as project support but were in fact crucial resources for physical car development. This implies that an opportunity within norms/authorities and technical development is improving the definition and expectations of the roles of authority figures.

5.3 Conclusion

The OSU Formula SAE is operating under a matrix management structure. Completion of the car was successful for the 2010 season, as evidence by a first place finish at the SAE Midwest competition in Detroit, Michigan in May of 2010. However, there are several key opportunities for improvement within the management structure that if addressed could lead to even more effective and efficient completion of the car with far less impact on schedule and team dynamics. While the existing structure may be sufficient for the short term, the extended success of the team may be limited unless the issues resulting from technical development, norms and authorities, and team processes are addressed.

6. References

Creswell, J. W. (1994). *Research Design: Qualitative and Quantitative Approaches*. SAGE Publications, Inc.

Formula SAE International. (2010). *About Formula SAE*. Retrieved from http://students.sae.org/competitions/formulaseries/about.htm.

Formula SAE International. (2010). *Rules and Competition Documents*. Retrieved from http://students.sae.org/competitions/formulaseries/rules/2010fsaerules.pdf.

Kerzner, H. Ph.D. (1979). *Project Management: A Systems Approach to Planning, Scheduling and Controlling*. New York, NY: Litton Educational Publishing, Inc.

Lock, D. (1984). *Project Management*. New York, NY: St. Martin's Press.

Miles, M. B., & Huberman, M. A. (1984). *Qualitative Data Analysis: A Sourcebook of New Methods*. Newbury Park, CA: SAGE Publications, Ltd.

Morse, L.C., & Babcock, D.L. (2007). *Managing Engineering and Technology*. Upper Saddle River, NJ: Pearson Prentice Hall.

Newman, W. E., Summer, C. E., & Warren, E. K. (1972). *The Process of Management: Concepts, Behavior, and Practice*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

APPENDIX A: IRB Application

Project Title: OSU Society of Automotive Engineers: Team Management		**IRB Application #:** Assigned by IRB Office
Principal Investigator: Dr. Toni Doolen	**PI email:** toni.doolen@oregonstate.edu	**PI Telephone:** 541.737.5641
College, Center, or Institute: Engineering	**Department:** Other	
If "other", indicate college:	**If "other", indicate department:** Mechanical, Industrial & Manufacturing Engineering	
Student Researcher: Hillary Shoop	**Class or Degree Program (if requirement for student):** Industrial Engineering	
Primary Contact Person: Hillary Shoop	**Email:** shooph@onid.orst.edu	**Telephone:** 503.705.7579
Campus or US Mail Address (to send correspondence): 332D NW 14th St, Corvallis, OR 97330		**Date:** 1/15/10

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 in the footer.
- Signature page must be mailed or faxed to complete the application.

1. **In one paragraph or less, please state your primary research question:** The purpose of the proposed research is to identify potential problem sources in the team management of the OSU Society of Automotive Engineers. The goal is to identify weak areas that if improved could potentially increase the overall performance of the SAE teams.

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)*
   ☐ Material, equipment, drugs, supplements, or devices: _____ *(source)*

☒ 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. Certification of Education:

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

Research Staff Name	Role in Project	Required Education Completed
Dr. Toni Doolen	Principal Investigator	☒ Yes ☐ No
Hillary Shoop	Student Researcher	☒ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No

5. Anticipated Project Start Date: January 2010 *(month/year only)*

6. 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

7. Subject Population:

Total number of subjects that will be enrolled over the life of the study: 25

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

☒ ≥18: include consent form, unless seeking waiver

Populations targeted in this research (check all that apply):

☐ Adults lacking capacity to consent

☐ Children in foster care or wards of the state

☐ Prisoners *(ineligible for exempt review)*

☐ Pregnant women and fetuses

☒ OSU Students or employees

☐ 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: _____

8. 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. Commonly permitted for minimal risk surveys*
☐	Waiver of informed consent	*Include justification in protocol*
☐	Non-English language material	*Include material in English and translated into a language spoken by participants*

9. Research and/or recruitment sites

☐ If multi-center study, list all participating academic institution(s): _____

Submit IRB approvals from other sites

☐ Attached

☐ Pending

☐ 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): _____
Provide letter(s) of support from appropriate authority at each site

10. 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: _____

11. 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**

12. 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.
- 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.

