Top Ten

Things NOT To Do When Designing Your FRC Team's Robot

Richard's Top Ten Boneheaded Mistakes
and suggestions for avoiding them

St. Louis Regional Fall 2007 Robotics Training Camp

Hosted by FRC 931 Perpetual Chaos, Gateway High School

How This List Was Made In Three Easy Steps

- Step One: Asked The Experts Online
  - Requested help (discreetly) from a community of respected FRC mentors
    - Responders include many people whose contributions to FIRST have been previously recognized; they represent several teams with strong records of FRC accomplishment
  - Received responses from across the US
    - Northeast, Southeast, Midwest, Texas, and West Coast
    - Fifteen mentors provided more than seventy suggestions
  - Edited, paraphrased, and added some items of my own
    - Omitted names to protect the innocent
- Step Two: Asked The Experts Locally
  - Met with regional group of FRC mentors and FRC event organizers
  - Presented summary of online responses and requested advice on how to prioritize each
- Step Three: Selected the Top Ten (and a few more)

Format of the Presentation

- Top level bullets describe the mistakes
  - Sub-bullets describe ways to avoid them
- Fair warnings:
  - Some boneheaded mistakes may have been left off this list! (doh!)
  - Reasonable (and unreasonable) people may disagree.
  - Your mileage may vary.
- Please, add to the list by telling us about mistakes your team has made or observed. And how they were corrected.
  - Easiest contact: Richard on the Chief Delphi Forum

The Top Ten

10. Bigger is better.
  - You will find reasons to add things to your robot design, even one that seemed perfect before you started testing it. Leave some room to attach things that will be needed to solve the problems you haven't found yet. Little things will stick out. Frantic sawing and filing to pass inspection is not much fun.
  - Rookie tip: if the maximum footprint is 38" x 28", design your chassis to be 37" x 27".

It has to fit.

The Top Ten (continued)

9. Decorations are for sissies.
   - The robot is the most visible expression of your team's identity. Spectators, officials, judges, VIPs, and your fellow competitors will all form FIRST impressions of your team based on the appearance of your robot. Make it a good one.
   - Coordinate your robot's markings to tie-in visually with team shirts, crate decoration, pit signage, and spirit items such as banners and mascots.
   - Rookie tip: make your team number the largest, most eye-catching feature of your tee-shirt design, and of the robot's markings.

Let your colors fly.

The Top Ten (continued) Maintainability

8. A good design never breaks.
   - Murphy's law dictates otherwise. Design for maintainability; that means knowing where break points will be and making those easy to access in the pit. Have the right tools and spare parts to minimize downtime.
   - Rookie tip: have a back-up plan that will help your alliance even if your robot is not able to perform all of its designed functions.

OUCH !

The Top Ten (continued)

7. Just stick the control system wherever it will fit.
   - Electrical and pneumatic systems require clean, accessible layout to avoid delays when things go wrong. Problems will occur; make it easy to find them so you won't have to miss matches waiting for them to get fixed. Your pit crew, your alliance partners, and your robot inspector will thank you.
   - Design the electrical and pneumatic systems with the respect they deserve. Identify all the needed components based on your robot's functions early so you can prototype and/or CAD them along with other critical systems.
   - Rookie tip: lay out electrical components so that fatter wires run shorter distances.

Accessibility

The Top Ten (continued)

6. My way or the highway.
   - Anyone can come up with a great idea. Don't forget to listen to everyone on the team. When mentors and veteran students listen and encourage, great ideas spring from new or unexpected sources.
   - Every team needs one person with the responsibility of making a final decision when differences of opinion lead to an impasse – that person must be able to consider all the facts and opinions of all team members, and then make the decision.

Communicate.

The Top Ten (continued) Put it on the scale.

5. Weight? No problem!
   - Take charge of robot weight on Day One. Make one student the weight czar. Know or model the weight of everything that goes onboard. Don't leave anything out: common omissions are chains, fasteners, and wiring. Check component and total systems weights frequently and update the budget.
   - Rookie tip: make the whole team aware of the robot's weight margin at least one week before ship day.

No Margin !

Have you ever watched a dozen people holding their breath?

And then exhaling all at once?

The Top Ten (continued) Stay on target.

4. Darn the schedule! Creativity happens when it happens.
   - Six weeks can slip by faster than you think.

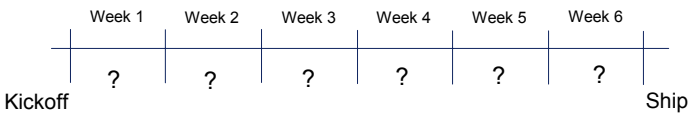
     Decisions your team doesn't make in the first and second week

     will lead to extra work, unplanned costs, frustration,

     a poorly functioning or non-functioning robot,

     and maybe some burned-out team members

     in the sixth week.
   - Schedule your build season activities and milestones. Then stick to the schedule even if it means eliminating some goals.



