FIRST

Our Future:
Built Better Together

Game Design Challenge Activities

1   Getting Started

Developing a *FIRST* Robotics Competition game is a new challenge for teams. To help educate teams about the process, get started, and get over roadblocks, members from the Game Design Team put together Activities for teams. These Activities are entirely optional and do not act as a step-by-step process, they do not have to be completed in any particular order. Completion of the Activities is not part of the judging process.

2   Activities Overview

Activity	Page #	Total Time for Activity	Description
Hats and Glasses	5	Variable depending on team size, likely 30 minutes	This activity helps a team understand the differences between members' roles and their perspective and how to communicate with teammates.
Think Like a Game Designer	7	~ 20 to 30+ minutes	This activity helps learn about thinking in a non-linear process and comparing your thoughts with those of your teammates.
Speak Like a Game Designer	9	~ 40 minutes	This activity helps teams learn common *FIRST* Robotics Competition Game Design lingo. These words may be used differently outside of game design, but this activity may help keep your team on the same page.
What Makes a Game "Good?"	13	~ 20 minutes	This activity is designed to help your team learn the desired qualities in a game to aid in the development of your game.
Discussion Prompts	15	Variable	This activity is a list of discussion prompts to help facilitate discussion.
***FIRST* Games – Staff Picks**	17	~ 10 minutes	This activity highlights top picks of previous *FIRST* games from *FIRST* Staff. It can be completed by individuals or as a full team.
***FIRST* Game Design Insights**	19	Variable	This activity provides insight into one way the *FIRST* Robotics Competition Game

FIRST is a global robotics community that prepares young people for the future.

Activity	Page #	Total Time for Activity	Description
			Designers go about evolving a game element from concept to final design.
The Power of Storytelling	21	Variable	This activity explains the power and purpose of incorporating story elements into a *FIRST* Robotics Competition game.
Developing a Game Using a Specific Idea	25	~ 15 min+ per question	This activity is designed to help teams who have a specific idea for a game piece, game mechanic, robot action, or human player action, but are not sure how to move forward.
Converging	27	See section for details.	This activity provides techniques for developing ideas generated by brainstorming and then converging on an idea with which to move forward.
Engineering Design Process	31	Variable	This activity describes how to use the Engineering Design Process (EDP) to design field elements for your game.
Thinking Strategically	35	~20-60 minutes	This activity helps guide a review of the game to look for issues or areas for improvement.
External Feedback	39	Variable – 1 day to 2 weeks, depending on the amount of material for review and availability of reviewers.	This activity describes a process for soliciting feedback and input from those outside your design team.

3   Presentation of Content

Each activity module contains the following elements:

- **Activity Summary:** an overview of the activity and its purpose.
    - o   Time: the amount of time an activity will likely take
    - o   Materials: the list of materials needed, if any
- **Introduction** – a brief description of the activity.
- **This Activity Will Help With…** – information about how the activity will help with the game design process.
- **Team Actions** – an overview of team actions and where to find additional resources for the activity.

4   *FIRST* Core Values

As you go through your activities, teams are encouraged to remember the *FIRST* Core Values, and think about how they can be applied to their team:

- Discovery: We explore new skills and ideas.
- Innovation: We use creativity and persistence to solve problems.
- Impact: We apply what we learn to improve our world.
- Inclusion: We respect each other and embrace our differences.
- Teamwork: We are stronger when we work together.
- Fun: We enjoy and celebrate what we do!

5   Hats and Glasses

5.1   Activity Summary

This activity helps a team understand the differences between members' roles and their perspective and how to communicate with teammates.

Variable depending on team size, likely 30 minutes

□ *Activity Overview video*
□ *Hats and Glasses slide deck*

5.2   Introduction

Hats and Glasses provides a platform for team members to explain the roles for which they feel responsible, the different perspectives that shape their opinions, and a team setting dynamic they don't like. A diverse group of contributors is important because it allows for different perspectives and experiences to help shape games and *FIRST* overall!

Hats & Glasses is used to better understand what individuals feel responsible for and what experiences shape their opinions. We recommend all team members (students & mentors) partake in this activity.

5.3   This Activity Will Help With…

- …identifying your characteristics and listening to teammate characteristics.
- …explaining roles for which you are responsible on the team.
- …analyzing how each team member contributes to team dynamics and success.

5.4   Team Actions

1. Watch *FIRST* Robotics Competition Game Designer Kelly Carlson explain the activity and provide examples.
2. Review slide deck about hats, glasses, and sunglasses.
3. As a team, generate team ground rules for this activity.
   a. See examples on slides 4 and 5.
4. Complete your individual hats and glasses brainstorming
   a. Examples shown below.
5. Each member shares their hats, glasses, and sunglasses

5.5 Hats and Glasses Worksheet

Ground Rules: Generating Content	Ground Rules: Sharing Content

Hats: Role(s) on your team
 	
Some examples are:
 	
   • Team Captain/President/CEO
   • Lead Mentor
   • Outreach Mentor
   • Scout
   • Award Submitter
   • Electrical Team Member
   • Programmer
   • Spirit Captain
	My Hat(s):

Glasses: Life experiences
 	
Some examples are:
 	
   • Work experiences
   • Hobby experiences
   • Education (including specific classes)
   • Personal life (being a sibling, parent, spouse, etc.)
	My Glasses:

Sunglasses: Dynamics you dislike
 	
Some examples are:
 	
   • When people raise their voice
   • When someone says they will do something, but they don't do it
   • When people are late
	My Sunglasses (only 1):

6   Think Like a Game Designer

6.1   Activity Summary

This activity helps learn about thinking in a non-linear process and comparing your thoughts with those of your teammates.

