Technical Director Handbook

“The difference between a dream and a goal is a deadline” – attributed to Napoleon Hill”

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REVISION HISTORY

DATE	DESCRIPTION OF CHANGE
V151123	RJV; revised engineering notebook content
V151107	RJV; added business model
V151025	RJV-review revision, updated references, revised robot model
V150608	RJV-Removed design process and handbook items and put them in their own documents
V150510	RJV-added training classes and design process to a new handbook
V141215	RJV-Revised game instructions: clarify rolls, develop robot function list
V141125	RJV-Revised game instructions to consider 6 independent approaches, schedule chart for decisions, decision process, revised instruction sheets, corrected wording to match design process description and following clarification descriptions
V141115	RJV-updated instruction sheets, decision matrix, electrical architecture dia; added process map of design process
V141030	Original draft

1 INTRODUCTION

1.1 Purpose

The purpose of this document is to provide for the technical director and Sub-Team Leaders of Cougartech Team 2228 that details the following:

1. Responsibilities of the tech director
2. Responsibilities of the Sub-Team Leaders
3. Technical Sub-Teams milestone schedule
4. Project management (Leadership characteristics, process, reporting, conflict resolution)
5. Technical training - Cross training description

1.2 Scope

The scope of this document covers project management and technical team leader responsibilities.

Scope gaps:

1) At this version 141125 the technical handbooks referenced in this document are not completed. They will be completed in 2015
2) Many design processes/management steps are not the present Standard Operating Procedure(SOP), however, they should be viewed as goals for the future.
3) The appendix design instruction sheets will be integrated into handbooks when they become available.
4) Document is weak in competition responsibilities and processes (scouting[pit-match]/drive team/pit team)

1.3 Audience

The intended audience is the Technical(Engineering) director, sub-team leaders and Technical(Engineering) mentors.

1.4 References

Behind the Lines episode 1: Things Every team Should Know - Team 359
Competition(Scouting/Drive Team) Handbook- Team 2228
Effective FIRST strategies for Design and Competition, YouTube: Simbot Seminar - Team 1114
Electrical Handbook- Team 2228
FIRST Robot Design: A Team Based Process - Team 45:
FIRST Robotics Team Project Management - Team 2775
Four Reasons People Follow a Leader -CEO think tank
FRC role playing - Chief Delphi:
Introduction to Project Management: Principles, Techniques and Tools - UCDavis 2013
Leadership Boot Camp 2006 Team 1511
Leadership Boot Camp 2013 Team -1511
Leadership-Getting it Done - Rex Campbell University of Missouri
Mechanical Handbook - Team 2228
Mission Project Management -Hewlett-Packard Company 2004
Program Management Basics - Purdue FIRST Programs 2006

Project Management Basic Principles for FIRST Teams Team 234 2008
Project Management 101 - MOE university - Team 365
Rapid Prototyping Concept - RAHS Robotics
Series, simbotics.org/resources
Seven Habits of Highly Successful People -
Software Handbook- Team 2228
Team358.org/Team Resources
Team 1511: penfieldrobotics.com/resources, wiki
Team 2228 - 2007, 2012, 2013 Design Process
Team Handbook- Team 2228
Winning Strategies for FRC - Memphis FIRST Teams
WPI: Strategy and Brainstorming, 2006,2007, 2008, Workshops and conference presentations

1.5 Definitions

CAD	Computer Aided Design
CCWM	Calculated Contribution to Winning Margin
COT	Commercial Off the Shelf
e.g.	For example
FIRST	For Inspiration and Recognition of Science and Technology
FRC	FIRST Robotics Competition
IDE	Interface Development Environment
i.e.	That is
I/O	Input/Output
KOP	Kit Of Parts
KPP	Key Performance Parameters
OPR	Offensive Power Rating (this is an estimated contribution)
PO	Purchase Order
PoP	Proof of Principle
PWM	Pulse Width Modulation
QFD	Quality Function Deployment
SOP	Standard Operating Procedure
STEM	Science-Technology-Engineering-Math
UL	Underwritters Laboratory
WBS	Work Breakdown Structure (see section "Project Planning" for detailed description)

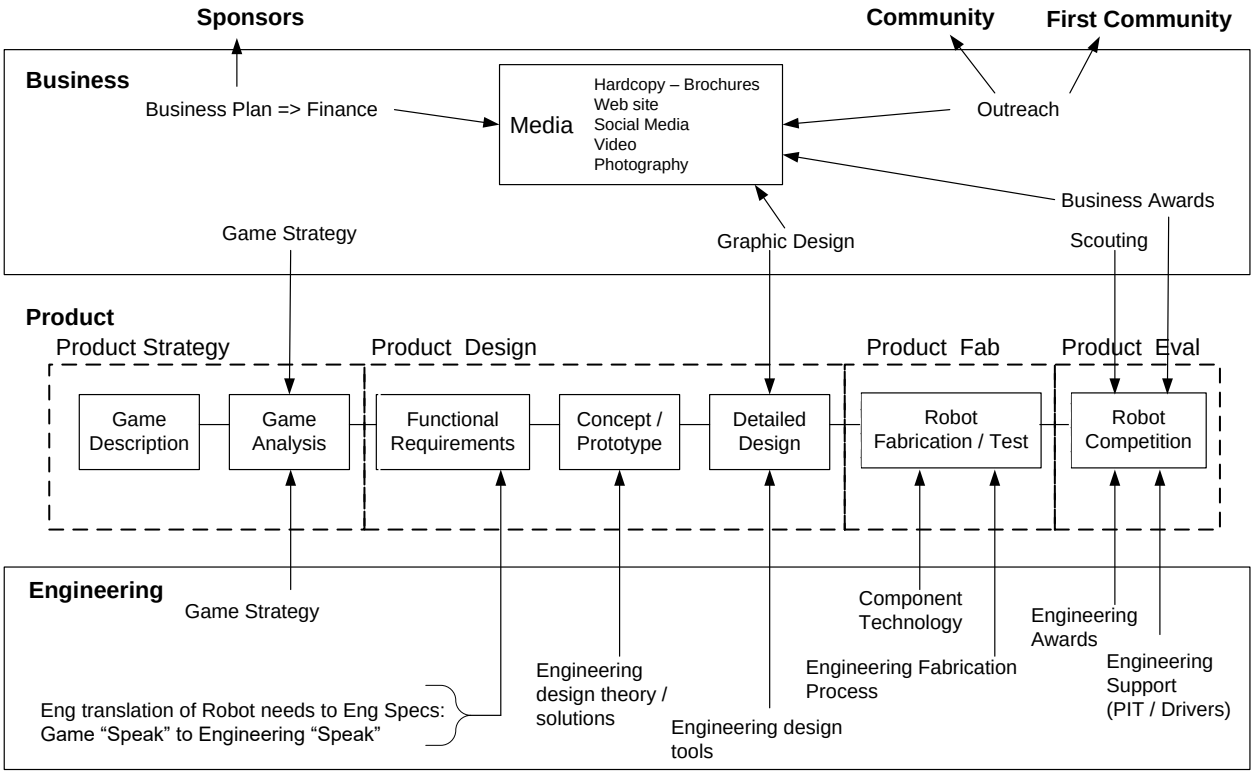
2 OVERVIEW

2.1 Description

This document details the project management process for FIRST robots based on industry standard project management techniques. It is important to note that all members have a role on the robotics team.

