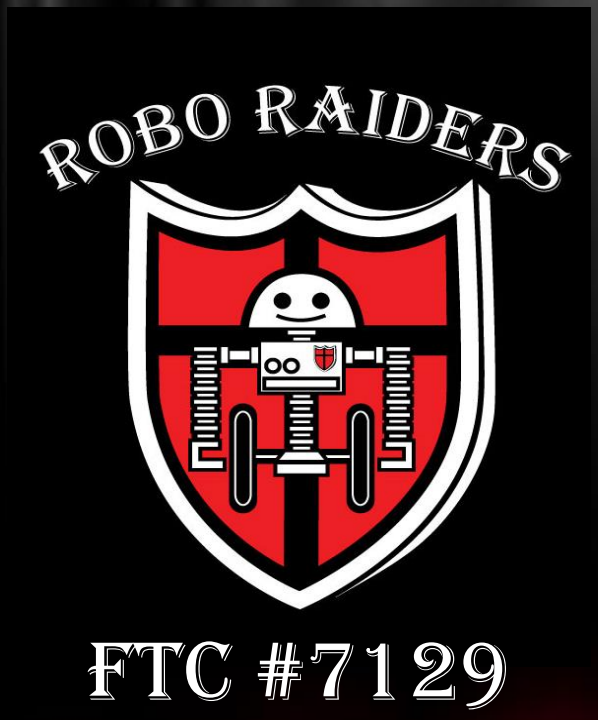
Engineering Design Process Applied to FTC And Our Building Strategy



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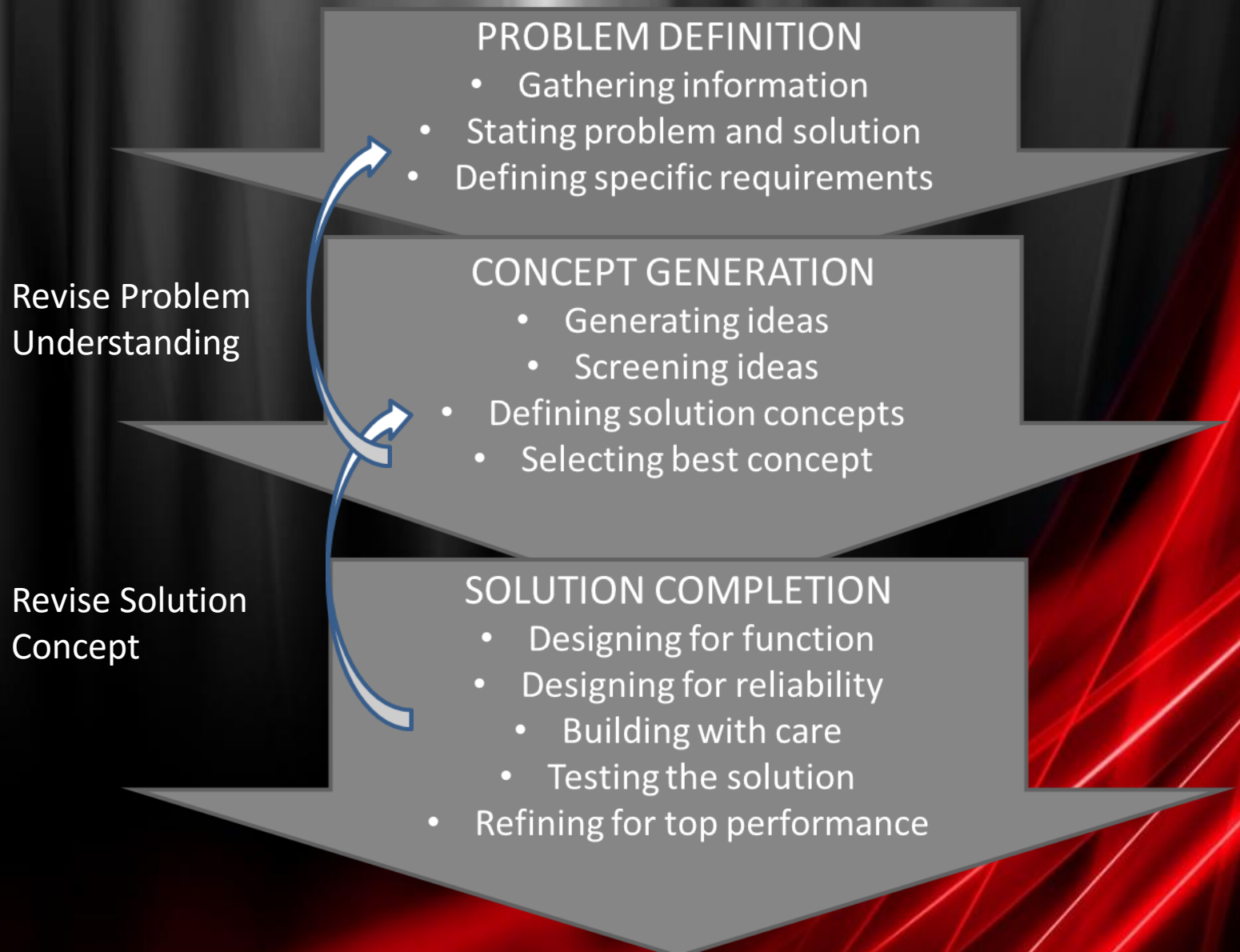
Design Process