~ 20 to 30+ minutes

□ Access to watch video
□ Ability to have group discussions
□ Items to complete chosen tasks

6.2   Introduction

Working as a team on a design process requires everyone to have a general understanding that the process is iterative. The path to a good design is rarely linear from concept to finished product. Ideas, concepts, and requirements often change during the journey and are tested, reviewed, updated, and sometimes even discarded. This is called iteration and is a very helpful and normal part of engineering and design. Iteration allows progress toward a better solution, and sometimes one or two steps backwards moves the overall process forward because they may provide insight in to previously overlooked or unprioritized aspects of the problem.

Iteration and the Engineering Design Process apply to elements beyond designing physical elements. They can be applied to the execution of any idea, including the way you communicate, organize, and implement ideas.

6.3   This Activity Will Help With…

…identifying examples of things on which your team has iterated and how the process has improved the outcome.

6.4   Team Actions

1. Watch this video about iteration.
    a. Video is 00:01:43 long. Ann Mei Chang, former Chief Innovation Officer at USAID, talks about the iteration process and its nonlinear nature.
    b. Additional video suggestions: see one process in action through the design of a digital set (00:23:06) or the Engineering Design Process through a taco party!
2. Conduct discussion on the iteration video(s)
3. Complete the 'It's all in the Details' activity

6.5   Iteration Video Discussion Questions

1. What are some scenarios where you have iterated?
2. How have you iterated on your…
    a. robot?
    b. Chairman's Award?
    c. layout of your physical meeting/ build space?
    d. team shirt design?

3. What can we do individually vs a small group vs whole team in this process?
4. How has failing through iteration helped us understand more about the problem?

To see how *FIRST* Game Designers, go through the process, see the *FIRST* Game Design Insights Activity.

6.6 'It's all in the Details' Activity

This can be done in partners or small groups. In a small group setting, Persons A and B may be more than one person.

Person A is the instructor and picks an activity or simple task (depending on the setting and available resources, examples include draw a star, fold simple origami, start a car, make a sandwich, etc.) and describes it to Person B. Person B must follow the directions exactly, without inferring or assuming anything.

Person A most likely needs to revise or iterate their instructions to complete the desired activity as they visualize it.

Examples of activities include making a sandwich, directions from point A to point B, brushing teeth, or a physical exercise.

6.6.1 Activity Discussion Topics

1. What assumptions did the instructor make?
2. At what points did the same words or phrases mean different things to the two participants?
3. Why did those words or phrases mean different things to the two people?
4. What iterations worked in getting the two participants on the same page?

7   Speak Like a Game Designer

7.1   Activity Summary

This activity helps teams learn common *FIRST* Robotics Competition Game Design lingo. These words may be used differently outside of game design, but this activity may help keep your team on the same page.

~ 40 minutes

□ *Glossary table*
□ *Worksheet*

7.2   Introduction

Working as a team on a design process requires everyone to have a general understanding of the vocabulary used in discussions.

7.3   This Activity Will Help With…

…understanding terms used in *FIRST* Robotics Competition Game Design.

7.4   Team Actions

1.   Review the Vocabulary.
     a.   Terms are used when developing a game and may not match the exact wording found in the Game manual.
2.   Complete the What's Your Analogy activity.
3.   Solve the Crossword Puzzle.

7.5   Vocabulary

Term	Definition
8-ball	a term used to describe a scenario in which as a competitor gains advantage, their adversary has more or easier opportunity to perform. It's an analogy to two pool players playing 8-ball; as one competitor clears their balls from the table, their adversary has cleaner shots for their balls still remaining.
alliance	a cooperative of typically three *FIRST* Robotics Competition teams and a backup team, as needed
audience engagement	A metric for discussing qualities of a game that capture the attention of the audience
autonomous	gameplay not under remote control
box bot	a robot that is just a drive train

Term	Definition
driver	an operator and controller of the robot
feels bad	an action or result in which may leave a team feeling unaccomplished or embarrassed
field element	a fundamental game item located on the field
game design team	a group of game designers
game designer	a person on the team that constructs the story of the match
game mechanic	an action that causes game play
game overview	a brief summary that describes the story of a match
game piece	an object that the field and robot may interact with; typically used for scoring points
game play	story of the match
human player	a student that supports game play
looks easy is hard	an action that to the audience appears easy, but is actually difficult to do (could lead to embarrassment or negative perception)
looks hard is easy	an action that to the audience appears hard, but is easy to accomplish (could lead to feelings of accomplishment or positive perception)
manual	a document that guides teams through the game, rules and other relevant info
movie in my/your head	phrase used to reference the content that a person visualizes internally
robot	an electromechanical assembly that participates in the game
robot action	robot movements that play the game
strategy	considerations and choices made in a game
teleoperated	a period that robots run with driver control
visual impact	the imagery of the field including static visuals and/or robot actions playing out on a field
what we celebrate	actions or design choices that game designers want to encourage, may also deserve some sort of return or reward such as points or a ranking point

7.6 'What's Your Analogy?' Activity

Using the terms above students can compare a game design to another activity in their life. Example topics to explore include cooking or sports.

7.6.1 Example: Music

The <u>robots</u> are the instruments, an <u>alliance</u> is an orchestra, a <u>game piece</u> is a musical note. If the <u>game</u> play is a musical performance then a <u>game mechanic</u> is like a movement, whereas to complete the musical composition or <u>game play</u>, the movements are played in succession. A <u>field element</u> is like a musical element of rhythm or melody, fundamental to the music.

8   What Makes a Game "Good?"

8.1   Activity Summary

This activity is designed to help your team learn the desired qualities in a game to aid in the development of your game.

~ 20 minutes

□ *Criteria list*
□ *Sticky notes or Virtual Whiteboard*
   (if choosing second option)

8.2   Introduction

FIRST Robotics Competition Game Designers measure game concepts against a set of criteria developed over years of game design (and feedback!) to make sure the game tracks with features that make a game "good." This is like comparing a job candidate's skills against the requirements needed for the position and their fit with the organization's culture.

8.3   This Activity Will Help With…

…identifying criteria and characteristics that are desirable in a *FIRST* Robotics Competition game.

