FIRST HANDBOOK

Version 1.0

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FIRST Handbook

1.0 Background

FIRST (**F**or **I**nspiration and **R**ecognition of **S**cience and **T**echnology) is an educational program chartered to spur excitement over science and technology. Through this program, founded by Dean Kamen, corporations team up with schools (generally high schools) to design, and build remotely controlled robotic vehicles. These vehicles compete head to head in gladiator style games.

The concept is built upon a MIT Mechanical Engineering course designed and developed by Professor Woodie Flowers. Each team is given a Kit of Parts, a set of rules and 6-1/2 weeks to design and build this robot. Each robot must conform to the rules and be designed to play a unique game that changes from year to year.

The goal is to have students work with and/or see engineers and scientists at work. FIRST strives to show the students that science and technology is exciting and fun. It illustrates interconnections between various disciplines (math, science, English, art, history, etc.). The Chairman's Award is what brings all of this together.

The Chairman's Award is the most prestigious award presented. It is given to the team that demonstrates the best partnership between School, Corporation, and Community. It is given to the team that best exemplifies FIRST's charter. The format is open, but generally teams submit documentation that includes - a video, written material, and photo journalistic material.

For more information you can contact FIRST by visiting their web site - http://www.usfirst.org, or by contacting them through traditional means.

FIRST
200 Beford St.
Manchester, NH 03101
(603)666-3906 Phone
(800) 871-8326
(603) 666-3907 Fax

1.1 Scope of Document

It is assumed that the reader of this document knows generally what FIRST is about and the concept behind the project. If not use the above address to contact FIRST.

This document is intended to be used by a rookie manager or team. However, since it is being written by a veteran of six years, some of the rookie perspective may not be well represented. This document will be tweaked with time, to suit the true rookie.

Please contact me with any suggestions/comments you may have to better serve your needs:

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2.0 Overview:

This document is a "how to" manual for FIRST. This is intended as a framework for rookie time teams. It is NOT intended to be used verbatim. Successful teams find their own solutions, and bend as individual problems/opportunities arise.

The rules and regulations for running FIRST are not well defined. Every team does things a little different, every manager handles the project differently. The more successful programs do not have rigid rules. FIRST is dynamic and somewhat organic. Let the project grow and take a life of its own. The trick is to let it grow while keeping control of all of the pieces.

Because of this FIRST can be a daunting project. Be prepared to be overwhelmed, but also do not get discouraged. The first year is always the roughest. Also remember that FIRST is not a typical competition. Everyone wants all the teams to compete and if possible to be competitive. So go ahead and contact other teams. Go ahead and ask questions. I have never found a team that would not help a rookie.

If at any time you get stuck, call another team or FIRST. Here is a list of teams that I have found to be helpful:
- XEROX - Elaine Anselm
- Delphi Interior Lighting - Joe Johnson
- Boston Edison/Plymouth North HS - Mike Bastonni

You might also try other teams web sites. Some teams have very useful information, (including pictures of past machines). In particular the Delphi Interior Lighting team page may be worth a visit. They contribute parts to FIRST and frequently have things like motor curves. The Delphi team has been improving this site every year to be more and more of a FIRST resource, not just a place of team advertisement. (For a full list of team web sites go to the FIRST home page - www.usfirst.org).

Now that you are questioning why you got involved in this project we'll lay out what you'll be doing. The FIRST project can be loosely broken down into 4 stages:
- Pre-Planning
- "Six Weeks of Hell"
- The Competitions
- Cleanup and Summertime Fun.

We'll cover each of these phases in turn. But before we begin lets briefly talk about a few "keys to success"

2.1 Keys to Success

Trial and error is the name of the game. This section points out some of the more important points that have been learned while working on this project.

2.1.1 STUDENT INTERACTION

FIRST is an interactive educational program. It is NOT a typical classroom curriculum. We talk about the "Team" and "Partnerships". Everyone is an equal. If you try to build the hierarchy of student/teacher, student/adult, you will not get as much out of this program.

This is a place where students can see the teachers and engineers as people and as equals. Let everyone claim ownership to the project. There is not enough time to deal with the formalities that we normally impose on students. At first this is as awkward for the students as it is for the teachers and engineers. Give it time, it will pay off.

With this philosophy, it pays to have the students do and be responsible for as much as possible. You'll be surprised at how much a high school student will give you when you give them a chance. I know … you know your students, but trust me on this one, once the project is over you won't recognize many of the students, or believe how much you've learned from them.

This also means that you need to treat them as you would colleagues. If they are not doing their job, don't accept this. Treat them as you would a peer, and make them responsible for their actions.

2.1.2 KEEP THINGS IN PERSPECTIVE

Many teams/people get hung up in winning awards and bringing trophies back home. While this can be satisfying, it is not what FIRST is about. FIRST is about education and making technology fun for the students. It is about building or rebuilding technology education and relearning how to interact with students. The trophies are pure fluff, do not get suckered in.

2.1.3 "WHATEVER IT TAKES"

In order to be successful the team must have a "whatever it takes" mentality. This may (and will) involve working 7 days a week for 6-1/2 weeks.

During the course of the project various obstacles will come into play. It is easy to use these as excuses. But do not allow this. Engineers are problem solvers. It shouldn't matter if the problem is to design some complex mechanism or trying to

figure out how to get 100 students off site during spring exams. With creative thinking and some good ol' negotiations, there is generally a solution.

2.1.4 NO INTEREST IS TOO OBSCURE

One of the great things about FIRST is that no interest is too obscure. Bring it all into the mix. The Chairman's award can house any interest. Teams have included Cosmetology, athletic programs, English as a Second Language (ESL), Culinary Arts, and of course Math, Science and English - to name just a few of the interests that have been involved.

Also don't let an opportunity pass you by. As spring comes along the team begins to get antsy, short breaks playing football, or some other sport can be just what the doctor ordered. Not only does this relieve some stress, but it also builds a sense of team. But don't leave it at that. Use the game play to reinforce gaming strategies that can be used at competitions.

Well enough of the philosophy - lets get on with the project.

3.0 Pre-planning

If you are lucky/organized enough to get started prior to the FIRST kickoff in January, you can use this time to get prepared for the project, and to build enthusiasm within the school.

Here are a list of the activities that you can start on.
- Registration
- Team Organization
- Resource Allocation
- Skill Development
- Fund Raising

3.1 Registration:

This is a simple one. All you need is money. Contact FIRST and sign your team up. The deadline is generally somewhere in the first week of December.

In 1998 FIRST is planning on implementing online registration. You should be able to do this through their web site - http://www.usfirst.org.

3.2 Team Organization:

It's never too early to get organized. And the more you do before FIRST's kick off the happier you'll be. These are typically the things that are done in the fall:

2.2.1 TEACHER KICKOFF

This is an introduction meeting with the faculty of the School. All staff should be invited. The more people that you can get to help with this project the better. There is no discipline that is outside of the scope of this project. So bring in Culinary Arts,

Basket Weaving or any "obscure" discipline that may exist at your school. (this is not a comment on basket weaving or any other interest)

The goal here is to inform the faculty that FIRST will be happening. This way they will be prepared when students are absent because they are traveling to a competition. It will also give them a chance to see how they might want to get involved. Participation might be in the form of helping out after school, or even bringing an aspect of FIRST into their curriculum.

Get the Administration involved in the planning of these meetings. This will help keep them informed and prevent miss-understandings of what is coming to their school.

3.2.2 STUDENT KICKOFF

FIRST is nothing without students. So you've got to let them know that this project is happening. Various teams have different models for student participation. Some schools use a application process, while other schools have open enrollment, still others have built this into the core curriculum.

It is my feeling that an open enrollment is the best. More often than not it is the interaction between diverse groups of students that have the biggest payoffs. New relationships are frequently forged. This can result in failing students suddenly making the honor roll, or if even deciding that college is important.

