



Design Process and Build Strategy

*Show yourself in all respects to be a model of good works, and
in your teaching show integrity, dignity, and sound speech that
cannot be condemned.*

Titus 2:7-8a

Robo Raiders FTC 7129

*INSERT
BOBO
HERE*

Design Process Steps

Each step to be revisited throughout the process so that your robot is continually improving along with design reviews at major development points.

1. **Defining Needs** *Define what the solution needs to do (functionality)*
2. **Generating Ideas** *Identify ideas for ways to perform essential functions*
3. **Screening Ideas** *Select best ideas with greatest potential to meet needs*
4. **Selecting a Concept** *Pick a set of ideas that work best to meet needs*
5. **Prototyping Solutions** *Model crucial parts of design to aid learning*
6. **Specifying Requirements** *Set targets or limits for the final solution*
7. **Detailing the Design** *Select/detail components to meet requirements*
8. **Evaluating Solution** *Evaluate fulfillment of design requirements*
9. **Iterating to Improve** *Repeat steps, refine design to improve performance*

Defining Needs

- Read the Game Manual!
 - *Includes valuable information regarding the game challenge*
- Define the problem your robot needs to solve
- Create criteria your robot needs to fulfill as it solves the problem
 - Consider things such as speed of scoring, success rate, robot speed, weight, etc.
 - Create specific requirements for the different subsystems of your robot (collection, delivery, etc.)
 - Criteria needs to be Specific, Measurable, Attainable, Relevant, and Time-bound (S.M.A.R.T.)



Generating Ideas

- Research mechanisms already used for that type of task
 - Take ideas that already exist in real-world situations and adjust them to fit your purpose
- Brainstorm!
 - Get as many ideas out as possible
 - Some ideas that may seem bad at first can lead to really good ideas
 - Make sure everyone has a chance to share their thoughts -- no judging if the ideas seem bad!

Screening, Selecting, and Prototyping

Don't just pick a concept and run with it, you need to make sure it will work

- Prototype (cardboard, Tetrix, legos, etc.)
 - Test under varied conditions and scenarios
 - Reality check to see if your initial idea is feasible
- Decide using a decision matrix
 - Ensures that you have rationale for your concept
 - Makes you think through strengths and weaknesses of your idea
- Combine different system ideas into a full robot concept
 - See how different system ideas work together
 - Figure out which concepts won't be effective
 - Gives you an idea of how it all fits together
- Make a list of criteria to weigh your ideas and concepts against

Example Decision Matrix

Designs	Speed	Steadiness	Durability	Weight	Simple	Size of Driving Mechanism	Vertical Accuracy	Ease of Maintenance	Wiring Ease	Size when folded	
Weight	3	3	3	3	2	2	2	3	2	2	
Misumi Slides	9	3	3	3	3	9	9	1	3	9	123
REV Extrusion	3	3	3	3	3	9	9	1	3	3	93
Double Scissor Lift	3	3	3	1	9	1	3	3	9	1	85
D.A.S.L.	3	3	3	1	9	1	3	3	9	1	85

CAD

CAD **before** you build--makes life way easier later!

- System Envelope
 - Space allocations for each system to make sure different mechanisms all fit together
 - Consider the location of your battery, phone, electronics, and each subsystem
- Create initial CAD for each system
 - Build each system separately to fit within their space allocations
 - Try to have them mostly CADed before combining them with the other systems
- Refine CAD
 - Integrate each system together into the full robot
 - *Tweak issues that come up*
 - Find ways to improve all your systems
 - *Are all the motors easy to get to?*
 - *Is everything easy to maintenance?*
 - *Can you change out the battery quickly?*
- Review CAD and make sure there are no problems before you build

Building

- Before building, have someone (a STEM professional, or a mentor, or an alumni) look over your CAD and help you see any potential problems that you might have missed.
- Be absolutely sure you've ironed out all your problems before you build so you can avoid having to do a last-minute redesign.
 - Look at how your design compares to your criteria
 - Check to make sure everything works together well
- Build it!
- Use your CAD as your "instruction manual" as you build
 - Keeps you from making mistakes
 - Problems that arise can be fixed by using the CAD as a reference

Testing

Test **everything!**

- Make sure you record your data.
 - Put it in the notebook!
- Use test data to find problems in your design and fine-tune mechanisms.
- Don't just test randomly, but have questions you're working to answer.
 - Which mechanisms fail the most often?
 - Which mechanisms have issues that affect your performance the most?
- Test everything multiple times.
 - The more you test, the better your data is.
 - We test everything at least ten times.

Strategic Design and Cost-Benefit

- Make sure you have an aim for what it is you want your robot to accomplish. You can't aim properly if you don't have a target.
 - A clear goal is doing the best you can in competition.
 - Other secondary objectives are aesthetics, design elegance, cool factor, etc.
- Beware of the “cool factor”.
 - Sacrificing effectiveness for coolness hurts your robot and your alliance partner
 - Your focus should be on building an effective robot. The “cool factor” should be secondary.
- For each task you want to complete, you must compare the difficulty of accomplishing the task to the reward for doing so.
- 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)

Golden Rules

- Always build within your team's limits
 - Evaluate your abilities and resources honestly and realistically.
 - Limits are defined by manpower, budget, experience, etc.
 - *Avoid building unnecessarily complex functions.*
 - As you get more experienced, start looking for things that might be more difficult but ultimately more effective.
- It's better to have a few systems that work really well and consistently rather than have a lot of systems that work half-ways decently.

Tips

- Strategic analysis is a MUST.
 - There's a tendency to skip this stage, but it's a really important stage to include in your process.
 - You have to know what you want to do before you can start figuring out how to do it.
 - Be realistic when evaluating strategies.
- .
- Try to identify the different types of robots that will exist.
 - Go through different permutations of alliances and try and figure out how you would do when paired with different types of robots.
- Consistency is key!
- Don't go the over-complex route.
 - K.I.S.S. (Keep It Simple, Silly)
- Frontload work. Having extra time at the end means you won't be scrambling right before competition.
- A good autonomous is essential.

Need Help?

Feel free to contact us with any questions you have about this resource or if there's anything we can help you with!

We often video chat with teams who need help or want to exchange ideas; we'd love to connect with you!

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