

FIRST Robotics Program Management Plan 2011-2012



**Souhegan High School
Team 138 – “Entropy”**

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ABSTRACT

This project plan describes the expectations and concept of operations for the Souhegan High School (SHS) robotics team. The SHS robotics team is a FIRST registered team: Team #138 - “Entropy”. Each year this plan will be revised to capture improvements derived from best practices and lessons learned from the previous year. The plan defines the team’s organization, roles & responsibilities, schedule, goals, and business planning.

OUR SPONSORS



1.0 Background

Souhegan High School (SHS) serves the towns of Amherst and Mont Vernon aspiring to be to be a community of learners born of respect, trust and courage with the following mission:

- To support and engage an individual's unique gifts, passions, and intentions.
- To develop and empower the mind, body, and heart.
- To challenge and expand the comfortable limits of thought, tolerance, and performance.
- To inspire and honor the active stewardship of family, nation, and globe.

Souhegan High School proudly sponsors the *FIRST* Robotics Team 138 - "**Entropy**". Entropy is group of students interested in the fields of business, engineering, math, and science. With the help of adult mentors, the team builds a robot to compete in the *FIRST* Robotics Competition.

For additional information about the SHS Robotics team, visit the team's webpage: www.robotics138.org

1.1 What is *FIRST*?

"For Inspiration and Recognition of Science and Technology" or *FIRST* was founded by entrepreneur & inventor Dean Kamen in 1989 in order to develop ways to inspire students in engineering and technology fields. "If we expect to remain the world leader, we must put more emphasis into mathematics and science at the high school level." Kamen is widely recognized for inventing the first insulin-regulating diabetic pump, the Segway personal transportation system, and an all-terrain electric wheelchair.

The *FIRST* robotics program uses the excitement of a sporting competition to expose students to the intriguing disciplines of science, technology, and engineering. The program enables students to work hand-in-hand with professional engineers & scientists in solving a unique engineering challenge. The *FIRST* robotics program exposes students to a real life business simulation long before they need to make a specific career choice. The lessons learned from this challenge are no different to those we experience everyday in the business world.

Students have to formulate a solution to a complex problem saddled with many competing budget & time constraints. They get to appreciate first-hand the power of teamwork & collaboration. The task is too large in scope to rely on just a few individuals to do all the work. Learning how to appreciate diverse perspectives and working towards a shared objective. They understand the importance of time management skills, decomposing a complicated task into a set of manageable activities. Students get to understand how engineers approach & solve problems. They get exposure to computer programming, computer-aided design, electrical engineering, mechanical engineering and marketing/fundraising disciplines. Finally, they get to pass the ultimate test by letting the competitive marketplace test the merits of their design implementation.

The FIRST Robotics Competition challenge is released in January and changes every year. Using a FIRST provided kit of parts, each team has only 6 weeks to complete their robot before it is shipped to their first regional competition site. A typical regional competition brings together 50 high schools to compete in an arena atmosphere for three days. Teams compete with and against each other as two or three team alliances. In 2011, the competition included teams reaching more than 51,000 high school students on 2,075 teams from Brazil, Canada, Israel, Mexico, the Netherlands, United Kingdom, and United States competing in 41 regional events and one national championship competition. ***“It’s like a way of life. There’s never enough information. There’s never enough time. There’s always a competition, and you need a strategy. We’ve created a microcosm of real engineering experience”*** - Woodie Flowers, FIRST National Advisor.

For more information about FIRST, please visit www.usfirst.org.

1.2 Team History

The Souhegan High School FIRST robotics team was organized in 1996. The SHS robotics team has grown substantially engaging more than 40 students and 12 mentors. Our team starts meeting in early October and wraps up the year with a team awards banquet in June. The team typically competes in a New England area regional and the National Championship. Entropy represents the school with very competitive robots & has won a number of competition & engineering awards.

Year	FIRST Event	FIRST Awards
2002	UTC New England Regional	Leadership in Controls
2004	Granite State Regional	Regional Finalist Sixth Saber Award (Ken Grabeau)
2005	Granite State Regional	Regional Finalist Radio Shack Innovation in Control Award Website Excellence
2006	Granite State Regional	Delphi Driving Tomorrow's Technology
2007	Granite State Regional	AutoDesk Visualization Award
2008	Granite State Regional	AutoDesk Visualization Award Website Excellence Sixth Saber Award (Bill Price)
2009	Granite State Regional	AutoDesk Visualization Award
2011	North Carolina Regional	Regional Finalist

2.0 Member Requirements

2.1 Code of Conduct

All SHS robotic team members are expected to observe the following team code of conduct:

- **Students shall abide by the workplace rules at Monarch Instruments:**
 1. FIRST robotics is a Souhegan High School extracurricular activity at Monarch Instruments. Students represent their team, their school, and their sponsors. All school rules apply during FIRST activities and will be strictly enforced.
 2. Students are expected to be on-time, exhibit a positive attitude, be respectful of mentors, share with team members and clean-up after the meeting activities.
 3. Team communications & meeting notices are accomplished through e-mail. Students are expected to check their e-mail frequently.
 4. Students are not to venture into the manufacturing area. A number of employees depend on the success of this business for their family's livelihood. Students are limited access to the kitchen area, machine shop, conference rooms, & upstairs storage area.
 5. Students shall abide by SHS Acceptable Use Policy for computer network usage (including all social media and Internet use).
 6. Students will observe responsible automobile operation on the Monarch Instruments facility.
- **Gracious Professionalism™** is part of the ethos of FIRST. It's a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community. With Gracious Professionalism, fierce competition and mutual gain are not separate notions. Gracious professionals learn and compete like crazy, but treat one another with respect and kindness in the process. They avoid treating anyone like losers. No chest thumping tough talk, but no sticky-sweet platitudes either. Knowledge, competition, and empathy are comfortably blended. In the long run, Gracious Professionalism is part of pursuing a meaningful life. One can add to society and enjoy the satisfaction of knowing one has acted with integrity and sensitivity.
- **Coopertition™** is displaying unqualified kindness and respect in the face of fierce competition. Coopertition™ is founded on the concept and a philosophy that teams can and should help and cooperate with each other even as they compete. Coopertition™ involves learning from teammates. It is teaching teammates. It is learning from mentors. And it is managing and being managed. Coopertition™ means competing always, but assisting and enabling others when you can.

