Design of a Motivational Model to Enhance Volunteer Student Group Performance

by

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Submitted to the Department of Mechanical Engineering in Partial Fulfillment of the Requirements for the Degree of

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ABSTRACT

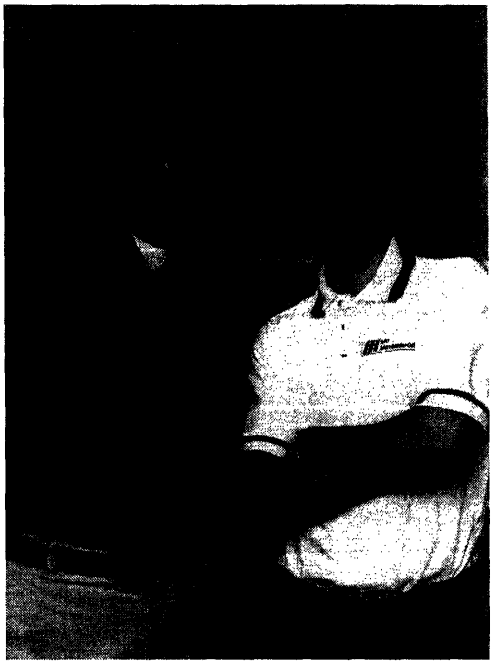
Motivation is a subject of great interest to managers seeking to improve overall team performance. Furthermore, motivation has been my greatest challenge as team manager of the MIT Motorsports Formula SAE team. This group is composed of volunteer students dedicating their time for an extra-curricular activity. This thesis serves to develop a motivational model unique to MIT Motorsports with the goal of increasing overall team performance.

MIT Motorsports team dynamics are described through performance observations and feedback from a survey given to team members. This analysis is combined with a discussion of traditional and contemporary theories of motivation to yield a new improved model of motivation.

Conclusions of this thesis are particularly useful for future MIT Motorsports team managers. While this model is specific to MIT Motorsports, the overall approach to the universal problem can enlighten any manager seeking to receive gains from the motivation to performance relationship.

Thesis Supervisor: Dan Frey
Title: Professor of Mechanical Engineering

Dedication



Father and Son

It is with great pride that I dedicate this work to my father. His support and guidance throughout my collegiate years has been a constant motivator for success. He has taught me the wisdom of life, which is the most valuable lesson of all.

Table of Contents

Table of Figures

1.0 Introduction

1.1 The Concept of Motivation and Performance

The concept of motivation has not been around very long. Managers fifty years ago did not think about what drives people, but rather were concerned with work specifications and specialization. If an employee was not producing results, it was because he/she was bored, lazy, or unfit for the job. Motivation was improperly viewed as a personality trait, either someone had it or he/she didn't. Managers increased performance through task variety and/or training. While these practices do improve results, the concept that individuals strive and work in response to some kind of internal or external stimuli is *relatively* a new notion. Over the past half-century, there has been a considerable shift for managers to focus on motivation in order to increase performance.

So what is motivation? Motivation, in its simplest form, accounts for an individual's intensity, direction, and persistence of effort toward attaining a goal [9]. Intensity is concerned with how hard a person tries. This is the element most people identify with motivation. However, intensity alone does not reach goals unless it is channeled in a direction that leads to the desired result. Effort is the action of the individual to reach a goal, but again, it is directed effort that is beneficial to the manager seeking productivity[1]. Finally, motivation has a persistence aspect, since managers want an individual to maintain his/her level of effort in order to achieve their goals

There are different "motivational factors" which effect levels of intensity, direction, persistence, and thus effort within each individual. These motivational factors define a person's "needs structure." Individual needs differ from person to person, and they can also be influenced by environmental and situational forces. This complexity is why motivational theory is so widely contested. Traditional and contemporary theories of motivation approach the individual and the environment differently, and in turn develop different models to help the manager improve performance. However, the more managers understand what drives human beings, the more productive organizational settings can be designed.

Motivation is important because it is directly related to performance. Coaches repeatedly tell their teams: "Winning is 10 percent ability and 90 percent effort." Whether you agree on the coach's percentage weighting, the fundamental thinking is correct. If the coach was from MIT, he would write this on the locker room board:

$$P = f(AxM),$$

where P stands for an individual's performance, A for ability, and M for motivation [7]. Just as with the example of the coach, the equation suggests that an individual's performance is

[1] Motivation is often used interchangeably with effort in literature. While they are quite similar, I define motivation as the end result, and effort as the action. We can think of effort as the motivated action taken by an individual.

related to the interaction between ability and motivation[2]. It is therefore critical for managers to concentrate on this interactionu if they are concerned with increasing performance.

1.2 Intrinsic and Extrinsic Motivation

Now that we have a handle on what motivation is, we can describe the different types of motivation. Motivational factors play a major role in the theories that will be described later. These factors can be external, such as compensation, or internal, such as achievement. The two types of motivation follow from this difference. In extrinsic motivation, rewards provide satisfaction to the individual independent of the activity itself. In the case of intrinsic motivation, people value tasks for their own sake.

It is not just enough to identify the difference between intrinsic and extrinsic motivation, but also discuss the interactions and relationship between the two. Individuals have a complex need structure of both internal and external motivating factors, as in the case of Maslow's Hierarchy of Needs (Section 2.2). The interaction between the two types of motivation is also of interest. A complete discussion of these interactions is not within the scope of this study, however we will look more closely at the negative effect of using extrinsic rewards to stimulate an intrinsically motivated individual (Section 2.1.2).

1.3 MIT Formula SAE

The Formula SAE Competition challenges student teams to conceive, design, build, and race small, formula-style racecars. The competition is sponsored by the Society of Automotive Engineers (SAE), as well as Ford Motor Company, General Motors, and Daimler-Chrysler. Restrictions are placed on the car design and powerplant so that the knowledge, creativity, and imagination of the students are challenged. "Formula" refers to the traditional open-cockpit, open wheel racecar format. The original competition was begun in 1980 in Detroit, but has since grown to encompass over 300 collegiate programs with international competitions in the United Kingdom, Australia, and Japan.

The MIT Motorsports Formula SAE (FSAE) Team builds a new car each year to compete in the Detroit competition each May. The project encompasses a wide range of disciplines, from component design to fabrication to business administration. Being such a young team, MIT Motorsports has had to build their resources from the beginning. For the members of MIT FSAE, it has never been just about building a car, but rather building an entire program.

The team is composed of anywhere from 10-25 students, depending on what level of involvement is considered to be a "team member." This is the greatest weakness of the team. Students of all ages and skill-levels volunteer their free time for this extra-curricular project.

[2] It is important to remember that motivation and ability are only part of the performance equation. There are other factors, such as quality, and skill level which can affect performance. However in the focus of motivation we will simplify the overall performance equation.

There is no pay or credit earned for a member's commitment, which can vary from 3 hours a week for one person to over 60 hours a week for another. The challenge of the team manager is to motivate this wide range of effort levels to continually improve the program.

The team began in 2002 with a small but dedicated group. They were young, and had little or no experience in building a car from scratch. Their first entry in the 2003 competition placed 97/132. A technical failure eliminated them from scoring points in any dynamic event but gave them the necessary experience to move ahead. The team returned in 2004 with a much improved design and finished 41/127. The 2004 entry completed every dynamic event, a feat accomplished by only 1/3 of the entire field.

2005 is the first year where team management has been transferred. Nikhil Gidwani, team founder, has passed on his position to me based on my dedication, effort, and leadership skills over the past three years. The team hopes to continue their improvement, not only in their vehicle design, but also in the professionalism and development of the program itself. As Chief Powertrain Engineer Jim Cuseo commented at the beginning of the 2005 season: "We had a competitive car [in 2004], but we did not have a competitive program." It was the consensus of the team that missing critical deadlines was the limiting factor in 2004. This weakness can be improved by increasing productivity and performance, and this means solving the problem of motivating a group of volunteer students.