8.4   Team Actions

1. Review the criteria.
2. Conduct the Interview a Game activity.
3. Complete group comparison.
4. Virtual whiteboard or sticky notes may be used to aid this activity

8.5   Review the Criteria

This work can be done as an individual or as a team activity. These criteria are recommended in addition to the considerations listed in Section 3.3 of the At Home Challenges Manual. "Good" game designs have the following attributes:

- are fun and exciting for the audience and teams
- game play is biased towards rewarding positive actions/behavior
- have no obvious solution (encourages diversity among robot designs and play strategies)
- encourage *Gracious Professionalism®* between alliances and teamwork within an alliance
    o difficult for a robot to win a match on its own
    o little incentive for robots to ram each other
- are accessible to:
    o a broad range of people (teams and audience)
        ▪ physical capabilities
        ▪ culturally appropriate
    o a broad range of teams
        ▪ can reasonably practice at a wide range of team meeting locations
        ▪ challenging for teams and robots with a wide variety of capabilities

- simple robots can earn points (i.e. low floor)
- high performing robots can show their full capabilities (i.e. high ceiling)
- incorporate new & different things than have not been seen before or use existing elements in new & exciting ways
- minimize costs and maximize efficient of use of materials
  - consider and re-use [evergreen field elements](#) where appropriate (side borders, truss, etc.)

8.6 'Interview a Game' Activity

- Each student is assigned a game to review and with which to become familiar.
- Students are paired or break into small groups.
- One student is the interviewer, the other students represent the game.
- The game can be a game idea the team has or a past *FIRST* Robotics Competition game.
- The interviewer asks questions on why that game should be considered for the job, or why that game is good.
- Once the first round of interviews is complete, switch roles and repeat.

8.6.1 Example

Interviewer: INFINITE RECHARGE^{SM}, how are you accessible to a broad range of teams?

Interviewee: Difficulty levels for teams may be assessed by determining if the action requires an active mechanism or not. There are multiple options for scoring the power cells. Robots can receive power cells from the loading station at a height slightly higher than the opening of the low goal to score them in that goal. This does not require an active mechanism. Robots can also use those same power cells and shoot them into the inner or outer port; this action requires an active mechanism.

8.7 Group Comparison

List game games on an interactive white board or with sticky notes, and ask students to add sticky notes of criteria each game meets.

8.7.1 Example

INFINITE RECHARGE

Accessible?

Robots can score power cells with an active or passive mechanism.
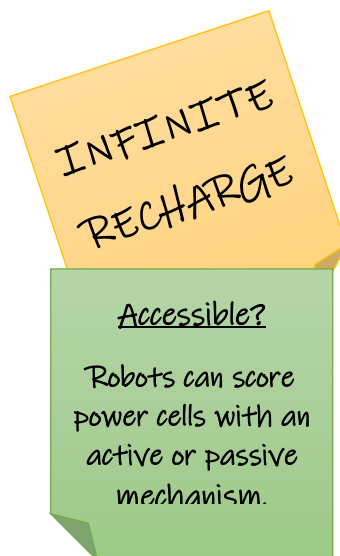
9   Discussion Prompts

9.1   Activity Summary

This activity is a list of discussion prompts to help facilitate discussion.

Variable   □ *None*

9.2   Introduction

If your team needs some help getting the conversation going, please use the suggested prompts below.

9.3   This Activity Will Help With…

…continuing conversations related to game design concepts to the team.

9.4   Team Actions

1. Review Questions and choose which ones to discuss.

9.5   Questions

9.5.1   Game Pieces

1. What makes a good game piece? (Or what do you want to see in a game piece?) Think about things like:
    a. Are there different ways a robot can interact with it?
    b. What are the different ways it can be picked up?
    c. Is the game piece durable?
2. Game piece brainstorming – where can you get game piece inspiration from? Think about the prompts below and try to name an item for each category
    a. Think about what you might find in a sporting store
    b. Take inspiration from household items - hinges, ramps, handrails, Pez® dispensers, etc.
    c. Consider different types of dog toys
    d. Think about video games, birthday party games, board games, etc.
3. Are there new ways to use previous game pieces?
4. What objects have never been used? Can they be used in similar ways as other *FIRST* Robotics Competition games or completely new ways?

9.5.2   Robots

1. What are different things robots can do?
2. Consider looking at videos from past games on the *FIRST* Robotics Competition YouTube® channel
3. Think of actions robots have done in the past. Is there a way to upgrade those actions?
4. What is something you would love to see a robot do in a game?
5. Think sports, playground games, industry, etc.
6. Can human movement be translated to robot interaction with the field/game piece?

9.5.3 Field & Gameplay

1. What are three types of game play ideas for game mechanics you're considering?
    a. Examples of game mechanics: pick and place, human player involvement
2. What are some of your team's favorite games (video, board games, etc.) to play? How can this be translated into a *FIRST* Robotics Competition game?
3. What is the theme or story from a game that you like?
4. Think about places that you might visit, like gyms, amusement parks, nature, etc. What sort of things do you see here that could be translated into a game?

10 *FIRST* Games – Staff Picks

10.1 Activity Summary

This activity highlights top picks of previous *FIRST* games from *FIRST* Staff. It can be completed by individuals or as a full team.

~ *10 minutes*   *□ None*

10.2 Introduction

FIRST has produced a lot of games over the years. These are some of our favorite game dynamics as chosen by *FIRST* HQ staff!

10.3 This Activity Will Help With…

…familiarizing yourself with past *FIRST* games and game elements.

10.4 Team Actions

1. View *FIRST* Games – Staff Picks slide deck.
2. Check out other *FIRST* Robotics Competition games.

11   *FIRST* Game Design Insights

11.1 Activity Summary

This activity provides insight into one way the *FIRST* Robotics Competition Game Designers go about evolving a game element from concept to final design.

Variable

□ *The provided worksheet (physically or virtually)*

11.2 Introduction

Field elements within a *FIRST* Robotics Competition game can be derived from a set of desired robot actions that are inspired by the overall story or theme of the game.

