

FRC Team 6962

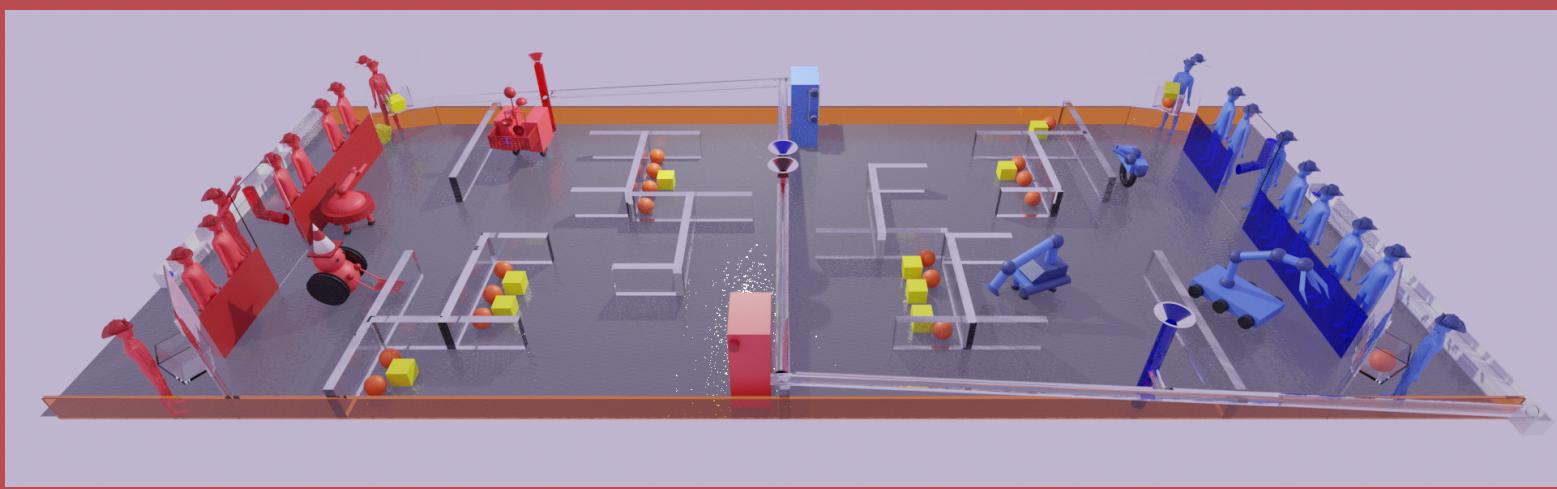
RobotX

FRC Game Design Challenge 2021
Submission Package



Game Overview

FIRST Responders is a search and rescue game where robots attempt to rescue precious artifacts from a burning building, which is represented as a navigable, yet sophisticated, MAZE layout. The MAZE walls are reconfigurable between matches, allowing for multiple predetermined layouts (provided in the game manual), allowing for preparation beforehand. A fixed wall divides the field into two isolated sections, one for each alliance to navigate through.



Robots can rescue either SPHERES (CARGO from Destination: Deep Space) or CUBES (POWER CUBES from *FIRST* Power Up), each being worth 20 points. Robots must pick up ARTIFACTS, 20 of which are distributed across the MAZE floor, and place them in the ARTIFACT DEPOSITS. ARTIFACT DEPOSITS are 16" x 16" square-shaped holes located on either end of the ALLIANCE STATION and can only fit one ARTIFACT at a time, so it's the human players' job to ensure that the ARTIFACT DEPOSITS are clear.