Feedback is critical to the manager striving to improve performance. Often times, managers are misled about the behavior of their groups because they rely on their own perceptions of the situation [4]. Two ways in which managers can do this are through questionnaires and personal interviews. This study utilizes both methods. A survey was given to the team in order to receive quantitative and qualitative data about team vision, management, and motivational factors. This survey will serve to support the assumptions and conclusions made throughout this paper. A copy of the questionnaire is included in Appendix 8.2.

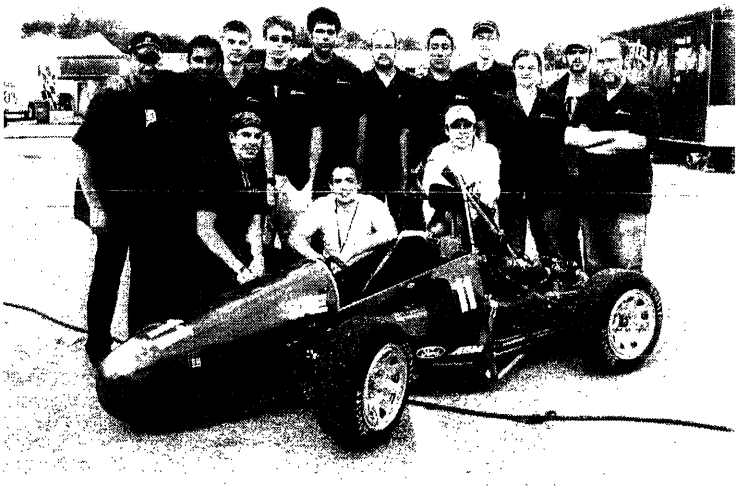


Figure 1-1: MIT Motorsports Team at Competition, May, 2005

1.4 Team Management

Since this paper serves to give recommendations to future MIT Motorsports Team Managers, it is important to identify the role(s) of a manager in a team environment. Coldly, a manager is an individual who achieves goals through other people [8]. It is the responsibility of the manager to coordinate the activities of an organization such to facilitate attaining goals.

However, there is more to running a team than just achieving goals. In the late 1960s, a student at MIT, Henry Mintzberg, performed a careful study to determine what managers did on their jobs. On the basis of observations, Mintzberg concluded that managers perform ten interrelated roles attributable to their jobs. These roles, or sets of behavior, are primary concerned with interpersonal relationships, the transfer of information, and decision making. Mintzberg's Managerial Roles are outlined below in Figure 1.2 [9]:

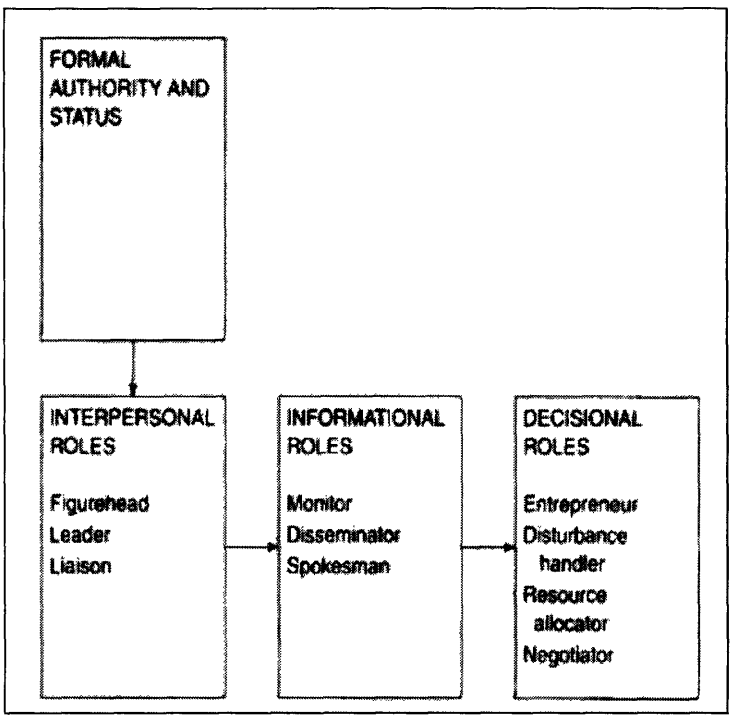


Figure 1-2: Mintzberg's Managerial Roles and their relationship [9].

Mintzberg's managerial roles completely outline a manager's responsibilities. However, in a goal-orientated and results-driven environment, a manager is chiefly concerned with team performance. According to Mintzberg, the responsibility for a manager to facilitate performance is through his/her role as a leader. As a leader, a manager is responsible for the motivation and direction of the team. A good manager is not often called a "good motivator," but rather a "good leader." Just as in our case with motivation, it is not clear what makes an effective leader, and the connection between leadership and the motivational responsibility supports confusion. "How does a leader produce results?" is more often the question than "How does a manager motivate his team."

An effective team manager leads a team to results through motivation. Mintzberg outlines the complete roles of a manager, but we will limit our discussion to the role of leadership. An effective manager is a good leader, an effective leader yields performance, and we have already introduced the connection between motivation and performance.

2.0 Common Motivational Theories

Over the past fifty years, several main theories have evolved to explain the concept of motivation. As stated earlier, the concept of motivation is rather complex, involving both an individual's unique motivational factors and his/her interaction with the situation. Theories have evolved from a simplistic approach involving only a cause and effect relationship (Behaviorism) to comprehensive theories which account for an individual's interaction with the situation (Expectancy Theory).

Behaviorism states that all human's actions are dependent on consequences. This motivational theory relies heavily on extrinsic rewards to produce results. We will challenge this theory and the use of rewards towards improving team motivation. Contemporary motivational theory began with Abraham Maslow's Hierarchy of Needs. Maslow expands upon behaviorism by giving the individual some control over their own decisions as well as increasing the importance of intrinsic motivation. Finally we will discuss expectancy theory, the most comprehensive contemporary motivational theory that will be later modified to design the MIT Motorsports motivational model.

2.1 Behaviorism

2.1.1 Fundamentals of Behaviorism

The idea behind behaviorism is an extension of Thorndike's basic law of effect: "Do this and you'll get that" [11]. The notion that rewards can be used to stimulate behavior has been around forever, but behaviorism takes that a step further, and dictates that all behavior is dependent on consequences. Behaviorism states that humans do not necessary control their responses but rather are controlled by outside factors.

Rewards or incentives are used in order to elicit a desired response. If this process is repeated, the aggregate sum of these responses can create a behavioral pattern. There are two different manners in which subjects "learn" behavior responses, through classical or operant conditioning.

Classical conditioning can be analogized though the classic example of Pavlov's Dogs. A dog's natural response is to salivate whenever it smells meat. By ringing a bell every time a dog smells meat, the dog will begin to associate the bell (an external stimulus) with the natural response. Classical conditioning occurs when the dog salivates when the bell is rung in the absence of meat. A behavior has been elicited through the association of an external stimulus, demonstrating the power of behaviorism.

In contrast, operant conditioning is concerned with an external stimulus *following* the natural response. In the classic case of Skinner's Rats, rodents navigate through the maze in order to receive an award of cheese. The rat's natural behavior is to navigate the maze and the stimulus is the cheese. This is the basis for Reinforcement Theory, which is

simply the scientific explanation of the Law of Effect. Operant conditioning is so commonplace, in fact, that Alfie Kohn coin the term "pop" behaviorism because of its integration into common society. Kohn describes this notion as ". . . so deeply rooted that it feels to us like plain common sense" [3]. However, as we'll soon see, reinforcements and pop behaviorism can in fact have negative implications on team performance.