3 TEAM 2228 ROBOTICS - "IT'S MORE THAN ROBOTS"

3.1 Team 2228 Robot Business Model



3.2 Robot Definition

The term robot stems from the Czech word robota, which translates roughly as 'dull, repetitive labour'. Word robot was coined by a Czech novelist Karel Capek in a 1920 in a play titled Rassum' s Universal robots (RUR).

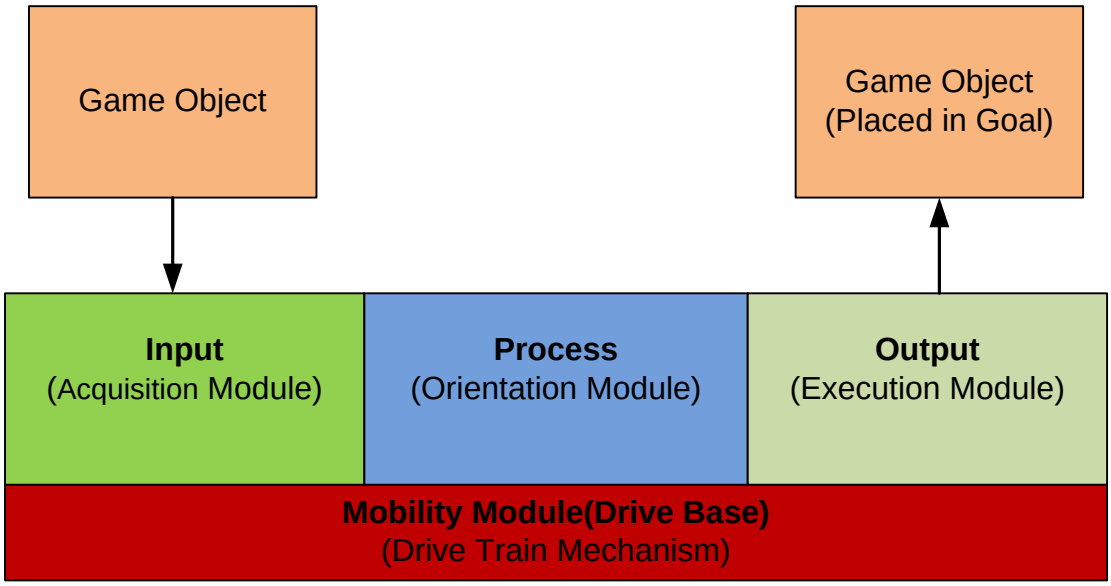
Robot Institute of America, 1979 defines a robot as:
A robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks.

4 ROBOT ARCHITECTURES

A robot converts electrical energy via commands into mechanical energy to do work. The following sections show the mechanical and control architecture for a FIRST robot.

4.1 Robot Mechanical Architecture

The following is a high level block diagram of the FIRST robot mechanical sub-system modules:



Literature from various FIRST teams refers to mechanical modules as manipulators. An Industrial robot manipulator is typically an arm mechanism created from a sequence of joint and linkage combinations, including the wrist. The wrist on the robot will also has an end effectors (e.g. grippers, vacuum cups, spray guns, welding tools).

The FIRST robot, as with industrial robots, is a reprogrammable, multifunctional manipulator designed to move materials, parts, or tools through programmed motions for the performance of a variety of tasks.

4.1.1 FIRST Robot Sub-Systems

There are four basic modules or sections in the mechanical anatomy of a FIRST robot. They are as follows:

1) **Mobility Module(Drive Train):** The drive train consists of motors through a gear train(mechanical advantage) to drive the robots wheels. *(e.g. 6 wheel/2 gear boxes tank drive, or 4 macanum wheels/2 gear boxes, or 5 omin wheel/3 gear boxes slide drive, 4 wheel/8 gearbox swerve(crab) drive)*
2) **Acquisition Module:** The input acquisition module gathers the FIRST game object into the robot and/or receives the game object from a human player or other robot. (*e.g 2014-Aerial Assist exercise ball acquisition capture, or 2013-Ultimate Ascent Frisbee capture Shute for human placement of Frisbees*)
3) **Orientation Module:** The orientation process module stores and/or transports and/or orients the game object for the action module to act on the game object. *(e.g 2013-Ultimate Ascent*

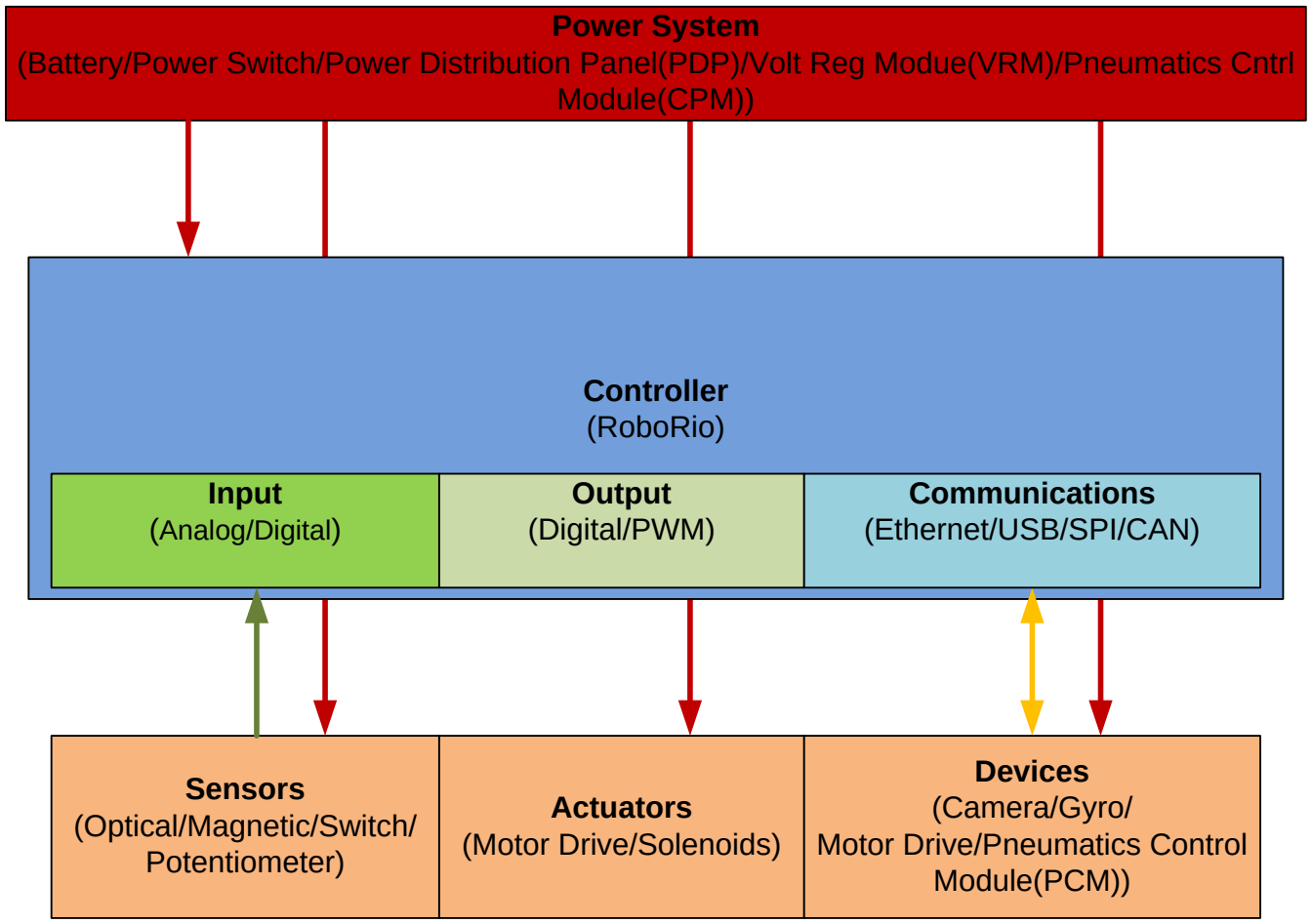
Frisbee orienteer/stacker, or 2012-Rebound rumble basket ball storage and conveyor system to ball shooter)