In addition to rescuing ARTIFACTS, teams can access WATER CAPSULES (FUEL from *FIRST* STEAMworks) via PUMP PANELS located on each of their ALLIANCE WALLS, three feet off the ground. Robots deliver WATER CAPSULES to two WATER DEPOSIT areas, one located above the other on the left outer wall of each alliance's MAZE, slowing down the fire. By doing so, alliances can extend the match play time from the original time of 90 seconds up to a total of 180 seconds. Every WATER CAPSULE in the higher DEPOSIT earns one scoring point and three additional seconds of play time, while the lower one requires three WATER CAPSULE for the same benefits. Water can also be delivered to an OPPOSITION WATER DEPOSIT located along the common wall that separates the two MAZES. By doing so, the opposing alliance gains one second per WATER CAPSULE, while the alliance that deposited the CAPSULE earns four points. Scoring 30 points from depositing water (for an additional 90 seconds, reaching the limit of 180 seconds) earns one Ranking Point. Teams may continue scoring points for water even after reaching the time cap.

A locked VAULT inside the MAZE contains four additional, specially colored, ARTIFACTS available for rescue. Teams earn 20 points by opening the VAULT. Depositing all VAULT artifacts earns one Ranking Point.

When the match timer goes down to 20 seconds, excessive smoke has built up in the building and the SMOKE MODE endgame is initiated. As a result, Drivers are unable to see the robots due to curtains blocking the ALLIANCE STATION windows (as during the Sandstorm period in Deep Space). If all three robots of the alliance are able to exit the MAZE successfully into the SAFE ZONE, the alliance receives one Ranking Point. Alliances have independent match timers based on the number of scored WATER CAPSULES, so the alliances might finish the match at different times.

The alliance that can strategically fight the fire while rescuing ARTIFACTS to earn the most points will be declared the winner!

Notable Field Elements

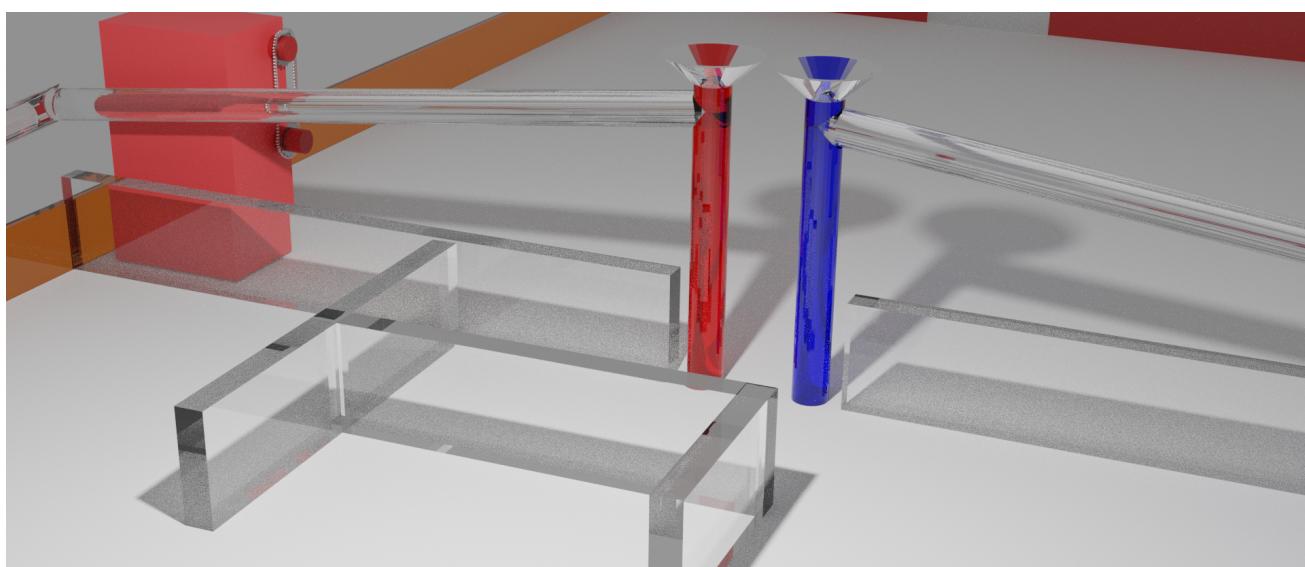
FIRST Responders' game field features a number of novel field elements, combined with some elements borrowed from historical games. The most notable of these elements are the MAZE WALLS within the building. They are J-shaped plexiglass structures (from a birds-eye view), made up of 0.25" thick 2'x8' and 2'x4' panels connected by corner braces for structural stability. Three of these structures will be placed symmetrically on each side of the bisected field, constituting each team's MAZE. 2' walls separate the two alliances' fields from each other, as well as separating the MAZE from the SAFE ZONE.