2.1.2 The Case Against Rewards

Managers embrace pop behaviorism when they use rewards to get quick results. Society has embraced this notion to the point where no one questions its overall long-term effects. Take for example, the mother who gives her screaming toddler a lollipop at the grocery store to quiet down. What has the toddler learned? The mother is reinforcing this negative behavior, not eliminating it. The mother may enjoy a small amount of quiet time, but through operant conditioning the toddler will now associate screaming with the end result of getting a lollipop. The mother has not set herself up to enjoy any future supermarket errands.

Kohn gives a solid explanation for the popular adoption of pop behaviorism:

> "There are identifiable reasons to account for [pop behaviorism's] popularity, beginning with the belief systems already in place which it compliments . . . A nation of busy pioneers and entrepreneurs has no time for figuring out the source of the problem; much more compatible with the American spirit is a simple declaration that would seem to assure results: 'Do this and you'll get that' [3]."

Managers are too busy to be concerned with theories, and thus will favor more practical techniques to get the job done. I can validate this myself, since I spent considerable more time pushing the team towards deadlines rather than improving the overall team dynamic.

But if rewards continually produce results, does this prove that reinforcement theory works? The negative effects associated with pop behaviorism appear over a longer period of time. Operant conditioning demonstrates that the more rewards are used, the more they will become necessary. Furthermore, over time, it may require *more* rewards to produce the same response. Let's look back at our example of the screaming toddler. Through operant conditioning, the toddler will begin to associate disruptive behavior with the reward of a lollipop. However, after several visits to the store, it may require a lollipop and a toy to quiet the child. The use of rewards does not solve the root of the problem, which is the child's behavior. In just the same manner, managers should focus on the means (in our case motivation), rather than the end result.

The theory of behaviorism demonstrates that individuals are motivated through the expectation of rewards, or reinforcements ("Do this and you'll get that"). However, there is a strong case to be made against the practice of using rewards to motivate your group. In the long run, behaviorism can limit, rather than improve, the manager's ability to elicit

performance. The team will become dependent on rewards, rather than motivated to produce results. Advancements in the ideas of behaviorism have yielded stronger theories of motivation which can be better utilized by managers.

2.2 Maslow's Hierarchy of Needs

The basis of most contemporary motivational theories is Abraham Maslow's hierarchy of needs. This well-known traditional theory hypothesizes that within every human being there exists a hierarchy of five needs [8]:

1. Physiological: Includes hunger, thirst, sex, and other bodily needs.
2. Safety: Includes security and protection from physical and psychological harm.
3. Social: Includes affection, acceptance, and friendship.
4. Esteem: Includes internal esteem factors such as self-respect, autonomy, and achievement, and external esteem factors such as status, recognition, and attention.
5. Self-actualization: The drive to become what one is capable of becoming includes growth, achieving one's potential, and self-fulfillment.

In Maslow's hierarchy of needs, every individual weighs these needs in a different order of importance. As each of these needs becomes substantially satisfied, the next need becomes dominant. As Maslow himself explains: "When a need is fairly well satisfied, the next prepotent (higher) need emerges, in turn to dominate the conscious life and to serve as the center of organization of behavior [5]." Therefore, a manager looking to motivate someone, according to Maslow, simply needs to understand what level of the hierarchy that person is currently on and focus on satisfying those needs at or above that level.

Maslow's theory has been highly contested, and research has developed more valid theories to explain motivation. However in any discussion of motivation, it is important to introduce Maslow's theory because it has laid the foundation from which contemporary theories have grown.

2.3 Expectancy Theory

Expectancy theory is a contemporary theory of motivation which links both intrinsic and extrinsic motivational factors, and gives control to the individual to weigh these factors to determine their ultimate behavior.. While the strength of this theory is still being tested and refined, it represents a comprehensive approach to understanding motivation. Particularly for our case, expectancy theory is a useful tool for managers seeking to improve motivation within organizations. Expectancy theory can be applied to various situations and conditions, and it is this robustness that makes it so beneficial to our application.

The theory is based on a number of specific assumptions about the causes of behavior in organizations [4]:

1. Behavior is determined by a combination of forces in the individual and forces in the environment.
2. People make decisions about their own behavior in organizations.
3. Different people have different types of needs, desires, and goals.
4. People make decisions among alternative plans of behavior based on their perceptions of the degree to which a given behavior will lead to desired outcomes.

The last assumption begs some explanation. In simple terms, people tend to do those things which they see as leading to desirable outcomes and avoid doing those things they see as leading to undesirable outcomes. Therefore, expectancy theory dictates that people's motivational level is dependent on the situation they are in and how it fits their needs.

In expectancy theory, people make decisions based on the probability that their effort will lead to results. These results can involve three distinct sources of value to an individual: value associated with the behavior itself, value associated with accomplishment, and value associated with rewards presented by others. Just as with Maslow's hierarchy of needs, expectancy theory incorporates both intrinsic and extrinsic motivational sources. R.J. House has developed the most complete expectancy model which incorporates all three of these sources of value [2]:

$$M = IV_a + (P)_1(IV_b) + \left[\sum_{i=1}^{n}(P_{2i})(EV_i)\right]$$

where

M	= task motivation
IV_a	= intrinsic value associated with task behavior
IV_b	= intrinsic value associated with task accomplishment
EV_i	= extrinsic value associated with task accomplishment
P_1	= perceived probability that one's behavior will lead to accomplishment of the task
P_{2i}	= perceived probabilities that one's task accomplishment will lead to external rewards

Expectancy theory gives the individual more control over their actions than both behaviorism and Maslow's hierarchy of needs. In this model, the individual estimates their own utility, which influences behavioral decisions. While at first glance this equation may seem complicated, it is helpful to understand the different components that define expectancy theory and their interactions.

Motivation is our focus in the larger goal of enhancing group performance. So how does expectancy theory relate motivation to performance? Figure 2.1 graphically depicts the relationship of motivation to performance in terms of expectancy theory:

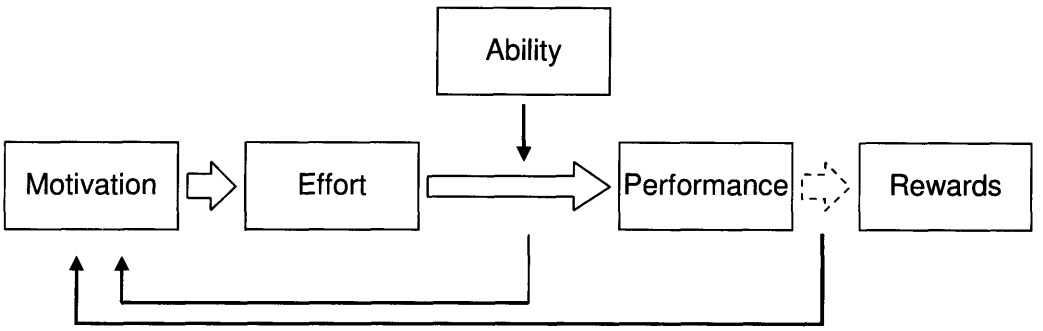


Figure 2-1: Expectancy Motivation to Performance Model [6]

The coach's relationship of motivation to performance from our introduction is elaborated upon here in House's expectancy theory. This model states that a person's motivation is a function of the probability that one's effort and performance will lead to favorable outcomes (rewards). This model expands our original relationship of motivation to performance, and thus gives insight to managers seeking to formulate specific strategies for changing motivation to increase performance. We will make use of this comprehensive model for our own design for MIT Motorsports (Section 4.1).

3.0 MIT Motorsports Team Dynamics

Before we design a new motivational model for the MIT Motorsports team, we must first take a closer look at the team dynamics and asses overall team performance. With an understanding of team behavior, we will be able to move ahead with the design of an improved motivational model.