- A robot spinning the control panel in INFINITE RECHARGE^{SM} is meant to mimic the data ports and door locks that R2-D2 manipulates throughout the *Star Wars* movies.
- Climbing the scale in POWER UP^{SM} simulates the action within the video game of the alliances working together to reach and defeat the boss in order to escape.

The *HQ Game Design Insights* video takes you behinds the scenes to understand the evolution of the shield generator from its initial concepts to final design characteristics.

11.3 This Activity Will Help With…

- …developing a story or theme for your game.
- …developing robot actions related to your story or theme.
- …determining how robots can interact with theme-specific field elements.

11.4 Team Actions

1. Watch *FIRST* Robotics Competition Game Designer Matt Pilotte explain *FIRST* Robotics Competition game design insights.
2. Complete the Story Elements Can Inspire Field Elements worksheet.

11.5 Story Elements Can Inspire Field Elements

What are some elements of your game that are inspired by its story or theme?

Field elements that mimic actions or concepts from your story help to engage the audience and create an easy to understand way to describe both the game and the robot actions (robots playing basketball or frisbee, storming a castle, or participating in an airship race).

What robot actions or field elements are related to the story?

```



```

Share your thoughts about your favorite action or elements with your team!

Field elements generally are used as challenges for a team and their robot. They are both fun to do and fun to watch. Finding the good balance between the two can be a challenge too!

What are the challenges with your elements? Are they easy for a robot to interact with, or do they require a complex manipulator? Do they have a lot of moving parts?

```



```

Share your thoughts with your team! Work together to develop details of your field elements.

Finally, your elements should also be safe. Take a few minutes to consider the ways a robot and/or a human interacts with the field element.

Now that your field elements are becoming defined, your team can start thinking about their design. Next steps include:

- Create CAD versions of the Field elements
- Assemble a proof of concept
- Use a robot to test out the interaction
- And more!

12   The Power of Storytelling

12.1 Activity Summary

This activity explains the power and purpose of incorporating story elements into a *FIRST* Robotics Competition game.

Variable

☐ *The provided worksheet (physically or virtually)*

12.2 Introduction

In recent years, *FIRST* Robotics Competition games have a story that ties together robot actions, field elements, season materials, and more. This activity dives into how we used story telling in the past few games, with an emphasis on the 2017 game *FIRST* STEAMWORKS℠.

12.3 This Activity Will Help With…

- …understanding the value of storytelling based on examples in previous *FIRST* Robotics Competition games.
- …determining an exciting theme.
- …understanding how the theme or story can be incorporated in a competition.
- …understanding how humans fit into the theme or story.
- …identifying other points of considerations for the theme.

12.4 Team Actions

1. View The Power of Storytelling slide deck.
2. Review Previous Themes.
3. Complete the Developing a Theme worksheet.

12.5 Previous Themes

| 2017 | Steampunk | *FIRST®* STEAMWORKS^{SM} invites two adventurers' clubs, in an era where steam power reigns, to prepare their airships for a long-distance race. Each three-team alliance builds steam pressure by collecting fuel and scoring it in their boiler. Boilers turn fuel into steam pressure which is stored in the airships. Each alliance starts rotors by delivering gears to pilots on their airship for installation. Finally, the alliances prepare for flight by latching robots on to their airship before launch. |

| 2018 | Video Games | *FIRST®* POWER UP^{SM} includes two alliances of video game characters and their human operators who are trapped in an arcade game. Both alliances are working to defeat the boss in order to escape! |

| 2019 | Space Travel | In DESTINATION: DEEP SPACE, Presented by The Boeing Company, we join two competing Alliances collecting samples on Planet Primus. Unpredictable terrain and weather patterns make remote robot operation essential to their mission on the planet. With only 2:30 until liftoff, the alliances must gather as many cargo pods as possible and prepare their spaceships before the next sandstorm arrives. |

| 2020 | Infrastructure | In INFINITE RECHARGE^{SM}, two alliances work to protect *FIRST* City from approaching asteroids caused by a distant space skirmish. Each Alliance, along with their trusty droids, race to collect and score Power Cells in order to energize their Shield Generator for maximum protection. Near the end of the match, droids race to their Rendezvous Point to get their Shield Generator operational in order to protect the city! |

12.7 Developing a Theme

What are some themes that excite you?

```



```

Share your thoughts about your theme with your team!

Now that you have your theme, think about a story that could accompany that theme.

Competition is an important element of *FIRST* Robotics Competition. Alliances are incentivized to win (for example, an airship race, defeating the boss, getting cargo off the planet, charging the shield generator).

How could your story include a competition?

```



```

Share your thoughts about competition with your team!

Another important element is that the story is coherent; it should make sense and each piece should connect with the other parts. Using the theme and competition ideas collected, think about additional elements that might work with your story.

What role do the humans play? What role do the robots play? What do the alliances represent? What goal are they working toward and how does that complement your competition?

```



```

Share your thoughts with your team! Work together to develop your story.

Another important element is that the story should be relatable across cultures. Think about the different cultures or perspectives on your own team and then think about the many other teams around the world!

Does your story or theme have any cultural considerations to think about?

Share your thoughts about cultural considerations with your team! Continue to think about how your story relates to other cultures as you finalize the process.

Finally, your story should be simple. It should take about 30 to 60 seconds to explain your story to someone else without leaving that person with more questions. Practice telling your story to different team members and see what's missing or what could be removed.

Now that your story is starting to come together, your team can start thinking about the ways that this story can help make decisions about your game. Next steps include:

- Logo and color selection
- Teaser content and development
- Game animation content and development
- Field Design and Aesthetics (lighting, artwork, etc)
- Nomenclature
- And more!

13   Developing a Game Using a Specific Idea

13.1 Activity Summary

This activity is designed to help teams who have a specific idea for a game piece, game mechanic, robot action, or human player action, but are not sure how to move forward.