2.2 Student Eligibility

Students must demonstrate a level of engagement to be considered an active Entropy member. In order to be considered "active", a student must meet these requirements:

- Students in grades 9 through 12 and residents of the Souhegan school district
- Student's grades are a higher priority than robotic team tasks. Students are required to meet team grade requirements (maintain a C average or better) and not have more than one N/A during a grading period.

- FIRST robotics participation requires a significant time commitment. Weekly meetings in the fall. Three-five meetings a week in January & February. Two meetings a week in March & April. Students are expected to maintain an 80% team attendance rate. Attendance will be taken at every meeting and it is the student's responsibility to sign the attendance sheet. Failure to achieve this participation rate could result in dismissal from the team.
- Students and parents must complete the necessary paperwork and pay the required travel expenses.

Students register for the program in late September. Active status for all students will be reviewed at the end of January. Final status will be announced the Monday prior to robot shipment identifying those active students to compete in the FIRST Robotics Competitions.

2.3 Lettering and School Recognition

The program director with input from all team mentors, will determine which students receive a varsity letter and/or team recognition awards based on team contribution and individual development.

- Students must be an active participant of the team (>80% attendance) and a member in good standing for two years.
- Student must attend a minimum of one competition in its entirety for two years.
- Students are required to meet team grade requirements (maintain a C average or better).
- Students are nominated

3.0 Team Overview

The Souhegan High School (SHS) robotics team is registered as FIRST Team #138 - "Entropy". The team has been in operation for 16 years. The team's location of operations is graciously provided by Monarch Instruments, 16 Columbia Drive, Amherst, NH 03031.

3.1 Mission Statement

The foremost goal of the SHS robotics team is to create a student experience that inspires every participant to turn pro - encouraging students to pursue exciting career opportunities in the science, mathematics, or engineering fields. Partnering with professional engineers & scientists, we introduce students to positive role models, create an environment to build student's self-confidence, and expose them to important life skills such as commitment, leadership, problem solving, teamwork, and time management. Our robots are student inspired and student built. Most importantly, WE HAVE FUN!

3.2 Mentors

Mentors must operate with the highest degree of integrity with all students and mentors. Mentors are expected to share knowledge and provide an environment where students can learn, explore, and develop their skills in business, engineering, and mathematics. The mentors support the students with all of the technical aspects of the competition, including

strategy, robot design, and safety supervision. Mentors from various fields of engineering use their expertise and experience to guide and support students in the engineering process of developing a robot that will be reliable & competitive in the FIRST Robotics Competitions. As the students learn from the mentors, the students gain more confidence and assume a greater role in the design, fabrication, and assembly of the robot. Mentors must always keep in mind that this is the student's robot. Mentor's must also appreciate they will serve as student role models and must be conscious of mentors interact with one another. *All mentors must agree to and pass a town mandated personal background check.*

Mentor	Team Assignment	Professional Affiliation
Bill Price	Project Director	Yankee Publications
Brian Walters	Project Manager	BAE Systems
Bruce Cordell	Animation (Lead)	BAE Systems
Jonathan May	Website	
Allan McGuy	Business Management (Lead)	SunGard
Eric Carlson	Business Management	
Brian Walters	Electrical (Lead)	BAE Systems
Tom Lewis	Electrical	Entera Systems
Mike Saffell	Electrical	NHPR
Nick Lambros	Mechanical (Lead)	BAE Systems
Tyler Andrade	Mechanical	BAE Systems
Ed Gormley	Mechanical	BAE Systems
Aidan McAllister	Mechanical	Peterborough Ball Bearing (SHS Alumnus)
Tom Campbell	Mechanical	BAE Systems (SHS Alumnus)
Scott Trecartin	Mechanical	Rapid Sheet Metal
Duane Pawson	Software (Lead)	Pawson Industries
Suresh Nair	Software	Rockwell Automation
Richard Kadrmas	Software	
Ian Doyle	Software	BAE Systems

Parents are critical and integral to the success of the team: supporting mentors, collaborating on fundraising, coordinating team snacks, promoting team pride, and assisting with team travel arrangements.

3.3 Team Organization

The Souhegan High School FIRST Robotics team is organized as follows:

3.4 Team Roles & Responsibilities

The program manager in conjunction with the electrical, mechanical, and software teams develop a game strategy and design, build, & test a robot to compete in FIRST sanctioned events. The animation team submits an entry for the AutoDesk Design in Excellence Award. The business management team facilitates all nontechnical operational aspects of the team.

3.4.1 Program Director

The program director (team leader) is the school liaison approved by the Souhegan HS principal. He is the principal interface to Monarch Instruments executive management, our home base of operations. The program director manages the corporate sponsorships, team budget, FIRST registrations, & team travel arrangements. He is also responsible for recruiting new mentors.

3.4.2 Project Manager

The project manager manages the day-to-day operations of the team. He will be responsible for coordinating team collaboration developing the robot concept, game strategy, and autonomous strategy. The project manager will coordinate the robot design across the multiple design teams, develop risk mitigation plans, coordinating team hand-offs, and managing the team build season schedule. The project manager will be responsible for maintaining an interface control document (ICD).

3.4.3 Animation Team

The animation team prepares students to be practitioners of applied computer graphics. The team submits an entry for the AutoDesk Design in Excellence Award - Animation. This award category honors excellence in student animation, including an understanding of the animation design process (character design, scene design, scripting, storyboarding, editing, integrating voice & background music, and final rendering), storytelling, and compelling communication. All FIRST teams are invited to create a 30-second animation clip in six weeks that best depicts a FIRST specified theme using Autodesk 3ds Max® software. This is the same tool professionals use in film (Pixar) and game design visualization.

3.4.4 Business Management Team

The business management team is responsible for team communications, team fundraising, preparing FIRST award submittals, and community outreach. Team communications requires both an internal & external focus. Internal communications include maintaining team updates using e-mail/social media and updates to the Souhegan newsletter. External communications include a relevant website, preparing press releases on team activities, and coordinating presentations to potential sponsors. The team website contains information about the SHS robotics history, team member profiles and sponsor recognition. The website highlights ongoing activities and provide links to other relevant sites.