Problem Definition

- Read the Game Manual!
  - *Includes valuable information regarding the game challenge*
- Define the problem using the Game Manual.
- Create criteria that your robot must fulfill.
  - *Consider things such as speed of scoring, success rate, robot speed, weight, etc.*
  - *Criteria need to be Specific, Measurable, Attainable, Relevant, and Time-Bound (S.M.A.R.T.).*

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Concept Generation

- Research mechanisms already used for the type of task.
  - *Scoop for block party*
  - *All terrain drivetrains*
- Brainstorm!
  - *Get as many ideas on the table as possible.*
  - *Some ideas that sound crazy at first can morph into something really good.*

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Selecting Your Concepts

- Don’t just pick an idea and run with it.
  - *You need to know that your concept will work well and be effective.*
- Prototype
  - *Cardboard, Tetrix, Lego, etc.*
- Decide using a decision matrix.
  - *Ensures that you have a rationale for your concept*
  - *Makes you think through the strengths and weaknesses of an idea*

Example Decision Matrix

Criteria:	Weight: (1-3)	Holonomic	Mechanum	Skid Steer	Tank tread
Maneuverability	2	5	4	3	3
Traction	3	2	3	4	5
Programming Accuracy	1	2	2	5	5
Durability	3	3	4	5	4
Speed	2	3	4	5	1
Total:		33	39	48	40

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Building the First Iteration

- System Envelope
  - *Sketch one out on paper (preferably in your Notebook).*
  - *Consider the location of your battery, phone, other electronics, drivetrain, actuators, etc.*
- Initial CAD
- Refine CAD
  - *Look over the CAD from before, and find ways to improve your design. Are the motors easy to get to? Can you change out the battery quickly?*

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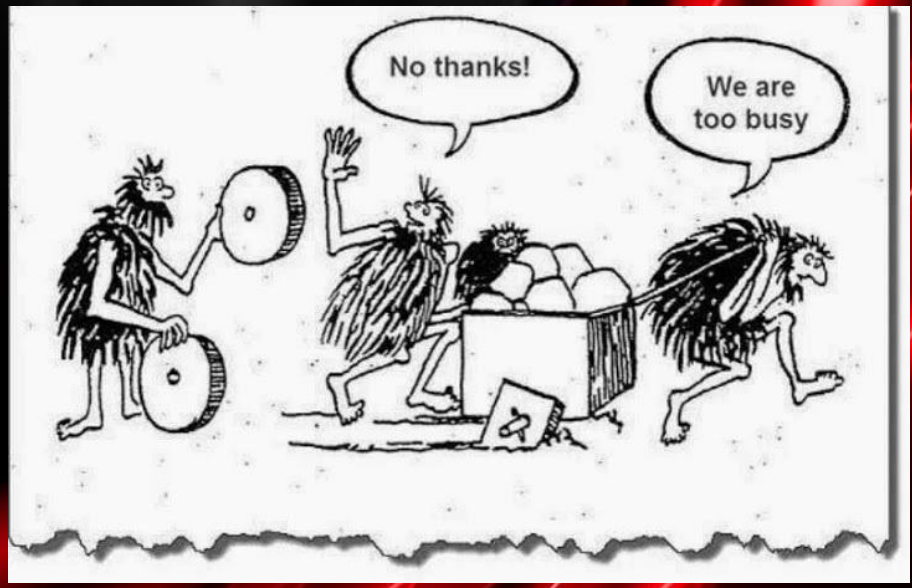
Building the First Iteration

- Design Review
  - *Look at how your design compares to your criteria.*
  - *Check to make sure everything makes sense and will work together well.*



- Build it!
  - *Use your CAD.*

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Testing and Refinement

- Test, test, test, test, test…
  - *When testing, be sure to record your data.*
  - *Which parts fail the most often and affect your performance the most?*
  - *We test in Tens.*
- Test everything!
  - *Autonomous, tele-op scoring, individual functions*
- Refine

Things to Remember

- The Design Process can be used in many ways.
  - *Designing robots, deciding on a notebook template, and structuring your team*
- Don’t be afraid to make changes.
  - *Test your new solution before you replace the old one.*
- Remember the end goal.
  - *Winning competitions is great, but it isn’t what matters.*
  - *Who wouldn’t want to do something like FTC for a living?*

Strategic Design

- Creating a cool robot is super fun!
  - *Creating a cool robot that does well in competition is even more fun*
- Does your team have an aim for your robot this year?
  - *If you want to hit a target, you have to know what you are aiming at. -Someone*

Strategic Design

- 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 you and your partner*

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Cost-Benefit Analysis

- For each task you must compare the difficulty of accomplishment to the reward for doing so
  - *Little balls VS big balls last year*
- 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)

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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 Rules

- 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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Other Tips on Strategy

- 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
  - *No one picked up small balls last year.*

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Other Tips on Strategy

- 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???

Things We Have Learned

- Consistency is key!
  - *80 points all the time is better than 100 points half the time.*
- K.I.S.S. (Keep It Super Simple)

Things We Have Learned

- CAD before you build.
  - *By following the design process, you can greatly improve your designs.*
- Frontload work
  - *Put in the extra time first. Then you won't be scrambling right before competition.*
- A good autonomous is essential.
  - *20 points is better than no points.*
  - *Leave time for programming the autonomous before competition.*

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Questions?

- These slides will be on our website in "Resources."

Find us on Facebook at Robo Raiders 7129

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