~ 15 min+ per question

□ *None*

13.2 Introduction

This activity takes a divergent approach and will help generate a variety of ideas. If you have multiple ideas and want help converging to pick a direction, see Converging. These discussion points can be used to further brainstorm and develop the game design concept.

13.3 This Activity Will Help With…

…taking an idea for a small portion of the game and generating ideas to fill out the game concept

13.4 Team Actions

1.   Choose the appropriate set of questions based on existing ideas.
2.   Go through each question in the chosen section and brainstorm answers.
3.   Use the brainstormed answers to generate concepts for the missing portions of your game.

13.5 I Have an idea for a…!

13.5.1 Game Piece

- How could a robot manipulate it?
    - o   Is it robust enough to not get damaged by gameplay?
- How could a Human Player use it?
- How is it scored? (e.g. into a goal, onto something, etc.)
- Where do they come from? (e.g. spread on the floor, single human station, single field location, etc.)
- Are there interaction restrictions (e.g. capacity limits, *Breakaway* Section 7.3.5.3)?
- Be sure to think about cost and availability of the game piece. Will teams be able to buy game pieces for a reasonable cost?

13.5.2 Game Mechanic

(e.g. time-based scoring, sandstorm, 2019 build a goal)

- Will the robots operate alone or cooperatively?
- What field elements could support this mechanic?
- What robot actions make sense with this mechanic?

- What game pieces work with this mechanic? Does the mechanic provide any restrictions on game pieces or is it wide open?

13.5.3 Robot Action

(pick & place, shooting, balancing, climbing, etc.)

- What game pieces work with this action?
- What do the field elements have to look like to support this action?
- Could this action support a certain game mechanic?

13.5.4 Human Player Action

- How can this human player role add value to the game?
- How do human players get access to the game piece?
- What game pieces work with this action?

13.5.5 Theme or Story

When considering these questions, you should be prepared to be flexible in how your theme/story translates to game pieces, game play, etc.

- What types of robot actions match or support the story/theme?
- Are there certain game pieces that map to the story/theme better than others?
- What elements of the story/theme could translate into a field element?
- Could this story/theme support a certain game mechanic?
- Is the theme inclusive to all teams?

14   Converging

14.1 Activity Summary

This activity provides techniques for developing ideas generated by brainstorming and then converging on an idea with which to move forward.

14.2 Introduction

Once a group has generated a host of ideas through divergent thinking, they're ready to start refining the idea set and converge on the ideas/ most compelling concepts.
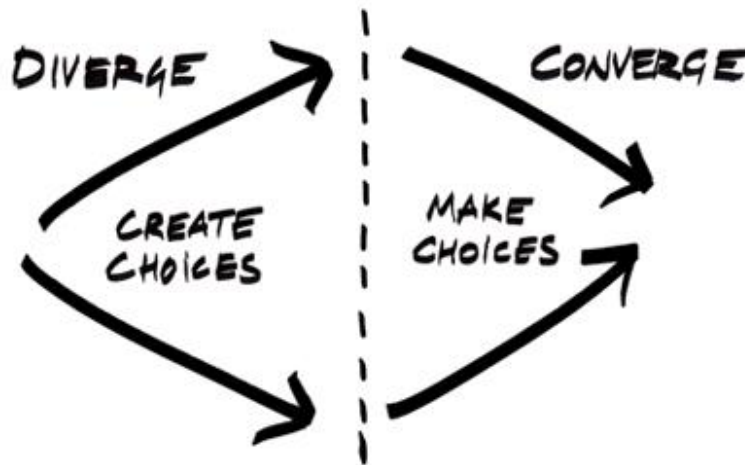

Image courtesy Wrike blog

This process works at a macro level (e.g. you have several game design concepts from which you're trying to select one or two for further development) and at more granular levels (e.g. your game has a few different end games, and you need to select one).

We don't mean to imply that this is the one and only way to converge; there are many ways groups do this well. This document shares a few ways we've approached this part of the process in *FIRST* Robotics Competition game design efforts.

14.3 This Activity Will Help With…

…taking a list of brainstormed ideas and selecting one idea with which to move forward.

14.4 Team Actions

1. Use Advocacy to narrow many ideas into the top few.
2. Use Develop and Rotate to expand the top ideas.
3. Use Thinking Hats to review the top concepts and choose one with which to move forward.

14.5 Advocacy

Depends on the number of ideas and the number of designers.
~ 2-3 minutes per idea per designer.

□ *Way for each team member to take notes.*
□ *Whiteboard for tabulating votes*

Team members to share thoughts on the ideas that resonated well and why. Allowing people to talk about what they didn't like can foster negative thinking, discourage members from sharing ideas, and threaten the process and product overall. It's temptingly easy to find fault with ideas, especially before they're developed fleshed out, and can provide a false sense of constructive contribution (that's not to say there isn't a time for, place to, or value in identifying concerns or areas for improvement; we'll get to that in a little bit).

It's harder, but far more valuable, to imagine potential. Also, for those that put themselves "out there" by sharing their thoughts, this method is a gentler approach. It's easier to end the day thinking "it's a bummer my idea didn't get selected" vs "wow, people really trashed my idea."

Encourage advocates to elaborate with the following questions:

- What is compelling about the idea?
- How can you see this idea evolving?
- How does this idea map to team core values/objectives?

To get a sense of where the group is collectively, take a temperature check to see if the group is evenly distributed among ideas or if the group is circling around a few. Focus on getting votes/tallies for ideas that people support; it's rare that it's important to solicit votes against ideas. Methods for checking group temperature include, but are not limited to, the following:

- Everyone gets x number of votes to support ideas they see worthy of pursuit.
  - E.g. each person can vote three times, presumably for their top three favorite ideas.
- Everyone gets x credits to use as they see fit
  - E.g. each person gets 5 credits, and they can apply one credit to their top five favorite ideas, put all five credits toward their clear favorite, or divide up in other ways.

If the temperature check reveals that people are evenly distributed among ideas, it's important to pause and have a discussion about how the group wants to proceed.