4) **Execution Module:** The execution module performs an action on the game object. Typically this action is to place the object or throw the object. *(e.g. 2014-Aerial Assist exercise ball thrower, or 2013-Ultimate Ascent frisbee shooter)*

Note: Combining modules reduces complexity and improves efficiency of the robot. For example, in "2014-Aerial Assist" one robot design combined the game object Acquisition, Orientation and Action Modules into one mechanism that could lower for acquisition and raise for shooting.

4.2 Robot Controls Architecture

The following is a high level block diagram of the FIRST robot control system modules:



4.2.1 FIRST Robot Electrical Sub-Systems

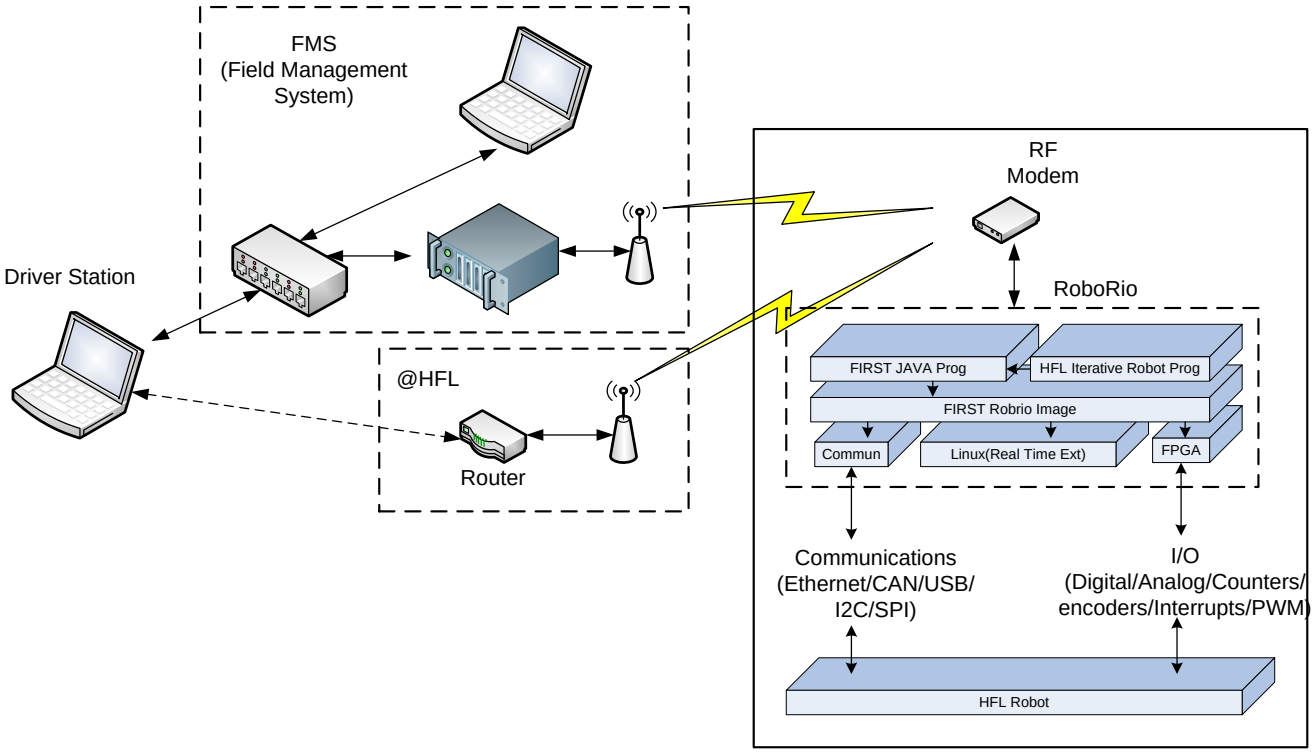
There are five basic sub-systems in the electrical anatomy of a FIRST robot. They are as follows:

1) **Power System:** The power system provides energy through a battery. The robot is energized through a main power switch and through a power distribution panel. On the

power distribution panel the electrical system is protected by the use of fuses that break the electrical circuit on excessive current.

2) **Controller:** The controller provides the logical sequence of commands to control mechanisms. It uses sensors to understand the state of the robot. Through a program sequence actuators are activated to provide mechanical motion to the robot.
3) **Sensors:** Sensors are transducers which convert one form of energy into another form to sense mechanical motion (e.g. Light energy[white light/infrared light] - with light energy present there is an electrical signal/no light, no electrical signal[e.g. encoders, horse shoe sensor], other sensors used sense magnetic, force, or pressure). These sensors provide useful information to the robot logic on the state of the mechanical mechanisms.
4) **Actuators:** These devices produce connectivity between the electrical system and the mechanical mechanisms. Actuators on the robot convert electrical energy into magnetic energy. Typical actuators include motor drives => motors, solenoid valves => pneumatic cylinders.
5) **Devices:** Devices are intelligent sensors or systems that have custom programs that manipulate sensor/actuator information and communicate data back to the robot controller.