The major student fundraising activity is the SHS Robotics Team Comedy Night. Boston Comedy Club comedians entertain the community in conjunction with a silent auction of donated items and a bake sale. Other activities include restaurant sponsored fund raisers, event concession sales, and golf tournaments. Our past success would not be possible

without the steadfast & generous corporate support from Monarch Instruments, BAE Systems, Control Air, BB Molding Company, JAWS, and County Stores. The business management team is responsible for soliciting new sponsors. They will prepare grant proposals to solicit financial support and services donations.

The business management team will prepare the team profile, judge's team essay, & team photo. They will also prepare submittals for team targeted FIRST awards including the FIRST Dean's List, Woodie Flowers Award, and Chairman's Award. The business management team is also responsible for coordinating the year-end banquet to recognize student achievement, mentor contributions, and sponsor support.

The business management team is responsible for raising awareness of FIRST in the school/community and promoting the SHS robotics team brand. This includes developing marketing materials, engaging in community events (e.g., Chamber of Commerce Business Expo), team shirts, and competition event team giveaways.

3.4.5 Electrical Team

The electrical team is responsible for the design, fabrication, assembly, and test of all electrical & pneumatic subsystems on the robot. The electrical team is responsible for power management, FIRST control system configuration, motor speed control, sensor design, pneumatic control, and all control/data/power/pneumatic interconnections.

3.4.6 Mechanical Team

The mechanical team is responsible for the design, prototyping, fabrication, assembly, and test of all mechanical subsystems on the robot. The mechanical team is responsible for the chassis assembly, drive system, game piece manipulator, robot articulation selection, and weight/balance management. The mechanical team is constrained by weight (120 lb robot), size envelope (28" x 38" x 60"), and motor selection limited to only those motors provided in the FIRST Kit of Parts (KoP). The team uses either AutoDesk Inventor or Solidworks 3D tools to design custom hardware parts and create a robot model to verify fit & clearances before fabricating the parts.

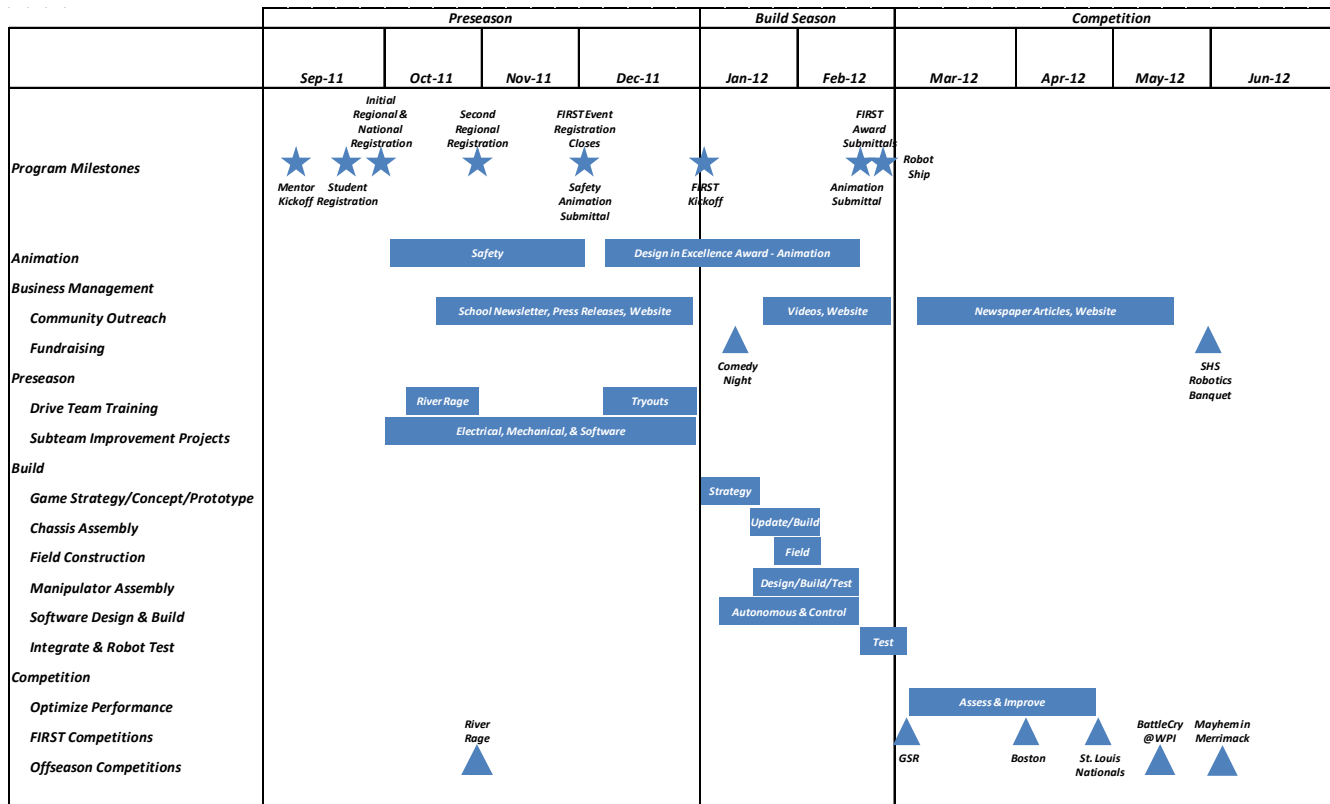
3.4.7 Software Team

The software team is responsible for the design, code, test, and build of control algorithms & data processing on the robot. The software team is responsible for the interface design (user & sensor) and algorithm implementations (drive control, game piece manipulator, and autonomous modes). The team uses the Wind River workbench and C programming language running on National Instruments' cRIO hardware. Many robotic functions are available by leveraging the WPI robotics library resource.

4.0 Schedule

The SHS robotics team consists of three distinct "seasons": preseason, build season, & competition season. The preseason is from October through December. The build season is the six week period defined by the FIRST Kick-off to the robot ship date. The program manager will maintain a build season schedule and develop risk mitigation plans. The

competition season includes 53 FIRST regionals, the FIRST national completion, and offseason competitions (BattleCry@WPI, Mayhem in Merrimack) from March through June.