Once a few ideas are clear contenders, the group dives deeper into those concepts.

14.6 Develop & Rotate

*Depends on the number of ideas.
~ 30-45 minutes per idea.*

☐ *Way for team members to take notes.*
☐ *Room (physical or virtual) for each group to meet without being distracted/disrupted by other groups*
☐ *Whiteboard/poster (real or virtual) for each idea*

Except for the originators of the ideas, the group divides into smaller teams, equal to the number of ideas being considered (we've typically done this once we're down to 3-5 concepts).

The originator of each idea stays with their idea/concept and acts as a facilitator.

Each sub-group spends 30-45 minutes with each concept and riff on it (please excuse the casual term, we really like the music analogy). During this time, team members talk through ways it can improve, identify concerns (and ideally ways to address those concerns), and highlight what's compelling about the concept.

Facilitators ask probing questions (What do you mean by that? Why do you think that's a concern? What about that part of the idea do you think will resonate most with customers/constituents/etc.?) and capture the team's work.

After time's up, groups rotate and go through the same process with the next concept. They can emphasize or build on ideas the previous group had and/or create their own developments. Once teams rotate through and spend time developing each concept, the process continues with the next section.

14.7 Edward de Bono's *Thinking Hats*

Depends on the number of ideas and the number of team members. Expect a 10-15 minutes per idea.

□ Different colored slips of paper/sticky notes
□ Board for capturing "hat" comments thoughts

We've used derivatives of Edward de Bono's lateral thinking methodology, *Six Thinking Hats* to help leading game ideas rise to the top.

Here's how we've implemented it… (you may tweak this approach as makes sense for you, even our implementation of the process evolves each time we do it).

After the *Develop and Rotate* part of the process, the entire group gathers around one idea at a time (in our case, this is a literal and physical gathering as we all focus on the same whiteboard but there are ways to do this remotely), and the originator summarizes and presents the various ways the groups developed their concept.

As the presenters share the evolutions of each concept, audience members capture their thoughts on different colored sticky notes which represent the different "hats."

White

What information do you need about this idea?
What information do you have about this idea?

Blue

What does your gut say?
How does this idea make you feel?
No need to explain or justify!

Yellow

What are the good, positive things about this idea?

Red

Where should caution be used with this idea?
What's missing in this idea?

Green

Are there any new ideas you can add?
What kind of development could take this idea from good to great?

For each idea, the facilitator invites group members to share their sticky notes, going hat by hat, and state the note's contents out loud for the rest of the group to hear. It's okay for group members to create/add notes based on others' contributions. Team members don't need to explain, justify, or defend their notes, though teammates may probe for clarity.

Once each concept has had each hat treatment, the facilitator polls the group again (using either methods described above or their own preferred polling process). If there isn't a clear front-running idea, the team should pause and discuss how they'd like to proceed. If an idea is a clear front runner, congratulations!

15   Engineering Design Process

15.1 Activity Summary

This activity describes how to use the Engineering Design Process (EDP) to design field elements for your game.

Variable   □ *None*

15.2 Introduction

Once a group has the basic skeleton of a game, they need to start designing field components. The Engineering Design Process (EDP) is a great way to come up with very robust designs. It is an iterative process, divided into a few simple steps, that helps guide a team from concept to finished product.

This activity uses the EDP from the *FIRST* poster linked in the table below, but in a few cases, it breaks a step in to two parts for more detail.

15.3 This Activity Will Help With…

…moving from a rough idea of a field element to a complete design.

15.4 Team Actions

1. Review the *FIRST* Engineering Design Process poster as a helpful reference.
2. Identify the Problem
3. Brainstorm and Explore
4. Design
5. Prototype
6. Test
7. Improve

15.5 Identify the Problem

It may be easy to identify the thing that needs to be designed (i.e. a goal for balls to be scored), but it takes more effort to understand all the constraints that impact the design. Understanding and recording the reasons driving the constraints is as important as the constraints themselves. Occasionally, you may develop a solution that doesn't satisfy a constraint as written, but still satisfies the reason the constraint exists. If this step is done quickly, you may end up with a product that doesn't work well and needs modifications.

1. Meet with the Game Design Team (if they are different people from the component designers).
2. Ask detailed questions that help define the problem. Example questions are below, but these are not exhaustive.
   o Size requirements? How high, wide, deep, etc.
   o What will be the scope of the design? Full size, CAD only, scaled model or something else?
   o Are heavy impacts expected?
   o Preference on materials? Wood, metal, colors, transparency…
   o Is there a desired aesthetic? Castle? Spaceship?
   o How many game pieces need to be processed per second?
3. Capture constraints and expectations in an Engineering Requirements document, the document that the entire team uses to stay on the same page. Some constraints may change as the game develops; that is okay. This document is used to record and communicate those changes.

15.6 Brainstorm & Explore

Brainstorm as many solutions as possible, and remember that there are no bad ideas while brainstorming. What some may dismiss as a "bad" idea might be an idea that can be improved upon by others and eventually evolves to the "best" idea.

1. Research topics related to the problem. Others may have already worked on a similar design. Research to see what they might have come up with, but don't let what other have done limit your creativity.
   o Example: when tasked with designing defenses for 2016's *FIRST* STRONGHOLD™, the design team did a bunch of research about medieval castles and defenses.
2. Meet in a group to discuss research findings, but also to come up with new ideas. Feel free to use whatever media seems applicable to describe your ideas:
   o hand sketches
   o very rough CAD (basic shapes to represent overall geometry)
   o Lego® brick models

      o   images from internet research

While it may be easy to judge an idea on the quality of the presentation, it is important to look past the presentation and examine the idea itself. Some great solutions have started on a napkin!

1. Make a list of all ideas.

15.7 Design

Narrow down choices and refine a few designs from the Brainstorm & Explore step. These designs probably won't be your final design, but they get you to a point where you can build a prototype. Lego brick models become a hand sketch of a wooden prototype; an internet image becomes a CAD model.

