Effective *FIRST* Strategies for Design and Competition

Karthik Kanagasabapathy – November 14th, 2007

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- 10 years of *FIRST* experience
- Lead Mentor for Team 1114, 2004-present
  - 7 regional championships, 2 regional finalists
  - 2006 Waterloo Regional Chairman's Award
  - 11 *FIRST* judged awards
- 2005 Waterloo Regional Woodie Flowers Award Winner
- Member of the FTC Game Design Committee
- Emcee for the Toronto & Waterloo Regionals

Strategic Design

- Designing and building a cool robot is a lot of fun
  - Designing and building a cool robot that does well in competition is even more fun
- Very hard to go through the build process without a concrete aim
  - The clear choice is success in competition
  - Lots of other (secondary) objectives: aesthetics, design elegance, coolness factor, etc.
- Beware of the “cool factor”
  - It can be fun, but sacrificing effectiveness hurts your partners

Analyzing The Game

- Read the rules!
- Examine every possible way to score points, no matter how obscure
  - Tape measures (2002), Swinging arms (2003)
- Examine every possible way to prevent your opponents from scoring
  - Stealing balls (2000), Capping robots (2004)
- Understand the ranking system
  - e.g. Win-loss-tie, loser's score, triple the loser's score, own score plus double the loser's score...
- Consider possible strategies
  - Leads into overall robot designs

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Chokehold Strategies

- A strategy which, when executed, guarantees victory, independent of any action by your opponents
- Determining if one exists should be the first step in game analysis
- *FIRST* tries to design games with no reasonable chokehold strategy
- If one exists, it will be very difficult to perform
  - Pulling three goals - Team 71, Beatty & Hammond (2002), Lifting all the bins (2003)
- Try to find one single, finite task that overwhelms all other possible ways of scoring

Cost-Benefit Analysis

- For each task you must compare the difficulty of accomplishment to the reward for doing so
  - Pulling goals easier than scoring balls (2002)
  - Small balls (2001)
  - This is where the strategic value vs. coolness factor decision often pops up
    - Vision tetra vs. hanging tetras...
- The best tasks to perform are those which are relatively easy, yet provide big points
- Remember denying your opponents 10 points is just as good as scoring 10 points (at least in terms of win/loss)
  - Descoring much easier than scoring (2003)

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Prioritization

- Two separate lists
  - Desired robot qualities
    - Things like speed, power, agility
  - Desired robot functionality
    - The things you want your robot to be able to do
      - Grab goals, pickup balls
- At this point you can merge the two lists, and decide on a drive system and functionalities

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Simplicity & Golden Rules

- **Golden Rule #1:** Always build within your team's limits
  - Evaluate your abilities and resources honestly and realistically
  - Limits are defined by manpower, budget, experience
  - Avoid building unnecessarily complex functions
  - On the other hand, as you get more experienced, start cautiously pushing a few boundaries
- **Golden Rule #2:** If a team has 30 units of robot and functions have maximum of 10 units, better to have 3 functions at 10/10 instead of 5 at 6/10

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Tradeoffs

- The key to deciding upon a design is to evaluate the tradeoffs
  - e.g. Speed vs. Power, Complexity vs. Durability, Goals vs. Balls
- Making the right choices based on your analysis will determine the fate of your season
  - Make sure tradeoffs are consistent (hard to do when the design is always changing!)
- Remember the Golden Rules – Teams who try to do more than they're capable of tend to fail

Tradeoffs

- Try to maximize functionality with simple additions or modifications to mechanisms
  - Lifting up on goal pushed low-speed, high-torque wheels into carpet (Team 67, 2002)
  - Frame-lifting used for both ledge climbing and goal pulling (Team 1114, 2004)
  - Drivetrain as power for winch (Teams 60 & 254, 2004)
  - Be careful – hard to change one part without affecting the other
- When making tradeoffs, remember your initial priorities!
  - Let your strategic priorities dictate design

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Other Tips

- This strategic analysis is a MUST
  - There's a tendency to skip this stage, and to head straight into design and implementation
- You must know what you want to do before you can figure out how to do it
- Be realistic when evaluating strategies
  - How high did the stacks get in 2005?
  - Did anyone stack and win in 2003?
- Remember, you have partners. It's okay do depend on them for certain tasks. (How much you leave to them should be decided by the Golden Rules)
  - However, be careful not to leave too much in your partners' hands

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Other Tips

- Try to identify the different types of robots that will exist
  - Go through the different permutations of alliances
    - e.g. How would we do paired with type ‘X’, against type ‘Y’ and type ‘Z’
    - What would we do if we had to play ourselves?

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Scouting

- An area that is often neglected by many teams
  - Offers a great opportunity to get a leg up on the competition
  - Excellent way to involve more students in the competition
- Crucial for two main reasons
  - Predict your opponents strategy for future matches
  - Essential for alliance picking
    - Especially crucial in getting a good second-round pick

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Advanced Scouting

- Regional results from current and past seasons
  - Match scores, awards, seedings, draft positions, eliminations results
  - Can further analyze data to find patterns
    - Least-squares scoring estimation, other custom metrics
  - High correlation between past success and future success

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Pit Scouting

- Make sure you check out every team at the event
- Start on Thursday
- Take pictures of every robot
  - Three views (get the team number in the shot)
- Things to look for
  - Functionalities
  - Type of Drivetrain
    - Number of wheels, Traction/Wheel Type, Gearing, Motors
  - Quality of Construction
- Ask questions

