Participating in a challenging activity can be either a rewarding or stressful experience. Whether it is the former or the latter, however, depends entirely on you. In 6.270, you will be faced with the challenge of building a functional robot in a short period of time, which is by no means an easy task. Accomplishing this will not only require technical expertise, but also the ability to motivate yourself and to contribute as a member of a team.

Since each person is different and has his own unique set of skills to offer, there is no one correct way to approach the course. This chapter, therefore, is meant to present some suggestions for dealing with the human aspects of the course. Whether you take this advice or develop your own approach is entirely up to you.

1 Survival Tips

When working on a large project, many human factors come into play. In order to effectively contribute, you must not only have the knowledge, but also the desire and ability to apply it. Remaining motivated for the duration of the task can be difficult, and participants often find themselves feeling burnt out and stressed. This stress results in fatigue, irritability, and poor performance which in turn leads to more problems and more stress. If you keep the following tips in mind, however, you will be able to minimize your stress and stay motivated:

- **Have fun.** The best way to remain motivated is to simply enjoy the experience and have fun. Beware of falling into the trap of thinking
that your robot has to be the best. This course is not about winning or scoring a lot of points; it is about having fun and learning something in the process. If you simply keep a positive attitude and take the time to enjoy the course, you will find it to be a very rewarding experience.

- **Take care of yourself.** While skipping a few meals or pulling an all-nighter might seem like a good way to get some extra work done, in the long run, it tends to be counterproductive. Neglecting your body's needs will inevitably leave you tired and drained, making you much less productive and increasing your chances of catching an illness. If you eat and sleep on a regular schedule, you will find that you are healthier and more motivated.

- **Start early.** Building a robot takes longer than you expect, even when you take that fact into account. By starting early and following a reasonable schedule, you will allow yourself the time to get things done without the stress of working at the last minute. If you plan well, you can spend the last few days goofing around with your robot and making those little last minute adjustments instead of pulling all-nighters just trying to make the robot work.

- **Share your ideas.** Many people think that by keeping the design of their robot a secret they will gain a competitive advantage; however, this is usually not the case. When you are willing to share your ideas with others, others will be willing to share their ideas with you. Quite often, another team will be able to suggest an idea that you have missed or a solution that you have been unable to find.

- **Take a break.** If you find yourself arguing with your teammates or becoming frustrated over a problem, take a break and do something else. Getting away from the robot and your teammates for awhile will help you relax and allow you to collect your thoughts.

2 **Teamwork**

One of the most essential parts of any large project is teamwork. A person working alone will not have the time to learn and do everything necessary
to accomplish the task. A team, on the other hand, can draw upon the talents and manpower of all of its members, making it much more productive than an individual.

2.1 Planning

Before a team begins work on a problem, it has to develop a plan. Rushing ahead is likely to cause work to be duplicated or important tasks to be missed. Worse still, failure to plan ahead can lead to incompatibilities in parts that are supposed to fit together. When discovered too late, these errors can prove fatal to the project.

A good place to begin planning is to decide what the team is interested in accomplishing. Some teams are focused on winning while others just want to have a little fun. Still others are interested in the learning process and would prefer to spend more time on the parts that are most educational. It does not matter what goals a team sets for itself as long as all the members understand and agree with the overall vision. This will help coordinate the efforts of all the team members and provide direction for the project.

2.2 Brainstorming

Teams often employ the technique of brainstorming for generating potential solutions to a problem. During such a session, participants think aloud, suggesting ideas as quickly as they can think of them. Other members of the team can then use those thoughts to create new ideas of their own which they throw back to the group. When it works well, a team can combine the knowledge and creativity of all its members to generate solutions that an individual would not even consider. The following guidelines will help make a brainstorming session as effective as possible:

1. No squashing. Negative comments have no place in brainstorming. Insulting another person’s ideas will cause them to be reluctant to offer further suggestions.

2. Don’t hold back. The process only works if everyone shares their thoughts. Even the silliest idea can often inspire a great one.
3. Stay on topic. During the course of discussion, it is easy to wander off on a tangent. Focus on the problem at hand and avoid distractions.

4. Relax. Ideas flow more freely in a relaxed environment. Find a quiet, comfortable place where the team can concentrate on the task at hand.

2.3 Constructive Conflict

Teams composed of members who always agree with each other work quickly and efficiently but never produce the best solution. Instead, the teammates who disagree often are the ones that build the strongest teams. This may seem counterintuitive at first, but it turns out that conflict, if handled correctly, can be one of a team’s greatest strengths.