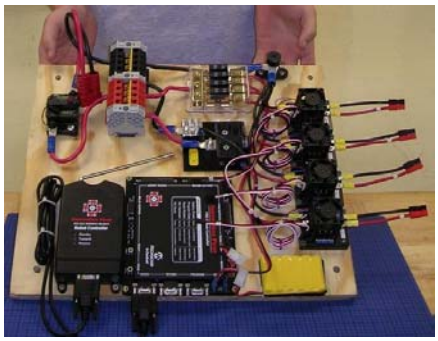
Good reference: MOEmentum from FRC 365 (MOE, 2007 Chairman's Award)

http://www.fsrobotics.org/moe365//moementum.php

The Top Ten *(continued)* Test it, again.

3. Software can wait.
   - Remember the old saying about strength of chains: your robot will only be as reliable as its worst system. Delays in prototyping the control system will almost guarantee that your software gets little or no test/debug time – so it will be the weakest link.
   - Early in the build season (or sooner!) provide a "mule-bot" that your programmers can use to test ideas.

Example: A complete electrical system prototyped during Week 1 of the 2007 build season.



The Top Ten *(continued)* Strategy

2. We finally got last year's robot to work; let's build it again.
   - Let the form of your robot follow the functions you want it to perform.
     - Reference: MIT 2.007 Open Courseware (Alex Slocum, 2005)
       - http://ocw.mit.edu/OcwWeb/Mechanical-Engineering/2-007Spring-2005/LectureNotes/index.htm
     - Process: steps to take your team from Kickoff to Design
       - One: Take stock of available resources.
         - » Kit of Parts, funding, knowledge, tools, skills, facilities
       - Two: Understand the rules and the physics of the game challenge.
         - » READ THE MANUAL. All of it. Frequently.
       - Three: Create game strategies. Use words and diagrams.
         - » Imagine the flow of robots, field elements, and game pieces.
         - » Keep asking questions: who, what, when, where, why, how
         - » Experiment. Play the game using students as robots.
         - » Think about how defenders are likely to respond.
   - Rookie tip: Base your design on a limited number of strategies. Robots that do one or two tasks well are more successful.

The Top Ten *(continued)* Solutions win.

1. It's a learning experience. We'll figure out what to do on our own.
   - Your team doesn't have to reinvent everything.
     - FIRST and the FIRST community provide many excellent resources.
       - FRC Manual: Tips and Good Practices.
         - http://www2.usfirst.org/2007comp/other/2007%20Guidelines_Tips_Good%20Practices_RevC.pdf
       - Chief Delphi discussion forum
         - http://www.chiefdelphi.com/forums/portal.php
         - Many helpful White Papers on topics of interest.
     - "Steal from the best, then invent the rest." -- Dave Lavery, NASA
   - Local veteran FRC teams are often eager to help you avoid mistakes they have already made.
     - "The biggest fallacy in FIRST is the belief we are just a bunch of different teams. We are ONE BIG TEAM with a lot of sub teams for the purpose of competition.

     … Gracious professionalism dictates that if you come to play, I must help you." -- Al Skierkiewicz, FRC 111 (WildStang, 2006 Chairman's Award)

The Contenders

- Let's put casters on one end, that will make the robot easy to turn.
  - Casters will make your robot easy for defenders to turn, too. And make it difficult (or impossible!) to surmount obstacles, climb ramps, etc.
  - Check out Chris Hibner's whitepaper on Drive Train Basics.

    http://www.chiefdelphi.com/media/papers/1443
- Oops! There went the battery!
  - Secure that battery, so that it cannot fall out when the robot is on its side or upside-down!
- Tank treads will make our robot unstoppable!
  - Well executed high-traction systems have succeeded in some FRC games. More often, the extra demand they put on your batteries is not worth the benefit.
- An exotic drivetrain (holonomic, swerve, mecanum, etc.) will let us outmaneuver the opposition.
  - Only if you have developed and tested it thoroughly, long before build season begins.

The Contenders

- We'll make that cantilevered axle out of drill rod, then heat treat it for added strength.
  - It'll snap when shock-loaded. Use 4130 or 4340 instead.
- Hurry up and cut that part we need, right now!
  - Measure thrice, then cut once. It's much better than cutting thrice.
- But my design looked great in Inventor!
  - Beauty and frustration – both reside in the details. CAD can be a great tool, but its results are only as good as the details you include. Oversimplifying can leave a big disconnect between design and build.
- Screw that tether on good and tight!
  - No, don't. Remove tether screws from the robot end, so it will self-protect by pulling loose if the robot gets away while you are testing.

The Contenders

- Our wiring doesn't need to be pretty, it just needs to work.
  - Take the time to organize your motor, PWM, digital, and analog wiring so that it is easy to trace, and mark each circuit on both ends with an identifying label. This will make it easier to reconnect things that come loose or need to be removed while something else gets serviced. And it will make life much easier for your programmers if the labels match up with your software I/O map.
- Auto mode is just like driver control, but without the driver.
  - PWM commands in auto mode should be set to an initial null value of 127. Driver controls can be tweaked to correct for other null values, resulting in predictable response in teleo mode and unpredictable results in auto mode.
- To protect the radio we'll put it inside the robot's metal skin.
  - Recall those pesky details known as Maxwell's Equations? Radios are much less effective when their signals are boxed in!