Like any secure building, there is a VAULT within the maze where four valuable items are stored. The VAULT is a closet system with dimensions 3'x2'x5' whose door is CHAIN and sprocket-operated. The bottom sprocket is actuated via a horizontally-oriented roller, which lifts a window-blinds construction, featuring a series of 4-inch wide slats each separated by 3 inches. Inside the VAULT are four specially colored ARTIFACTS.

Inside the building, there are two places where teams can extend their time by scoring WATER CAPSULES into WATER DEPOSITS. The ALLIANCE WATER DEPOSIT is a 6' tall, 8" diameter cylindrical structure with two openings: one 6-inch cutout 33" off the ground, and one at the top in the form of a 21.5"-wide funnel. There is another similar structure at the center of the field without the lower opening, and, like the rest of the game structures, they are mirrored on each alliance's side.

CHAIN ELEMENT

For each alliance, a VAULT is located on the right side against the wall that splits the two MAZES. Opening the VAULT rewards the alliance with 20 points and accesses four additional ARTIFACTS. If an alliance successfully opens the VAULT and deposits the four ARTIFACTS, they receive one Ranking Point. The VAULT is opened by actuating a horizontally oriented roller. When a robot rotates the roller, the attached sprocket spins and pulls the CHAIN, lifting the slats up. The CHAIN mechanically connects the bottom sprocket attached to the roller with the top sprocket that is responsible for rotating a rod. The sprocket system incorporates a ratchet so that it can only turn in one direction, and thus robots do not have to remain engaged with the roller for the door to stay up. The VAULT door resembles and functions like window blinds, with cords connecting each slat. Six cords are responsible for opening the door with two identical configurations of three cords on each end. Two cords are configured like ladders with slats resting on each rung so that they don't fall to the floor. The third cord passes through the holes in the slats, and is only attached to the bottom slat. As the rod above the VAULT is rotated, the cord is rolled up and the slats are pulled up with it.



Expected Robot Actions

As robots maneuver around the field and earn points, they require versatility in order to complete the various tasks. The most straightforward of these actions is retrieving maze ARTIFACTS scattered within the building and returning them to the ARTIFACT DEPOSITS on the ALLIANCE WALL. Since the ARTIFACTS come in two shapes (13" SPHERES as from Deep Space, and 13"x13"x11" CUBES from Power Up), teams will have to find innovative ways to collect, carry, and deposit these ARTIFACTS without interfering with their maneuverability -- a key challenge of this game. To maximize efficiency, alliances may develop ways to take advantage of the 3-item carry limit to increase the productivity of each cycle.

The opening of the VAULT is a unique action, exclusive to this game. Robots actuate the VAULT by rotating a horizontal roller, unlocking it and granting access to four more ARTIFACTS.

The other main gameplay action that robots are expected to perform is the interaction with the WATER CAPSULES, whose main function involves increasing an alliance's game timer. Each robot may carry up to 5 WATER CAPSULES simultaneously, though, due to their much smaller size (5" diameter wiffle balls from STEAMworks), robots will likely require a different carrying mechanism for them than the ARTIFACTS. At the WATER DEPOSITS, robots can either launch their WATER CAPSULES into a vision tape-marked high funnel, or unload them directly into the lower ALLIANCE WATER DEPOSIT (albeit for less reward). Additionally, robots can make their way to the center of the field and launch their spheres into the OPPOSITION WATER DEPOSIT, which will, while giving their alliance points, provide time to the opposing alliance instead. Robots may make their cycles more efficient by carrying both WATER CAPSULES and ARTIFACTS simultaneously, but should bear in mind the carry limit.