4.3 Software Architecture



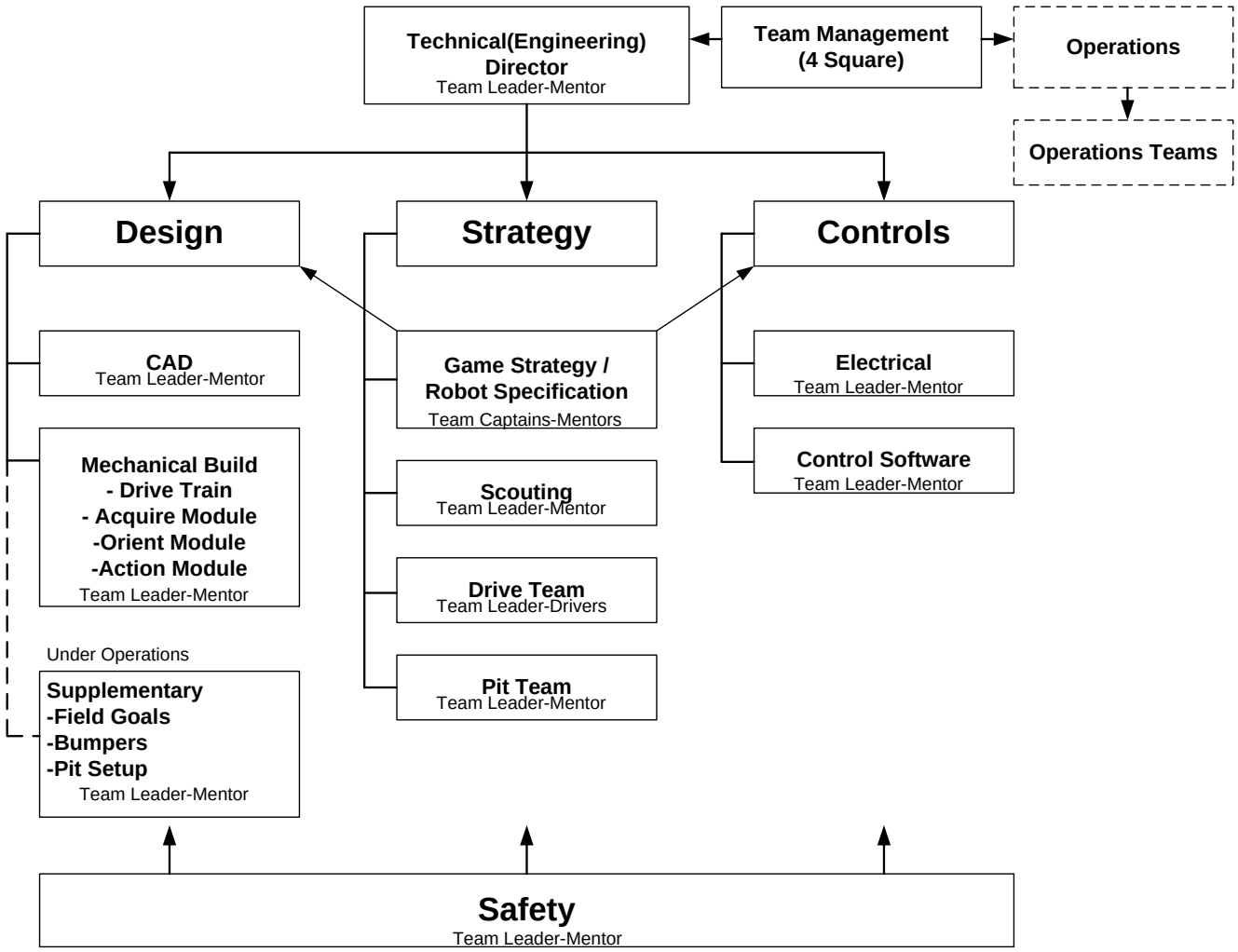
4.3.1 Software Sub-Systems

There are five software sub-systems

1. **Driver Station:** The driver station provides an interface for the operator to load software, setup devices, test software, provide analog(joy sticks) and digital input(Push buttons) to the RoboRio robot controller.
2. **Robot Communications to operator:**
    a. Competition: At a competition all commands go through a Field Management System, which is controlled by FIRST, to the RoboRio
    b. At HFL: At HFL a router is used to communicate to the RoboRio.
3. **Robrio software architecture:** The software inside the RoboRio is layered; Linux with real time extensions is the kernal with a FIRST image for the Field Programmable Gate Array(FPGA). The HFL robot program is an extension of the FIRST Robot program.
4. **Communications:** The RoboRio is designed to provide several industry standard communications hardware.
5. **Input/Output (I/O):** The RoboRio is also designed to have a hardware interface for analog, digital and PWM signals to interface to robot sensors or actuators.

5 TECHNICAL TEAM ORGANIZATION

5.1 Technical (Engineering) Team Organization Chart



The team captains are responsible for maintaining the assignment of team members to sub-teams in the organization chart.

5.2 Technical Discipline Leader Responsibilities

Project leaders are the first level of team members that define the character of the team. Thus your commitment to the team has far reaching consequences. The expected time commitment to the team includes: All team meetings, workshops, 4-5 days a week during actual build season and attendance at outreach events.

Each discipline leader should have an understudy that can be a backup. In the absence of the team leader the understudy in conjunction with the discipline mentor will continue executing present tasks.

5.2.1 Technical(Engineering) Director

The Technical(Engineering) Director is responsible for overseeing the sub-team work through the design process.

The Technical(Engineering) Director responsibilities include, but not limited to:

1) Robot design Team Leader - Mechanical / Electrical / Software
2) Develops the Technical(Engineering) notebook
3) Manages the overall robot build schedule
4) Hosts the build season team status meetings
5) Reports to the Team 2228 management(Captain/Vice Captain/Tech Dir/Operations Dir/Lead Mentors)

5.2.1.1 Robot Committee

The Robot Committee consists of the Technical Director/Mentor, Mechanical Team Leader/Mentor, Electrical Team Leader/Mentor, Software Team Leader/Mentor, and interested Seniors.

The Robot Committee is responsible for defining Module Teams and developing the final robot concept/design. Changes to the design are approved by Robot Committee.

5.2.1.2 Module Teams

Module Teams are defined by the Robot Committee. There are three sets of Module Teams: Concept Module Teams, Prototype Module Teams and Design Module Teams. Team member assigned to Module Teams may change during the robot build season.

The Module Teams are responsible for delivering design and documentation during each of the design phases.

5.2.2 Mechanical Team Leader

The mechanical team leader is responsible for overseeing the work to build and assemble the robot during build season. The work also includes maintenance of the robot at competitions and during the off season.