1. Choose two to three of the best ideas from Brainstorm & Explore.
2. Sketch/CAD possible designs of those ideas. During this part keep in mind:
   - robot geometry, and how it might affect your design (bumper heights, max/min robot sizes, extension limits)
   - constraints from Identify the Problem
   - human safety (human players, referees, audience, etc.)
3. Perform a risk analysis of each design.
   - Identify concerns or risks
   - Assign an unmitigated impact level
   - Decide the mitigated probability
   - Record ideas regarding mitigation
4. Select the best design based on risk analysis and how well the design solves the problem identified in Identify the Problem. Keep in mind that even the best design will likely involve tradeoffs. It is important to acknowledge tradeoffs and make a deliberate decision. Reference Converging for ideas in selecting a design!

15.8 Prototype

Build a prototype of the selected concept. The nature of the prototype may vary greatly based on what the goal of the first iteration of the EDP. Prototypes could be:

- scaled or full size
- 3D printed
- foam core
- wooden
- metal

15.9 Test

Evaluate the design through testing. Testing will vary greatly depending on the requirements set in the Identify the Problem phase. Collect and analyze data in order to create a list of strengths and weaknesses. Some examples of possible testing:

- CAD testing
  - CAD simulation and analysis
  - use robot models to test for choke points, robot access
  - understand human sight lines (drivers, refs, human players)
  - check for scale or usability issues by using human models
- Robot testing

- o   Is there an exciting new robot task? Build a robot to test it!
- o   Do you need to test durability? Use a robot to impact designs.
- o   Building and designing a prototype robot can be an EDP all of its own.
- o   Keep in mind that prototype robots do not need to be fully legal *FIRST* Robotics Competition robots. They can be simple designs to prove that an obstacle is able to be solved.

15.10 Improve

In this step, teams should be deciding on what to do next:

- Are there specific weaknesses that need to be improved on?
- Does a wooden model need to turn into a metal version?
- Is the design ready for release?

Based on the answer to these questions, the EDP cycle may begin anew in order to refine or strengthen the current prototype to become the finished version.

16   Thinking Strategically

16.1 Activity Summary

This activity helps guide a review of the game to look for issues or areas for improvement.

~20-60 minutes

☐ *Visual representation of field with way to position robots (CAD, 2D model, 3D printed, etc.)*

16.2 Introduction

An important aspect of designing a *FIRST* Robotics Competition game is thinking about the game from a strategic perspective, or, in other words, how will teams and alliances actually play your game? Thinking about your game strategically means going beyond the obvious strategies of completing your game's objectives and looking for alternative strategies and loopholes.

The game design should be fairly fleshed out before attempting this activity. This activity involves reviewing the game design as a whole and thinking about how teams and alliances will play the game. It is generally used as a review activity to identify issues and help iterate on the game design.

16.3   This Activity Will Help With…

- …identifying problematic loopholes or issues with the game design/rules/scoring
- …checking that the game has no major issues when viewed from various perspectives (team, volunteer, audience)
- …verifying that the overall gameplay will match what's desired

16.4 Team Actions

1. Review Mindset to prepare to review the game.
   a. May be done as pre-work, individual work, or as a read-aloud/discussion.
2. Review the game using the guiding questions in Questions.
3. Make a plan to address any issues discovered through this activity.

16.5 Mindset

Analyzing your game strategically involves focusing on a couple of different mindsets:

1. Risk Management Mindset – Thinking about how thousands of other really smart people will play your game is like looking into a very cloudy crystal ball. It's very, very difficult to be certain of assessments of how teams will approach your game. This makes it important to proceed through this activity with a mindset of risk management. This means thinking not only of how likely something is to happen ("Will teams actually do this?") but also what the impact is if it does happen ("What if we're wrong and this does happen?"). Often some of the biggest tradeoffs in game design come from hedging against possibilities with low perceived likelihood but high impact.
2. Open Mindset – While listening to others and considering alternative perspectives is important in all aspects of *FIRST* Robotics Competition game design, it's especially crucial during this activity. Different

people will think differently about a problem and come at it with different perspectives and experience. This will mirror how different teams approach your game and it's critical to listen to all of these ideas and analyze them using the risk management mindset.

3. All-Teams Mindset – The other mindset to use is to go beyond how your team would play the game and think about how all teams will play the game. How will the top teams in the world play this game? How will average teams play this game? How will less competitive teams play this game? How will lower resourced teams play this game? Some of the questions below will help walk you through some ways to consider this.

4. Mind "Movie" - When Dr. Woodie Flowers helped design games, he'd often describe his worries or excitement by starting his thoughts with the phrase "the movie in my head is that..." We've adopted this as a way to set up and play through the scene we're envisioning - or prompt teammates to share their vision.

16.6 Questions

If working on this activity by yourself, or preparing for a group conversation, spend approximately 5-10 minutes thinking about each question and writing down your thoughts. If working in a group, give everyone a minute or two to consider each question before starting discussion and then discuss as a group, letting the pace of the discussion dictate how long to stick on each question. If discussion extends beyond 15-20 minutes for a particular question, this may indicate an issue with your game; either let the discussion continue, shifting toward how to modify the game to resolve the concerns, or move on and circle back to the topic later.