Just like the Teacher Kick-off the purpose here is to drum up interest. Generally the hardest students to get involved are the honors and varsity sports students. Their schedules are booked. But do not despair, if history is any indication these students will come either later in the project or in following years as the word gets out. Students have decided to work on FIRST instead of playing varsity basketball and baseball. (Sometimes it helps to promote FIRST as an attribute of a high school transcript. This tends to encourage some of these more "A" type personalities to join the project.)

Try something new to spur on interest from year to year. Teams have had parties with bands, and pizza (have pizza and you'll get students).

3.2.3 PARENT KICKOFF

Do not forget this group. You can have this meeting now, or wait until the project begins in January when you know a little more about the competition - but what ever you do don't forget to include the parents. Good parent support can make or break a project. Parents have chaired committees, brought food for the team while working late, raised vast amounts of money, etc.

The level of parent support will vary from school to school. But remember FIRST is a partnership between School, Company AND community. The parents are one aspect of the community you don't want to miss.

3.2.4 THE ORG CHART

Now is the time to get organized - not in January! (Have I said this enough yet?) Once you've introduced this project to the faculty, administration and students, you can begin calling organizational meetings. Layout a project organizational chart (you can change it as you move along) Below is a sample Organizational Chart. You should modify it to suit your needs.

Management Team - Oversees overall project
- Budget Allocation/tracking
- transportation
- Hotels/meals for trips
- Scheduling
- Team Coordination

Company Project Manager

School Coordinator(s)/Project Manger

Chairman's Award

Photography

Written

video

Vehicle Design

Players (Drivers/Human players)

software

Decoration

Strategy/espionage

Design/building

Shipping
- Vehicle
- tools/supplies

Business
- Vehicle Tracking
- T/Hat budget
- general budget

Other Written Awards

Team Spirit

Logo Design

Team Profiles

Team Name

Vehicle Name

Other -
- Bands
- Songs
- Costumes
- Mascots,

Animation

Rules

PR

Web

Newspap

TV/Cable

Have students, faculty, and parents sign up for the teams. Pick team leaders (it is generally a good idea to have both a student and faculty leader)

Some of these teams may barrow people from other teams until the project gets started. For instance fund raising may be the focus in the fall and may utilize all of your resources. Discuss this with the team and determine what you want to accomplish.

3.2.5 SCHEDULE OUTLINE

Project Managers, Team Leaders, committee heads, can start laying out schedules. Some of this might be difficult since actual deadlines are not yet established, but by laying out a rough schedule you'll be prepared when you get the final one from FIRST. You can also use this to identify things that you can do in preparation for January.

If you are a rookie team, try calling FIRST and asking them for the previous years schedule. In most cases the schedules are very similar from year to year. (SEE ALSO APPENDIX C)

3.3 Resource Allocation

You've had a teacher kickoff, a student kickoff and presumably you've been talking to the administration. But do you have the space and other resources to run the project?

3.3.1 FIELD SPACE -

You'll need a space about half a basket ball court to house the field. You can use a smaller space, and create only part of a field, but it is much harder to run the project in this mode.

Typically the field should be close to the place where the robot is being built. This is your testing grounds. In addition it is helpful to have this in as public a space a possible. When the school sees this field and the robot running around on it, it is going to create additional interest.

Also preferably this space has a very tall ceiling. The competitions take place in gyms. The height is important for practice purposes.

3.3.2 DESIGN/BUILD LOCATION -

This should be in or near to the shop facilities (it is assumed that the robot is being machined and built in the school.) If possible pick a room with oversized doorways since the robot itself can be up to 4'x4'x'4. In addition make sure that if the room itself is not lockable, then that there is a lockable storage closet that you have full

access to. You'll store tools, materials, and objects used in the game itself (balls, tubes, etc.).

3.3.3 COMPUTER FACILITIES -
This project has an animation component. A good high speed PC is highly desirable. FIRST distributes a complete copy of Autodesk software. This can be used in the robot design and will be used in an animation competition that Autodesk sponsors. (the Autodesk competition is subsumed within the FIRST project.).

Computer facilities are also invaluable when creating the Chairman's Award presentation and other documentation. They can be used for logo design and other graphic arts, creating presentations for kick-off's and an assortment of other desk top publishing activities that are generated during the course of this project.

You may also want to locate computers for a web page. You'll need a place to do development, and someplace to host the Web site. Many schools and/or corporations have sites that may be able to be utilized. Check with the administration to determine any rules and regulations that may be involved in hosting a site either on an official location (the schools/companies page) or even as an independent site.

3.3.4 SCHOOL ACCESS -
Now is the time to deal with school access. Prepare the administration for the unusual access periods. This project will run from the first week in January until the last week in February 7 days a week. Typically the team will be working until 8-9 at night on week nights and from 8 am to 11 or so at night on weekends. As the sixth week approaches these hours might get extended. This means that the team needs to find a way to have access to this school. A lost half day or more is equivalent to loosing 2-3 weeks on any other project.

Also note that most teams work through vacations and through snow days. This all may mean that the school may need to allocate funds to keep/open the school during non-traditional hours. Generally the janitors take care of opening and closing buildings - sometimes a school representative (teacher) can be appointed to take on this responsibility.

3.3.5 MATERIALS
The Kit of Parts change from year to year, This makes it hard to buy extra Kit materials ahead of time. However, as part of the Kit each team is allowed to buy certain materials from a hardware store. Some of these things can be bought ahead of time. These materials are unlikely to change, and even if they do they will come in handy for prototyping:

Description	Kit Allocation	Recommended Amount
½ Plywood (I'd get a better grade A-C, or even	4'x 4'	2-4@4'x 8'

Luan)		
¼ Plywood (I'd get a better grade A-C, or even Luan)	4'x 4'	2-4@4'x 8'
¼ Al Plate	1'x 2'	1@ 4'x 4'
1/32 AL Plate	4'x 4'	1-2@4'x 8'
1/16 Polycarbonate sheet (this is expensive, you might want to set up an order and wait until you get the rules. But it can also be hard to find so do the ground work ahead of time. Also do not get plexiglass)	4' x 4'	2-4@4'x8'
¼ Polycarbonate sheet (this is expensive, you might want to set up an order and wait until you get the rules. But it can also be hard to find so do the ground work ahead of time. Also do not get plexiglass)	4' x 4'	2-4@4'x8'
3/8 Polycarbonate sheet (this is expensive, you might want to set up an order and wait until you get the rules. But it can also be hard to find so do the ground work ahead of time. Also do not get plexiglass)	4' x 4'	2-4@4'x8'
1"ID PVC Pipe (schedule 40)	10'	50'
1-1/2 ID PVC Pipe (schedule 40)	10'	50'
½ ID PVC Pipe (schedule 40)	10'	50'
¾ ID PVC Pipe (schedule 40)	10'	50'
MISC PVC Pipe fittings	unlimited	

3.4 Skill Development

3.4.1 BRAIN STORMING

FIRST utilizes different teaching techniques than is found in most classrooms. FIRST is modeled closely industry projects. Teams/groups rather than individuals are assigned tasks. The project as a whole is too large for any one person to tackle. To be effective the team must learn basic techniques. Brainstorming is one of these essential skills. Typically both the facilitator and the students need to know how to effectively brainstorm. It is very easy to get sidetracked, or otherwise lose control of the session. (see Appendix B)

3.4.2 DESIGN/BUILD

Bringing a project from concept to implementation can be somewhat daunting even for very simple tasks. One exercise to help everyone get over this mental hurdle is to build a basic mechanism. One easy project, and somewhat useful later on, is to build a first generation robot "Base". This should be very basic. Something that simply rolls

around on the ground and is remote controlled or tethered. A simple plywood sheet with a couple of wheel and motors attached to it should suffice. The goals here are:

- Build something from concept up
- Get the hang of building something in a quick prototype fashion to test concepts. (This is important. It is very easy to get stuck in the details)
- Build something that may be later used to mount other mechanism, visualization, driver tryouts, etc.

Note - you do not need rules to do this. Hobble together whatever you have. You will be discarding this work later on. If you spend more than a couple of weeks on this you are doing something wrong.

