

Effective *FIRST* Strategies for Design and Competition

Karthik Kanagasabapathy — April 25th, 2012



Karthik Kanagasabapathy

- ▶ 15 years of *FIRST* experience
- ▶ Lead Mentor for Team 1114, 2004-present
 - ▶ 19 regional championships, 2 regional finalists
 - ▶ 2008 World Champions, 2010 World Finalists
 - ▶ 2010 Robot went undefeated in regional play!
 - ▶ 2006, 2008 - 2012 Regional Chairman's Award
- ▶ 2005 Waterloo Regional Woodie Flowers Finalist Award Winner
- ▶ Emcee for the Toronto & Waterloo Regionals
- ▶ Regional Manager, Innovation First International, Canada



Some Quotes

- ▶ *"Enthusiasm is one of the most powerful engines of success. When you do a thing, do it with all your might. Put your whole soul into it. Stamp it with your own personality. Be active, be energetic, be enthusiastic and faithful and you will accomplish your object. Nothing great was ever achieved without enthusiasm" -- R.W. Emerson*
- ▶ *"Gentlemen, we are going to relentlessly chase perfection, knowing full well we will not catch it, because nothing is perfect. But we are going to relentlessly chase it, because in the process we will catch excellence. I am not remotely interested in just being good." -- V. Lombardi*
- ▶ *"What lies before us and what lies behind us are small matters compared to what lies within us. And when we bring what is within out into the world, miracles happen" -- R.W. Emerson*
- ▶ *"Limits, like fears, are often just an illusion" – M. Jordan*



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
 - ▶ Laps (2008), Hanging off the bridge...? (2012)
- ▶ 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, own score plus double the loser's score, Coop bridge...
- ▶ Consider possible strategies
 - ▶ Leads into overall robot designs



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), Deflecting Balls? (2010)
 - ▶ 133, 134 (2011) – Why are these numbers relevant?
- ▶ 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
 - ▶ Balancing easier than scoring (2012)
 - ▶ 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)



Prioritization

- ▶ Two separate lists
 - ▶ Desired robot qualities
 - ▶ Things like speed, power, agility, centre of gravity
 - ▶ Desired robot functionality
 - ▶ The things you want your robot to be able to do
 - ▶ Shoot balls, climb bridges, traverse field
- ▶ At this point you can merge the two lists, and decide on a drive system and functionalities



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



Tradeoffs

- ▶ The key to deciding upon a design is to evaluate the tradeoffs
 - ▶ e.g. Speed vs. Power, Complexity vs. Durability, Shooting vs. Balancing (High CoG vs. Low CoG), Wide vs. Long
- ▶ 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
 - ▶ Shoot out of a claw, instead of a claw loading a shooter (Team 1114, 2008)
 - ▶ Drivetrain as power for winch (Teams 60 & 254, 2004, 254 & 1114, 2010)
 - ▶ Intake used for bridge manipulation
 - ▶ Be careful – hard to change one part without affecting the other
- ▶ When making tradeoffs, remember your initial priorities!
 - ▶ Let your strategic priorities dictate design



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 to 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



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
 - ▶ Gained popularity this year, known as “OPR”
 - ▶ High correlation between past success and future success

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OPR

▶ Calculated Contribution / OPR

- ▶ How can I know how well a team has performed without watching their matches?
- ▶ Could look at average score, but that only tells part of the story
- ▶ Let each team's contribution be represented by a variable
- ▶ For each alliance, let $t_i + t_j + t_k = s$, where s is the amount of points scored by the alliance
- ▶ Solve the matrix
- ▶ Now you have calculated the average contribution of each team throughout the regional
- ▶ How valuable is this data?
 - ▶ Depends on the game!!!



OPR in 2012

▶ It's Awful

▶ Using raw match scores

- ▶ Includes penalty points incurred by opponents

- ▶ Doesn't include the coop bridge

- ▶ Because the coop bridge is so valuable, good teams spend less time scoring, more time achieving a goal with no score value

▶ Adding in a factor based on coop %

- ▶ A low factor hurts good teams, a high factor favours bad teams (good teams coop sooner)

▶ Regional Variance

- ▶ Defense is very hard in 2012, so effective D is only seen at stronger regionals, lowering OPR at those events



OPR in 2012

▶ It's Awful

▶ Ball shortages

▶ With balls being in limited supply, alliance scores actually decrease when you reach a certain threshold of scoring on the alliance

▶ Similarly, 3 scorers on one alliance can cause chaos and confusion

▶ In both these cases, OPR decreases at high level regionals

▶ Still useful

▶ If you're not at event, it's a decent predictor, however, things like standings, teleop score and hybrid might be better

▶ Why is there an OPR obsession?

▶ Baaaaaaa



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
 - ▶ General strategy and tendencies
 - ▶ Drivers and human players
 - ▶ How fast do they react after autonomous...
- ▶ Make sure you capture this data for all teams in the match



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
- ▶ Make it fun!
 - ▶ A team with a culture that respects scouting will result in better scouts
 - ▶ Sim Bucks!



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 & tablets
 - ▶ Can pose difficulties synchronizing



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
- ▶ The “Do Not Pick List”
 - ▶ Should you have one or is it excessive?



Alliance Selection

- ▶ Tweak the list through Saturday's matches
- ▶ Make sure your alliance captain 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
- ▶ To break up alliance or not to break up alliances? (Galileo 2011)
- ▶ Strategies should be different based on selection point



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

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Match Plans

- ▶ Each plan should include contingencies
- ▶ Winning the match is the first priority, showcasing features is second
 - ▶ Not playing to win is no different than throwing a match
 - ▶ Throwing matches is UNACCEPTABLE
- ▶ Never mislead your partner about your abilities
 - ▶ Can't 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



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

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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

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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



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



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

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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

- ▶ www.simbotics.org/workshops
- ▶ www.simbotics.org/scouting
- ▶ www.simbotics.org/app
- ▶ www.simbotics.org/kitbot

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Questions?

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 - ▶ Feel free to bug me any time. I love this stuff.

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