3.1 MIT Motorsports: A Special Case

If the MIT Motorsports Formula SAE team was like any other organization, there would be no interest in this thesis. As stated earlier, MIT Motorsports is comprised of students volunteering their time for an extra-curricular activity. This makes MIT Motorsports different from the organizations which underlie the common motivational theories described above. For this reason, managers seeking to increase performance need to design an alternate model from the ones already described.

3.1.1 Motivation in Volunteer Organizations

Volunteers enter into an organization based on their own free will. The members of MIT Motorsports do not receive any pay or academic credit for their commitment to the team. Rather, interviews with team members have identified three common motivational factors: a desire to learn, a desire to apply skills, and an appreciation for racing and automobiles. Research has shown that students find inherent satisfaction in some of their tasks, which drives them to learn [10]. Other volunteers are simply looking for a chance to exercise and develop their skills, particularly in fabrication. Finally, many team members simply find racing and cars cool and interesting, and want to be surrounded with those of like interests.

Whereas the motivational theories we described earlier account for both intrinsic and extrinsic factors, in the case of MIT Motorsports, team motivation is dominated by intrinsic qualities. This is consistent with most volunteers, but creates a much more difficult problem for the manager trying to enhance performance.

As described in Section 2.1.2, there can be a negative correlation between extrinsic and intrinsic motivation. One such situation where this is especially true is in the case of volunteer organizations. Team members are motivated by intrinsic factors: satisfaction growth, and personal interest. There is no need for external forces, in the form of rewards, or "carrots" to elicit performance. Managers who utilize extrinsic motivators to stimulate intrinsically-motivated individuals are only serving to destroy their future capacity to increase performance.

3.1.2 The MIT Mentality

A short discussion must be made regarding the MIT student. This is not based on any tangible research, but rather on personal observation (being a student myself). I will limit my discussion to simply MIT students, but I feel as though it can be expanded to describe most college students.

We have seen that in expectancy theory individuals estimate the probability that effort will yield certain results. In the case of MIT Motorsports, the motivational factors which drive team members are only a small facet of the overall need structure of the student. To put in terms of Maslow's hierarchy, a team member may have a hierarchy of needs specific for the team, which in turn is only a single tier in a much larger hierarchy of needs.

MIT students have a rather large and developed hierarchy of needs. Students strive for success in the classroom, success in their extra-curricular activities (which can often be numerous), and success in their social lives. Conflict occurs through competition between the different need structures for an individual's time and effort. A student is limited in their overall capacity to fulfill all their needs. Therefore, just as Maslow states students prioritize their effort towards the highest level need. Since time is a limiting factor for the student, often times this practice leads to putting off certain needs until the last moment.

This is a much more complex situation than that described in most motivational theories. The most comprehensive theory to date, expectancy theory, does not taken into account the effect of one need hierarchy on another. This challenges the team manager not only to enhance motivation within the team, but also compete with a student's other commitments.

3.2 Performance Observations and Analysis

Now that we have an understanding of the driving forces and unique conditions of MIT Motorsports, we can evaluate the current performance of the team. We will assess the performance of the team based on three observable characteristics:

1. Team adherence to schedule
2. Effort Levels
3. Team Vision

These observable characteristics are chosen based on their importance to the team. MIT Motorsports has been hurt by missing deadlines in the past and can therefore relate team performance this year to adherence to our schedule. Performance was observed by recording average effort levels over the course of the year. MIT Motorsports is a young program, still coming into itself. Therefore a unified team vision was an important factor to keep the team on target throughout the year.

3.2.1 Team Adherence to Schedule

The main weakness of the 2004 team was missing critical deadlines. The racecar was ultimately completed for the competition but only in a rushed manner a few weeks before the race. This effected quality, and required a great sacrifice by many team members in the weeks leading up to completion. However, the relative success at the 2004 competition (41/127 finish) served to motivate the team to outline a detailed schedule for 2005:

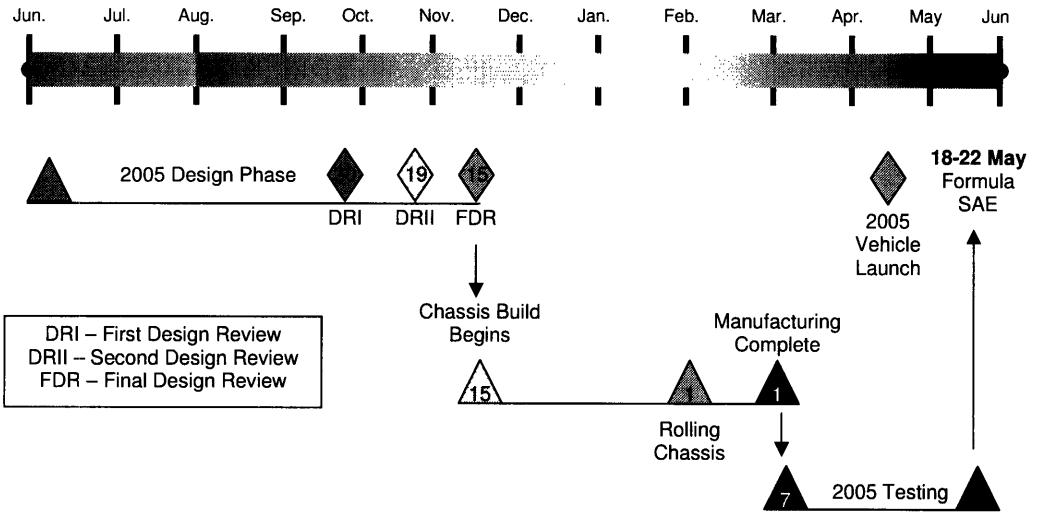


Figure 3-1: 2005 Schedule

Due to a lack of sustained effort (which we will discuss shortly) combined with fabrication complications, deadlines were missed again for 2005. The team completed the car a month after its scheduled completion date (May 7th). This month took away valuable time from the testing period in preparation for the 2005 competition. While the 2005 car was completed several weeks ahead of the 2004 schedule, the goals outlined above were not fulfilled.

The 2005 schedule and relative deadlines were organized by the team management but agreed upon by the entire team. As stated earlier, the relative success at the 2004 competition motivated the team to continue their improvement in 2005 and strive for a Top 20 placing. This is a lofty goal for a team in only their third year in a competition 25 years old. The 2005 schedule, while aggressive, was developed to fulfill this team vision. Missing deadlines is an indicator that the team may not have been completely unified in this overall vision. While the team may have believed in the end goal, they did not understand the intermediate steps necessary to achieve this end result. The manager

should have been more involved throughout the course of the year, developing short-term milestones to keep team members on task.

3.2.2 Effort Levels

As discussed earlier, performance is a function of ability and motivation. However, there is not an inherent concept of time in this equation. The intermediate steps missing from the above schedule require a sustained amount of effort over time. Section 3.1.2 described the MIT Mentality. Students have too many responsibilities and must prioritize and concentrate their effort on the most critical task. More often than not, this means that tasks are put off until the last moment. This limits overall team performance. Throughout the year, team effort was observed and an estimated average for each team member's contribution was recorded in a log. These observations are depicted in Figure 3.2, and depict average effort over the course of the year:

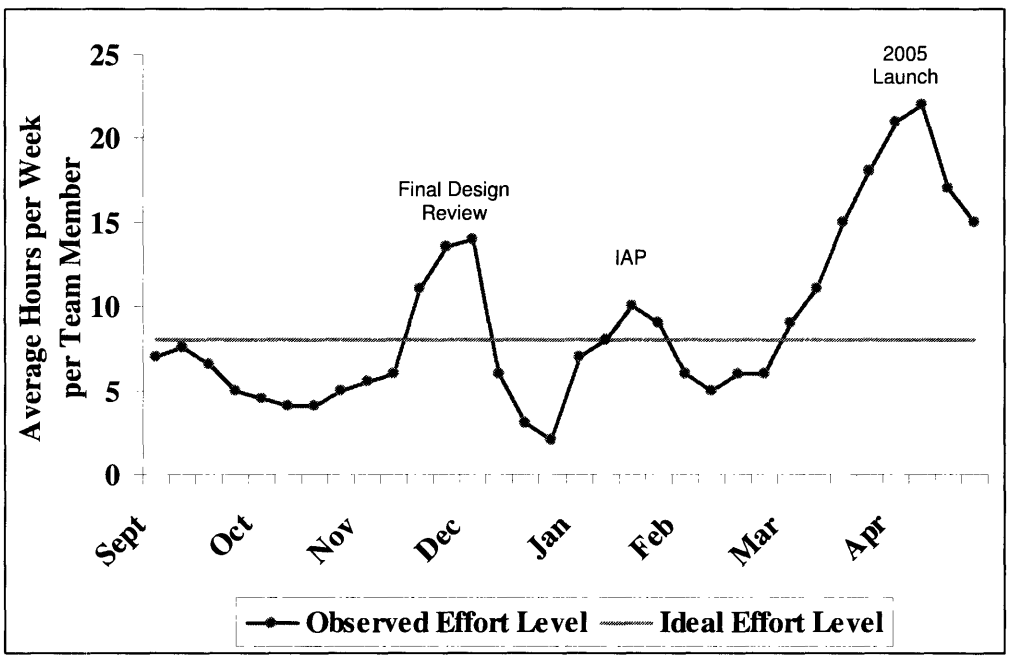


Figure 3-2: Average Effort over Time

From looking at the graph, especially in direct comparison to the team schedule (Figure 3.1) increased effort levels are typically seen around large team milestones. These "hard" deadlines serve to motivate the team and raise the commitment in team members' "hierarchies". The effect of competition with other commitments is also noted by the heightened effort levels during IAP in January, when students have no class.

Figure 3-3: "Hard" deadlines serve to push the team to fulfill goals, but often at a cost of high stress and fatigue.

A variable work ethic does not produce good results. In terms of team dynamics, it has further negative effects by creating a division within the team. While some team members do maintain relative constant levels of effort, others repeatedly postpone their tasks until the last moment. This forces them to work late nights in order to accomplish their goals. These individuals have created a social distinction because of their late night sessions, dubbing themselves "The Night Shift." While these individuals are some of the hardest working and most skilled individuals on the team, a less, but sustained, effort level over time would yield better results with less stress and fatigue (depicted above as the green line).

The division within the team arises because there are multiple effort levels given at critical milestones throughout the year. While the night shift dramatically increases their effort levels during these critical periods, other team members will simply be maintaining their constant level of effort. However, because these individuals do not visibly increase their effort levels, this is seen negatively by those who do. This creates an uneasy tension between the two groups, which hampers communication and unity. Furthermore, respect is given to those individuals who step up their effort levels, and disrupts the balance of authority and power in the team.

Figure 3-4: A few of the Night Shifters pose proudly with the 2005 car. While variable effort levels are not good practice, they get the job done.

3.2.3 Team Vision

We have already discussed the MIT Mentality and how that can compete with members' effort levels over time. However, we have also seen the split that can grow within the team because of various effort levels. For good performance, the team must be unified in their direction towards their goals, this is the team vision

In the survey given to the team, members were asked what they felt the vision of the team was. Samples of some responses are given below:

> *"My vision is an efficient team with innovative, quality design and construction, and an attitude of professionalism."*
>
> *"A social, innovative FSAE team that uses its students and resources to explore new designs in FSAE."*
>
> *"Have fun. Build car. Win competition."*
>
> *"A win at competition."*

Clearly, team members have a range of ideas of what the MIT Motorsports team vision is. For the most part, these ideas can be separated into two different overall visions. There is one group on the team that believes the team vision should be towards all around improvement and growth (as seen in the first two comments). The second group is more concerned with the competitive aspect of the team and striving for a win.

In the survey, team members were asked to measure, on a scale from 1-10, how much they felt the team was unified in their direction and vision (with 10 being completely unified and directed). Overall, the team rated unification towards their particular vision at 5.8/10. However, an interesting conclusion is drawn if we separate the two different visions and observe the relative ratings subjects gave in each case:

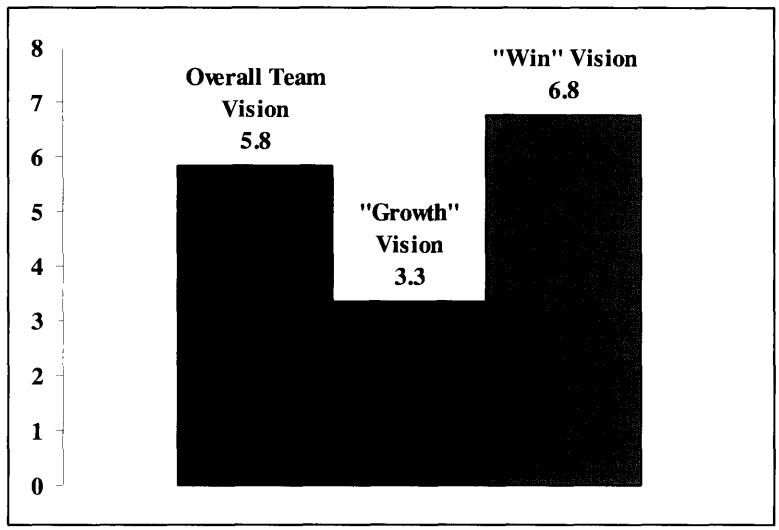


Figure 3-5: Average Measure of Team Unity Towards Vision

It is clear that those concerned with growth do not feel that the team is unified towards such a vision (3.3/10). On the contrary, team members concerned with winning feel as though the team is more unified (6.8/10). This difference could be attributed to relative team members' maturity and experience levels. Senior team members with several years invested in the project could have a much broader vision than newer, younger members. Experienced team members realize that in order to win the competition there must be growth in all aspects of the program. A great car does not, however, guarantee a win. While maturity seems like a valid parallel to make, this cannot be verified because personal information was not gathered on the surveys.

For the manager focused on improving team performance, the difference in team vision must be resolved. In order to meet goals, the entire team must be unified in reaching these goals. It is the manager's responsibility to lead the team towards a unified vision. This difference is a significant weakness of the team, and will lead the design of our motivational model.

3.2.4 Performance Analysis

Overall, the team has performed relatively well this year. Critical deadlines were missed, but the team consistently worked ahead of the previous years' schedules. Furthermore,

the team worked with a higher level of quality and pride than in previous years. At this point in the program, the team understands what is necessary to improve. However, we lacked the experience and understanding of the necessary effort to compete at this higher level. I think the biggest accomplishment of this year is gained from our failures. We now understand the necessary effort required to achieve our greater goals, and therefore the team will be able to strive towards those goals in future years.

This is analogous to the improvement process seen in the first three vehicle designs. 2003 was a learning tool. The challenge here was just to complete the car for the competition. In 2004 we learned what designs worked, and applied them to a much more refined, but slightly over-engineered vehicle. In 2004 we had a solid design concept, just poor implementation. This is exactly what has happened this year as far as program performance. We have a solid design (vision), but we lack the expertise to follow-through on our design. Just as the 2005 vehicle is an optimized design iteration of the 2004 car, I feel as though next year will be an optimized performing group based on the lessons learned from this year.

One team member grasps this idea in a response on the survey:

> *"This year, I believe, was the first, small and often difficult step, in transforming MIT FSAE from being in the competition to being competitors. This year has really begun to pave the way for MIT to be champions in the next 3 or 4 years."*

3.3 Motivational Factors

While it is important to observe team performance, in order to improve motivation the underlying motivational factors must be identified. This is one example where questionnaires can become very beneficial to team managers. It is clear that what motivates one person does not necessarily motivate another. Identifying these factors is the biggest challenge for managers looking to increase team motivation. Once these factors are identified, a strategy can be developed to enhance them.