Make sure you do this in the fall when you have time. Otherwise you'll be spending your first week or so doing it. This is lost time out of your schedule. (All teams go through this phase)

3.5 FUND RAISING /MONEY

It is never too late to start finding money. Creative projects can be integrated into fund raising. Be imaginative. You can do things other than car washes (do these in the fall while it is warm) and bake sales.

You'll need to establish a formal mechanism to track all of your funds. Some of this may be taken care of from the partnering company while other aspects of the project may be tracked from the schools side. These funds need to be controlled! It is not unusual to have the project raise $30-40,000.00 throughout the duration of the project. You'll need to have a method to deposit and withdraw this money. In addition the team will want to write "thank you's" to your sponsors.

Typically the partnering corporation funds certain aspects of the project, while the school pays for others. In many cases the school pays for trip expenses for spectators (busses, planes, etc). This is paid through team fundraising and co-contributions. The corporation pays for some or all of the project operating costs. But every team does this a little different. Some teams have nine or more sponsors, each one sponsors different aspects of the project.

3.5.1 MONEY MONEY MONEY - (A note to the corporation)

Traditionally most of the materials are bought by the partnering company. This can create problems. Normal corporate avenues are slow. It takes time to create, get approved and then be issued PO's. This can be a huge bottle neck in the production process. In addition many corporations have restrictions on how corporate credit cards can be used.

If at all possible look into this before the project begins. Here are some suggestions:
- Use Blanket PO's

- Set up accounts with hardware stores, paint stores, catalog ahead of time (McMaster, Small Parts, Digikey, Staples) and get corporate sanction (if necessary)
- Use corporate credit card and voucher the expense (there is generally some personal risk here because the card user is then laying cash out and is essentially bank rolling the project.)
- Cash advances

4.0 " Six Weeks of Hell"

You've done all of the pre-season stuff, you are ready to go to NH for the Kickoff. This generally occurs in early January. Ready…Set…GO!

4.1 FIRST Kick- off

At the Kick off you'll get your kit of parts, rules and they'll show you the field. FIRST will explain the game and send you on your way. This is a full day event.

Bring cameras, video recorders, and anything else you can document the event with. This is important since only a few (<5) people are going to be able to go to the kickoff due to space limitations. This information will also be helpful when you are trying to build a field of your own. Some of the finer details are frequently left out of the FIRST drawings. So take pictures of joints and methods of field construction.

Also use this time to make contacts. Other teams are your friends. Get phone numbers of veteran team members. You'll be glad you have them around week 3-4.

Now drive home as quickly as possible and copy the rules. FIRST has recently been putting the rules onto the FIRST web page (www.usfirst.org). However, these are in Adobe Acrobat format which means that some of the details (esp in drawings) are lost.

NOTE - Your team gets ONE kit of parts. Make sure that the entire team understands this and that it is EVERYONE's responsibility to keep track of it. The kit should not be used for prototyping. Many of the materials are hard if not impossible to replace in a timely fashion. Keep the kit in a safe place when it is not being used. Unsuspecting students may have a tendency to "barrow" elements from the kit.

You are now ready to start your 6-1/2 weeks of ????.

4.2 Initial Schedule

You now have the rules in hand. That means that you can update your schedule. Do this as quickly as possible and distribute it to your team. This schedule should include:
- Kick-off Meetings times
- Team Logo due date
- Team Profile due date
- Team Name due date
- Chairman's Award due date
- Woodie Flowers Award due date
- Transportation/Accommodations due dates
- Fund Raising schedule
- Driver Selection cut off date

- Pit Crew Selection cut off date
- Driver Practice preliminary schedule
- Vehicle Design/Build preliminary schedule

FIRST establishes deadlines. This will be the basis for your schedule. Miss a deadline and in most cases there is no way to make up for it. So what ever you do, make sure you know when things are due and get them done on time.

The Project Manager's (PM) job is to make sure everything gets done. For this reason make sure that good team leaders are put in place. If someone is not doing their job, either find someone to do it or do it yourself. If something does not get done it is the PM's responsibility.

4.2.1 KICKOFFs
A quick word about kickoffs - HAVE THEM. Do not assume that just because you had an introduction kickoff in the fall that everyone will know what is going on. This is where you'll be giving out the rules for the first time (in order to keep costs down, and/or get enough copies quickly enough, you may not need to hand out a full copy to everyone. The leaders will need a copy, but other team members may only need certain sections. You can direct anyone who wants a full copy to the FIRST web site)

If you neglect to have this kick-off meeting you will get questions around week 5 and later from people that want to get involved. Most participants will wait for you to go to them, or at least wait for some formal announcement.

Also by having kick-off's you'll avoid annoying faculty members who feel that they "should be invited" to work on the project. It will also alleviate non-participating faculty members from getting disturbed that the participating members are doing this to "make them look bad". (I know it sounds a bit silly but these things do occur.)

4.3 Materials Revisited
OK, now you have the rules and know what the Kit of Parts really is. Order items that you have put off ordering (LEXAN). Also look through the kit for critical elements and buy some extras. There is a swap program with FIRST, but who wants to wait 2-3 days for a new motor?

Some of the items you might consider getting extras of are:
- Seat motors
- Drill motors
- Batteries (you want more than FIRST gives you so that you can practice. Normally a battery lasts 10-15 minutes max. and takes 30-40 minutes to charge. Unless you have extras, you'll be waiting around more than practicing)
- Fuses
- Other motors
- Rod material

- Speed Controllers

Some of these parts can take 2-3 weeks to find/be delivered. So do this as early as possible to make sure you have the parts when you need them.

4.4 The Field

"If you build it they will come". Well it is time to build it. FIRST will supply a complete list of materials. You'll want to order this stuff as soon as possible. Generally there are lead times for lumber yards, carpet shops, and other vendors to ship the goods.

The field is a very important aspect of the project. It is where you'll go to visualize how a mechanism may interact with the field. It is where you'll test out prototypes, and test finalized mechanisms. Most importantly it is where you'll train the drivers and coaches.

I've even used the field as a source of getting special needs students involved. They can paint and decorate it.

4.5 Organize it and Track it!

Now the fun begins. The project manager must keep track of everything. Committee heads and team leaders will take care of the details and will track items that are locally important. Make sure that the entire team is communicating. Some teams will meet daily (Chairman's, robot) while others may meet 2-3 times a week or even less frequently. If a team is meeting less than 2-3 times a week make sure that everyone is doing their job. One person slipping when you wait for a week to get an update can be catastrophic.

Some he things you'll need to track are, Budget - Overall for the project, Robot budget - allowable by FIRST, and Schedules.

The following sub-sections are a hodgepodge of things to use and/or consider when organizing and tracking your project.

4.4.1 GROUP CALENDAR

Make a group calendar. Use it to let groups communicate public information. There should be a centralized place where everyone can go to find out when things are due, and when meetings are occurring. Therefore make sure that this is in place that everyone has access to at all times. (Avoid putting it classrooms that may be inaccessible during the day) This will make the PM's job much easier (Staples sells large white board type calendars that are very useful for this purpose)

HINT - Be sure to build in one week for driver practice and make sure that it happens. No matter what you do the Robot Build and Design team will have at least one "crunch" week. Make sure that this is done in week 5 not in week 6. If you put it off your drivers will not have enough practice time and you will not have time to put your machine through testing. As a result you are assured not to do as well in competition and assured to be constantly fixing your robot at the competition. This is

no fun. If you do not leave yourself this week it is because of poor leadership and poor scheduling.

Managers must get into the habit of using the calender and referring people to it. If someone says that "they did not know that X was due" point them to the calendar. This should NEVER be an excuse if the team leaders/managers are doing their work.