FIRST Responders Game Animation



(Click to view)



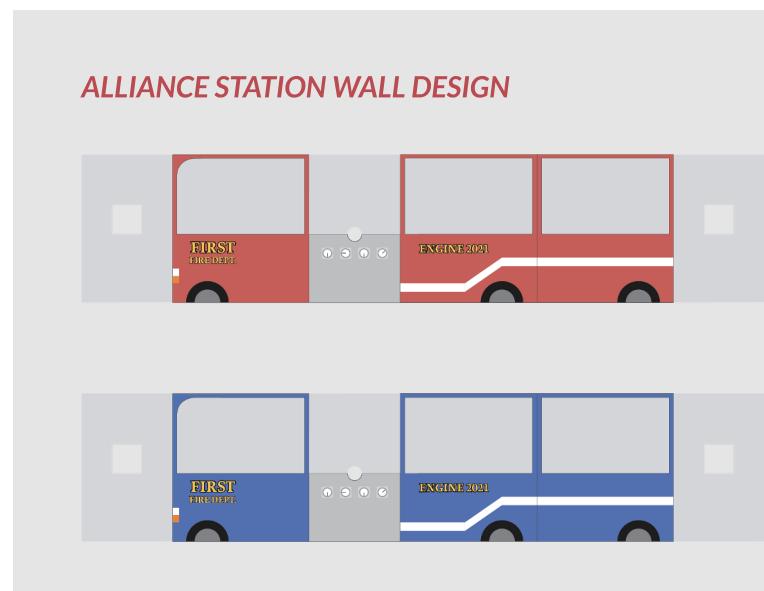
UNIQUE GAME FEATURES

In pursuit of more dynamic gameplay FIRST Responders features:

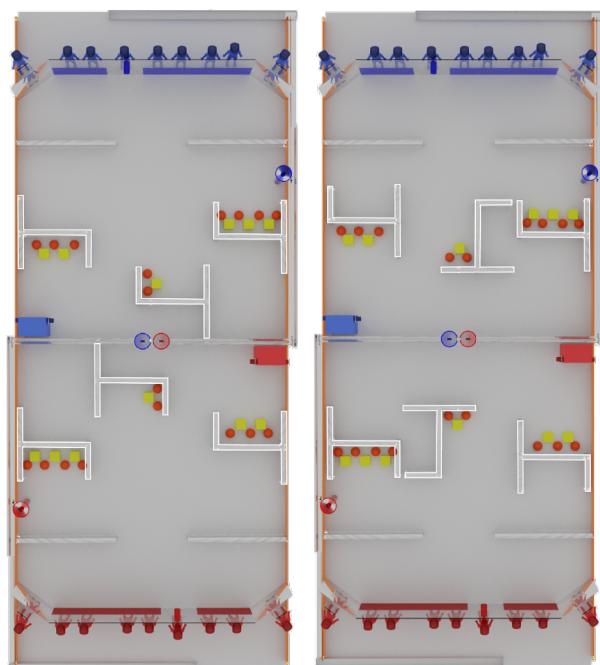
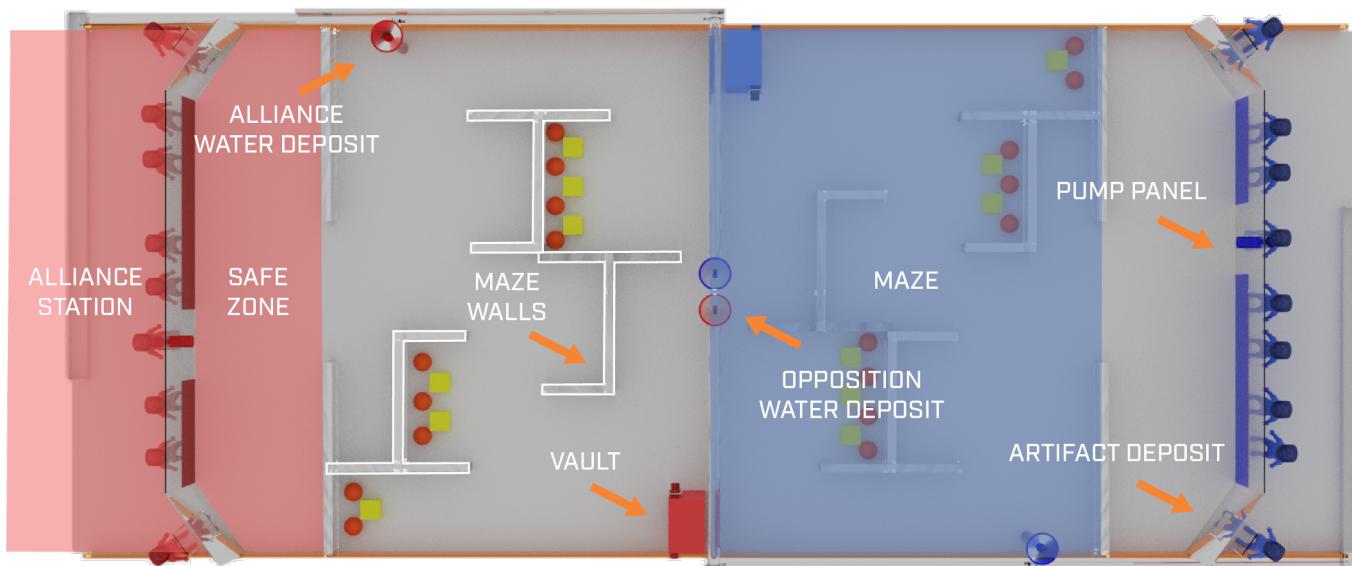
FIRST Responders is the first game to feature **variable game time**, forcing teams to strategize not just in terms of game points, but also game length. Traditionally, strategizing before a match involved assigning duties to different teams to accomplish parallel tasks causing robots to independently pursue their assignments. In contrast, the tasks in *FIRST* Responders are interdependent; working cohesively forges an alliance that is worth more than the sum of its parts. Active communication and quick responses to opponents' actions during a match are the only ways to optimize alliance strategy. Each robot's best course of action depends on the current state of the game, especially how much time each alliance has left. Even if a robot is only capable of scoring **WATER CAPSULES**, in-game intra-alliance communication is the only way to know when to switch from extending its own alliance's time to capitalizing on the points earned by extending the opponents' time. A robot retrieving **ARTIFACTS** must know when **SMOKE MODE** will obstruct their view and how much time they have left to escape the **MAZE**. Variable game time is a unique tool to incentivize teamwork while fostering creative, exciting, and dynamic gameplay.

FIRST Responders rewards alliances that take a **communication-oriented approach** to the game. Firefighters in real-life situations depend on strong communication and planning to safely and efficiently put out fires. Similarly, in *FIRST* Responders, robots must quickly navigate the **MAZE** and retrieve **ARTIFACTS** before the building collapses and time runs out. Like firefighters, the robots must be agile enough to navigate through potentially dangerous situations. The **MAZE** is designed with narrow hallways, which may cause robots to easily block each other or get jammed. To be effective firefighters, alliances must organize well throughout the match. Teams must communicate constantly to re-strategize with their alliance members, and drivers will have to be conscious of their robot's surroundings to safely navigate the **MAZE** to win. Transporting game objects through these complex **MAZE** configurations is a unique task. This game will require maneuverability and coordination from robots and drivers like no game has before.

