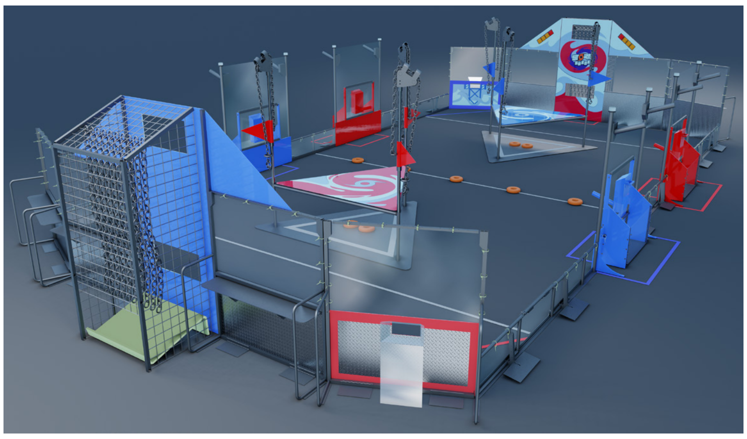
STORM SURGE
SUPPLEMENTAL INFORMATION

THEME



In STORM SURGE, teams race to upload and send data to alert FIRST® City of an approaching hurricane. We created a game with STEM featured prominently in the theme to reinforce FIRST®'s mission "to inspire young people to be science and technology leaders and innovators." We based STORM SURGE on a computer security/cyberpunk theme initially created for a separate game concept. The storm was added in the early development of the final theme to incorporate a sense of urgency into the plot of a match, serving a similar place in the story as the asteroid shower from 2020: INFINITE RECHARGE or the sandstorms in 2019: DESTINATION: DEEP SPACE. We continually refined the narrative and terminology to capture the unique spirit of FRC games while creating a new and engaging storyline.

GAME DESIGN PROCESS

After the Game Design Challenge (GDC) was announced on September 24th, our Strategy subteam began reviewing previous games to highlight key mechanics: match flow, human player roles, design challenges, types of scoring, etc. We determined that a game must appeal to three groups—the spectators, robot designers, and strategists—and evaluated what previous games did most and least effectively to reach these different audiences. Meeting twice a week, the GDC subteam split into groups, discussed and categorized specific aspects of FIRST® games, and spent the remainder of each meeting developing game concepts. Topics discussed included game pieces, scoring types (e.g. linear or threshold scoring), placement types (e.g. stacking, shooting, placing), and match structure. By Kickoff, we had created four distinct and playable game concepts.

After reading the GDC manual, groups integrated the CHAIN element into their games and the subteam reviewed each of the four complete concepts. Following two rounds of subteam feedback, we presented the game concepts to our team's student leads and mentors. GDC groups combined games based on feedback from this presentation to create two final game concepts to present to the rest of the team and alumni.

In the last week of January, the subteam selected a final game concept to perfect for submission. The subteam broke into groups that would work in parallel: scoring, written submission, and animation. The scoring group determined point weighting based on results of simulated games, the difficulty of scoring tasks, and the prioritization of certain tasks to improve match flow and audience engagement. This process used our experience from scouting and analyzing past FRC games, as well as a methodology originally proposed in a FIRST® Canada webcast by Karthik Kanagasabapathy. The written submission team outlined, wrote, and revised each section of the written submission. They got feedback from the scoring group, 1678's Business and Media subteam, and mentors. The animation team modeled the field and game elements, wrote and recorded the voice-over, and animated and produced the game reveal video.

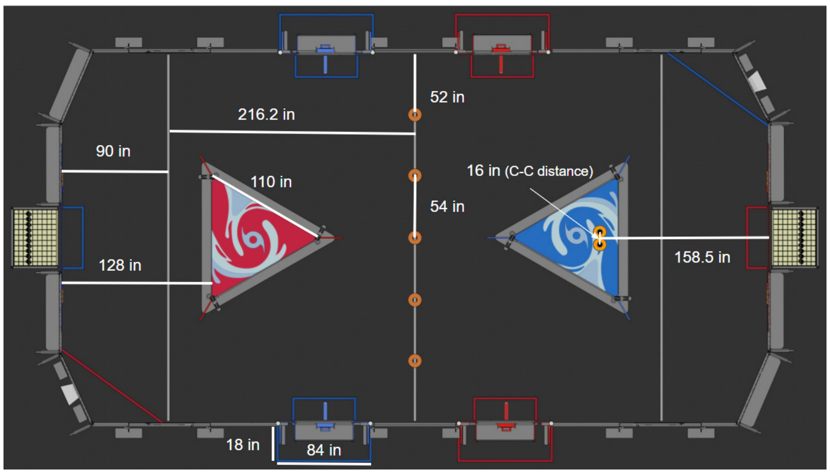
Due to COVID-19, all work was done remotely to ensure safety while creating STORM SURGE.