Below is a calendar that was setup for 1998 for the robot only. Each sub team will have similar calendar of events. All of these milestones/meeting time and places should make it to the group calendar.:

Jan 10	All team Members	Kick off in NH
Jan 11	All Team Members	Team kickorr/Copy rules and distribute to team
Jan 12	All Team Members	Brain storm
	field team	review prints and order materials
Jan 13	All Team Members	Brain Storm
Jan 14	All Team Members	Brain Storm/Prototype
Jan 15 -16	All Team Members	Prototype
Jan 17	Design/build	• Pre -Prototype base complete (something that runs around the field) • Base concept complete and general over concept in place for robot
Jan 18-23	Design Build team	Design/prototype build
Jan 24	Field Team	playing field complete
Jan 25	Design Build team	First set of drawings complete - begin manufacturing.
Jan 26-Feb9	Design Build team	Design and build
Feb 10	Design Build team	Vehicle complete
Feb 11-Feb 17	Design Build team	Test and redesign as needed
Feb 18-23	Drivers, Design build Teams	Driver training, modifications
Feb 24	ALL	SHIP

One may notice that this project does not last long.. Put this together with all of the other aspects of the project and you have a major Project Management nightmare. This is why organization is so important.

As a point of interest - The 1998 GHS/BA team set up this schedule before the NH Kickoff. There were 2 engineers from BA who where the main designers and project managers/consultants for the rest of the project. There were also 2 engineers from a

engineering/machining Co. The team worked from 2:30 - 9:00ish. every week day and all day during weekends and holidays. There were approximately 10 students involved with Design and Build.

With these resources, the team stayed very close to schedule. The vehicle did not totally get completed on Feb 10 as planned, but enough was up to begin testing. By Feb 17 the vehicle was complete and was run through its paces. The only exception was one mechanism that needed to be redesigned when an arm was extended to make scoring easier. (note we would never have been able to determine that this change was helpful without building in the week of practice)

So if you think that the above schedule is not realistic, think again. It is doable, it just takes some discipline and hard work.

Remember that things take time. T-shirts take time to print, the graphics guy need time to get your designs onto acetate, etc. Build all of this into your schedule!

4.4.2 RESERVATIONS

FIRST and the hotels give deadlines for reservations. However DO NOT WAIT UNTIL THE DEADLINE! Many times hotels get booked. This is especially true at Disney where there are at most rooms for 70% on Disney grounds

This is also true for flights. If you can get enough information together in the fall you can charter a plane for a reasonable rate. Generally there are fairly liberal cancellation policies for individual seats. But even if you can not make arrangements in the fall do not wait until the last minute to make flight arrangements to Disney. The Nationals generally fall over spring break and flights get booked.

(Side Note - Disney packages tend to be expensive. If you can deal with all of the hassles of staying off campus you can get cheaper deals, however consider the following:
- Liabilities with staying off campus
- If a student gets sick do you have someone that can stay behind and watch
- bussing - Disney supplies busses but they are not nearly as convenient as on campus ones

In general most teams prefer to stay on campus if possible)

You'll probably have 2-3 groups of reservations. The Drivers, Coaches, and Human Players need to stay overnight even for regionals. They will probably need to stay from Wednesday Night through Saturday Night. For regionals the rest of the team may be able to commute to the competition on a daily basis.

Whatever the situation don't for get getting the students to and from the competition(s). Also you'll need to deal with responsibility. One of the constraints

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I've put on the driver selection is that the driver could get a chaperone (parent, guardian, other) to stay with them at the competition and possibly even get them to and from the competition. This shifts the responsibility onto the parents.

(SEE ALSO SECTION 5.1)

4.4.3 WHITE BOARDS

Have a White board (Large! - 4' x 8' is great). You can get them from home Depot. Put this in a very central location and use this to post notices to the team. Upcoming deadlines, notices for driver tryouts, etc. Managers must get in the habit of using this and referring people to it.

White boards are also great for impromptu brainstorming sessions, or sketching out quick designs. So make sure that your Design and Build Team has access to one as well.

4.4.4 PHONE TREE

Build a phone tree and test it BEFORE the kickoff. Make sure that your phone tree wraps back up to the top (i.e. all of the outer most leaves of the three call back up to the top most level). This is the only way that you will know if the tree has worked.

Also have set rules about contact. Make it the responsibility of the caller to make sure that the information gets passed on. Therefore it is not sufficient to leave a message on a machine or even with a parent. The caller must call back to verify that the person has gotten the message and has continued the calling. If not then they should jump over that person and make the calls to the next level themselves.

The phone tree is invaluable in getting information like last minute meeting time changes, meeting time/places during snow days, etc

4.4.5 Process

If the team leader can lay out a concise process that the team will (attempt) to follow it can greatly help keep everyone on the same track. Note however that just because a process was created does not mean that it can not be deviated from. The team leader will need to assess this as time goes along.

(see Robot Design and Build for a sample process.)

4.6 Key Project Elements

FIRST is fluid enough to allow anything to be incorporated into the project. The basic requirements involve two elements - the robot itself and the Chairman's Award, but we'll cover a few other points as well.

4.6.1 ROBOT DESIGN AND BUILD

The robot is definitely a key aspect of the project. But remember it is NOT the entire project. The robot design/build room is frequently the center point of the project. By using it as such it is an easy way to keep the entire team abreast of what is going on.

4.6.1.1 *PROCESS*

In 1998 the following process was developed.
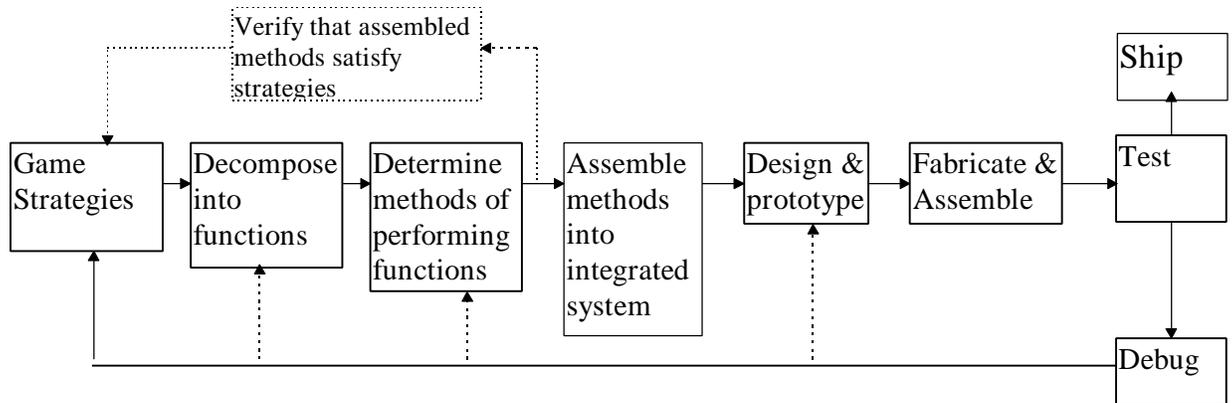
Game Strategies:
> Generically how would one play the game. (e.g. go pick up all balls then score, defend first, etc)

Decompose into functions:
> To play any (and all of the strategies) what fundamental functions will be required (e.g. pick up balls, scrore balls at location X, move, etc)

Methods of performing functions:
> How can one accomplish any of the functions (e.g. to hold a ball one could use suction, 3 fingered gripper, etc.)

Assemble Methods:
> Select your favorite methods. Make sure you feedback into the strategy box to assure that you really can perform all of the strategies that you have decided upon.

Design and Prototype:

DO NOT leave out the prototype stage. If you think you do not have enough time to prototype you are wrong!!! Prototyping will save you time in the long run. Use PVC, wood, plastic, rubber bands or anything you can to QUICKLY test the CONCEPT. Remember this is to test concepts. These are throw away designs. If a prototype takes you more than a day or two to test you are probably over designing the prototype.

PVC,PVC,PVC. I can not say it enough. This is great material to test concepts with. It is easy to cut, is inexpensive and easy to get a hold of. You may find it best to screw in your fittings with wood screws instead of gluing. This allows you to test out multiple iterations without totally rebuilding the prototype.

Foam core and hot glue guns is another great medium for prototyping.