The mechanical team leader responsibilities include, but not limited to:

1) Develops a work breakdown structure(WBS) and schedule with sub-team mentor for the robot build
2) Maintains a build schedule and keeps mechanical build team to the schedule through supervision and communication
3) Communicates mechanical build progress to robot design team
4) Work closely with CAD, electrical and programming teams
5) Oversee mechanical build in accordance with mechanical standard (Mechanical Handbook)
6) Monitors mechanical weight of robot - documented on a spreadsheet; formatted as the following: item/module/component name/weight
7) At competition, responsible for maintenance and upkeep of the robot
8) Supervises work in pit during competitions in coordination with Safety Captain

5.2.2.1 Supplementary Team Leader

The supplementary team reports to the operations part of the team, however, they have responsibilities to support the technical part of the team.

For the technical part of the team, the supplementary team leader is responsible for overseeing the work of the supplementary team to build game field elements for robot testing and to support construction of the CougarTech Pit at competitions.

The Supplementary team leader responsibilities include, but not limited to:

1) Interprets FIRST-supplied blueprints of the playing field and builds parts of the field according to those specifications.
2) Develops a work breakdown structure(WBS) and schedule with sub-team mentor
3) Organize and supervise design and build of all non-robotic materials including: crate, pit, and practice field; design and construct bumpers for robot; manage workshop and inventory of tools; coordinate with marketing the pit design regarding, and placement of, corporate logos on robot
4) Support field component assembly for robot testing at the end of the robot build cycle

5.2.2.2 CAD Team Leader

The CAD team leader is responsible for overseeing the work of the CAD team in developing CAD models of the robot and fabrication drawings of the mechanical components that require machining.

The CAD team leader responsibilities include, but not limited to:

1) Oversees the development of CAD models of the overall robot structure and feasibilities of design choices in accordance with CAD standard (CAD Handbook)
2) Oversees the development of robot sub-system prototypes
3) Maintains a CAD design notebook
4) Provides annotated Bill Of Materials(BOM) from input of mechanical team - annotation BOM is formatted as follows: item/quantity/part name/mfg/mfg part number/cost/web address of spec sheet
5) Insure BOM is delivered to the Technical(Engineering) director for the Technical(Engineering) notebook
6) Communicates CAD progress to robot design team
7) Coordinates with mechanical and electrical build teams all pertinent information regarding the robot design

5.2.3 Controls Team Leader

There is a close relationship between the control system and the control program. There may be one team leader for the electrical and software components of the robot or there can be separate team leaders for the electrical and software sub-teams.

5.2.3.1 Electrical Team Leader

The electrical team leader is responsible for overseeing the work of the electrical team to provide electrical support for the robot build team and software team.

The electrical team leader responsibilities include, but not limited to:

1) Oversee electrical design including electronics, sensor systems, motion systems and wiring in accordance with electrical standard (Electrical Handbook)

2) Develops robot build work breakdown structure (WBS) and schedule with team mentor
3) Communicates electrical build progress to robot design team
4) Provides annotated electrical Bill of Materials (BOM) - annotation BOM is formatted as follows: item/quantity/part name/mfg/mfg part number/cost/web address of spec sheet
5) Monitors electrical weight of robot - documented on a spreadsheet; formatted as the following: item/module/component name/weight
6) Provides cost analysis of the robot electrical system
7) Provides electrical documentation: schematics, Robot controller I/O definition

5.2.3.2 Software Team Leader

The software team leader is responsible for overseeing the work of the software team to provide control logic for the robot and to support control testing during the build season and at competition.

The software team leader responsibilities include, but not limited to:

1) Oversee software design including I/O definition, programming schema, robot functions in accordance with software standard (Software Handbook)
2) Develops robot build work breakdown structure (WBS) and schedule with team mentor
3) Communicates software program progress to robot design team
4) Oversees software support for offseason robot activites
5) Oversees robot programming
6) Provides software documentation: robot program, Robot drive station-robot setup instructions

5.2.4 Strategy - Scouting Teams

Strategy and scouting have a close relationship. Typically the strategy team is lead by the team captain and vice-captain with a separate team leader for scouting.

5.2.4.1 Game Strategy Team Leaders

The strategy team leaders are responsible for leading the team through the robot strategy sessions during the robot build season.

The strategy team leaders responsibilities include, but not limited to:

1) With the Technical(Engineering) Director, Oversee the process to analyze the game and determine the game strategy
2) With the Technical(Engineering) Director, Oversee the process to develop the robot requirements (Robot Function / Design constraints)
3) With the Technical(Engineering) Director, Oversee the process to develop the robot concepts and final design

5.2.4.2 Scouting Team Leader

The scouting team leader is responsible for overseeing the work to provide the team with data on robots from other teams and robot/driver performance. This information is used for improving team 2228 match performance and alliance team selection.

The scouting team leaders responsibilities include, but not limited to:

1) Oversees the design/analysis of game competition in accordance with Scouting standard (Competition Handbook)
2) Oversee the development of competition scouting data collection process

3) Assign and coordinate scouts during competitions. This should include Pit scouting and match scouting.
4) Oversee the development of an alliance selection process that includes the types of data to be used
5) Provide current team data to drive team
6) Oversee database of teams/capabilities during competition
7) Oversee preparation / deliver of competition scouting information for alliance selection team

5.2.5 Safety Team Leader

The safety team leader is responsible for overseeing the work to keep each CougarTech member safe by understanding and observing all safety rules in the shop and at competition. The safety team leader responsibilities include, but not limited to:

1) Oversees the team safety in accordance with Safety standard (Safety Handbook)
2) Plan, create, and present annual team safety seminar
3) Work with team members to participate in hands on safety training
4) Distribute and collect safety glasses in the shops
5) Coordinate safety of tools and oversee tools management
6) Download, print, and understand the current year safety manual, including safety (MSDS) information about batteries
7) Represent Team to UL as Safety Captain
8) Act as Pit Boss at all competitions, monitor pit safety, proper tool use, and remove non pit crew personnel.

5.2.6 PIT Team Leader

The pit crew team leader oversees the operation of the pit at competitions. The pit team leader responsibilities include, but not limited to:

1) Maintenance of robot
2) Trouble shooting lead with a software member

5.2.7 Drive Team

The Drive Team is a tightly coordinated team for running the robot. The drive team coach should be the drive team leader.

The drive team is expected to have backups in the event they are not able to participate.

5.2.7.1 Drive Team Coach

The role of the coach is to know the strategy for the entire alliance and communicate well with other teams on the alliance, relay relevant information to the driver and collector, be able to coordinate all three teams so that they can work as one, and have the ability to change the strategy mid-game when needed

The drive team coach responsibilities include, but not limited to:

1) The Coach's job is to coordinate the Drive Team & keep track of all things happening during a match, and advise the Driver, Co-Pilot, & Human Player as they deem necessary

2) Coordinate with other teams in an alliance strategy

5.2.7.2 Drive Team Robot Driver / Co-Pilot

The drivers' main focus is to efficiency execute fundamental driving maneuvers. Even a great strategy will fail if with poor fundamental driving. The driver should definitely know all the in's and out's of how to: control their robot, pinning, as well as how to avoid being pinned

The drive team driver responsibilities include, but not limited to:

1) Drive the robot during competitions
2) The co-pilot is to control robot devices during competitions

5.2.7.3 Drive Team Human Player

The human player responsibilities are defined in the game rules. The human player plays an important role in the game object cycle time. The human player needs to minimize the time a robot does not have a game object.