5.0 Team Responsibilities

The FIRST robotics program exposes students to a real-life business simulation. The lessons learned from this challenge are no different to those we experience everyday in the business world. Students have to formulate a solution to a complex problem saddled with many competing budget & time constraints. They get to appreciate first-hand the power of teamwork & collaboration working towards a shared objective. The task is too large in scope to rely on just a few individuals to do all the work. Students learn how using diverse perspectives can result in a more robust final solution. They understand the importance of time management skills, decomposing a complicated task into a set of manageable activities. They get to understand how engineers approach & solve problems. They get exposure to computer programming, computer-aided design, electrical engineering, mechanical engineering and marketing/fundraising disciplines. Finally, they get to pass the ultimate test by letting their design solution be tested by the competitive marketplace.

5.1 Preseason (September-December)

Learn the Basics; Practice the Fundamentals; Experiment. The SHS robotics team preseason period is from October through December. The preseason meeting tempo is at least one night per week. Preseason objectives include assimilate new team members (mentors & students), practice FIRST robotic fundamentals, experiment with new

technologies or design concepts, conduct driver training, and prepare for critical fundraising activities. The team will also participate in the offseason event, River Rage in Manchester in October to acquaint the 2011/2012 team with robotic competitions, leverage a driver practice opportunity, and build some team camaraderie!

5.1.1 Animation

The animation team 2011 preseason focus is setup the animation computing environment and familiarizes the students with the Autodesk 3ds Max® software tool. Early work on character design is a good choice to prepare the students for the six week competition. All FIRST teams are invited to create a 30-second animation clip that depicts a FIRST specified safety theme. The winning entry will be played at the FIRST Kick-off and all FIRST regionals! The animation team 2011 preseason objectives:

- Acquaint the team with animation processes, Autodesk 3ds Max® software, & SHS computing environment
- Develop character themes in preparation for the 2012 animation design
- Use FIRST safety themed animation to practice storyboarding process

5.1.2 Business Management

The business management team's 2011 preseason focus is on community outreach, fundraising activities, and website development:

- Soliciting additional sponsorships or grants from individuals, parents, & local businesses (unsolicited letters, on-site visits)
- Complete preparations for comedy night fund raiser (SHS arrangements, ticket sales, silent auction, & bake sale)
- Community outreach projects (newspaper articles, FLL support, etc.)
- Develop a plan to submit 2012 SHS FIRST award proposals
- Website design update & content refresh

5.1.3 Driver/Operator Training

The program manager will develop a driver/operator screening & training plan using the 2011 robot. Robot drivers and operators need to gain an appreciation for operating a powerful, 120 lbs robot at distances of 50 feet in the midst of chaos. Students need to gain the perspective of trying to complete tasks with the robot moving towards or away from the driver (driver left is not always robot left!). Participating in River Rage will help indoctrinate students regarding the time pressures & quick decision making required to play the game.

5.1.4 Electrical

The electrical team's 2011 preseason focus is on resolving 2011 outstanding performance issues, expanding our technology toolkit, and enhancing team simulators:

- Troubleshoot right encoder issue on the 2011 competition robot

- Partner with the software team to debug CAN/Jaguar anomalies on 2011 robot
- Partner with the software team to resolve autonomous navigation issues – troubleshoot gyro performance
- Characterize new FIRST KoP sensors: Contactless magnetic rotary encoder, linear rotary motion detection, photoelectric (line follower) sensor
- Characterize SMC solenoid valve types (replace FESTO's)
- Update driver station design

5.1.5 Mechanical

The mechanical team's 2011 preseason focus is investigating optimizing the chassis assembly as well as experimenting with alternate arm & manipulator configurations:

- Optimize chassis configurations for strength/weight trade-offs & wheel configurations
 - Wheel size (4"-6", & 8") & wheel type (omni vs. pneumatic)
- Research methods to acquire different scoring objects
 - Research prior competitions, propose methods to acquire different scoring objects
 - Active aids (rollers, belts, etc) to speed grasping or manipulating
- Research light weight, balanced arm implementations
 - Linear motion components and/or telescoping columns
 - Prototype configuration

5.1.6 Software

The software team's 2011 preseason focus is on resolving 2011 outstanding performance issues and implement enhancements:

- Partner with the electrical team to debug CAN/Jaguar anomalies on 2011 robot
 - Investigate options for drive Uberjaguar configuration
- Partner with the electrical team to resolve autonomous navigation issues
- Code & test new drive control strategy
- Enhance camera capability understanding - color or pattern recognition, target tracking
- Develop scouting app (Offensive Power Rating) to ease scouting demands on students at competitions
- Develop a recording or playback diagnostic capability provisions for all control loops & bus error messages

5.2 Build Season (January-February)

The build season is defined by the six week period between the FIRST Kick-off, where the game challenge is unveiled and teams receive their FIRST kit of parts, to the robot ship date. The meeting tempo is dynamic, meeting multiple times per week (nights & weekends) to complete a challenging robot project. The students will work as a team, collaborate on ideas to solve a problem, decompose a complex activity into a manageable set of tasks, and practice time management skills in a constrained environment to achieve a common goal.

During the build season, the team will assign students to act as **rule lawyers, web investigators, award advocates, & scouting prospectors**. At least one representative from each team will be designated a “**rule lawyer**” to make sure each team understands & are compliant with the plethora of FIRST rules. This will help avoid potential inspection issues at the competitions. They will read the team updates on a regular basis & report back on a regular basis to the team on what has changed. At least one representative from each team will be designated a “**web investigator**”. Web investigators query YouTube™ & other FIRST team websites to see how other teams are solving game challenge problems. **Scout prospectors** are assigned to begin to formulate what are the key game discriminators and how we will collect scouting intel on each team’s capabilities at the competitions. **Award advocates** are assigned to write the team essay used by the regional judges and any FIRST award submissions (FIRST Dean’s List, Woodie Flowers, Website, etc.).