Building a wooden box or frame that is the outer size of the robot is also handy. It will allow you to have a framework to hang prototypes off of.

Some teams have also used "Erector Sets" and "Legos" for prototyping. One team has even created custom Erector set pieces so that they can model in full scale.

(SEE ALSO APPENDIX A)

Build

You've got the prototypes down, now you need to create drawings manufacture the pieces and assemble the robot. Many times sketches are used instead of detailed drawings. If you are manufacturing the parts yourself, or have the ability to work with your machinists you can get away with this and speed up your cycle time. However, it is still a good exercise to document the vehicle.

This can give the CAD students real parts to draw. In addition it is very easy to loose track of what napkin a part was drawn on and as a result have to redesign the part when you want to make a modification and or replace it.

One of the challenges to FIRST is to find ways of making parts designed for a specific purpose do something else (e.g. drill motors driving mechanisms). One perpetual problem is the restrictions of gears, sprockets and pullies. The Small parts catalog that comes in the Kit of Parts (you are allowed approximately $400 out of this catalog) has some sprockets. However, these are expensive and many of them are made of nylon. These generally are not optimal for the high load applications. For this reason it is generally a good idea to make sprockets out of AL or steel. Since machine costs are not

considered, this is a cheap solution. If you can not crank out sprockets yourself, use an outside source.

In general the $400 limit is tricky. You'll need someone who is somewhat creative and can figure out how to keep the costs down. That may involve re-calculating methods of using materials every day (this occurs towards the end of the project when the Robot budge is getting tight). Remember that manufacturing costs do not count in the $400 budget, therefore it is generally cheaper to manufacture than to buy.

For all of these reasons the person who is working on this aspect of the vehicle will need to know the robot very well and will need to work with the Design and Build Team very closely. When this person sees 100ft of chain, they'd better scream before it becomes an critical part of the machine.

Note - you need someone very honest here. It is very easy to let a small item slip that would put the project over by a few dollars that would avoid the redesign of a complete mechanism. But remember, this is education. Although you might be able to get away with this, it is certainly not in the spirit of the competition.

Test

Testing can be done in conjunction with driver tryouts and/or training. There is a fine line here. You want to stress test the machine as much as possible. You want the machine to break at home not at the competition. On the other hand the drivers can do things that can cause headaches. They might be able to avoid breaking something by changing the way that they operate the vehicle.

Remember these competitions tend to be fairly rough. Although nobody tries to intentionally damage another vehicle, it is up to the design and build team to make sure that the robot is rugged enough to sustain some fairly major blows

The selected coaches should be working with the drivers at this point if at all possible. The drivers need to get the hang of working with coaches. To avoid confusion, it is generally preferable to have one coach looking at the game strategy/counting points and one coach coaching the drivers on how to be handling the robot. DO NOT have both sets of coaches barking commands at the drivers. This only leads to confusion. (this format also implies that at least one of the coaches should be very familiar with the operation of the robot)

Also it is a good idea to have adult coaches. Student coaches with student drivers has traditionally been a major disaster. Unless you like breaking up fights, I'd suggest that you stay away from student coaches.

4.6.1.2 *HELPFUL HINTS*

When building the "base" (the chassis only) get two of them made. This allows you to build on one of them and make mistakes. While you are doing this the second base can be pointed and begun to be decorated. Then in the 5th week or so, move everything over the painted base.

This may sound like extra steps, but it is a time save. It allows you to cut holes and try things on one base. The final product will be much more professional looking and structurally sound if you use this approach.

4.6.2 CHAIRMAN'S AWARD

The Chairman's award is the single most important part of the entire project. It is what holds all of the pieces together and allows any one and any interest to get involved. The Chairman's Award is a prize given to the team that demonstrates the best partnership between community, corporation and school. The robot is ONE ASPECT of the chairman's award.

Over the years teams have been raising the bar to this prize. It is now to the point that first year teams are drastically handy-capped. Veteran teams are making FIRST into full year programs, are hosting their own competitions, are establishing relationships with sister schools in foreign countries.

However, this does not take away from the importance of this award. FIRST is not about winning trophies. It is what you can do with the program to develop educational programs and get students excited about math and science. This is what FIRST is about.

So I would not be worried about winning this award. Do what ever you can under its umbrella, it will make your project that much more successful. If you do have your heart on winning the award come up with a 2-3 year plan. This was the approach that Plymouth North used and finally won the award in 1998.

If you are intent on trying to win this trophy, then plan on attending the National Competition. The judges are at this competition and it is a very, very long shot to expect to win this award without actually being there. (A large component of this award includes interviews with the students and schools at the National competition)

4.6.3 DRIVERS/PIT CREW

You'll need drivers and pit crews to operate your vehicle (play human player roles) and to maintain the vehicle.

4.6.3.1 *DRIVERS*

Driver selection can take on various forms. Generally, RC race cars are helpful for this. You'll want to start this process before the robot is actually ready to be driven (this is a somewhat length process).

It is also helpful to put your drivers through some sort of "stress test". This might be done by issuing a series of random commands while operating the vehicles. It might be putting them into a one on one interview (I like this one because it also gives them experience in the interview process). It could include having them work with a vehicle that is not operating properly. Whatever the method, this is designed to test the driver to get an indication of how they might respond in a situation when the robot malfunctions, and or when 2-5000 people are screaming at them. Competition is very stressful. We've seen more than one team win a match because the drivers (and coaches have kept a cool head).

Also in the Drivers have some constraints on them. You must be sure that they will be available during the end of the project for practice. This means that if students on sports teams may be excluded, if they can not get out of sports practice. Also you need students that will be reliable.

Reliability is important. You need students that will show up for practice. In addition you need students that you can trust at competitions. The drivers should not stray too far away during competitions. You never know when you may need to have a rematch or the schedule accelerates. For this reason you need trustworthy students otherwise you will be chasing students around universities and/or amusement parks.

The drivers and coaches will also need to get to the competitions on Wednesday preceding the event. This group will want to get to the competition site as it is opening up (generally 8-9:00am) and therefore traveling the day of can be tiresome. These folk should also stay overnight close to the competition so that they can maximize rest times. The week end is long so anything you can do to give this group some sleep is helpful.

This support another reason that the drivers need to be reliable. The last thing you need to be doing is dragging a driver off of a hotel building top at 2:00am. To help you out here you may mandate that the driver is accompanied by a chaperone. Students tend to be a little better behaved when accompanied by a parent.

(SEE ALSO SECTION 5.1)

4.6.3.2 *PIT CREW*

As for the pit crew, this is a team (generally no more that 5) that will help maintain the vehicle and pit area. They will be responsible for making sure batteries are charged, and the vehicle is competition ready. Generally the pit is open to anyone, but FIRST

reserves the right to limit the number of people in the pits, this group of 5 should be the ones that are elected to stay.

However, the pit crew must be warned. There may be times when things need to get done very fast. Sometimes complete mechanisms or motors need to be replaces, rebuilt or otherwise fixed within a 4 minute time frame. This is generally best done by the engineers. In these fire drill cases, the students should just stand back and watch. (Actually it is somewhat fun to watch a team of engineers in high gear and peak efficiency.)

As for travel the pit crew can travel with the rest of the team, or can stay overnight with the drivers. This is more of a budgetary issue rather than a requirement.

4.7 Practice Makes Perfect

Many teams have had fantastic robots only to find that they get eliminated immediately. This is due to a single factor - practice. Many teams do not build enough time into the schedule for practice. This means that the first time the drivers ever work with the robot is at the competition. If you would trust your teenage son or daughter to drive your new car down the highway without any training, then I guess you might as well here. But most of us would be nervous like that. So why do you think it OK to drive a 150lb vehicle with no training.

Not only can it be dangerous, but it will almost certainly mean that you will not do as well in a competition. I know - winning the competition is not the name of the game. But it is very discouraging to have a vehicle that you have worked so hard on and then to do poorly because of lack of practice. So give your team a chance - let them practice.