Conflict of Interest Statement:

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:** _____

Study title: OSU Society of Automotive Engineers: Team Management

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

***Fax this page with the PI's signature to the IRB at 541-737-3093**

OSU Society of Automotive Engineers Team Management

1. **Brief Description:** The purpose of the proposed research is to identify potential problem sources in the team management of the OSU Society of Automotive Engineers. The goal is to identify weak areas that if improved could potentially increase the overall performance of the SAE teams. 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.

2. **Background and Significance:** The OSU Society of Automotive Engineers (SAE) is a nonprofit, student-run organization that designs, builds, tests and competes an auto-cross style race car (Formula) and an off-road vehicle (Baja) every year. SAE is not, however, a purely technical competition. It is generally accepted that SAE is as much a management competition as it is an engineering design competition. Without effective team management, an excellent design is simply an idea, not a reality.

3. **Methods and Procedures:**
   I. Identify Participants: participants will be selected from the different management groups of SAE.
   II. Schedule Interviews: interviews will be scheduled based on availability of each individual member. No interviews will interfere with work or school requirements of the participants.
   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.

4. **Risks/Benefit Assessment:**
   - **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.
   - **Benefits** – There most likely be no direct benefits to participants in the 2010 race season, but the results may help to identify factors that could improve team management in upcoming years.
   - **Conclusion** – There are no foreseeable risks and several important benefits. Therefore, the benefits outweigh the risks.

5. **Participant Population:**
   - Up to 25 individuals will be invited to participate.
   - The participants will be members of the OSU Society of Automotive Engineers, all of whom are students of OSU (both undergraduate and graduate).
   - At least one member of each management level will be interviewed. Management levels will be determined by the faculty advisor.

6. **Subject Identification and Recruitment:** The faculty advisor for OSU SAE will first be notified of the study and asked to participate with the Recruitment Script for Faculty Advisor (included). If in agreement to participate, this individual will identify participants based on their level of participation and position in OSU SAE and will notify these students of the study via email with the Interview Recruitment Document included as an attachment.

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

8. **Informed Consent Process:** Potential participants will be given the Informed Consent Document at the beginning of the interview. After reading the document, they will decide whether or not they want to participate. To proceed with the interview, the participant must sign the form, which will be kept in a locked storage cabinet after the interview is complete. The Informed Consent Document is included as an attachment.

9. **Anonymity or Confidentiality:** Confidentiality of the information provided during this research study will be kept confidential to the extent permitted by law. The anonymity of the participants will be waived if they decide to participate and sign the Informed Consent Document.

APPENDIX B: Advisor Recruitment

Recruitment Script for Faculty Advisor

My name is Hillary Shoop, and I am a student at Oregon State University. I am undertaking a research study with your organization—the Society of Automotive Engineers (SAE). I would like to conduct half-hour interviews with selected student members at different management levels of the team.

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, I will need your assistance in identifying participants. You will need to select a set of participants from the OSU SAE student population. I am looking to interview at least one student from each management level of your organization. Once identified, you can send the students the attached recruitment form. Then students can voluntarily contact me to participate.

Please contact me at shooph@onid.orst.edu if you are interested in participating.

APPENDIX C: Student Recruitment

Recruitment Script for Interviews

My name is Hillary Shoop, and I am a student at Oregon State University. I am undertaking a research study with your organization—the Society of Automotive Engineers (SAE).

You are being invited to take part in a research study designed to identify potential problem sources in the team management of SAE. The goal is to identify weak areas that if improved could potentially increase the overall performance of the SAE teams. 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 agree to take part in this study, you would be interviewed for approximately a half an hour at your convenience. Are you willing to participate?

If NO: Thank you for your time.

IF YES: Please let me know a day and time that would be convenient _____.

Please contact Hillary Shoop at shooph@onid.orst.edu or 503.705.7579.

APPENDIX D: Interview Consent

WHO WILL SEE THE INFORMATION I GIVE?

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. You will be requested to submit information that ties your responses to the Society of Automotive Engineers, but only the research personnel at Oregon State University will have access to this information. If the results of this project are published your identity will not be made public.

DO I HAVE A CHOICE TO BE IN THE STUDY?

If you decide to take part in the study, it should be because you really 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.

WHAT IF I HAVE QUESTIONS?

If you have any questions about this research project, please contact: Hillary Shoop at 503.705.7579 or shooph@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.

Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Participant's Name (printed): _____

_____ _____

(Signature of Participant) (Date)

APPENDIX E: Interview Results

INTERVIEWEE 1

(1) Think of a recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. TD (−)

An important subsystem of the car was almost damaged during construction.

Summarize the problematic actions in chronological order. RA −

One of the subteams was working on their subsystem. The whole subteam had been working hard for an extended period of time. One of the team members was completing a task on a part and did something to potentially damage that part.

What was the result in terms of project scope, schedule, cost, or team dynamics?

Team dynamics were affected, people were upset. AP −

What was done to remedy the situation? NA +

Got a team advisor to ask if the part was in fact bad or damaged. It was decided the part was fine. Also, the interviewee sent out an email to apologize for their negative attitude. AP +

(2) Think of another recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. CI (−)

Sometimes team leaders do not have good communication, especially when tasks change.

Summarize the problematic actions in chronological order. NA − AP −

The interviewee was working on a task and some team leaders were unaware of why certain changes had been made with how this person was completing the task.

What was the result in terms of project scope, schedule, cost, or team dynamics?

Team dynamics were affected because everyone was not on the same page. AP −

What was done to remedy the situation?

More team meetings were held to reduce lack of communication. CF +

(3) Think of a recent time when you or someone else successfully completed a daily team task.

Please describe the situation.

Weekly team meetings were held much better than last year. CF (+)

Summarize the actions taken in chronological order. P +

Main senior project team leaders talked about their subsystem projects and gave visuals every week of what their team had worked on. The meetings were held more formally in a classroom with a projector instead of in the shop. CF +

What were the benefits in terms of project scope, schedule, cost, or overall team relations?

-Team dynamics were better because people were more motivated after seeing visuals of projects. AP +

-Schedule was affected because the meetings were much more organized and more structured.

(4) Think of a recent time when you or someone else might have tried something new and creative to overcome a challenge but were unable to implement it.

Please describe the challenge. TD (−)

Keeping track of tasks needed to complete a part and recording what had already been done.

Summarize the actions taken in chronological order. NA −

A couple team leaders tried to use the system that was created last year for completing this same part.

1

What led to the unsuccessful implementation of this solution?

There were many more people working on this part than last year, and the system was pretty confusing for that many people to keep track of.

NA –

What was the result in terms of project scope, schedule, cost, or team dynamics?

Schedule was slightly affected because people were unsure of what had been done and what was left to do; they had to ask around to find out the answer.

CI – AP–

What was done to remedy the situation?

A new system was created that was more detailed and that more people understood.

P +

INTERVIEWEE 2

(1) Think of a recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. CI (–)

It's difficult to get responses quickly by email. Probably because there are so many emails circulating and people don't have efficient email systems.

P –

Summarize the problematic actions in chronological order. CI –

The interviewee tried to accomplish a task by sending out an email and soliciting response from team members. Three sets of emails were sent out to the entire team, and only about two responses were received each.

What was the result in terms of project scope, schedule, cost, or team dynamics?

-Team dynamics could be a problem if people didn't help with the completion of this task. It could affect how people feel toward each other.

AP –

What was done to remedy the situation?

Decided to send out several new emails in new email threads in different ways of communicating the same situation to increase the likelihood that team members saw the emails. Different methods were used.

P –

(2) Think of another recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. NA (–)

Old ways of operating seem to be the hard set ways. This is the only way we do it, and we don't need to waste time figuring out a different way to do it.

AP –

Summarize the problematic actions in chronological order. P –

A task needed to be completed for competition. Interviewee was trying to argue that doing this task in a different way might work much better than how it had been done before. Person in charge was not willing to listen to the ideas.

AP/NA –

What was the result in terms of project scope, schedule, cost, or team dynamics?

NA – -Schedule: Inefficiencies were kept from previous years and they were not improved upon. The team had always done it this way, so it was scheduled like this way.

NA – -Scope: constricts having new ideas and improving the old way.

-Team dynamics: with student environment and engineering, the desire to make it to top 5%, you need an open-minded, accepting community to succeed. Last 5% is about how you manage the team, not the car itself.

AP – P –

What was done to remedy the situation? AP –

Completely gave up. The interviewer new if they pushed it, the leader would get angrier. Also, if the situation would have been brought to upper management, the leader would have been angry and their professional relationship would have been damaged.

AP –

(3) Think of a recent time when you or someone else successfully completed a daily team task.