Build Season Phase	Phase Objective
Strategize	Develop team game strategy & robot concept
Prototype	Verify design assumptions & simplify implementation
Design	Detailed robot subsystem design
Build	Fabricate parts & assemble robot
Test	Verify design, optimize performance, & build drive team capability

5.2.1 Strategy & Robot Concept

The first week of the SHS robotics design process is to analyze all of the scoring possibilities, identify potential game discriminators, develop a game strategy, and create a robot concept to achieve that strategy.

Golden Rule #1: Don’t SKIP the game analysis & team strategy and dive straight into the detailed design. You must know WHAT you want to do before you can figure out HOW to do it. It is more important to have the design follow the strategy than to have the strategy follow the design!

Golden Rule #2: Don’t design the robot to be a jack of all trades, master of none. There are TOO many tasks for one robot to do everything - we have alliance partners! Important to concentrate on making the robot performs one crucial aspects of the game VERY, VERY WELL. What will make us a very attractive alliance partner?

Once the team has identified a game strategy & robot concept, the SHS robotics team is broken into at least four groups of mentors & students to brainstorm potential solutions. Ideas are shared, integrated, and the group selects their robot concept. At the conclusion of this effort, student representatives from each group present their group’s robot concept explaining how it will achieve the team’s game strategy. After integrating all of the group’s ideas, the team votes on the preferred robot concept.

5.2.2 Prototype Key Concepts

The second week of the SHS robotics process is devoted to prototyping critical attributes of the robot concept before committing time & energy to a detailed design. The temptation is to

charge full speed ahead into the detailed design. Prototyping critical robot concepts validate team hypotheses and assumptions. This activity also offers the opportunity to simplify the design resulting in a lower robot implementation risk. In the end, we will fabricate & assemble the robot in less time, have less rework, & have more time to test.

5.2.3 Detailed Design

The next step in the robot process is the detailed hardware & software design. Robot weight/balance is the toughest design constraint. Weight budgets are established & updated using CAD models & measured values. The preferred team CAD tool is AutoDesk Inventor. AutoDesk Inventor is also used as an integration tool to verify fit & clearance before fabricating the parts. The team uses the Wind River workbench and C programming language running on National Instruments' cRIO hardware. Many robotic functions are available by leveraging the WPI robotics library resource.

Given a game strategy & robot concept, the team can now architect an autonomous game strategy. Informal design reviews for the scoring object acquisition/manipulation, autonomous modes, and user interface are recommended practices.

5.2.4 Build

The build phase is the fabrication and assembly of the robot subsystems. The team builds two identical robots. The first robot is the competition robot; bagged & tagged or shipped for the initial FIRST regional competition on the required robot ship date. The second robot is identical to the competition robot but is retained by the team to complete software integration, optimize robot performance, optimize autonomous modes, and continue drive team practice until the first regional competition. Following the initial FIRST competition, the second robot is used as a platform to retrofit & test upgrades for subsequent competitions.

Custom metal parts are fabricated using our waterjet sponsor, JAWS, and precision machinist sponsor, BB Molding Company. The waterjet is the tool of choice for cutting rough part profiles & weight reduction. Avoid sharp edges or "inside" corners. The waterjet can cut a sharp angles but the cutting head must slow down and stop as it gets to the corner. This adds considerable time to the cutting process. The waterjet also has a kerf due to the size of the water stream limiting the size of holes smaller than about 0.200" diameter. JAWS requires cut sheet drawing files in a .dxf format.

BB Molding prefers to have dimensions relative to something in the center of the part, not an edge or corner. Watch your dimension tolerances. When cutting "inside" corners, they cannot be 90 degree angles because the cutting tool is round (1/8" inside radius). He prefers the part has some parallel flat edges so it can be held in a vise while machining. BB Molding accepts drawing files in .dxf format (2000 AutoCAD version). NOTE: Let the waterjet do an oversized rough profile cut, and then let the machinist precision machine the part to the required dimensions.

5.2.5 Integration & Test

The final step in the process is integrating the software on the robot hardware. The goal is to complete all robot assembly to allow at least 7 days of integration & test to complete software integration, optimize robot performance, optimize autonomous modes, and advance drive team competency prior to robot ship date. The team builds the minimum number of field elements required to test critical functions of the robot & enable the drive team to practice aspects of the game challenge.

The business management team needs to complete and submit all potential award applications (FIRST Dean's List, Woodie Flowers Award, Chairman's Award). They need to coordinate procurement of team shirts & team competition giveaways.

Team will also plan to attend the BAE Systems Robot Unveiling typically in the fifth or sixth week.

5.3 Competition Season (March-June)

The competition season includes 42 FIRST regionals and the FIRST national completion as well as offseason competitions BattleCry@WPI & Mayhem in Merrimack. FIRST robotics competition performance is typically based on four factors: an efficient & reliable robot design, a well trained drive team, a sound game strategy complimented by good scouting Intel, and good alliance partners. We have control over three of the four factors!

The program manager & lead mentors will select a competition drive team (driver, operator, coach, & human player) based on demonstrated aptitude (physical & mental) as well as a reward for student's contributions/impact to the SHS robotics team. The team will have to create a bill of materials listing all parts on the robot (including respective costs).

Following competition, the team will assess competition performance and identify potential lessons learned from the competition could translate to robot modifications for upcoming competitions. Design enhancements (hardware and/or software) will be implemented on the second robot to verify enhancements meet expectations & speed the process to upgrade the competition robot at the next event.

5.3.1 Drive Team

Robot drivers, operators, coach, and human players need to have a clear understanding of the game rules/penalties as well as be skilled in the ways of robot operations. This will require a training regime during the offseason & practice scenarios during robot integration/test using the practice field elements. Drive team selection is based on team contributions & skill levels, an earned privilege.

1.1.1 Pit Crew

The pit crew sets up the competition pit and prepares the robot for matches using a robot checklist. The pit crew needs to impress FIRST inspectors & judges with their knowledge of the robot design & how the robot operates. A pit safety captain is appointed to ensure the team operates in a safe & effective manner.