Just as in the case of team vision, several clear categories of motivational factors surfaced in team interviews. These factors focused on the opportunity for future jobs from involvement in the program, the "cool factor" of racing, and the challenge in simply building something and developing one's skills. These factors where then used in the team survey to get a clearer understanding of what "drives" MIT Motorsports. Members were asked to place an "X" between three points on a triangle to correspond to the relative force(s) which drive their commitment to the team. The results of this survey are outlined in the following triangle:

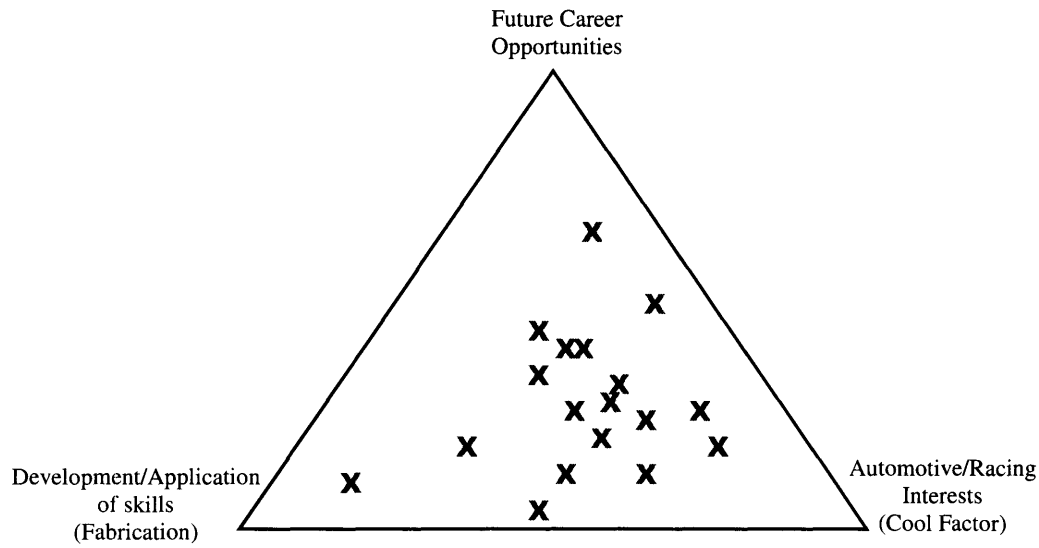


Figure 3-6: Summary of Team Motivational Factors

Although results are not overwhelming, there is a trend towards the overall "cool factor" driven by an interest with racing. This supports the earlier conclusions from measuring team vision. Team members concerned with a growth vision will be more driven by development of skills and future career opportunities. Team members striving for a win at the competition are more involved because of their competitive spirit. The team manager should exploit this data, using the excitement of the program to motivation members to increase effort levels.

3.4 Flow of Authority

In any organization, there is a direct relationship between commitment, respect and leadership. In terms of a volunteer organization, this is particularly critical to a manager's role because he/she has little "real" power over the volunteers. There is no external accountability to hold against individuals. Often times this means the manager must rely on his/her personal relationship and affiliation with the team in order to assert control.

On the MIT Motorsports team, respect is given to the hardest working individuals. This dynamic is supported by equity theory, which states that individuals compare their task inputs and outcomes with those of others and then respond to eliminate any inequities [8]. Therefore, the hardest working individual(s) will have the most control over the actions of others. However, as we have seen in the case of the Night Shift, if the manager's effort level does not increase along with the greatest contributing members on the team, this will be viewed negatively on the team and power will shift.

This makes it difficult for managers to maintain their authority level, especially in the sensitive situation with volunteer team members. Furthermore, there is another issue

created by the idea of team member visibility. "Effort" is often misconstrued as visibility, and therefore respect. Effort should be determined by results and not by face time within the team.

Tension is generated between management and the team because of the difference in *perceived* commitment. While the team management wants to see a constant effort level, the team expects the authoritative figures to work as hard, if not harder, than them at all times. The team often does not understand the amount of extra work required by the management team outside of the shop, and likewise the management team oftentimes does not recognize the team for their extra efforts at critical periods. The two sides become frustrated at each other, which can lead to further conflict and division within the team.

In a volunteer group, motivation is almost entirely intrinsic; there are no structured external rewards. Therefore, team members will become emotionally involved with the project. Team managers need to understand this and dictate their actions to circumvent their own emotions. In this manner, effective managers can utilize the team's emotions rather than conflict with them.

4.0 Improving Performance in Volunteer Student Organizations

We have outlined traditional and contemporary theories of motivation. These theories can be utilized by managers to improve the performance of their organization. However, the MIT Motorsports Formula SAE team is a unique organization: a volunteer student group. The special case of MIT Motorsports requires a different approach then found in the theories previously discussed. This alternative approach will be a modified model of expectancy theory, and can be used by future team managers to enhance and increase performance levels.

4.1 The Motivation-Performance Relationship

Expectancy theory is the most comprehensive contemporary theory of motivation. It includes both intrinsic and extrinsic motivational factors, and accounts for individuals' ability to make conscious decisions of their behavior. Expectancy theory is an example of cognitive-evaluation, stating that individuals make behavioral decisions based on their perceived evaluation of probable outcomes [2].

In the case of MIT Motorsports, team motivation is driven by intrinsic qualities (Section 3.3). We have also discussed the negative effects of applying extrinsic rewards to individuals intrinsically motivated (Section 2.1.2). Since intrinsic motivation dominates the members of MIT Motorsports, we will completely eliminate the extrinsic aspect to the motivation equation:

$$M = (P_1)[IV_a + IV_b + IV_c] + (P_2)(IV_d)$$

where

- M = task motivation
- P_1 = perceived probability that effort will lead to desired intrinsic value
- IV_a = intrinsic value associated with working on a racing team
- IV_b = intrinsic value associated with applying and developing one's skills
- IV_c = intrinsic value associated with future career opportunities
- IV_d = intrinsic value associated with task accomplishment
- P_2 = perceived probability that effort required to complete task will lead to task accomplishment

The three intrinsic factors outlined in section 3.3 dominate the motivation equation. There is an interest in racing, including a social aspect of being a part of the team that creates value. It is true of this team, and most educational organizations, that students enjoy learning in a project that is inherently interesting to them [10]. Therefore they will value the application and development of their skills for this task. Also, it was noted in interviews that team members are also motivated by future career opportunities

associated with their involvement in the program. Finally, an additional form of intrinsic motivation is included to account for the value created with task accomplishment. This phenomenon is witnessed with increased effort levels as the car nears completion. It is this factor that motivates team members for the "final push" to get a running car.