Please describe the situation. (AP)(+)

The work the interviewer is doing on a conceptual level is very appreciated. The interviewee feels the captains/leaders would give the interviewee more time for discussion if possible (not restricted by need to work on car).

CI/NA +

Summarize the actions taken in chronological order. CI +

At the captains meeting really good feedback was received. The team captains would have probably kept talking if the car had not needed to be worked.

What were the benefits in terms of project scope, schedule, cost, or overall team relations?

-Team dynamics: gave this person motivation to do more work because of the appreciation AP +
-Scope: improved scope of overall team because emphasis was moved away from focus on just the vehicle. Discussing the work made other team mates more aware that there is more than just the car. P +
-Schedule: help the team be more organized. By starting conversations, things are getting done more.

(4) Think of a recent time when you or someone else might have tried something new and creative to overcome a challenge but were unable to implement it.

Please describe the challenge. (P)(−)

Subteam tried to create something new that was not implemented.

Summarize the actions taken in chronological order. RA −

They tried to get input from the other team members. Only one person gave input.

What led to the unsuccessful implementation of this solution? CF −

-They did not solicit help publicly enough to get enough buy-in; not enough enthusiasm put into it from their end
-They didn't have a lot of top-down support NA −

What was the result in terms of project scope, schedule, cost, or team dynamics?

Affected subteam's scope because there was no information. They started doing things that didn't need input from the team to insulate themselves from not getting enough input.

P −

INTERVIEWEE 3

(1) Think of a recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. (TD)(−)

Manufacturing of an important part was abandoned on a critical night.

Summarize the problematic actions in chronological order.

One subteam needed to get a part done in just a few days and needed a part of it done one specific night. The subteam members left and the captains and other team leaders were the only people there to finish the job.

RA −

What was the result in terms of project scope, schedule, cost, or team dynamics?

-Schedule: schedule of this part was put behind. RA −
-Team dynamics: first big indicator of 'burnt-out' team members. AP −

What was done to remedy the situation? CF +

A meeting was held to discuss roles and responsibilities of all team members. This meeting was effective for a few weeks.

(2) Think of another recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem.

Members of a certain subteam did not know what they were doing and were not receptive to constructive feedback.

(TD)(−) AP −

Summarize the problematic actions in chronological order. TD −

This problem started the very first week of class. One of the subteam members was using inappropriate tools to make ineffective and dangerous parts.

What was the result in terms of project scope, schedule, cost, or team dynamics?

-Scope: development of the subsystem did not progress as far as desired.
-Cost: increased because of so many broken parts.
-Team dynamics: pulled resources from other areas causing stress.

What was done to remedy the situation?

Someone else had to do all of that work. RA −

(3) Think of a recent time when you or someone else successfully completed a daily team task.

Please describe the situation.

The interviewee took over responsibility for a certain subsystem of the car. TD (+)

Summarize the actions taken in chronological order. TD+

This person established requirements for the system, designed the system to meet needs and reduce weight. This happened after discovery of the corresponding subteam's inadequacies. RA +

What were the benefits in terms of project scope, schedule, cost, or overall team relations?

Scope: Much improved system from last year→more reliable and ½ the weight.

(4) Think of a recent time when you or someone else might have tried something new and creative to overcome a challenge but were unable to implement it.

Please describe the challenge.

The interviewee wanted to do complete a part in a new way. TD

Summarize the actions taken in chronological order.

This person talked to team leaders to convince them that it would be beneficial.

NA +

What led to the unsuccessful implementation of this solution?

The team leaders agreed it would be beneficial, but too many resources (people) would have to be used.

NA − RA −

What was the result in terms of project scope, schedule, cost, or team dynamics?

Nothing was really affected. This option may be evaluated for next year.

INTERVIEWEE 4

(1) Think of a recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. RA (−)

Equipment was missing from the SAE shop and was being kept in an inaccessible (controlled by other people).

Summarize the problematic actions in chronological order.

The equipment was missing; this person did not have access to the location where it was being held; no one was around to unlock the lab. RA −

What was the result in terms of project scope, schedule, cost, or team dynamics?

-Schedule: decreased efficiency of the work. IT −
-Team dynamics: caused frustration.

What was done to remedy the situation?

This person had to borrow tools from the shop manager.

RA −

(2) Think of another recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. P (−)

A piece of information for competition was not submitted on time.

Summarize the problematic actions in chronological order.