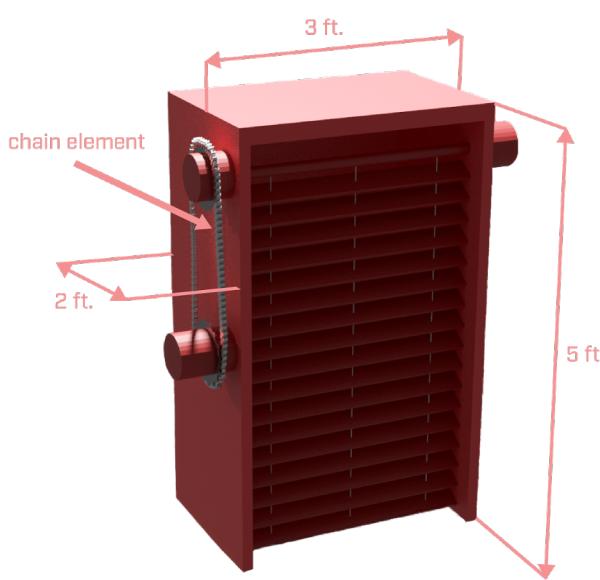
FIRST Responders will support newer teams by including **mecanum wheels in the Kit Of Parts**. The importance of maneuverability in this game may disadvantage the traditional tank-drive robots, as piloting around tight corners and narrow corridors would be no small feat. In *FIRST* Responders, teams are racing against the clock and these small inconveniences will add up. One solution to these problems is to use mecanum and omniwheels since a robot is able to drive in any direction without needing to turn. Some teams have never had the resources or opportunity to experiment with mecanum wheels. Providing the wheels along with instructions on how to use them would encourage teams' skill growth while still offering a challenge. Access to these robot design options will enrich and add nuance to teams' approaches to future competitions.



In keeping with the **search and rescue theme**, FIRST Responders revolves around the recovery of pre-set items from the field back to the ALLIANCE STATION, putting teams in the firefighter mindset. While in previous games, teams were compelled to complete as many tasks as possible, and robots were even encouraged to defend their progress by inhibiting the other alliance's abilities, alliances in FIRST Responders work towards the same goal: salvaging as many items from the burning building as possible. Reinforcing the morals that all firefighters work with, and in the spirit of Coopertition™, alliances are also encouraged to extend their opponents' time in return for points. FIRST Responder's search and rescue theme leads to exciting gameplay focused on players' bravery and courage.



Alternate maze configurations



A variety of **MAZE Layouts** ensures matches will be unique and eventful. Teams will know which configuration will be in place during each of their matches and may strategize ahead of time with their alliance. The variety would still keep robots from executing the exact same path every match, and be more conducive to dynamically planning within their alliance. Considering a robot's strengths and weaknesses for a specific configuration will be a more nuanced aspect of the game that drive coaches haven't needed to consider in the past. Rotating through layouts would give a balance of novelty and variety without putting drivers in completely unfamiliar scenarios every match they play, much like OUTER WORKS did in FIRST Stronghold. Changeable field configurations keep the drivers alert and the matches exciting.

FIRST Responder's usage of the **CHAIN ELEMENT** in the **VAULT** is conducive to creative robot design. Robots have easy access to an open roller and the chain it is connected to, and are allowed to interact with any part of it. The VAULT stores more ARTIFACTS than a robot is allowed to carry, so it further encourages alliances to coordinate emptying the VAULT once it has been opened. Incentivizing alliances to retrieve every ARTIFACT from the VAULT helps the game feel more natural, preventing teams from venturing to the back of the maze to open it, only to abandon its contents in favor of closer pickups. Opening the VAULT is an optional task robots can take on, challenging teams both during build season and on the field.

RULES & EXPLANATIONS

Variable Game Time: Robots gain time for scoring WATER CAPSULES in the ALLIANCE WATER DEPOSIT. This means that since each alliance is running on a different timer, they may not always finish their match at the same time. When time runs out for an alliance, their robots are deactivated even if the opposing alliance is still playing. Even after alliances have reached their upper limit of 90 additional seconds, they may continue to score WATER CAPSULES to earn extra points, though they will receive no additional time. Teams may also score WATER CAPSULES in the OPPOSITION WATER DEPOSIT, earning points while extending their opponent's time, as long as their opponent's building hasn't already collapsed. As alliances' times are extended, their SMOKE MODE will be delayed, up until 160 seconds into the match. If WATER CAPSULES are scored after SMOKE MODE has begun, they receive points and time as they would otherwise, but the curtains will remain down for the rest of the game. Gaining extra time will allow alliances to rescue more items out of the maze and score more points, but the variable time requires teams to strategize a delicate balance between prioritizing time for depositing WATER CAPSULES and rescuing ARTIFACTS.