5.3.2 Scouting Team

Scouting intelligence is critical to formulate alliance qualifying match game play strategies as well as alliance selection for the elimination rounds. Scouting consists of understanding autonomous, offensive, and defensive capabilities. The program manager will appoint a scouting captain. The scouting prospector prepares strategy for the scouting team and also supplies them with robot analysis sheets, comparison charts, and data sheets. The program manager will select scouts, they need to make a plan and use scouting sheets to evaluate other robots. They will also need training so that they know what they are doing.

5.3.3 FIRST Regional(s)

The SHS robotics team traditionally competes at the Granite State Regional sponsored by BAE Systems. Only active team members are allowed to travel and compete with the team. All members of the team are expected to exhibit exemplary behavior and act as role models for their peers. Team members will be in the public eye both on and off the playing field. The actions of a team member are a direct reflection of themselves, their team, their school, and our corporate sponsors. Failure to observe this behavior will be grounds for dismissal from the team.

5.3.4 FIRST National Competition

The SHS robotics team traditionally competes at the FIRST National competition. Only active team members are allowed to travel and participate on the team. Out-of-town travel arrangements are coordinated by the program director. Typically, arrangements are coordinated in the fall & installment payments are due in December, January, & February. While traveling with the team, students will stay at hotels. They will stay in rooms with up to 4 students in one room. Students need to communicate their special needs with regard to travel to team mentors and the team travel coordinator.

All members of the team are expected to exhibit exemplary behavior and act as role models for their peers. Team members will be in the public eye both on and off the playing field. The actions of a team member are a direct reflection of themselves, their team, their school, and our corporate sponsors. Failure to observe this behavior will be grounds for dismissal from the team.

5.3.5 Offseason Competitions

The offseason competitions are more relaxed events that other teams use as fundraising vehicles. Within the New England area, BattleCry@WPI and Mayhem in Merrimack are established competitions. These competitions offer the opportunity to expose more members of the team to the competition aspects of FIRST robotics.

6.0 Safety

Safety is a critical FIRST tenet. The SHS Robotics team will make every effort to provide a safe and healthy working environment for mentors and team members. Unsafe working

conditions, practices, or machines that are unsafe to operate must be reported to the safety captain or team mentor. Any injuries must be reported to a mentor.

6.1 @Monarch Instruments

Students shall abide by the following workplace & safety rules at Monarch Instruments:

1. **IF YOU DON'T KNOW – ASK! IF YOU DO KNOW – SHARE!**
2. Safety glasses are always required when working with power tools or on the robot.
3. Students are not allowed to use power tools before being trained by a mentor on how to safely operate them. Never operate machine shop equipment unless you have mentor permission.
4. Students must treat the machines and tools with respect and use them in a safe manner.
5. Do not remove or disable any safety device or tool guard.
6. When fabricating, all parts need to be adequately secured (vise or clamped to a work surface) before using a power tool.
7. No loose clothing - no open toe shoes
8. Good housekeeping helps prevent injuries. Students are expected to keep work areas clean. Clean up spills immediately.
9. Replace all tools and supplies at the conclusion of all team meetings.
10. Horseplay and running are prohibited.

6.2 @Competition Venues

A pit safety captain is appointed to ensure the team operates in a safe & effective manner at FIRST competitions. He is responsible for maintaining the team safety manual and interfacing with the safety committee at the competitions. During competitions the safety policies and procedures put forth by the *FIRST* Robotics Competition Team Safety Manual govern the team's behavior. During competitions the Safety Checklist in the *FIRST* Robotics Competition Team Safety Manual shall be completed by the Safety Captain. The Safety captain and pit crew shall read and understand the *FIRST* Robotics Competition Team Safety Manual. Safety glasses are always required when working with power tools or on the robot.

7.0 Business Plan

The business plan contains important information regarding resources, budget management, sponsorship details, fundraising tactics, and travel arrangements. This program costs on the order of \$25K - \$30K a year to administer. Student fundraising (comedy night, event concessions, golf tournaments) help defray some of these costs. Entropy is thankful to have the following loyal & generous corporate support:

Corporate Sponsors	Team Sponsorship
Monarch Instruments	Robotics Home Facility Financial Support
Souhegan School Board	Financial Support

Corporate Sponsors	Team Sponsorship
BAE Systems	Financial Support (Grant Application Required – GSR Website)
Control Air	Financial Support
Yankee Publishing	Financial Support
Mentor Graphics	Financial Support (Mike Mahar POC)
Rockwell Automation	Financial Support
BB Molding Company	Precision Machining (Benny Beebe)
John Albert Welding Services (JAWS)	Water Jet Machining & Welding Services (John Albert)
RAPID Sheet Metal & Machining	Sheet Metal Fabrication Precision Machining
County Stores Milford, NH	Retail Hardware Discount (50%)

All sponsors' names are displayed prominently on our team website and on our competition robot. Sponsors receive a memento in appreciation for their support and these are hand delivered whenever possible.

Each student is responsible for helping to raising at least \$100 in team sponsorship support. This requires students to participate in team fundraising activities or solicit companies / community members to support this noble venture. In addition to the financial benefits to the team, this requirement also helps students develop their communication skills as they coordinate directly with these sponsors.

Item	Team Budget	Description
FIRST Initial Regional Event Registration	\$5,000	The cost of the year's kit of parts and registration for the Granite State Regional
FIRST Second Regional Event Registration	\$4,000	The team plans to attend two regional events (2011 GSR & NC).
FIRST Championship Event Registration	\$5,000	Annual cost to participate in the annual Championship Event, held in St. Louis, Missouri
Robot Shipping & Drayage Expenses	\$4,500	Robot shipping charges to/from competitions. Drayage charges at the competition venue
Travel Expenses	-----	Travel costs to out-of-town events are paid by team members. <i>Team members paid 2011 expenses total of \$850, including airfare, local transportation, and lodging, to attend NC regional.</i>

Item	Team Budget	Description
Robot Expenses	\$3,500	Allotted preseason experimentation & part expense to build two robots. <i>The 2011 robot total cost was \$3,025.</i>
Other Expenses	\$5,000	Covers the cost of fundraising supplies, team shirts, competition giveaways, mentor/sponsor recognitions, student awards, and off-season competition registrations.
Management Reserve	\$1,000	Unanticipated expenses needed to support other team activities.
Total Budget	\$28,000	

8.0 Key Best Practices & Lessons Learned

The following best practices & lessons learned have been highlighted from prior year competitions and need to be considerations in developing the 2011/2012 implementation plan.