During practice is also when you'll learn how to optimize the robot. This is when you'll know if you need s visual indicator to help you line up a mechanism.

You'll want to practice using a 2 minute timer some too. You'd be surprised at how long a 2 minute match can be when you are ahead, or how short it becomes when you are trying to catch up. Work with lots of noise if possible. You in the competition you can barely hear the person standing right next to you, so if you are planning to use audible queues from your robot you might as well forget about it

Your coaches will want to work with the drivers here too. They need to learn how to communicate with the drivers and learn the nuances of the game.

4.8 Shipping/Delivery

You've now completed an aspect of the project and you need to ship it off. Go to the rules to find details on the shipping. Remember FIRST is **VERY** strict about this. There is no such thing a missing a deadline by an hour. If you miss the shipping of the robot for instance, you probably will not be competing - 6-1/2 weeks just went down the drain! It is better to ship an incomplete robot that may be able to be fixed at the competition than to ship late.

If this happens to you, you can use the time between shipping and the competition to get yourself organized so that when you get to the competition you can use the practice day (and seeding if necessary) to complete the robot. Make sure you know everything that you want to do before you ship so that you can pack the correct the materials and tools.

Some of the things that need to be shipped:
- Team Profile
- Team Name
- Team Logo
- Woodie Flowers Award
- Robot
- Chairman's Award

Again remember that the Robot is not the only thing going on. Although your efforts may be focused on the Robot there has been a lot of work going into every aspect of the project. It is just as disappointing to the team that worked on the Chairman's Award or Team profile to miss a deadline as it is for the robot to miss the shipping schedule.

As for the robot shipping - make sure that you pack enough stuff so that you can fix your robot. This includes tools, spares, and materials. If you know you have a critical part, bring extras. (if you T-shirts and hats are done you can pack them in with your robot.)

5.0 The Competition

You've lived through the 6-1/2 week , made all of your deliverables, and are not ready to go compete.

Depending on the regional that you select you will have varying wait periods between shipping and the competition itself. This is one of the hardest times to keep the project on track. Keep on having meetings if possible. Fund raising, Team Spirit, PR, Web Page, etc can all still meet and use this time to catch up on some of the items that were not completed during the 6-1/2 weeks.

Also keep on making your human player practice and if possible talk strategy. A week or more of sitting around can lead to some pretty rusty players.

During this "dead" time, you might want to schedule a trip to one or more competitions that occur before the one that you are competing in. this will give you some first hand experience of what a competition is like. It will also tell you the tone of that particular years competition. I try to get the drivers and coaches to at least one competition.

5.1 Travel

Most schools have their own policies, restrictions and guidelines. In general the school is very good at these things. The only warning I have is watch out for Disney. It is hard to keep track of the students. More than one room has been vandalized due to improper supervision.

In addition if you are going to Disney then it is generally a good idea not to market the trip as "Going to Disney". Your team is going to support the drivers and the rest of the team, and to show the country what a great school you are a part of. They are going to learn about robotics and technology. They are NOT going to an amusement park. In fact if you ask around there is very little time spent in the parks (This will help assure that you do not just get students that want to go to an amusement park for a school field trip)

This is important when "Selling" the program to school administration and parents. THIS IS NOT A DAY OFF. The spectators can learn as much from this experience as the drivers and coaches. On some levels, it is simply exposure to science and technology. On other levels it is an opportunity for everyone to see multiple solutions to a single problem. Teachers can even bring the experience back into the classroom.

In general there are two separate traveling needs. The first is for the competing team members (Drivers, Coaches, and possibly the Pit Crew). This group needs to get to the competition site the day before if at all possible. The first day starts early and tends to run long. You want this team to be as rested as possible

The rest of the team (the cheering section) needs to be at the competition on the day of seeding and on the competition day itself. For events that are close by (i.e. regionals) this

group is normally bused in daily. This keeps cost and the logistics of trying to house upwards of 50-150 students at bay.

5.2 Competition

Well your there. The event itself is broken down into three days:
- DAY 1 - Practice
- DAY 2 - Seeding
- DAY 3 - Double Elimination Competition

5.2.1 DAY 1 - Practice

You will spend this day unpacking, testing and fixing your robot. You'll also need to register, and get your robot inspected on this day. If you need to make modifications (a common modification is weight reduction) then this is the day to do it. So get there early.

5.2.1.1 *CHECK IN*
Some time during this day you'll need to check in. Note, practice times are established relative to your check in times. Therefore if you need time to work on your robot before you can practice, postpone check in as long as possible.

For check in you'll need to hand over some parts of your control system. (you can get these back at the end of the weekend - SEE ALSO CHECK OUT). In particular you'll need to turn in -Rnets and antenna.

You'll get your practice times when you check in. You'll also get an orientation packet.

5.2.1.2 PRACTICE
This is a hectic day, as you test things out. Listen carefully to the announcements, if you miss your practice round you may not be able to make it up. Also have one of the coaches feed the human player during practice. Otherwise they will probably be standing around on stage.

You may be able to swap practice rounds with other teams if you are working on your robot and are not able to get the robot on the field in time. If nothing else let your human player practice. Also at the end of the day you may be able to pick up an extra practice round or two. Listen carefully to the announcements and act quickly. These slots fill up almost instantaneously. (Your team will get 4-5 ten minute practices)

You'll be able to see the basic functions of the robots, but no one will be playing rough and a few teams will keep a couple tricks up their sleeves. What you see here and what you see on competition day can be two entirely different things.

Also be kind. Many teams will be struggling. If they are and you can lend a hand, please do so. The teams are here to have fun. If a team can not compete after all of this hard work, it is not very fun.

HINT - Drivers Badges: When you check in you will be given Driver and Coach badges. Store these safely, and tape up the back flap of the plastic holders. These things have a tendency to walk. You will not be allowed onto the field without them so guard them carefully. You'll probably want to collect and distribute them before and after each match. This way they will not be forgotten in a room, or get lost on some amusement ride.

5.2.1.3 *INSPECTION*
On day one you'll also go through inspection. This is where your robot will be check for rule conformance. In 1998 a new rule was added that restricted the number of people allowed at the inspection area. All questions from the inspector will be directed to a student representative. So make sure that you have a student that knows the robot well.

You'll need an itemized list of all parts and materials on your robot ($400 budget). You'll also need to answer questions regarding part usage. Some of these questions may be precise - "how many sprockets do you have", "did you manufacture or buy this part", etc.

In general make sure that you have a protocol. If the student does not know a response, then they should not answer but ask some other team member (an engineer or teacher). It is very easy to make the wrong response and have to fix something that is not broken, or conforms to the rules.

5.2.1.4 WHEN THE DAY IS OVER.
On Day One, the most important thing is to get your drivers to bed! This week end gets longer and longer. If you start out on the wrong foot it is very hard to catch up. So have a curfew or what ever it takes, just get your drivers to bed.

5.2.2 DAY 2 - Seeding
On day one you should have received your seeding schedule. Depending on whether you are still working on the robot, and when your first round is, you might be able to sleep in a little. Don't be too late - matches are only 2 minutes long . You do not miss too much, because you will want to watch the other robots. This will be the first time you'll really be able to see the other robots and how you will need to play them.

HINT:
Use Polaroids, video and pre-made sheets to take notes on. Each sheet should include a place for at least the following information
  • Team name
  • Team number

- Method of scroing
- Unique characteristics

At national there are 150-200 teams. This can lead to a lot of confusion so make sure that the strategy team is taking good notes.

Do the best that you can, but don't worry about the results. Unless you are good enough (and lucky enough) to be able to be a contender for first place, the actual standings do not really mean much for competition day. Use this day to practice and to get a feeling of what competition is like. Do not lament if you do poorly.

Once again, watch the other robots, but also watch out on DAY 3, you still may see a few surprises.

At the end of this day it is generally a good idea to have a team meeting to discuss the day. Talk about the games you played and go over the strategies that you saw.