Now that we have a motivational model of the MIT Motorsports team, we need to establish the motivation to performance relationship unique to this equation. Expectancy theory elaborates on our coach's simplistic relationship between performance, and motivation. Likewise, we will extend the comprehensive expectancy model to incorporate the unique dynamics discussed in Section 3.0:

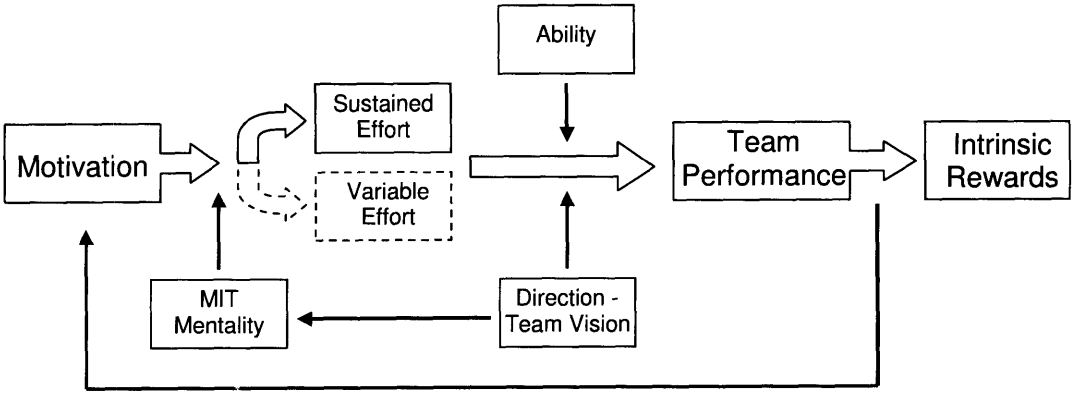


Figure 4-1: The MIT Motorsports Motivational Model of Performance

As in expectancy theory, motivation is dependent on the perceived probability of the intrinsic outcomes discussed above. There are two types of effort put forth by team members, with sustained effort being the more desirable for quality performance. This effort is determined by an individual's personality but more so by the environmental conditions imposed at MIT. Students must prioritize their many commitments, and more often than not this creates variable, rather than constant, effort levels.

An important aspect of this model is the direction and team vision. The team manager is responsible for unifying the team in vision. The manager can thus direct the effort and ability of team members to achieve the highest possible level of performance. Managers can do this at two points in the model, by first envisioning team members towards sustained effort levels and directing the skill of this effort to produce results.

4.2 Improving Intrinsic Motivation

Now that we have a complete model of the MIT Motorsports team, we can focus on specific areas and methods to improve overall performance. Significant research has been conducted regarding improving intrinsic motivation [1]. Although much of this research

was conducted largely in industrial organizations, the characteristics of tasks are stated in rather general terms, and can be made applicable to our unique organization. The following is a brief discussion of task characteristics that could improve intrinsic motivation for MIT Motorsports.

Task Significance

In order to increase intrinsic value within an individual, greater task variety can be used to maintain member interest. This procedure is often used to limit boredom associated with repetitive tasks. While MIT Motorsports has plenty of excitement, it is important for all members to have identity with the project. Increased satisfaction comes from involvement in the end task (everyone needs to be able to "point to their spot on the car"). It is important for the manager to allow all members to be involved in the car production, even if it is only a small portion. This is particularly important with motivating new members, and was achieved very successfully this year with involvement of several new members on the intake group. Task variety and identity can increase perceived significance in task accomplishment.

Social Interaction

MIT Motorsports is an outstanding group, not only because of our end product but also because of the personal make-up of the team. The team began with a group of friends coming together to build a car, but now as the team grows and expands, it is the responsibility of the team manager to support a new dynamic: a group of car-builders coming together as friends. Team members derive greater task satisfaction from interacting and working with others. Take the example of the Nigh Shift. The most enjoyable times in the shop are the most stressful late nights, because we have all developed a bond through the mutual struggle. Increased satisfaction can come as a result of fostering social interaction among team members.

Knowledge of Results

Knowledge of results, or feedback, can also be used to improve one's intrinsic motivation. If an individual receives no feedback on the quality of their results, it will be difficult for him/her to derive satisfaction from this accomplishment. Therefore it is critical for managers to relate to members exactly how they are doing, and vice versa. Communication between management and the team is the link for information exchange.

Responsibility for Results

From reading the feedback on my management in the survey, one clear weakness was my implementation of team member accountability. If an individual does not feel responsible for their task, it is doubtful he/she will place a high value on task accomplishment. The manager can motivate his team by giving them more opportunity to fail and succeed. In industry, the autonomy of workers is often increased by allowing them to schedule their own work activities, decide on work methods, and check the quantity of their own

output[10]. However, this would be difficult in our own organization due to conflict of interests with other responsibilities. The team manager must generate responsibility and accountability while at the same time micromanaging (to some degree) the team schedule.

Improving intrinsic motivation is no trivial task, as we have witnessed just how complex the concept of motivation is. The manager must have a good understanding of team dynamics when developing a motivational strategy. I have given several recommendations concerning specific actions a manager can take to improve motivation, specifically intrinsic motivation, but let us now turn our attention to the manager's position as a whole to conclude our discussion of the bigger picture: improving group performance.

4.3 Characteristics of an Effective Team Manager

Performance is certainly a function of more than just motivation. Although this thesis has focused on using motivation to improve performance, this thesis also serves as a resource to future team managers in their challenging positions. To this point our recommendations for managers have been limited to motivational strategies, and while I do not want to diminish the importance of motivation in performance, an effective leader must be more than just a motivator.

I have recommended strategies for team managers and described team dynamics for MIT Motorsports throughout this paper. I will now summarize the characteristics of a manager that will successfully implement these motivational strategies and increase performance of the team. These are characteristics that I have concluded over the course of the year, supported by personal feedback and performance observations.

Respect

Authority comes from respect, as discussed in Section 3.4. Managers must be able to both earn respect and utilize it. Managers earn respect from the team due to their past commitment and ability to lead by example. This involves being visibly committed to the team as well as demanding nothing of the team that they themselves would not do. If the team respects the hardest working individual, the manager must be willing to step into this role.

Good Communicator

Communication is critical in every aspect of a manager's job. We have seen how important team vision is to provide direction to members' efforts. It is the responsibility of the team manager to communicate this vision to the team. Communication also facilitates proper feedback between groups, further improving performance. Finally, communication is part of social interaction, and we have already described those positive effects. The manager is the spokesperson for the team, and serves as the hub of

communication between areas of the group. The manager must facilitate good communication in order to have good performance.

Assertiveness

We have not yet discussed management styles, and while a complete discussion of management theory is not within the scope of this project, an effective team manager must maintain a level of assertiveness. Past team managers, myself included, have at times been passive, especially with deadlines. This is unacceptable, and managers must assert more control over the program. This requires respect, and also giving team members responsibility and accountability for their actions. A manager must be assertive from the start, and not allow the team to continue to degrade over the course of the year.

Optimism

I am a true believer in the power of a positive attitude. There is no denying the strength of the human spirit to motivate and drive results. For this reason, the team manager should facilitate a positive attitude at all times within the team. Attitude goes a long way towards improving or degrading the social interaction within the team. Positive reinforcement improves satisfaction in task accomplishment as well as supporting communication and feedback. An optimistic attitude also helps to foster the team vision of success. To steal a personal creed: "Will is the only difference between a dream and a reality," and this sort of attitude innumerably helps improve intrinsic motivation.

Figure 4-2: The 2005 MIT Motorsports Team

5.0 Discussion

This paper summarizes the lessons and research I have performed throughout my time as manager of the MIT Motorsports team. It is my hope that this paper will serve as a resource to future team managers in the continuation and growth of this team. While the conclusions are not revolutionary, I think the thoroughness and approach of this new model are just as important as the model itself. Furthermore, I structured this approach so that insight can be gained by any student-group manager, not just MIT Motorsports managers. The most difficult aspect of designing this model was developing an understanding of motivation beyond the common notion of "do this and you'll get that." Once volunteer managers develop this understanding, and can then lead a similar approach to their unique program.

Motivation has been my biggest challenge as team manager of MIT Motorsports, which is why it is the focus of my thesis. I will be the first to admit that I have made mistakes in judgment and errors in management over the past year. I do not regret anything that I have done, or rather not done, because this team is still in its earliest stages of development. We are all learning as we go along, and hopefully this document serves to highlight some of my errors: I did not make myself visible enough to the team, I did not practice enough micromanagement to keep us on schedule, and I did not realize the importance of a unified team vision. It has taken me a full year to realize and understand some of these errors, and it is my hope that this document will prevent such errors from being committed by my future replacements.