1. **Breaking the game –** Are their ways for teams to break the game?
    a. It's up to you to define exactly what this means, but generally it refers to things like:
        i. A strategy that results in very little ability for the opposing alliance to win regardless of their skill.
        ii. A strategy that results in the opposing alliance having very little opportunity to play any significant portion of the game as intended.
        iii. A loophole that allows a team or alliance to bypass intended challenges of the game or circumvent rules. These may or may not be ok, it's up to you to figure out if these are a problem to be fixed or not.
2. **Defense/De-scoring –** How can teams inhibit scoring? Are these methods balanced how you intend? Consider how much time and precision is required to complete the scoring action versus the defense or de-scoring action. Think about how this impacts both strategic balance and how the match feels to a team if they spent a long time completing that scoring action.
3. **Robot Design –** How will each type of team design their robot?
    a. Are their tradeoffs the team will have to make (short vs. tall robot, focusing more on specific game objectives, etc.) or does the solution of what robot to build feel obvious?
    b. Does this game provide a good level of challenge for all teams?
4. **Alliance Strategy –** How will alliances play this game?
    a. Think about different alliance constructions (all great robots, all weaker robots, a mix of skill levels), how will each of these alliances play the game?
        i. Think individually about each portion of your game (auto, teleop, endgame, etc.). Are the alliances encouraged to play the game together and contribute constructively, or are there incentives to having some teams not participate in parts or all of the match?
        ii. How does this game play in Quals vs. Playoffs?
        iii. How does this game play at a Week 1 small event vs. District Championships and Championships?
5. **Overall "movie" –** What does the overall "movie" of the game look like as you discussed these strategies?
    a. Is it what you intended? If not, is that good or bad?

b. How does it feel from an audience perspective? Does it seem exciting to watch? Can the audience follow what an alliance is trying to do? Can they tell who is winning?
c. How does it feel from the team perspective?
d. How does it feel from a volunteer perspective (refs/scorers)? Are they going to be able to see everything they need to make calls effectively?

16.7 Iterate

If the guided review revealed any weaknesses or issues, make a plan of how to move forward trying to address them. This may result in anything from minor tweaks to major changes to the game. The game design process is not linear, it's ok to jump backwards and make a significant change to fix an issue. If you do make significant changes, make sure to re-do this review when you're done!

17   External Feedback

17.1 Activity Summary

This activity describes a process for soliciting feedback and input from those outside your design team.

Variable – 1 day to 2 weeks, depending on the amount of material for review and availability of reviewers.

☐ *Deliverables that detail your game*
☐ *Way for reviewers to collaborate and report back their findings*

17.2 Introduction

One way to test your concept is to invite a diverse group of people to review it: separately and together. This can be done in person or remotely. Like many processes, you start by stating what you wish to accomplish. Then you figure out individuals that will best serve your objectives, engage effectively, and close the process by showing your gratitude for their help.

17.3 This Activity Will Help With…

- …identifying problematic loopholes or issues with the game design/rules/scoring
- …checking that the game has no major issues when viewed from various perspectives (team, volunteer, audience)

17.4 Team Actions

1. Discuss, agree on, and document objectives
2. Select & invite team of external reviewers
3. Prepare deliverables for reviewers
4. Define the process
5. Thank your reviewers

17.5   Define Your Objectives

Consider what you want to get out of this part of the process. For example,

- Do you want to see if anyone can find loopholes in the game play?
- Do you want to make sure your game is appealing and relatable to do a diverse community?
- Do you want feedback on your documentation (i.e. are you looking for copy editors to identify typos? are you hoping to confirm that what your words say match what you *mean* them to say? both?)
- Are you looking to see if your game is relatable and understandable to those that are new to the *FIRST* Robotics Competition?
- What other ways can a team of people test your game against the goals and objectives you've defined?

17.6 Select Your Reviewers

Depending on what set of questions or objectives you settled on in your preparation, you'll get a better sense for who to invite to your review team. For example, if you're asking reviewers to identify strategic loopholes, you may want to make sure you include someone that has experience and skills in navigating games and optimizing their

chances of winning a match. If you want to make sure the game is understandable, you may consider inviting someone who has no experience with *FIRST* Robotics Competition games.

17.7 Invite Your Reviewers

Reach out to those you've identified to invite them to help you. Share how much time you think they'll spend on the effort, anything they may need to participate (computer with CAD? Ability to join a group video call?), and any other expectations you have (confidentiality? participation in a group call? etc.).

It's also important to let them know what they can expect from you (for example, should they expect a report back after the process about what your designers did/didn't implement? Or should they expect to hand over their feedback and hear no more – both methods have merits, but it's helpful to make sure your reviewers are on the same page about what you do/don't plan to do).

You're asking a big favor of them, so be as transparent as possible early in the process so they know what to expect.

17.8 Prepare Your Deliverables

Your objectives will help map the deliverables you should provide to the team. For example, it's very likely that you'll want to provide a document outlining your game and images of your field regardless. Additionally, if you're trying to find out if your field design has any issues, flaws, gaps, etc., you may consider providing your field's CAD model (either directly, or via an application that presents CAD models to non-CAD users, like SOLIDWORKS' eDrawings).

17.9 Set Your Plan

How would you like your review team to work, and over what time frame? Depending on how much material you're planning on asking your reviewers to digest, this could decrease time to one day or a few hours. If you want to have your reviewers communicate with each other, consider setting up a group chat for them to use.

Your plan can be rigid, or you can invite reviewers to help shape the plan. For example, if you have reviewers that span time zones, you may ask that they schedule their video conferences in a way that best accommodates each reviewer instead of setting a date and time and hoping it works for all. Further, your reviewers may prefer to meet more frequently for shorter durations or once for a longer call. It's up to your team to decide how flexible you can be with logistics and communicate that with your reviewers.

17.9.1 Example

A recent review team for *FIRST* was provided with a digital packet of deliverables (a game manual, CAD model, and a list of specific questions) for their private digestion and given approximately five business days to review. After time with the material, reviewers participated in two video conferences:

1. Reviewers only: This video conference was for reviewers only and gave them an opportunity to compare notes, ask questions of each other, and refine their list of items to share back to *FIRST* Robotics Competition Game Designers.
2. Reviewers & *FIRST* Robotics Competition Game Designers: This video conference was a presentation by the reviewers and covered all their concerns, observations, and suggestions for improvement. It provides an opportunity for *FIRST* Robotics Competition Game Designers to ask clarifying questions. For reviewers, it's important to get and stay in an active listening mode and avoid the temptation to defend the game and its elements.

17.10 Thank Your Reviewers!

Regardless of how much of their input and feedback your designers take, remember to thank the reviewers for their time, attention, and feedback!