Shouting at each other and throwing tantrums will certainly not accomplish anything, but calm, rational debate allows the team to view a topic from multiple perspectives. This not only allows the team to consider various possible solutions, but it also forces the issue to be examined in greater depth. Often, you will find that an idea that seems good at first will not hold up under the scrutiny of another teammate. Disagreements between teammates force the team to constantly reevaluate and improve the design and may even help generate new ideas.

In order to engage in rational debate, you must walk the fine line between strongly defending your position and being open-minded enough to consider other ideas. Debate is not about being right or winning the argument; it is about examining both sides of an issue, so that the team can choose the best course of action. It is very easy, during an intense debate, to forget that you are supposed to be participating in a productive task, so it is helpful to keep the following guidelines in mind:

1. Prepare a strong position and present it forcefully, but keep an open mind.

2. Allow others a chance to speak and listen attentively while they do.

3. Try to view the problem from multiple viewpoints, including the opposing one.

4. Do not take disagreement and rejection personally.
2.4 Friends and Enemies

Forming good relationships with your teammates is one of the primary lessons of 6.270. In past years, the ability to work well together has often been the most critical factor in a team’s success or failure. Participants whose robots do not perform well often attribute their failure to poor team dynamics and arguments between teammates. Contest winners, on the other hand, usually attribute their success to their enjoyment of the course and the fun they had working together with their friends.

The relationships you form with your teammates are likely to continue long after the course is over. In the past, teams formed by complete strangers have left as very good friends, and unfortunately, good friends have left the course no longer speaking with one another. Remember that your teammates are human, and your actions affect not only the project, but also the people you are working with. Putting in the extra effort to work well with your teammates will pay off both in the contest and for a long time afterwards.

3 Implementation

Building a robot is usually more work than an individual can handle on his own, so it is necessary to work as part of a team. Everyone should help out by providing part of the labor necessary to design and implement the robot, but in order to do this, the work needs to be divided up in some fashion.

3.1 Division of Labor

Each person brings a different set of strengths to the team, so many teams opt to divide the work into a number of subtasks, each of which becomes the responsibility of an individual team member. In this specialist approach, each person works on one area of the project and becomes an expert at it. The most common division in 6.270 is into hardware, software, and LEGO construction, but as long as the work is divided along clearly defined abstraction barriers, the communication needed to organize the team is small. This tends to be very efficient, especially for teams whose members come into the course with varying backgrounds and interests, though it tends to lead to a very narrow learning experience for the individual.
Another popular division of labor is the generalist approach, where every member of the team shares equally in all aspects of the implementation. This allows each individual to have a say in every part of the design and to gain an overall understanding of the process. It also requires that the teammates work in close proximity which can lead to a more fun and relaxed experience. Because of the amount of coordination needed between teammates, though, a great deal of time will have to be spent on organization and communication. This makes the implementation less efficient, but can often lead to a better learning experience.

3.2 Debugging

Debugging can be a long and tedious process, so it is important to follow good design practice to minimize the number of bugs you will have to fix. Regardless of how careful you are, though, mistakes are inevitable and debugging will be necessary. As a general rule, it will take longer than you think to debug, so it is always better to allocate too much time for debugging than too little.

Occasionally, you will run into a bug that just seems to elude you. In these cases, instead of banging your head on the wall, you should have a teammate review your work and search for the bug. It may be that you are using a bad assumption or that you are continually missing the same mistake. When this happens, a teammate can bring a fresh perspective to the problem which might yield the answer.

Some teams take this debugging philosophy even further. No person on the team ever debugs his own work. Instead, each person gives their work to another teammate and that person debugs it. This way, each part of the project benefits from the input of at least two people.

4 Contest Tips

Everything always goes wrong at the worst possible time, which in 6.270, is contest night. There is nothing more heartbreaking than having your robot not work because of some small oversight. To help minimize the chances of such unfortunate occurrences, follow the tips below when preparing for the competition:
1. When making practice runs with your robot, try to avoid helping it. During actual competition, you will not be able to touch your robot when it does something wrong.

2. Practice your calibration routine in lab, so you can do it quickly and accurately at the contest. You must be able to complete your routine within a fixed time limit.

3. The lighting conditions at the contest will be different from those in the lab. Make sure that your light sensors are well-shielded and can be calibrated to work under different conditions.

4. Be aware of how your proximity will affect the calibration of your robot. When you lean over your robot, you can cast shadows or cause reflections which could affect the measurements of your sensors.

5. Develop a checklist for preparing your robot to compete. Between rounds you should examine your robot and repair anything that has broken.

6. Bring a repair kit to the contest. This should include a fresh set of batteries and a replacement for any part that tends to wear down or break during operation.

7. Have fun.