(In regionals Day 2 ends with a team reception)

5.2.3 DAY 3 - Competition
The competition at last!

5.2.3.1 *THE COMPETITION*
On Day 3 get there early. You will not know when your first match is until you get there. If you have an early match you'll need to strategise quickly. Otherwise sit back tune your vehicle and watch the matches. The strategy team should be watching as many matches as possible, so that they can feed information to the Driving team and coaches.

This is a double elimination event. Now you'll see a no bars hold competition … well not exactly no bars. There are always rules against intentionally damaging a robot and dangerous play. Remember THIS IS FOR FUN!!!

5.2.3.2 *PACK IT UP AND CHECK IT OUT*
The competition is over, but your work isn't quite over. DO NOT FORGET TO CHECK OUT. Pack you vehicle and tools, and then go to FIRST to check out. This is when you'll get your Rnets back so that you can practice during the 3 days between the regionals and the time you need to ship to nationals (SEE APPENDIX C).

It is also when you'll be telling FIRST's drayage company who will be picking up your robot (if you will not be brining it home yourself.) This means that you must have all of this information ready. It is not unusual to have a robot stuck in drayage or shipped to the wrong location because wrong information was provided.

Also if this is your last competition, you might want to rent the control system so that you can run the robot during the summer and fall. In order to do this you'll need to have a $500 check ready for a deposit. (a PO is not acceptable).

Otherwise you'll need to had in the following items:
- Rnets
- Antennas
- Batteries
- Battery Charger
- Joysticks
- Transmitter
- Receiver
- Tether Adapter
- Power Supply
- Rnet Adapter
- Kit Containers (you can send these back separately if you need them for shipping materials back home
- BNC Coax Cable
- Ground Plane
- BNC Bulkhead Connector

(note this list may vary from year to year)

5.3 More about the Competition

The robot is not the only thing competing at the competition. Your entire team, including spectators, are part of the competition. Judges will be circulating through out the three days to determine various awards (including the Chairman's award). Everyone should consider themselves representatives from the school, community, or company.

6.0 Cleanup and Summertime Fun

Wheh! You made it. Its time to clean up and wrap up. Typically there is some sort of wrap up. It is also good to have a postmortem. Discuss the good point bad points and changes that can be made for the following year.

Use this time to pack up and store everything. And finally look into whats available during the summer. More and more teams are sponsoring their own summer time events. These tend to be very low key one day events that are nothing but fun.
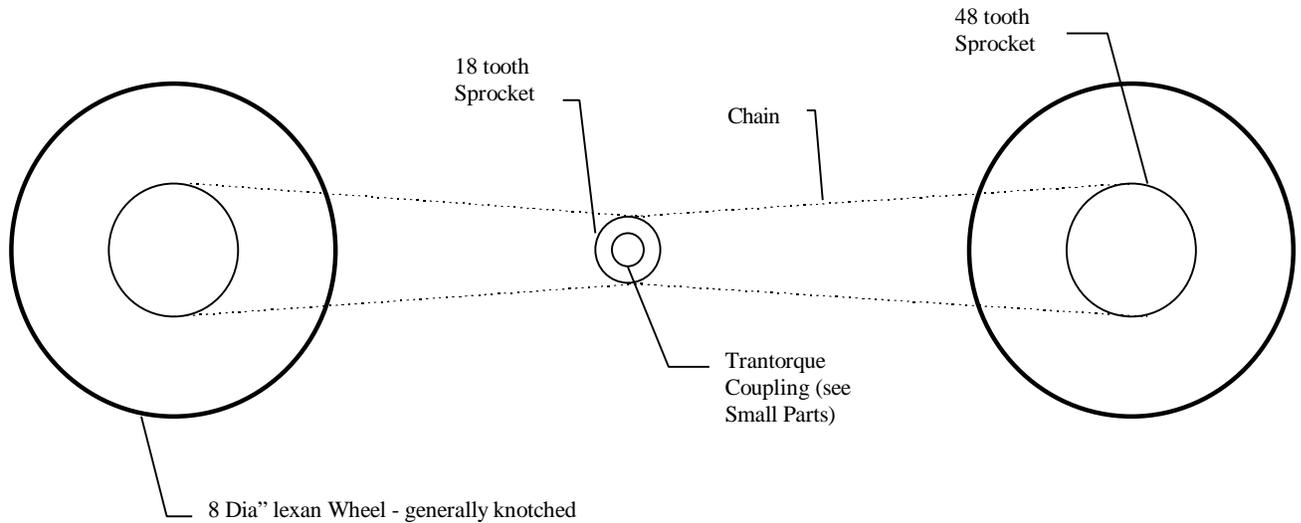
Plymouth North's Rumble at the Rock is a favorite of many teams. This has turned into an invitational due to the overwhelming demand. If you can get yourself invited - go.

Also FIRST frequently asks for volunteers to help them brainstorm on some of the logistics during the summer. This can be a fun way to get further involved

Other schools use the summer to start preparation for the following year. Companies work with schools systems to help develop things like pre-engineering courses, or help individual teachers integrate FIRST into the class room. So although FIRST is officially over there is still plenty to do.

The hardest part of this time of year is the sudden ending. Many o the students will complain about being bored. It is generally a let down for all of the activity that has been happening over the last 3 months to suddenly end.

Appendix A - Robot Design Hints

48 tooth
Sprocket

18 tooth
Sprocket

Chain

Trantorque
Coupling (see
Small Parts)

8 Dia" lexan Wheel - generally knotched

> **Drive Mechanism:** This has been a common design used at competitions. It is generally powered via a drill motor. However in 1998 teams began to diverge from this design because the competition became less of a pushing match and more of a maneuvering match.

Sprocket Center to Center Distance

$$c = (P/8) * (2L - N - n + sqr((2L-N-n)^2 - 0.810*N-n)^2))$$

Where
 c = center to center distance of sprockets
L = chain length in pitches
P = pitch of chain
N = Number of teeth in large sprocket
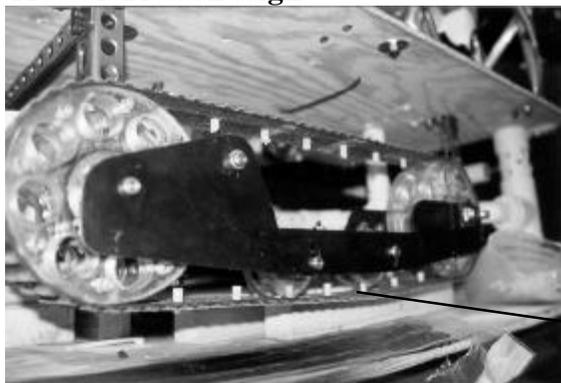n = number of teeth in small sprocket

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Drill Motor Mount
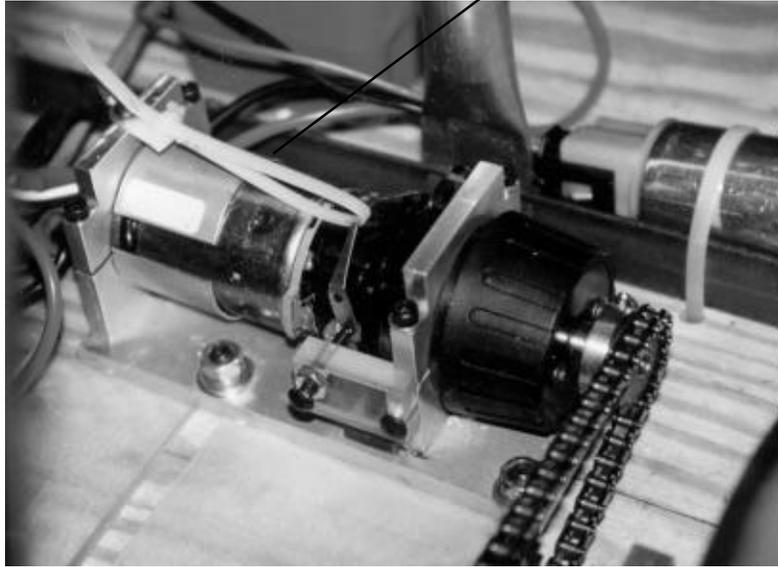
This keeps the transmission engaged to correct setting
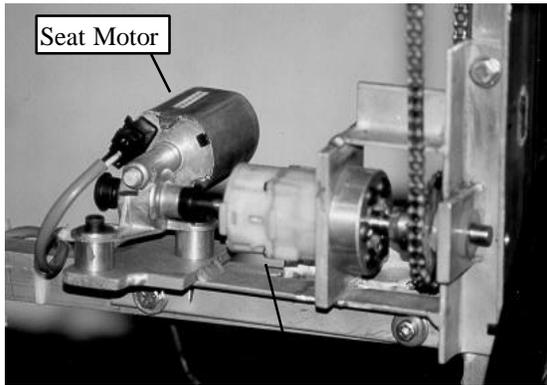
Wheel Chair Wheel Mounting

Note: Some playing is required. The spokes of the wheels are a little tricky to mate with.