CI − An email was sent out delegating responsibility for turning in the information. People met to discuss the email. Responsibility was allotted to these team members but there must have been a miscommunication because they did not end up turning in the information on time.

What was the result in terms of project scope, schedule, cost, or team dynamics?

-Schedule: entry was late.

What was done to remedy the situation?

The information was turned in late, and the situation ended.

(3) Think of a recent time when you or someone else successfully completed a daily team task.

Please describe the situation.

The team pulled an all-nighter to get the car driving. TD (+)

Summarize the actions taken in chronological order.

The team needed to test drive the car. The team members [core team members and team captains] went to dinner, agreed to stay up to finish the job, and got everything done needed to drive.

AP + TD +

What were the benefits in terms of project scope, schedule, cost, or overall team relations?

They were able to have a testable car to work out bugs and move on to the next stage of development.

TD +

(4) Think of a recent time when you or someone else might have tried something new and creative to overcome a challenge but were unable to implement it.

Please describe the challenge.

The shop is always dirty. NA (−)

Summarize the actions taken in chronological order.

It was decided to make people stay around after work sessions until the shop was cleaned.

NA/AP −

What led to the unsuccessful implementation of this solution?

People weren't used to staying. It was hard to enforce because people often had real reasons to leave.

NA −

What was the result in terms of project scope, schedule, cost, or team dynamics?

Still working on this, people are getting used to the fact that it is what you have to do. Team dynamics are improving.

AP +

INTERVIEWEE 5

(1) Think of a recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. CF (−)

Often at local and international subteam meetings, no one was there from management. NA −

Summarize the problematic actions in chronological order.

Meetings were held, no management team members were there.

CF NA −

What was the result in terms of project scope, schedule, cost, or team dynamics?

Affected scope and schedule because there was lack of direction. TD −

What was done to remedy the situation?

CI –

There had to be casual meetings at other times to discuss problems.

(2) Think of another recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. (CI) (–)

Often times upper management would decide on something without team captains knowing.

IN –

Summarize the problematic actions in chronological order. CF – CI –

Upper management meetings would happen, team captains would not consent to decisions made, they would not be aware of the decisions, and they would do something else.

What was the result in terms of project scope, schedule, cost, or team dynamics?

-Schedule: not time and money to change decisions.

-Team dynamics: caused a lot of frustration.

What was done to remedy the situation? CF +

The team captains started attending the upper management meetings more.

(3) Think of a recent time when you or someone else successfully completed a daily team task.

Please describe the situation. (CF) (+)

Members of one of the subteams were normally always present at meetings to coordinate tasks.

Summarize the actions taken in chronological order.

Local subteam meetings were held every week to discuss work for the car. Most all members were always there.

NA +

What were the benefits in terms of project scope, schedule, cost, or overall team relations?

Schedule: tasks could be agreed on and completed much more efficiently.

(4) Think of a recent time when you or someone else might have tried something new and creative to overcome a challenge but were unable to implement it.

Please describe the challenge. (P) (–)

Training of new team members, especially new seniors for design projects is inadequate.

Summarize the actions taken in chronological order. P – CF –

The goal was to get new members familiar with the car and other members through weekly Monday meetings and car info sessions. Not all new members were caught up to speed in time.

What led to the unsuccessful implementation of this solution?

Management did not put as much emphasis on this at the VERY beginning of Fall term: who's on the team and what are they doing?

CF –

What was the result in terms of project scope, schedule, cost, or team dynamics?

All aspects were affected because not all team members were knowledgeable of what there were doing and why they were doing it. Suggestion is to provide a document that goes over all subjects related to the car (including management and operations) and cover these topics early on.

CF + TD/P +

INTERVIEWEE 6

(1) Think of a recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. (TD) (–)

One of the team leaders wanted a certain part made.

Summarize the problematic actions in chronological order.

CI −

NA −

The team leader asked the interviewee to complete tasks to incorporate the part but a different team leader didn't want him to do that because it wouldn't be a good use of time. They all argued for an hour and then went back to the car to figure out that they didn't need the part anyways. AP −

What was the result in terms of project scope, schedule, cost, or team dynamics? AP −

Team Dynamics: there is a tendency for heads to butt and it's not very productive. This is probably largely due to lack of sleep. It seems like these sorts of problems would occur less often if people would go home more often and sleep so they are less cranky.

What was done to remedy the situation?