EARLY DECISIONS

Through the design process described above, the GDC subteam quickly became interested in using one game piece in different ways as this was a design space that had not been filled in an FRC game before. Groups brainstormed possible game piece designs, ranging from icosahedrons to cylinders. The subteam decided on a moderately sized torus that could be placed on pegs and shot into high and low goals.

The GDC subteam also explored field elements that robots would interact with to create varied robot actions and make the game more engaging and memorable for spectators. Before Kickoff, the most popular idea—because of its significant visual appeal—for robot-field interaction was for robots to turn a crank and raise a flag. After Kickoff, this idea easily evolved to include the CHAIN element and became the UPLINK.

FIELD DESIGN



At the beginning of a match, two PACKETS are placed beneath each UPLOAD STATION and five PACKETS are placed on the SURGE BARRIER. Unlike the two PACKETS beneath each UPLOAD STATION, the PACKETS that start in the middle will be accessible to both ALLIANCES to increase interaction between ALLIANCES. The excitement this creates during AUTO increases audience engagement while keeping AUTO scoring a reasonable percentage of the final match score. The PACKETS underneath the UPLOAD STATION are guaranteed game pieces for an ALLIANCE during AUTO, but due to the extension limit, ROBOTS will be required to drive under the UPLOAD station.

To let teams score more easily and to decrease damage to CACHES during competition, each CACHE has a protected zone in front of it. Both CACHES for an ALLIANCE are on the same side as their DATA PORTS so teams can interact with them during AUTO. DATA PORTS and CACHES are also surrounded by retroreflective tape, allowing teams to use computer vision systems to align their ROBOTS and aim PACKETS.

When the TELEOP period begins, teams are able to cross the SURGE BARRIER and access their TRANSFER STATION. In front of each TRANSFER STATION is a protected zone to let teams intake game pieces without interference from the opposing ALLIANCE. CACHES, TRANSFER STATIONS, and the low DATA PORTS are all at the same height to allow teams to use one multi-purpose mechanism for each basic match action, simplifying build requirements for lower resource teams.

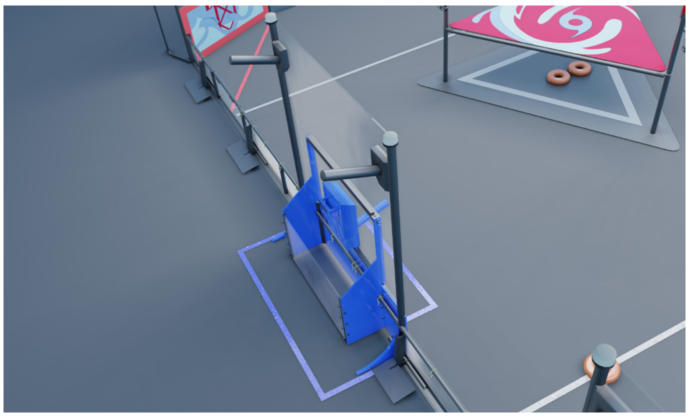
During TELEOP, a typical cycle begins with collecting a PACKET from the TRANSFER STATION and scoring it in a DATA PORT or on a CACHE across the field. ROBOTS are limited to carrying one PACKET at a time, which increases the need for coordination between ALLIANCE partners. ROBOTS can decrease cycle times and avoid the opposing ALLIANCE'S protected zones by traveling under the UPLOAD STATION, which is about 4 in. above the tallest point of a CACHE. The orientation of the UPLOAD STATION allows for a straighter path between an ALLIANCE'S TRANSFER STATION and their far CACHE. It also encourages interaction between ALLIANCES by creating more space in the middle of the FIELD. ALLIANCES have to balance CACHE cycles with DATA PORT cycles to optimize efficiency and thus maximize points.