- 2011's emphasis on ***drive team practice*** paid tremendous dividends & translated into a tremendous competitive advantage. Our discriminating competitive advantage was not the robot itself but how the drive team made the robot dance! Very strong lesson learned here that other successful teams devote time & energy to – drive team practice! I remember the PINK team mentor saying “we design & build the robot in two weeks – we spend the rest of the time working with the drive team”. We need to plan in the fall to do preliminary driver/operator screening & training using the 2011 robot. I don't believe the specific scoring object is that critical – more important for the students to gain an appreciation for operating the robot at a distance and the perspective of trying to complete tasks with the robot moving towards or away from the driver (driver left is not always robot left!).
- The 2011 strategy to ***build two identical robots*** turned into a competitive advantage! Discussions with other FIRST teams revealed many others have adopted this practice. The second robot provided invaluable practice time to hone autonomous performance & enhance drive team proficiency. This bought us another 7 days of software integration, robot test, and driver practice time before competing at the GSR. The second robot gave us a test platform to evaluate design modifications we made after the GSR – we knew they would work going to the next competition!
- We need to pay more attention to the ***game piece articulation speed*** and the ***sequence of events to acquire & score*** the game pieces. As a rule we need to design to accomplish these scoring object manipulation tasks in less than a 2 second timeframe. Acquiring, manipulating, & scoring the game object should be done from the same side of the robot. Complimentary actions to acquire & score game pieces turn into speed discriminators.
- Application of "active" methods to assist ***acquiring & manipulating the scoring object*** have been key discriminators in recent competitions. The scoring tasks usually

are complicated & the drive team is hampered by visibility & depth perception. Sensors need to be integral in automating these tasks for the drive team.

- Our experience with the CAN bus re-emphasizes an overlooked FIRST proverb – use at your own risk! Never assume the new **introduction of capability or technology** is plug & play! TEST, TEST, & TEST!
- Plan to implement an **incremental capability** mindset, especially with software. Ensure we have basic functionality first - add more complexity in stages. In the event we run out of time, we will always have some capability the students can use in the competitions.
- Competitions are turning into **CRASH & BASH!** We can never make the robot totally infallible but we need to be sensitive to protecting critical articulation systems & sensors to avoid potential damage from other robots
- **Weight, balance, & size constraints** are the toughest challenges. Weight budgets are established & updated using CAD models & measured values. Robot design needs to allow 1/2" clearance on each side of the robot to account for frame racking, bolt heads, lexan, etc.
- Select **common hardware sizes** & constrain hardware types to limit what tools are required to assemble & service the robot as well as how much spare hardware we need to take to the competitions.
- Pay attention to the **static loading** on the articulation systems to avoid back driving the motors when power is removed.
- Understand the **consequences of potential failures** in our design & tactics. We need to incorporate default or fail safe features to keep the robot functional when something breaks.
- Dangers of sharing the **FIRST game simulation video** with the students in that the ideas portrayed in the video limit the student's imagination of how we could play the game. The idea to simulate the game with the students using chairs as robots on a mock field was BRILLIANT!
- With the growing complexity of the game challenge & technology employed to control the robot, it is becoming harder to understand what the robot is actually doing. With the introduction of the cRIO, I believe we have enough memory to create some recording capability that would translate to **test diagnostics** or a playback capability. The CAN bus enables us to monitor critical faults. This would prove to be extremely useful for troubleshooting robot issues during the final week of integration & test as well as at the competition. Imagine if we knew what the robot inputs were in autonomous? What sensor feedback was the robot reacting to? What was the operator input? What critical parameters that should be monitored and/or stored in memory for review after the fact?

- We need to be more attentive to **wheel position & wheel alignment** on the chassis. Our new approach to the frame assembly with precision hole locations & through bolting the wheel axle mounts ensured the wheels were properly aligned and the frame was square.
- We need to be more attentive to protecting installed electronics from **metal shavings & chips** during on-robot modifications. We had a lot of Jaguar failures & found way too many metal shavings inside the Jaguars when we took them apart.
- Using **molex (PWM) connectors** with the Jaguars, we need to go back to hot glue or silicon staking of these connectors. The wire hooks do not provide enough retention force.

APPENDIX A: Robotics Team Application – 2011/2012

As a member of the robotics team, you must be willing to invest a significant commitment to “promoting” FIRST robotics and “creating” a competition robot.

- FIRST robotics is a Souhegan High School extracurricular activity at Monarch Instruments. Students represent their team, their school, and their sponsors. All school rules apply during FIRST activities and will be strictly enforced.
- Students should put their grades before any team needs. Students are required to meet team grade requirements (maintain a C average or better) and not have more than one N/A during a grading period.
- FIRST participation requires a significant time commitment. Weekly meetings in the fall. Three-five meetings a week in January & February. Two meetings a week in March & April. Students are expected to maintain an 80% team attendance rate.
- Students are expected to be on-time, exhibit a positive attitude, be respectful of mentors, share with team members and clean-up after the meeting activities.
- Team communications & meeting notices are accomplished through e-mail. Students are expected to check their e-mail frequently.

Personal Information (print clearly):

Name _____ Grade _____ Shirt Size _____

Student E-mail Address _____ Student Telephone _____
(team communication is done by e-mail – ensure this is legible)

Parents Name(s) _____

Parent E-mail Address _____ Parent Telephone _____

Team Information:

1. This activity is more than just building a robot! Why are you interested in joining the robotics team?

2. Indicated your preferred interest/skill level below (1=highest; 6=lowest).

____ Animation ____ Business Management (Fundraising, Public Relations)
____ Electrical/Pneumatic ____ Mechanical
____ Software ____ Website

IMPORTANT INFORMATION – STUDENTS AND PARENTS

- Students will be responsible for fundraising \$100 to help defray program costs.

- Students must meet team and school academic requirements before traveling with the team to competitions. If a student becomes ineligible to travel, there will be no refunds given for team fees.

I understand the above team expectations and costs. I am willing to make these payments if my son/daughter (student) is accepted as a member of the Souhegan HS Robotics team.