Didn't need the part and it wasn't implemented.

(2) Think of another recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. TD (−)

One of the team members informed the team that they couldn't get a critical part for one of the subsytems until a month after they needed it. CI −

Summarize the problematic actions in chronological order. RA −

They found out that the company making the part wouldn't have them done for another month, which was a full month later than the initial deadline. They were going to have to move the overall critical deadline in order to wait for the part.

What was the result in terms of project scope, schedule, cost, or team dynamics?

Schedule: potentially a much later deadline

What was done to remedy the situation? CI −

The interviewee talked to the team member and expressed that this situation was unacceptable. He listed all the possible actions they could take to fix the problem and broke down the options into very simple steps. The team member was able to talk to the company and get the parts made within a week. CI +

(3) Think of a recent time when you or someone else successfully completed a daily team task.

Please describe the situation.

Coming up with a new design for one of the subsystems. TD (+)

P +

Summarize the actions taken in chronological order.

General design process to create this. Looked at what exists now through patents and found a similar device that this person then tweaked for this application. The interviewee came up with rough idea and talked with a team leader to figure out if it was mechanically feasible. NA +

What were the benefits in terms of project scope, schedule, cost, or overall team relations?

Schedule: By working with the team leader, it saved a lot of time for testing. It has proven to be more reliable than they could have hoped for. NA +

(4) Think of a recent time when you or someone else might have tried something new and creative to overcome a challenge but were unable to implement it.

Please describe the challenge.

One of the team members tried to make a part stiffer by redoing geometry. TD (−)

Summarize the actions taken in chronological order.

The team member spent a lot of time doing analysis and changing geometry to make stiffer. This meant that when it was time to assemble, there hadn't been much time spent to make a jig. This affected the end quality of the part on the car.

What led to the unsuccessful implementation of this solution? P −

The team member focused so much on that one thing he was doing, he wasn't thinking about the peripherals.

What was the result in terms of project scope, schedule, cost, or team dynamics? P –

Schedule: there were several assemblies that had to be scrapped because they were welded poorly because of lack of jigging. This delayed things because it had to be put into chassis and probably delayed things for about a week.

INTERVIEWEE 7

(1) Think of a recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem.

Oil line blew off during practice. TD (–)

Summarize the problematic actions in chronological order. RA –

The oil line blew off and leaders were asking people who weren't familiar with the tools/parts to bring them things. This caused further frustration during a critical moment.

AP –

What was the result in terms of project scope, schedule, cost, or team dynamics? RA –

Team Dynamics: frustration. It's difficult to expect someone who's not as experienced to help efficiently during that critical time, but help is still needed, so it's frustrating for the people who do need help.

AP –

What was done to remedy the situation?

RA – The people that were more experienced continued to fix the problem with the car while those who weren't as experienced couldn't do much else.

(2) Think of another recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem.

Working on a certain subassembly with another team member. TD (–)

Summarize the problematic actions in chronological order. RA –

The subassembly was originally the other team member's task to do, and the interviewee was assigned to help because it was apparent that the team member wasn't working on it. It was very frustrating to get all the work done because it was constantly difficult to get the other team member to show up to do work. Specially, one time the interviewee asked the team member to work on a specific thing and the team member said no he would work on something else, a less critical thing. There was minimal upper level management to enforce that. AP – CI –

NA –

What was the result in terms of project scope, schedule, cost, or team dynamics?

- Team dynamics: frustration between teammates.
- Schedule: put subassembly behind schedule.

What was done to remedy the situation? RA –

The interviewee basically worked on subassembly alone. The other team member ordered parts.

(3) Think of a recent time when you or someone else successfully completed a daily team task.

Please describe the situation.

A certain subsytem was able to endure extended driving due to a last minute fix. TD (+)

Summarize the actions taken in chronological order. NA +

The interviewee and a team leader came up with the idea to use a new idea to fix a failing subsystem. They started discussing possible options and came up with a somewhat unorthodox method.

CI +

What were the benefits in terms of project scope, schedule, cost, or overall team relations?

Scope: it would have been very difficult have a successful car if this solution had not been implemented.

(4) Think of a recent time when you or someone else might have tried something new and creative to overcome a challenge but were unable to implement it.

Please describe the challenge. TD (−)

The original design of a part for one of the subsystems.