Tractor Tread Design

Studs in tread help keep tread from derailing

Transmission with gear box on Non-drive component

Seat Motor

Use of components from
multiple mechanism to
achieve desired performance.

Drill Motor
Gear Box

Compound Steering Mechanism

This compand drive/steering mechanism allowed the
vehicle to move in any direction from a stopped position
(zero turning radius)

Tie rod used to connect
right and left to reduce
chain length

Other Helpful Design Hints

If the game uses balls, consider a harvester
A harvester comes in many varieties and shapes. The most primitive variety uses a driven roller(s) spaced some distance above a fixed plate. As the roller comes in contact with the ball it tends to "suck" the ball up. This mechanism can be used to pick balls up off of a field, can be used to raise balls to various heights, or can even be used to "extrude" the balls into a scoring area.

Spinning roller

(side view)
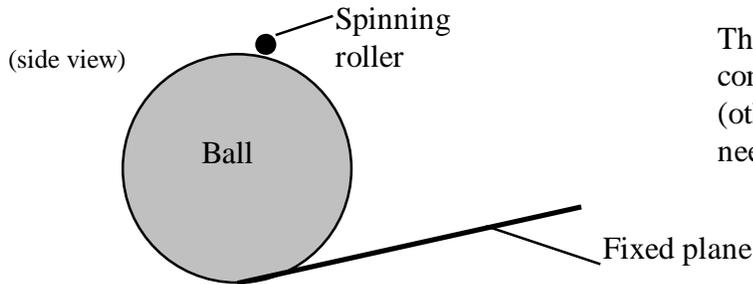
Ball

This mechanism requires some compliance in the ball (otherwise compliance would need to be built into the roller)

Fixed plane

More sophisticated versions will use another set of rollers, spinning in opposite direction from the (top) ones. Other iterations replace the rollers with belts.

In general this is a very handy way to manipulate balls. The spacing between the spinning roller and the fixed plane is somewhat critical. Too large and you will not be able to pick up a ball, too small and it will jam. It helps to put a high coefficient of friction/elastic material on the top roller so that the mechanism can handle the tolerances in ball sizes

Also if the mechanism is designed to pick up multiple balls at a time (i.e. the vehicle is wide enough to handle 2 or more balls side by side) you must be careful bout jamming. Many of the ball types used in FIRST will tend to climb over one another and jam up in your mechanism.

Picking up a Ball

Roller

Ball

Arm

Pivot

Stop
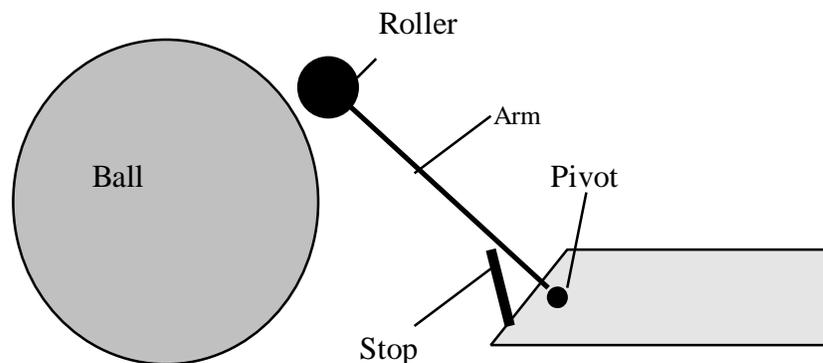
This mechanism (or a form of it) can be very handy to pick up a ball. The roller must be on a pivoting arm (or otherwise compliant). If design correctly the ball will be sucked up into the machine as the machine drives over the ball.

This mechanism is especially handy for robots that utilize grippers. The ball can be contained to allow easy pickup and to allow the vehicle to be driven (to the goal or to another ball) while the ball is being captured in the gripper. (remember matches are only 2 minutes long so efficiency is a key)

Appendix B - Brainstorming

The basic rules behind brainstorming are simple:
- NO IDEA IS A BAD IDEA! Do not through any ideas away at this stage in the game. Many great features come out of "stupid" ideas, or work arounds happen through partial implementation of "non-workable" solutions. Sort these all at the end of the brainstorming and keep the list around to refer to later. So encourage flying machines, walking machines or other "off the wall" solution ideas.
- Use large paper (easel size) to put up ideas. You can also use this to draw the idea if the person is having troubles describing it.
- Limit the brainstorming groups to 5-7. Many more than this will result in having only a few of the people actually throwing out ideas
- Invite non-traditional people. Some of the best ideas come from people that do not have a background in the area that you are brainstorming in.

What they don't tell you when brainstorming is that there is a lot of preparation needed to have a successful session. Brainstorming is more than just throwing out ideas. If you do this, you will have troubles keeping everyone on target, and soon you'll be discussing an aspect of the project that is not important.

The leader of the session needs to clearly bound the brainstorming space. Input and output parameters need to be clearly defined. For example, in one session I assigned one group to discuss game strategies for the first 15 seconds of the game, one group to discuss the middle 1-1/2 minutes of the game and the last group to discuss the last 15 seconds of the game.

The group assigned to the first 15 seconds had no problems. The starting conditions (where the point values were, where the robots were, etc.) were all well defined. As a result they ended up with 30 or so ideas in a 30 minute session. The last group had a little harder time because they had to make some assumptions of where everything was. But the ending point was very well defined and as such this group came up with 20 or so ideas. The middle group had lots of problems. They had to make assumptions on both ends of their solution space as well as during the 1-1/2 minutes. It was not until their leader bounded the problem by saying that they were loosing by 3 point and the point values where at X,Y,Z locations did they begin to come up with ideas.

So be very careful when setting up brainstorming. It is deceivingly simple which can lead to frustration.

Appendix C- Sample Schedule of Deadlines

The following has been pulled from the 1998 FIRST competition. This has been added to give the you a feeling for the types of deadlines and the relative time frames between deadlines so that you can create a preliminary schedule. These are deadlines established by FIRST.

December 4 - Registration cutoff
January 10 - FIRST Kickoff
January 20 - Team Profiles and Logos due (in FIRST's hands by 5:00pm)
Feburary 17-25 Hotel reservation cutoffs (actual date dependent on hotel choice)
Feburary 18 - Chairman's Award due (in FIRST's hands by 5:00pm)
February 24 - Shipping for Regionals
March 5-7 Southwest regional
March 10 - Shipping deadline for teams going from the Southwest Regional to the Nationals
March 12-14 Midwest Regional
March 15 - Woodie Flowers Award submission (essay to nominate the engineers/teacher who
            truly inspires the team)
March 16 Autodesk Submission due (in FIRST's hands by 5:00pm)
March 17- Shipping deadline for teams going from the Midwest Regional to the Nationals
March 19-21 Mid Atlantic Regional
March 24- Shipping deadline for teams going from the Mid Atlantic Regional to the Nationals
April 2-4 National Championships
April 4 - Daniel Webster College Scholarship Award Ballot
April 4 - WPI Scholarship Award Ballot