Student (Applicant) Signature _____
Date _____

Parent / Guardian Signature _____
Date _____

APPENDIX B: Business Management Checklist

Preseason Tasking (October-December):

- Team coordination/communication
 - Create team roster (e-mail addresses, telephone nos., shirt sizes)
 - Distribute lists to lead mentor of each team
 - Create meeting sign-up sheets & maintain attendance records
 - Complete required SHS forms (parent permission & medical forms)
 - Identify method to communicate team updates to school (e-mail blasts, school posters/newsletter)?
 - Execute one teambuilding event
- Fundraising
 - Soliciting additional sponsorships or grants from individuals, parents, & local businesses
 - Send e-mail with sponsorship solicitation letter to parents (distributed at registration meeting)
 - Target Amherst businesses & students draft solicitation plans communicating value of sponsoring team
 - Seek Ken Grabeau's advise, contact Milford Rotary president?, target Amherst Business Park?
 - Comedy night fundraiser
 - Coordinate student assignments for event
 - Comedy night program & MC's
 - Student skit (Dave Brooks might help us again)
 - Design & print programs
 - Coordinate, monitor, & expedite student ticket sales – each student sells 8 tickets by 12/31
 - Coordinate silent auction (Wendy Hunt, other volunteers?)
 - Students solicit donations from local businesses
 - Students write thank you notes for donated items
 - Coordinate bake sale – solicit parent engagement to take on this responsibility
 - Restaurant fundraiser (Longhorn, Uno's, or Texas Roadhouse)
 - Well publicized with students, parents, & school
 - Event promotion - well in advance of event (start in December)
 - Amherst Citizen, school posters/e-mail blasts, Comcast local access programming (ACTV CH20)

- Community outreach projects
 - Support FIRST Lego league (FLL) events (volunteers, judges, concessions, etc.)?
 - Amherst Citizen preparing press releases on team activities & or events
 - Promoting team activities or events (River Rage, fundraising, community service)
- Website design update & content refresh (John May to lead – help with content)
 - SHS information
 - Team history & mission
 - Team picture(s)
 - Recognize sponsors (logos on the front page, links to company websites) & mentors (pictures)
 - Fundraiser events/details
 - Pictures of past robots & awards
 - Post some of our better matches from previous competitions
 - Past animation clips
 - Past community service & upcoming opportunities
 - Team schedule?
 - Links to other relevant sites (Chief Delphi, GSR, USFIRST, etc.)?

Build Season Tasking (January – February):

- Team coordination/communication
 - Assist with regional/national trip payment collection
 - Communicate team updates to school (e-mail blasts, school posters/newsletter)
 - Maintain attendance records
- Fundraising
 - Comedy night fundraiser
 - Coordinate facility arrangements with SHS
 - Book Boston comedians
 - Coordinate student assignments for event
 - Comedy night program & MC's
 - Student skit (Dave Brooks might help us again)
 - Design & print programs
 - Coordinate silent auction (Wendy Hunt, other volunteers?)
 - Students solicit donations from local businesses
 - Students write thank you notes for donated items
 - Coordinate bake sale – solicit parent engagement to take on this responsibility
 - Event promotion - well in advance of event (start in December)
 - Amherst Citizen, school posters/e-mail blasts, Comcast local access programming (ACTV CH20)
- Community outreach projects
 - Amherst Citizen preparing press releases on team activities & or events
 - Promoting team activities or events (River Rage, fundraising, community service)
- FIRST award proposals
 - Prepare the team profile, judge's team essay, & team photo
 - Prepare FIRST Dean's list nomination
 - Prepare Woodie Flowers nomination
- Website design update & content refresh (John May to lead – help with content)
- BAE Systems Robot Unveiling
 - Coordinate student support for event and transportation (>75% attendance)
 - In the event we do not have a functioning robot, create progress video to show at event
- Coordinating procurement of team shirts (Phoenix Graphics)
- Coordinating procurement of competition giveaways

Competition Season Tasking (March - June):

- Team coordination/communication
 - Complete required FIRST liability release forms
- Community outreach projects
 - Amherst Citizen preparing press releases on team activities & or events
 - Promoting team activities or events (GSR, fundraising, community service)
- Website design update & content refresh (John May to lead – help with content)
 - Update with 2011 animation clip
 - Update content to reflect our 2012 competition results
- Year-end banquet (recognize student achievement, mentor contributions, and sponsor support)
 - Coordinate SHS facility reservations

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
30	31	1	2	3	4	5
Driver Practice						
Manipulator Electrical	Manipulator Test	Optimize Manipulator	Optimize Manipulator			
Articulation Assembly	Articulation Assembly	Articulation Assembly	Articulation Assembly	Articulation Electrical	Articulation Test	Optimize Articulation
Autonomous Scenarios	Autonomous Scenarios	Autonomous Scenarios	Autonomous Scenarios	Autonomous Scenarios	Autonomous Scenarios	Autonomous Scenarios
Control & Sensor	Control & Sensor	Control & Sensor	Control & Sensor	Integrate Control Loop	Integrate Control Loop	Integrate Control Loop
6	7	8	9	10	11	12
Integrate Articulation & Manipulator	Integrate Articulation & Manipulator	Integrate Chassis, Articulation, & Manipulator	Integrate Chassis, Articulation, & Manipulator	Final Wire / Plumb Robot	Final Wire / Plumb Robot	FLOAT
Integrate Control Loop	Integrate Control Loop	Integrate Control Loop	Baseline S/W			
13	14	15	16	17	18	19
FLOAT	Test Robot	Robot S/W Integration	Robot S/W Integration	Robot S/W Integration	Robot S/W Integration	Robot S/W Integration
					Driver Practice	Driver Practice
20	21	22	23	24	25	26
Robot S/W Integration	MONARCH CLOSED Robot S/W Integration	ROBOT SHIPS				
Driver Practice	Driver Practice					
	Team	Mechanical		Electrical	Software	

- Coordinate potluck dinner
- Coordinate letters & certificates of participation with SHS
- Team MVP & rookie of the year recognitions
- Sponsor recognitions
- Mentor recognitions

APPENDIX C: Build Season Schedule