The drive team human player responsibilities include, but not limited to:

1) The human player is to carry out the tasks set forth by the game rules for human players during competitions
2) The human player is expected to be present or a backup at all competition matches

6 PROJECT MANAGEMENT

As the project managers(Technical(Engineering) Director and Team Leaders), your job is to plan, budget, oversee and document all aspects of the specific project you are working on. Project managers will work closely with upper management to make sure that the scope and direction of each task is on schedule.

Remember perfection can kill a schedule. "Never let perfectionism get in the way of getting a good job done" To meet the schedule everyone has to understand their support and the execution of the plan.

The mentors role is to advise and assist in the development of the plan and execution. A mentor will intervene if plan or execution do not meet project milestones.

6.1 Personal Characteristics

Project leaders are the first level of team members that define the character of the team. Thus your commitment to the team has far reaching consequences.

The personal characteristics of a project team leaders include, but not limited to:

1) **Behave ethically:** All leaders should follow FIRSTs' "Gracious Professionalism"
2) **Communicate Effectively:** Using appropriate communications tools, leaders in a timely manner should speak, listen and write clearly
3) **Lead:** Leaders should always influence others to achieve results for the team with a positive attitude
4) **Plan:** Team leaders should understand team strategies, create implementation plans and evaluate progress

5) **Solve Problems:** Assess problem situations to identify causes, gather and process relevant information, generate possible solutions, and make recommendations and/or resolve the problem

6.2 Project Planning

In the next section two levels of planning are described. The High level task schedule and the detailed weekly task schedule. To accomplish the goals of Team 2228 the team leaders need to develop plans to meet these goals. This is accomplished in the following manner.

1) Based on team strategies develop a scope of work(high level tasks)
2) Create a detailed work break down structure(WBS) which identifies and sequences the activities/documentation needed to successfully accomplish each task
3) Identify resources, training needs, task deliverables, technical approach, and system development process
4) Execute the plan and provide effective communications between the teams and the management team

6.2.1 Work Breakdown Structure (WBS)

A work breakdown structure (WBS) is a common framework for overall planning and control of work to complete a project. The WBS divides work into definable increments called tasks. Each task may have several steps to complete the defined work.

When creating a WBS, the sub-team leaders need to defined what tasks need to be executed to complete the project. Each task should list the work to be accomplished and who on the sub-team will be doing the work.

The Work Breakdown Structure (WBS) is an essential tool for planning and executing the project. It is used to communicate work content, status, resource(sub-team members) utilization.

6.2.2 Milestones

Milestones are specific points along a project time line. The "Build-Competition Season" details the milestones of the build season for each sub-teams. The "Team2228 Design Process Handbook" also has a detailed milestone chart for the build season.

6.3 Reporting Process

There are three reporting processes. The team management reporting process and the team reporting process.

6.3.1 Team Management Reporting Process

The Management/Mentor meetings provide a forum to effectively keep the teams focused on critical elements of the seasonal team phases. The Team Management meetings also provides an effective forum to present problems, shift resources, make decisions. We have named this meeting the "4square" (Members include: Captain/Vice Captain/Tech Dir/Operations Dir/Lead Mentors).

When: Prior to each team meeting or as needed. Thus, each team meeting night would have the following schedule:

1) Team Leader/Mentor meeting.Team members would bring out and setup all equipment needed for their respected areas. (30min)

2) Execute team meeting plan (3hr)
3) Return team equipment to storage and have an end team meeting (30min)

Chair: Team Captain and Vice-Captain
Who: Captains, Technical(Engineering) and Operations Directors/Mentors and Lead Mentors
Agenda: 1. Status of team events/tasks, next steps, and help needed.

6.3.2 Off-Season and Pre-Season Reporting Process

During the Off-Season and Pre-Season, Team Leader/Mentor meetings are required. The Team/Mentor meetings provide a forum to effectively keep the teams focused on critical tasks for the particular season. The Team Leader/Mentor meetings also provides an effective forum to present problems, shift resources, make decisions.

When: Prior to each team meeting or as needed. Thus, each team meeting night would have the following schedule:

1) Team Leader/Mentor meeting/ team members would bring out and setup all equipment needed for their respected areas. (20min)
2) Execute team meeting plan (3hr)
3) Return team equipment to storage and have an end team meeting (20min)

Chair: Captain / Vice-Captain
Who: Team Leaders / Mentors
Agenda: 1. Progress toward team event milestones; 2. brief status of teams, next steps, and help needed.

6.3.3 Build Season Team Reporting Process

During the robot build season Team Leader/Mentor meetings are required. The Team/Mentor meetings provide a forum to effectively keep the teams focused on critical elements of the build season. The Team Leader/Mentor meetings also provides an effective forum to present problems, shift resources, make decisions.

When: Prior to each team meeting or as needed. Thus, each team meeting night would have the following schedule:

1) Team Leader/Mentor meeting/ team members would bring out and setup all equipment needed for their respected areas. (30min)
2) Execute team meeting plan (3hr)
3) Return team equipment to storage and have an end team meeting (30min)

Chair: Technical(Engineering) Director
Who: Team Leaders / Mentors
Agenda: 1. Progress toward design/build milestones; 2. Brief status of teams, next steps, and help needed. 3. Review: game play, KPPs, design and related decisions

6.3.4 Design Reviews

Design reviews are import part of any design process. They accomplish the following:

1) Catch errors early
2) Allow everyone to be on the same page of understanding
3) Reduces re-work (Saves time in design process)

The intension is NOT to REDESIGN or to CRITICIZE the design. There are multiple answers to any problem. The only question at hand is "Does the solution meet the requirements"

When: Prior to each design phase
Chair: Technical(Engineering) Director
Who: Sub-Team Leaders / Mentors
Agenda: Information presented should be electronic documentation showing design documentation (sketches/calculations/decision matrix/drawings). For fabricated parts dimensioned drawings should be presented.