Throughout the match, each UPLINK'S CHAIN will hang 6 in. above the height of the UPLOAD STATION surface to make it easier for ROBOTS to access during ENDGAME. To CLIMB, ROBOTS have to end the match with their BUMPERS completely above the UPLOAD STATION surface and be supported solely by the UPLOAD STATION. With these minimal requirements, ROBOTS can CLIMB on the UPLINK CHAIN, on the UPLOAD STATION surface, or use various other techniques. Mechanically advanced teams can also choose to lift their ALLIANCE partners as part of their CLIMB.

GAME DESIGN CONCEPTS

FIELD VISIBILITY

One of the main requirements we took into consideration for our game design was visibility. Scoring on CACHES would be difficult to see from the audience's perspective, so we added stack lights by the CACHE STATIONS and DATA PORTS to indicate the number of PACKETS in STORAGE. When a PACKET is scored in a DATA PORT, the PACKETS in STORAGE reset and HUMAN PLAYERS move PACKETS from STORAGE to the attached box. To guarantee visibility for referees, the CACHE STATIONS are placed between traditional referee locations along each side of the FIELD, similar to HUMAN PLAYER locations in 2014: AERIAL ASSIST. Additionally, for both referee and audience visibility, CACHE STATIONS are constructed almost entirely out of transparent polycarbonate.



AUTOMATIC SCORING

Automatic scoring simplifies the referees' jobs and increases accuracy. PACKETS scored in the DATA PORTS are automatically registered by the Field Management System (FMS). HUMAN PLAYERS remove PACKETS from the CACHE and place them onto STORAGE poles to count them automatically, similar to the 2018: POWER UP Vault. When a PACKET is scored in the high or low DATA PORT, HUMAN PLAYERS remove the scored PACKETS from STORAGE and discard them into the box on the CACHE.

SCORING CONSIDERATIONS

During our design process, we looked at a variety of scoring types, such as linear, non-linear, and time-based. We considered using multiplicative scoring bonuses similar to Recycling Containers in 2015: RECYCLE RUSH. However, we ultimately decided on dependent additive bonuses—similar to Assists in 2014: AERIAL ASSIST—because they shift the majority of the points to a task achievable at all levels of play. Integrating this scoring type with our decision to use a game piece for both placing and shooting yielded the CACHE BONUS, which is the most efficient way to score points as long as ALLIANCE partners work together to coordinate cycles. Without implementing a shooter, ROBOTS are still able to make significant contributions to scoring because the majority of points are earned through CACHE BONUSES. This allows for a variety of ROBOT designs from a range of team experience and resource levels.

PENALTIES AND FOULS

We have not listed rules that remain the same year to year, such as keeping ROBOTS on the playing FIELD, pinning, and most ROBOT design rules. We consider the following rules to be the most important for intended gameplay:

- ROBOTS cannot extend more than 12 in. beyond the frame perimeter *(Violation: FOUL. If strategic, RED CARD)*
- ROBOTS may not have greater than momentary control of more than one PACKET at a time (directly or transitively through other objects) *(Violation: FOUL for each additional game piece. If egregious, YELLOW CARD)*
- ROBOTS cannot shoot PACKETS if their BUMPERS intersect the area between their ALLIANCE STATION and the nearest CHARGING LINE *(Violation: TECH FOUL. If repeated, YELLOW CARD)*
- A ROBOT whose BUMPERS intersect the opponent's TRANSFER STATION, DATA PORT, or CACHE protected zones cannot contact opponent ROBOTS, regardless of who initiates contact. *(Violation: TECH FOUL)*
- An opponent ROBOT may not contact a ROBOT whose BUMPERS are intersecting its TRANSFER STATION, DATA PORT, or CACHE protected zones, regardless of who initiates contact. *(Violation: TECH FOUL)*
- Two or more ROBOTS cannot blockade or barricade major elements of play, field areas, etc. *(Violation: TECH FOUL. If egregious, YELLOW CARD)*
- During AUTO, a ROBOT'S BUMPERS cannot cross the SURGE BARRIER *(Violation: TECH FOUL. If egregious or strategic, YELLOW CARD)*
- CACHE STATION HUMAN PLAYERS must keep at least one foot within the HUMAN PLAYER ZONE at all times during the match *(Violation: Verbal warning. If repeated at any point during the event or egregious, YELLOW CARD)*