My father has always emphasized that "an education is what you make of it," and throughout my time at MIT, my capstone experience has my involvement with this program. This team has given me experience and skills that have prepared me for my future career (which, I am happy to say, comes from a connection with the team's main sponsor).There is a bright future ahead for MIT Motorsports, and I look forward to seeing the team grow and develop into one of the top programs in the country.

"One team, one dream" – Joseph Audette, 2005

6.0 Conclusion

The principal intention of this thesis was to develop a motivational model of volunteer student behavior on the MIT Motorsports Formula SAE team. This group was used as an example for the application and approach to similar unique groups. This model can be used by team managers in order to enhance and increase overall performance within their organization.

The concept of motivation is complex and controversial. While psychologists agree that motivation is a result influential factors stimulating one towards achieving a goal, there are countless theories of motivation which differ in their approach to both motivating factors and the environments. Expectancy theory offers the most comprehensive contemporary motivational model for our application. It accounts for the ability of individuals to make conscious decisions about their behavior based upon perceived probability that their effort will lead to desirable outcomes.

MIT Motorsports is a unique group composed of student volunteers. Team managers have no direct power over the team because it is a volunteer group. Rather, authority is given to those who the team perceives as the most committed (puts forth the most effort). A further unique characteristic of this team is the MIT student mentality. Team members have conflicting commitments, such as school, other activities, or social lives that compete with their commitment to the team. Managers must counteract this competition in order to maintain constant effort levels throughout the year.

The MIT Motorsports team is entirely intrinsically motivated. In fact, external rewards may degrade the intrinsic value team members put on the project. Such a strategy should be avoided at all costs. Rather, managers should direct the team vision, develop accountability, and facilitate feedback throughout the year to improve task accomplishment and intrinsic value. Managers can use their respect, communication skills, assertiveness, and optimistic attitude to accomplish their strategy. Improvements in performance will be seen by increasing intrinsic motivation among team members.

Up until this point, the two past team managers have been founding members of the original program. We have envisioned this program and shared a vision for its future. 2006 will be the first year in which the team will be led by all "new" members. "New" in that they were not around during the team's earliest beginnings. It is up to these new members to create their own vision for this program and support it. We are a young program with, at this point, no limit to our potential. MIT Motorsports will continue to improve with improvements in not only the car's design, but also the team's design.

7.0 References

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Discussions with Dan Frey, Faculty Advisor: MIT Motorsports Formula SAE (11/04 – 4/05)

Discussions with MIT Motorsports Executive Team: Richard James, James Cuseo (7/04 – 4/05)

8.0 Appendices

8.1 Data Log for Figure 3.2

Week	Hours		Week	Hours
Sept	7		Jan	7
	7.5			8
	6.5			10
	5			9
Oct	4.5		Feb	6
	4			5
	4			6
	5			6
Nov	5.5		Mar	9
	6			11
	11			15
	13.5			18
Dec	14		Apr	21
	6			22
	3			17
	2			15

8.2 *Copy of Survey*

MIT Motorsports Formula SAE
Management Questionnaire
21 April 2005

Participation in this survey is completely voluntary and anonymous. Please be candid and honest in your responses. Data from this survey will be used to help future MIT Motorsports Team Leaders.

What is your vision for the team?

On the scale below, mark where you feel MIT Motorsports currently lies in relation to your vision. *With 10 = the entire team is completely united and accelerating toward your vision, 1 = the team has no vision or direction (i.e. Solar Car).*

1 2 3 4 5 6 7 8 9 10

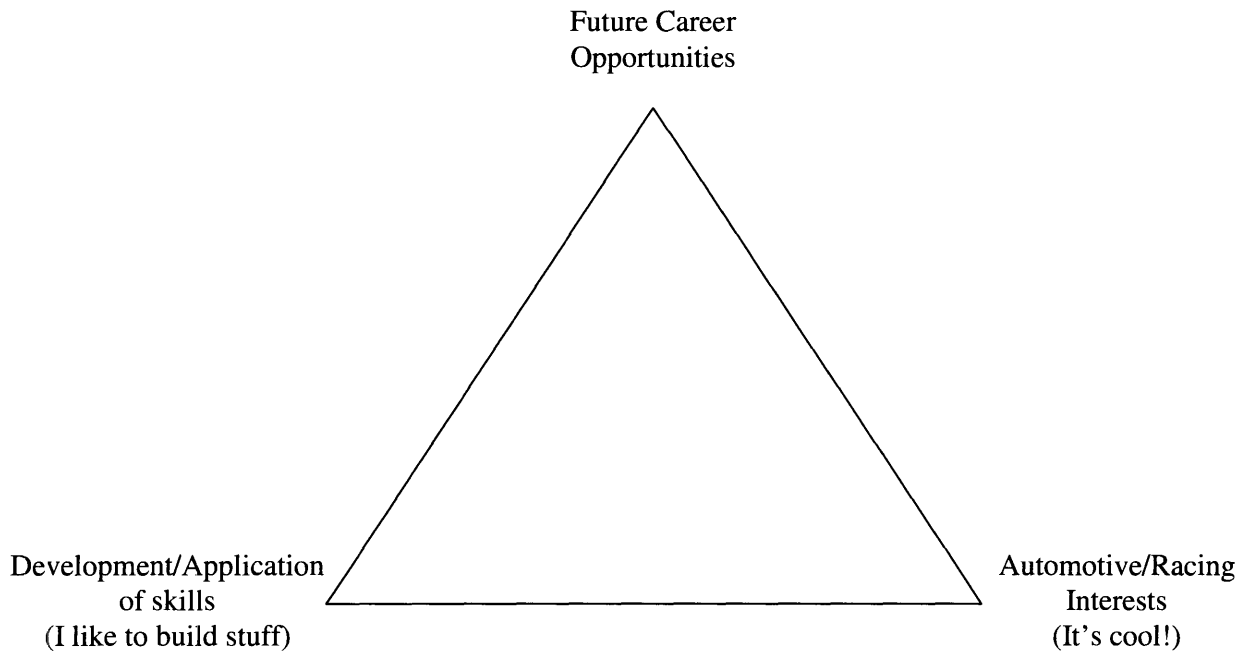
What do you see as the roles and responsibilities of the team manager?

Concerning this year's team management:

What do you feel has been done well?

What do you think should be improved for following years?

On the chart below, place an X between the three points which corresponds to your motivating force(s) as a team member of MIT Motorsports.



Additional Comments:

8.3 COUHES Application

12 April 2005

Ms. Judy Medeiro-Adams
Project Coordinator
Committee on the use of Humans as Experimental Subjects (COUHES)

Dear Ms. Medeiro-Adams,

I am writing to seek COUHES approval for a survey experiment to be used to support findings for my undergraduate thesis: *Design of a Motivational Model to Enhance Volunteer Student Group Performance.* My thesis advisor is Dan Frey, Professor of Mechanical Engineering (danfrey@mit.edu), and he will be overseeing my work and final thesis submission.

My survey seeks to gain feedback from team members of the MIT Motorsports Formula SAE team. I currently serve as team manager and I hope to gain some insight on my own performance as a manager, as well as some of the motivating factors that drive current team members. I hope to use feedback from this survey to analyze team performance and relate this performance to team motivation.

This survey will be given to team members during a weekly team meeting and they will be given an allotted time to complete the questions. I will leave the room during this time and ask that another team member collect the surveys and place them in an envelope. I hope that team members will be honest and candid in their responses, and therefore the survey will be anonymous and voluntary.
Please see a completed version of our survey attached.

I have attached a copy of the survey as I will give it to the team members. If you have any questions please do not hesitate to contact me at the information below. I look forward to your approval and the results of this survey!

Thank you in advance for your consideration,

Joseph Audette
Team Manager
MIT Motorsports Formula SAE
617.838.9306
joearlo@mit.edu