The VAULT: The VAULT holds 4 ARTIFACTS: 2 CUBES and 2 SPHERES. They are differently colored from the rest of the ARTIFACTS but are worth the same number of points. The alliance earns 20 points when the VAULT is opened, and it remains opened for the rest of the match. Alliances earn a Ranking Point if they successfully open the VAULT and deposit all 4 ARTIFACTS stored inside.

Control Limit: A robot may not intentionally manipulate more than 5 WATER CAPSULES and 3 ARTIFACTS at once. Carrying 3 ARTIFACTS, especially while maneuvering through the hallways, is expected to be challenging.

SMOKE MODE: With 20 seconds remaining SMOKE MODE begins: the fire flares up and smoke permeates the building, inhibiting driver vision. Curtains fall and obstruct the view through the ALLIANCE WALL. Drivers must rely on either autonomous code, remote cameras, or the provided overhead view to continue controlling their robots for the rest of the match. Drivers are allowed to navigate blind, though this is not recommended.

Overhead View: To ease MAZE navigation, cameras are mounted on a mast above the OPPOSITION WATER DEPOSITS, giving a live overhead view of the alliance's MAZE, which drivers can connect to their dashboard and utilize at all times during the match, including SMOKE MODE.

MAZE Layouts: There are three MAZE layouts defining specific locations for the MAZE WALLS and ARTIFACTS. The MAZE WALLS are composed of J-shaped pieces that can stand independently. The field changes configuration every 6 Qualification Matches. During Playoffs the MAZE configuration changes after each alliance has played a match. Since each pairing plays their first match before any pairing plays their next, configurations can be cycled so alliances are playing a new one each match.

RANKING POINTS

In FIRST Responders, alliances can earn up to five Ranking Points in each Qualifying Match. The victorious alliance receives two Ranking Points and a tie earns both alliances one Ranking Point, as in previous games. Alliances receive one Ranking Point if they open the VAULT and successfully retrieve and deposit every ARTIFACT stored there. These ARTIFACTS are worth the same number of points as those placed throughout the MAZE, but are colored differently so judges can tell that all have been rescued. Another Ranking Point is awarded to alliances that put out their own fire. To do this they must have scored 30 points worth of WATER CAPSULES in their ALLIANCE WATER DEPOSIT, whether or not they received assistance from the opposing alliance. If they did receive assistance they will not get a further extension to their clock, but they will still receive the usual points for each WATER CAPSULE scored. A Ranking Point is also awarded if all three robots are out of the MAZE and fully in the SAFE ZONE when their independent timer reaches zero.

MORALITY IN GAME DESIGN

Like any good product, *FIRST* Responders went through a number of iterations and refinements, and a number of features were removed or reconsidered to better support the story and morality of rescue operations. One example of an interesting feature that had to be altered for moral reasons was the idea of a single, shared maze. In this case, we realized that while it would have made for a more traditional-style game with direct robot interaction, optimal defensive play would involve restricting the opponents' movement between the MAZE and the SAFE ZONE, which roughly translates to trapping rescue operatives in a burning building. We would be hard-pressed to defend this (technically optimal) strategy, so we redesigned our game to remove this concern. Likewise, another strategically interesting concept that was ultimately discarded for the sake of morality was a shared timer. It was removed as it would have encouraged teams with a lead to run the clock out, leaving the opponent alliance floundering for time while the leading alliance watched the building burn. Instead, the cross-alliance interaction was added in the form of a secondary OPPOSITION WATER DEPOSIT, in which alliances could extend their opponent's timer for a point gain. This new feature resolved our moral dilemma, and added a new dimension of prisoner's dilemma-style strategy to our game. In the end, even though some of these concepts would have produced an equally complex game, these moral changes make the game feel more natural and help players immerse themselves in the story.