- During ENDGAME, ROBOTS may not contact an opponent's ROBOT that is in contact with their UPLOAD STATION or is intersecting the area directly above or below their UPLOAD STATIONS *(Violation: the contacted opponent ROBOT will be considered CLIMBED and will be awarded one completed UPLINK if all UPLINKS have not been completed by their ALLIANCE)*

GENERAL ROBOT DESIGN

Frame perimeter: 120 in. Robot height: 48 in. Starting configuration: within frame perimeter

Robot Weight: 125 lbs Robot extension: 12 in.

QUANTITY AND WEIGHTING CALCULATIONS

Award	Awarded for	Auto	Teleop
MOBILITY BONUS	Moving off the charging line during AUTO	4	—
CACHE BONUS	Scoring in the DATA PORT with one or more PACKETS in STORAGE	15	10
High DATA PORT	Scoring a PACKET in the high DATA PORT	12	8
Low DATA PORT	Scoring a PACKET in the low DATA PORT	3	2
UPLINK	Fully raising an UPLINK flag	—	8
CLIMB	Ending a match with fully supported by and with BUMPERS fully above the UPLOAD STATION	—	16
DOCK	Ending a match with BUMPERS intersecting the area under the UPLOAD STATION	—	4
FOUL	Opposing ALLIANCE commits a penalty that results in a FOUL	4	4
TECH FOUL	Opposing ALLIANCE commits a penalty that results in a TECH FOUL	20	20

The primary task of the scoring group was to determine the point values for each scoring action and the thresholds for each RANKING POINT. To accomplish this, we generated realistic example matches by modelling ALLIANCE performance as a series of normally distributed random variables based on historical match data. After determining the winner of each match, we represented the sample matches as an overdetermined system of linear inequalities. The numerical solution to this system was approximated using optimization functions from SciPy, a free and open source Python suite for mathematics, science, and engineering. This approximation provided a reasonable starting point for finding the point weighting, although there was evidence of some noise in the results.

Outliers in the raw results were then corrected based on weights for similar tasks in previous games before multiplying the weights by a constant to get round numbers. An analysis of how 1678 would approach this game from a strategic design perspective indicated that the high DATA PORT was undervalued due to the additional complexity required to score in it. The point values for all PACKET scoring were adjusted to make the high DATA PORT more valuable, especially at medium and high levels of play. We also increased the value of a CLIMB relative to an UPLINK due to the difference in difficulty. Following each adjustment, we reevaluated the scoring balance at every level of play. This ensured that the point weighting would lead to engaging and competitive matches while rewarding desired design and play strategies across the expected range of resources available to teams. We also compared our weighting to past games to verify that the point weighting was comparable to previous seasons.

To determine RANKING POINT thresholds, we drew upon our set of sample matches to determine when a RANKING POINT should be awarded to an ALLIANCE. Most importantly, we ensured that RANKING POINTS could be completed primarily by one high level team or an ALLIANCE of lower level teams, requiring some collaboration in both instances. This achieves the primary purpose of RANKING POINTS, which is to allow higher performing teams to distinguish themselves and rise to the top of the rankings with less dependence on a favorable schedule. As the season progresses, we expect the PACKET RANKING POINT scoring threshold to increase, similarly to the Tower Strength Ranking Point in 2016: STRONGHOLD or the amount of Gears needed to power a Rotor in 2017: STEAMWORKS. While the threshold will not change between weeks of Regional or District Competition play, it may be raised for District Championship and/or FIRST® Championship play.

The minimum number of game pieces available for a match was determined by taking an upper estimate of the cycles an ALLIANCE would complete in a match and adding a safety margin to account for extreme outliers. We assumed that each ROBOT would score at the rate of an undefended Einstein level team, or about eight TELEOP cycles per match along with scoring all available PACKETS during AUTO. Comparison to past games, specifically the 60 Power Cubes available every match in 2018: POWER UP, shows that recycling PACKETS would not be required and that our upper estimate of 71 game pieces was enough to ensure that game pieces would never be exhausted, even at the highest levels of play.