7 TECHNICAL MILESTONE SCHEDULES

7.1 Off-Season (April - August)

7.1.1 Team

1) Team lessons learned meeting and handbook update

7.1.2 Mechanical

1) Cleanup/Reorganize the team closet
2) Cleanup/Store mechanical parts away after competition
3) Do a Mechanical Part Inventory
4) Mechanical Inventory BOM: Format of BOM should be organized out as following:
    a) Item number
    b) Item description
    c) Key part parameter description
    d) Item manufacture Part number
    e) Supplier Part Number
    f) Supplier web site address

    PDF spec sheets should be saved on the team school hard drive
5) Development Team projects to improve team skills(Old/New team leader and team)
6) Participation in team community activities

7.1.3 Electrical

1) Cleanup/Store electrical parts away after competition
2) Do an Electrical Part Inventory
3) Electrical Inventory BOM: Format of BOM should be organized out as following:
    a) Item number
    b) Item description
    c) Item manufacture Part number
    d) Supplier Part Number
    e) Supplier web site address

    PDF spec sheets should be saved on the team school hard drive
4) Development Team projects to improve team skills(Old/New team leader and team)
5) Participation in team community activities

7.1.4 Software

1) Archive robot software
2) Development Team projects to improve team skills(Old/New team leader and team)

3) Participation in team community activities

7.2 Pre-Season (September - December)

7.2.1 Mechanical

Mechanical task for the Pre-Season:

1) Competition Robot Ready for Ruckus
2) Competition Robot breakdown after Ruckus and update mechanical inventory BOM
3) Mechanical Shop Tool Training
4) Electrical cross training
5) CAD training
6) Safety Training
7) Mechanical tool inventory (Determine what tools are broken)
8) Mechanical Cost Budget
9) Mechanical part pre-orders - A notebook should be keep for PO requests

7.2.2 Electrical

Electrical tasks for the Pre-Season:

1) Electrical Shop Tools training
2) Mechanical cross training
3) Electrical schematic training
4) Safety Training
5) Competition Robot breakdown after Ruckus and update electrical inventory BOM
6) Electrical Tool Inventory (Determine what tools are broken)
7) Electrical Cost Budget
8) Electrical part pre-orders - A notebook should be keep for PO requests.

7.2.3 Software

Software tasks for the Pre-Season:

1) Electrical cross training
2) Software development environment (IDE) training
3) Software device setup training(e.g. modems, Robrio, CAN devices, etc)
4) Robot program structure language training
5) Robot software standard(code grammar rules) training
6) Download software upgrades for lap top and install
7) Robot I/O software construct training
8) Software hardware Tool(PC/routers/modems/joy sticks/etc.) Inventory (Determine what tools are broken)

7.2.4 Scouting

Scouting tasks for the Pre-Season:

1) Analyze completion team data for regional teams
2) Develop scouting training for team
3) Improve on data collection process

7.3 Build-Competition Season (January - March)

7.3.1 Week 1: Robot Requirements Capture/Develop Robot Concept

Saturday: Go to kick off, study rules, develop strategy, and play game (Robot "What")
Sunday: Complete robot strategy and develop robot module list

Design Research Teams(Mechanical/Electrical/Software): Develop concepts(i.e. concept sketches, prelim calculations, SWOT analysis, decision matrix). Review KOP's.

Mechanical: Start prototype concepts to prove feasibility, order parts if needed

Electrical: Support prototype electrical systems; Define electrical architecture; order parts if needed

Software: Define software architecture; Define I/O(i.e physical connection and agreed upon I/O names); develop mobility module code functional specification

Scouting: Develop scouting strategy for mobility module(i.e. pit crew/robot pit scouting sheet);

Technical(Engineering) notebook: electronic versions of: concept sketches, prelim calculations, pro/con lists, decision matrix; electrical architecture dwg; software I/O definition; Mechanical/electrical BOM; Mechanical/Electrical component weight

Design Review: Design review/release of mobility module for detailed design (mechanical/electrical/software)

7.3.2 Week 2: Develop Robot Concept/Preliminary Design

Mechanical: Continue prototypes; Complete design calculations. Estimate robot weight; Build mobility module

Electrical: Support prototype electrical systems; Complete electrical architecture; Develop electrical layout with CAD team; Estimate electrical component weight; Build mobility module controls;

Software: Define software architecture; Define I/O; Develop mobility module code; Start robot functional specification

Scouting: Develop scouting strategy for robot(i.e. drive team/match scouting sheet)

Supplementary: Complete field goal construction by the middle of the week

Technical(Engineering) Notebook: electronic versions of: concept sketches, prelim calculations, pro/con lists, decision matrix; electrical architecture dwg; software I/O definition; software mobility functional specification

Design Review: Design review/design release to develop/complete detailed robot design

7.3.3 Week 3: Detail Design/Robot Build

Mechanical: Develop robot detailed design; Design review/release of parts to manufacture; Driver training; Drivers test mobility module; check mobility module weight, Mechanical buid BOM: Format of BOM should be organized out as following:

a) Item number
b) Item description
c) Key part parameter description
d) Item manufacture Part number
e) Supplier Part Number
f) Supplier web site address

PDF spec sheets should be saved on the team school hard drive

Electrical: Integrate mobility controls; Develop electrical schematics; Develop fuse map diagram; Design review/release to build electrical sub-panels; Build electrical sub-panels, Mechanical buid BOM: Format of BOM should be organized out as following:

a) Item number
b) Item description
c) Key part parameter description
d) Item manufacture Part number
e) Supplier Part Number
f) Supplier web site address

PDF spec sheets should be saved on the team school hard drive

Software: Load mobility software and test mobility module; Complete robot functional specification; Develop autonomous or end game program software

Drive Team/Scouting: Understand the capabilities of the mobility module and drivers. Start the driver strategy notebook

Technical(Engineering) Notebook: electronic versions of: concept sketches, prelim calculations, pro/con lists, decision matrix; electrical schematics; software I/O definition; robot functional specification Mechanical/electrical BOM; Mechanical/Electrical component weight

Design Review: Mechanical review/release of parts to manufacture; electrical schematic review/release to manufacture; software walk through of autonomous or end game program, scouting pit crew/robot pit scouting forms

7.3.4 Week 4: Robot Build/Robot Module Integration

Mechanical: Complete part fabrications; Weigh fabricated parts; Start robot module assembly

Electrical: Bench test electrical sub-panels; Weigh electrical sub-panels; Program Jaguar motor drivers for CAN addresses; Check electrical fit on robot

Software: Test autonomous or end game software; Develop teleop robot software

Technical(Engineering) Notebook: electronic versions of: concept sketches, prelim calculations, pro/con lists, decision matrix; electrical schematics; software I/O definition; robot functional specification Mechanical/electrical BOM; Mechanical/Electrical component weight

Design Review: Teleop software review/release (i.e. teleop software walk through)

7.3.5 Week5: Robot Module Integration/Test and Evaluation

Mechanical: Complete module assembly; Fabricate spares; Support software testing

Electrical: Integrate electrical control panels; Support software testing

Software: Integrate software and test

Scouting: Develop match data collection forms and set up scouting training for team

7.3.6 Week6: Test and Evaluation/In Service-Competition

Mechanical: Drive the robot; Evaluate performance; BOM review; Weight review; Print out documentation for Technical(Engineering) notebook; Photograph; Bag and crate; Competition check list review

Electrical: Support robot evaluation; BOM review; Print out documentation for Technical(Engineering) notebook

Software: Support robot evaluations; print out documentation for Technical(Engineering) notebook

Drive Team: Complete robot operation understanding. Complete game strategy playbook.