Match Scouting

- Watch every match
- Things to keep track of:
  - Match score
  - Points scored by each team
  - Scoring attempts and failures
  - Penalties
  - Autonomous modes
  - Starting position
  - Speed, Power
  - General strategy and tendencies
  - Drivers and human players
- Make sure you capture this data for all teams in the match

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Match Scouting

- 1 team of at least 3-6 people
- Very tiring, some people have a hard time focusing for the entire day
  - Rotate team members, allow time for ample breaks
- Forcing people to scout will result in unreliable data

Information Management

- You need a way to keep track of all the information your team collects
- Pen & Paper
  - Have standard forms for Team and Match reports
  - Fields for all the key information mentioned before
  - Easy for everyone to use
- Database
  - Very efficient way of doing things
  - Very easy to generate statistics on each team, and rank teams by various criteria
  - Requires laptops & PDAs
  - Can pose difficulties synchronizing

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Alliance Selection

- The entire process is dependent on scouting
- Make a preliminary pick list on Friday night
  - Review scouting data
  - Discuss criteria of ideal partner based on elimination strategy
  - Rank teams from 1 through ~28 based on established criteria
    - Slightly more than 24 necessary for full eliminations tournament, to allow for robot breakdowns on Saturday

Alliance Selection

- Tweak the list through Saturday's matches
- Make sure your alliance captain can keep track of which robots have been picked, and is levelheaded enough not to get flustered on the field
- Remember that the second pick can be crucial to the success of your alliance
  - Excellent teams often (usually) get missed in the first round
    - S.P.A.M. 2002, Huskie Brigade 2003

Match Strategies

- Planning and Execution
  - The most important part of the competition
  - Good strategy and scouting can allow a mediocre robot to win the majority of its matches
  - Good strategy and a good robot are an almost unbeatable combination

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Pre-Competition

- To develop a good set of strategies, you need to know what you can do
- Analyze and evaluate your robot's abilities
  - Be honest, don't under or over-estimate
  - Factor in the abilities of your drivers
- Create a playbook
  - Possible match strategies that can be run
  - Different strategies for different circumstances
    - Defensive, High Risk, Safe

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Match Plans

- Develop a plan for each match with your partners
  - Everyone must agree on the plan, or chaos will ensue on the field
- The plan should outline what each robot will do for the entire match
- Create time limits on actions. If something is taking too long, you have to move onto the next
  - Many teams lose matches because they don't abandon failed objectives

Match Plans

- Each plan should include contingencies
- Winning the match is the first priority, showcasing features is second
- Never mislead your partner about your abilities
  - If you aren't sure that you can do something, make sure they know that
- Make sure your strategies are complementary
  - Don't try to occupy the same space of the field, leave each other room

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Coaching a Match

- The role of the field coach cannot be overstated
- Drivers can only watch the robot and the immediate area
- The coach must watch the entire field, keep track of the score and the robots
- The coach should make all decisions to deviate from the initial strategy

Coaching a Match

- Must keep the drivers aware of what's going on
- The field coach must also watch the referee for warning
- Field coach also must communicate with the alliance partner's field coach
- Instructions must always be given
  - The driver will come to depend on the coach, don't leave them hanging

During a Match

- You must be able to make on the fly decisions
  - Too many teams lose matches because they behave in a very static manner
- The drivers do not have time to look up at the clock
  - The field coach should be updating the clock every 10 seconds, with a 10 second countdown at the end
- Everyone on the field must focus on the match
  - Tune out the crowd and the announcer

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During a Match

- Never lose sight of the main goal – Winning the match
- If you fall behind, don't panic, calmly re-evaluate and come up with a new plan
- Leave it all on the field
  - Give it your all, don't be afraid of damage
  - That being said, don't take overly dangerous risks
- After the Match
  - Sit down with the key team members, discuss what went right and what went wrong
  - After a couple of matches, you'll quickly discard and add strategies
  - You must adapt to the competition

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Other Tips

- Change things up
  - Teams with good scouting will notice if you do the same thing every match
- Don’t be too conservative or too risky
  - Know your abilities
  - Don’t try to do too much in a match
- Learn how long two minutes is
  - Run your practices with a timer
- Slow and steady wins the race
  - Spend 5 seconds setting up, as opposed to 30 seconds doing it over again

Preparing for the Finals

- Meet with your new alliance and discuss strategy for eliminations
- Make sure key players from all three teams know each other
- Start planning match strategy for the first round
- Be prepared for more (and more targeted) defense
- Good strategy is the only way to beat a technically much superior alliance

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Preparing for the Finals

- Be prepared to be unconventional if necessary
- Take advantage of extra planning time to come up with more effective strategies
  - It's too late to change your robot; it's not too late to change your strategies

Final Comments

- Read the rules!
- Come up with a clear, consistent strategy for how your robot will play the game
- Remember the Golden Rules
- Scouting is the easiest way to make your team more successful at competition
- The role of the coach cannot be understated
- Each FIRST match is like a high-speed game of chess: You need to have a well thought-out plan, but be prepared to counter your opponents' moves
- Have fun!

Resources

- http://www2.usfirst.org/vex/2006/2006_FVC_Robot_Design_Tips_and_Best_Practices.pdf
  - This document is intended for the FIRST Vex Challenge, but most of the same principals apply
- http://www.chiefdelphi.com
  - http://www.chiefdelphi.com/media/papers/1826
    - 2006 Scouting Database
  - http://www.chiefdelphi.com/media/papers/tags/scouting

Questions?

- kkanagas@gmail.com
  - Feel free to bug me any time. I love this stuff.

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