Team 5826 Design Team Handbook

Image Credit – Vex Robotics

Everyone on the design team will get a notebook. Do all your work on this process in the notebook. Any thoughts about design or strategy should be written down.

Timeline – Goals and Tasks

Reveal Day – 5826 full team discussion analyzing the game and strategies to play it. There can be some analysis of robot design, as well, but the focus should be on understanding the game and figuring out the best ways to play it.

Week 1

Monday – Design team only - Continue game analysis and look at what is easy/hard vs benefits. Start setting priorities and listing trade-offs.

Tuesday – Continue on game analysis, setting priorities and discussing trade-offs. Use these to begin robot design

Thursday – Finish up basic robot design, start defining mechanism concepts. Possibly pass off some mechanism concepts to prototype team.

Saturday – Continue to work on mechanism concepts, including design criteria for prototyping. You can break into smaller teams to work on different mechanisms. Communicate and work with the prototype team.

Week 2

Monday, Tuesday, Thursday – Mechanism concepts should be defined. Concept prototyping and parameter evaluation prototyping should be in full swing. If any mechanism is not meeting their goals start looking at possible changes to the designs. Design should be locked down by Thursday.

Define

Game Analysis –

Deliverable: Strategic game plan

Watch the reveal video a few times and use the game manual to fill in missing details. Take notes in your design notebook. Key takeaways from your analysis should include:

- What are the ways to score and different point values for each?
- Where and how can game pieces be acquired?
- How and where can defense be played?
- How are ranking points earned?
- Examine the field layout
    - pinch points

    - high/low traffic areas
    - obstacles
    - safe zones
- What are the physical restraints for the robot at start and during a match?

Once you have a basic understanding of the game, then start looking for effective strategies to play the game. The goal here is to figure out what you want the robot to do, not necessarily how.

It's important to look at what aspects of the game are hard to do and what aspects are easy to do. Does it make sense to perform the hard tasks? How much longer will they take to perform? Will failure rate increase? What are the benefits (how many extra points or ranking points)?

Design Team Brainstorming Sessions –

Step One: Set Your Priorities

Deliverables: Priority lists

The design team should meet and discuss strategies to play the game. Some discussion can also be around functionality and subsystems required for various strategies. Once you have defined how you want to play the game, then make two ranked lists. One for robot qualities (speed, center of gravity, frame dimensions, etc) and another for robot functionality and tasks it should be able to perform. These two lists will be the basis of our design process. Higher ranked items will be given priority over lower ranked items for the remainder of the design and build process.

As an example, functionality priorities will look something like this –

1. Drivetrain
2. Game piece acquisition (Floor? Station?)
3. Scoring type 1
4. ???
5. ???

Step Two: List Trade-offs

Deliverables: Documentation of trade-off decisions and basic robot design

Start thinking about and discussing the robot's features and architecture. There are a lot of decisions that need to be made. Make a list of these trade-offs. Using the 2024 game as an example, trap or no trap, over or under the bumper intake, etc. These decisions will, of course, drive our final design so give them careful thought.

Important trade-off considerations:

- Try to use proven solutions and/or features 5826 has experience with
- Simplicity
- Reliability – how often will a mechanism fail to perform its task
- Ruggedness – can it take a hit (or 100)
- Minimize moving parts that lead to complex feedback systems
- Cycle time is king, how long will each task take to perform
- Autonomous compatibility

From here, use the priorities and trade-off decisions to make a rough robot design. A key component of this design step is to remember that **you don't have to do everything, but the things you choose to do, you must do well**. The priorities and trade-offs should guide you.

Step Three: Define and design your mechanisms

Deliverables: Concepts for each mechanism and associated criteria

Now we know what we want to do, but not necessarily how to do it. Start defining your different mechanisms by what it needs to be able to do. Also set quantifiable criteria values for each mechanism that can be used to determine its efficacy (how fast, how accurate, etc). A key part of this is researching what teams have done in the past and looking at off the shelf solutions. Try to come up with at least two design ideas for each mechanism.

Using a design matrix will help to evaluate competing ideas. The trade-off considerations are also valid here in evaluating your design. You can modify it for different mechanisms, changing weights, and adding or removing design criteria. The matrix shouldn't make the decision for you, but it is a good data point.

Here's an example:

Criteria	Cycle time	Reliability	Simplicity	Auto	Score
Weight %	30	35	25	10	
Design 1	6	9	7	8	7.5
Design 2	8	7	9	8	7.9
Design 3	9	5	6	10	7

Give some thought to the possibility of adding in lower priority functionality if schedule allows or between competitions. Could mechanisms be modified or new ones added without affecting higher priority functions. Consider geometry and weight concerns for later additions. Higher priority functionality must not be sacrificed.

Prototyping –

Concept Prototyping

Deliverables: Quantifiable, documented analysis of mechanism concepts

The goal of concept prototyping is to determine the efficacy of a mechanism concept and compare it to a different concept. Which one works better for what we are trying to accomplish. Prototyping should be done quickly and using any type of material that can adequately simulate the mechanism. Use the criteria you set for the mechanism and document results in your notebook. It may take a few iterations on a prototype to get it right.

Parameter Evaluation Prototyping

Deliverables: Mechanism prototypes that meet design criteria

Once you've decided on a mechanism, some tweaking may be required to make it optimal. You may be experimenting with different materials or geometries or speeds or gear ratios. Continue to evaluate the mechanism against the criteria. The best practice is to only change one aspect between each test. Document results and changes that were made.