Scouting: Complete data collection forms and set up scouting training for team

Technical(Engineering) Notebook: printout for completed notebook: concept sketches, prelim calculations, pro/con lists, decision matrix; electrical schematics; software I/O definition; robot functional specification(autonomous or end game/teleop); CAD images; Mechanical/electrical BOM; Mechanical/Electrical component weight

Design Review: Completed scouting forms; scouting training

8 LESSONS LEARNED PROCESS

8.1 Continuous Improvement

In the robot design/build/test/competition process we learn new methods to improve the process. The key to a good continuous improvement program is based on one principle: "If it is not written it does not exist". Going through the lessons learned review process is only part of the process. The lessons learned need to be integrated back into the handbooks for future teams.

If it is not written we approach insanity principle: "Doing the same thing over and over expecting different results" or the Not invented here syndrome: I don't like what was done before. Let's start over again.

8.2 Lessons Learned process

8.2.1 Lessons Learned and Review

During the different robot seasons team members should note in their note books what didn't work and what was done to improve the process. At the end of the robot seasons all members should develop a lessons learned list based on the following headings:

1) Start: What processes should the team start to do.
2) Stop: What processes the team should stop doing
3) Continue: What processes should the team continue doing

There should be a lessons learned scribe documenting the lessons learned

8.2.2 Lessons Learned Integration

The management team and mentors will then convert the lessons learned into the team handbooks.

9 TECHNICAL(ENGINEERING) NOTEBOOK

9.1 Technical(Engineering) Notebook Leaders

The Technical(Engineering) Director is responsible for the development of the Robot Technical(Engineering) Notebook. **Golden Rule:** "If it is not written, it does not EXIST"

9.2 Technical(Engineering) Notebook Content

The Technical(Engineering) notebook should contain, but not limited to the following section:

9.2.1 Cover

The cover should include:

1) Name of the team,
2) Team number, and
3) This year's game logo

9.2.2 2228 Team introductions

This section should include:

1) Organization chart,
2) Team manual or a description of the team

9.2.3 Engineering Design Process

This section should include:

1) A description of the design process we used
2) Description of team 2228 training process and web page resource section
3) Copy of the design process handbook
4) Technical handbooks or a description of the handbooks. The handbooks could be placed in a Team Manual notebook

9.2.3.1 Team Manual

A team manual notebook would include:

1) Team Manual
2) Team Business plan

3) Technical handbooks(Technical Director handbook, Mechanical Handbook, Electrical Handbook, Software Handbook, Competition Handbook)

9.2.4 Requirements

The requirements section should include:

1) Description of the requirements process
2) Scoring analysis developed during the requirements process
3) Robot Functional Specification: Game strategy developed during the requirements process.(What the robot has to do to play the game.)

9.2.5 Concept

The concept section should include:

1) Description of the concept process
2) Module engineering specification
3) Concepts developed(sketches, calculations)
4) Concept analysis (SWOT)
5) Robot concept decision process and documentation
6) Proof Of Principle projects, requirements, results

9.2.6 Preliminary Design

This section should include:

1) Preliminary software I/O definition (Interface Control Document)
2) Preliminary software model for robot code (UML models)
3) Preliminary electrical schematic / start of electrical BOM
4) Preliminary mechanical module sketches / start of mechanical BOM
5) Engineering calculations
6) Project design reviews

9.2.7 Detailed Design

This section should include:

1) Detailed electrical design: schematics, BOM with material weight
2) Detailed mechanical design: CAD images, BOM with material weight
3) Software programs

9.2.8 Testing

This section should include:

1) Unit testing: setup, pictures, and results
2) Robot testing: setup, pictures, and results

10 TECHNICAL TRAINING

10.1 Leadership Training

There are two levels to leadership training:

1. Tech101-The Technical(Engineering) handbook will be used as the basis for team leadership training. Workshops will provide training in work breakdown structure, decision process, and communications;

2. Tech102-Management skills(public speaking, presentations, conflict resolution), Project management tools, Technical problem solving

10.2 Mechanical Training

The mechanical training content is detailed in the Mechanical Handbook.

1. Mech101-Mechanical Architecture and components
2. Mech102-Mechanical Tool usage-Assembly techniques
3. Mech103- Drive Train / Power transmission
4. Mech104-Mechanisms
5. Mech105-Mechanical CAD / 3D Printing
6. Mech106-Engineering Calculations (energy calculations, torque, motor sizing),
7. Mech107-Design excellence: design for manufacturing, six sigma design

10.3 Electrical Training

The Electrical training content is detailed in the Electrical Handbook.

1. Elect101-Electrical Architecture and components.
2. Elect102-Electrical tool usage-Assembly techniques
3. Elect103-Electronics / Motion
4. Elect104-Electrical CAD(schematics)
5. Elect105-Engineering calculations
6. Elect106-Design excellence-motion control, custom design (e.g Printed Circuit boards), failsafe wiring

10.4 Software Training

The Software training content is detailed in the Software Handbook.

1. Soft101-Software Architecture and components
2. Soft102-Software tool usage
3. Soft103-Device setup/update procedures (e.g. modems, routers, Robrio, CAN devices)
4. Soft103-Program Development
5. Soft104-Design excellence -Software algorithm/control theory.

10.5 Competition

The Competition training content is detailed in the Competition Handbook.

1. Comp101-Pit crew / Drivers
2. Comp102-Scouting
3. Comp103-Judge response / Hospitality

10.6 Cross training matrix

The following cross training chart enhances individual contribution to the team and expands student knowledge of robot design.

Mechanical	Electrical	Software	Competition
Mech101	Mech101		
Elect101	Elect101	Elect101	
Mech102	Mech102		
	Elect102	Elect102	
	Soft101	Soft101	
Comp101	Comp101	Comp101	Comp101
Comp102	Comp102	Comp102	Comp102
Comp103	Comp103	Comp103	Comp103

11 CONFLICT RESOLUTION

11.1 *FIRST "* Gracious professionalism"

Dr. Woodie Flowers, FIRST National Advisor and Pappalardo Professor Emeritus of Mechanical Engineering, Massachusetts Institute of Technology, coined the term "Gracious Professionalism®." 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." (www.usfirst.org)

“It's a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community.” (www.usfirst.org)

11.2 Team Schedule Conflicts

If out of season or during build season scheduled work is not completing on time, mentors will help in organizing and support the work needed to be completed to meet schedule.

11.3 Behavior Conflict resolution hierarchy

It is expected that each team member comply with the HFL, RH school, and Gracious Professionalism rules of conduct.

Team Leaders are responsible for addressing issues with a "Gracious Professionalism" approach. Conflicts should not be address in the general public. If resolution is not obtained the team mentor and team management team should be informed.