Summarize the actions taken in chronological order. RA +

One of the team members originally designed this part. This design broke a few minutes into testing and no analysis was done to prove that the design should not have been successful. The second safer iteration was implemented and also failed. P −

What led to the unsuccessful implementation of this solution? CF −

P− The subsystem kept failing. Even through the analysis, it appeared that the other parts should have worked, their lack of understanding of that type of part and the material from which it was made probably led to poor decision making.

What was the result in terms of project scope, schedule, cost, or team dynamics? CI −

- Cost: increased cost because they went through more parts than they expected
- Schedule: the part fix was done in time for competition, but now they have to go back to the drawing board to come up with a new set of rotors.

INTERVIEWEE 8

(1) Think of a recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. NA (−)

With current management system, there is a minimum of 5 people that believe they are in a position of leadership.
P− The issues (1) decisions take much longer than necessary because there are many people disagreeing that believe AP − they are right, and even simple tasks took a long time to decide; (2) these people have different opinions, so you can be told to do one thing by one leader and another thing by a different one.

TD −

Summarize the problematic actions in chronological order. CF −

For example, in any given week, the team would have one all-team meeting, one subteam leader meeting, one local subteam meeting, one international subteam meeting AND one senior project meeting all discussing the same basic thing. This would use up a lot of time, which could have been possibly avoided by combining multiple of these meetings. All of these meetings were held so all of the different members of management could hear the same thing. Probably two meetings could be sufficient, maybe three (suggestion: all team meeting and at least one more technical meeting). CF − RA −

What was the result in terms of project scope, schedule, cost, or team dynamics?

- Schedule: many hours were wasted.
- Team dynamics: when a team member does something wrong, they get apprehended many times by different people. It is not very motivating.
- Scope: for example, a part was suggested to be made in a new way by one leader and a different leader said to make it the old way. Both leaders were disappointed when the part wasn't made the in the way they suggested.

What was done to remedy the situation?

Ignored people. Parts got done in the old way and people who were disappointed were disappointed.

AP −

(2) Think of another recent time when you or someone else encountered a problem related to daily team functionality.

Please describe the problem. NA (−)

Goals were set that were unrealistic. These goals were made to feel more unrealistic through the use of false deadlines. Setting an unrealistic goal in the first place does not encourage a team member to meet this goal so much as to set them up for failure. It is also important to be honest about the deadline. AP −

Summarize the problematic actions in chronological order.

For example, the shipping deadline to Germany. It was initially set at an unrealistic date. It was demanded that the ship date be met and that it would include all parts required to build a car in Germany. The result was in fact not one subteam was prepared for neither the initial shipping date nor amended but still unrealistic shipping date.

RA −

What was the result in terms of project scope, schedule, cost, or team dynamics?

- Schedule: for example, the initial schedule stated that one of the subassemblies was supposed to be finished by the beginning of winter term.
- Team dynamics: it was insinuated that a certain part should have already been built when this person was working very hard on other parts. Leaders being angered and making remarks like this severely hurt team dynamics, even if they reacting because of other reasons.

What was done to remedy the situation? RA – TD –

The schedule kept getting bumped back. The result: not only was the first shipment incomplete, but it was also much later than the actual deadline, and its critical arrival date. Also, it postponed the completion of the U.S. car, and jeopardized any sort of decent performance at the first competition.

(3) Think of a recent time when you or someone else successfully completed a daily team task.

Please describe the situation. 3 (F) (+)

Even though they were long-winded, the Fall term design meetings were very successful because basically everyone was there.

Summarize the actions taken in chronological order. TD +

Design sessions were held internationally at all hours of the night. These were tiresome but a lot got done.

What were the benefits in terms of project scope, schedule, cost, or overall team relations?

Schedule was improved because a lot of work was completed.

TD +

(4) Think of a recent time when you or someone else might have tried something new and creative to overcome a challenge but were unable to implement it.

Please describe the challenge.

Building a new part a certain way. (TD) (–)

Summarize the actions taken in chronological order. NA –

The interviewee was told by a member of management that a certain part should be completed a certain way. A different member of management said that the parts should be completed the way they had been in the past first and then completed the new way after the old way was done.

What led to the unsuccessful implementation of this solution?

Time constrictions made it impossible to complete the part BOTH ways, so the part was completed the old way.

RA –

What was the result in terms of project scope, schedule, cost, or team dynamics?

Team dynamics: each member of management was angry that the part didn't get completed the way they suggested it should.

AP –