

## Game Design Challenge Finalist Team 4342

**Team Name:** Demon Robotics

**Location:** Kennett Square, Pennsylvania USA

**Game Name:** Harvest

### **Game Overview:**

The world's population is on track to hit 10 billion people by 2050. Today, at 7 billion, almost one billion people are undernourished, and this number is expected to triple by 2050. We need to change. We need to find new methods to grow and harvest crops.

Additionally, almost all farms burn fossil fuels to power tractors, irrigation networks, and heating systems. Many farms have acres of excess land just waiting to be used for solar energy production. Moving agriculture to renewable sources will not only be good for the earth, but it will also be more affordable and effective for farmers in the long run.

"Harvest" is designed to draw attention to these needs in the inventive engineering community of FIRST. Set in the near future, robots work to harvest and store hay bales (five-gallon buckets) in the "silo" and "barn." In the silo, hay bales can be elevated by pulling down on a chain. At the end of the day, robots climb the walls of their solar charging stations.

Over the past few years, we have collectively watched thousands of FRC matches, both from the perspective of a casual spectator and from that of an invested team member, analyzing matches for a strategic edge. We endeavored to create a game that would satisfy people on both ends of this spectrum -- and everyone in between. "Harvest" is designed around large game pieces, which are easily visible to everyone in the stands, and is fairly simple to understand: place the buckets and climb the charging station. However, we also wanted to make a game that encourages significant strategic decisions in both the build season and during competition. For example, teams can choose to score hay bales only horizontally on the pallets and in the barn in order to minimize cycle times, or to score them vertically in the barn to earn the "barn pair bonus" to accumulate more points (as shown in the game animation). In addition, FRC game strategies progress over the competition season, so we designed our game with this in mind. The abundance of scoring locations in the silo and the challenge of scoring hay bales in different orientations in the barn allows for exciting matches at all levels of play.

One of our primary objectives was to design a feasible game, both for FIRST, and for the teams. Last year, many teams, including ours, struggled to find enough power cells to test and practice with. Hay bales, which are simply five-gallon buckets wrapped in fabric, can be easily found at any hardware store for a fraction of the price of last year's power cells. In addition, five-gallon buckets will not go to waste after use in an FRC season. Instead, they can be repurposed for storage containers, trashcans, and a variety of other uses.

Overall, "Harvest" is designed to be a fun and feasible game that will raise awareness about the importance of innovation in agriculture and promote the core values of FIRST.

### **Describe Notable Field Elements:**

"Harvest's" game piece is the hay bale. Hay bales are five-gallon buckets, 14.50 inches tall, 11.91 inches in top diameter, and 10.33 inches in bottom diameter, covered in durable yellow fabric. We chose to use five-gallon buckets because they are inexpensive and easy to obtain. They can also be reused after the season comes to a close. Robots can access hay bales from the haystack in the center of the field and from the loading stations, located in the corners of the field. Hay bales can be scored on pallets or in the barn.



Silos are the main place to score hay bales, and each alliance has one in the center of their side. Each silo contains five pallets, each of which has three levels and an alignment line. Pallets are attached to chains with large rings at the end. Chains can be pulled to hoist pallets, earning additional points for each hay bale on the hoisted pallet.

The barns serve as alternative locations in which to score hay bales and are located next to each alliance's center driver station. Hay bales can be scored either vertically or horizontally, with bonus points being awarded for each pair of hay bales in different orientations. This provides a "low goal" for less experienced teams, and a challenge for the more experienced teams, rewarding them for being able to manipulate and score hay bales in multiple orientations.

During the endgame period, robots climb their solar charging stations, which are located halfway between the two alliance walls on the edges of the field. Robots can either park, climb off the ground, or climb above the wood. Points are awarded according to how high the robots climb.

"Harvest's" field elements are unique, inexpensive, and easy to obtain or build.

### **What are robots expected to do?**

"Harvest" is designed to accommodate multiple game strategies by offering scoring locations of varying difficulty and point values to play to each team's strengths.

Inexperienced teams will contribute to their alliance by crossing the auto line and completing straightforward cycles. The loading station, lowest pallets, and barn are designed to be only four inches off the ground, simplifying robot design, while allowing robots to remain competitive. Although the option to play defense exists, "Harvest" emphasizes contribution to the alliance through scoring. At the end of the match, inexperienced teams can choose to park or climb using the cut-out slot.

Mid-tier teams will consistently cross the auto line, possibly placing their pre-loaded hay bale. Mid-tier teams will likely decide to collect hay bales from the ground or loading station. Another design consideration is the ability to score hay bales both vertically and horizontally in the barn, which would increase complexity, but also increase potential points. For the majority of the match, mid-tier teams will aid their alliance by filling all levels of the pallets, as well as hoisting. During endgame, these teams lift themselves off the ground, achieving either a low or high climb, occasionally allowing them to earn the "Fully Charged" ranking point.

During the autonomous period, top-level teams will aim to cross the auto line, place their preloaded hay bale, and pick up another hay bale. They will be able to collect and score hay bales in all locations and orientations. Most notably, they will cycle through hay bales significantly quicker than other teams, enabling the "Filling the Silo" ranking point. During endgame, they will consistently achieve high climbs and the "Fully Charged" ranking point.

"Harvest" embodies FIRST's core value of inclusivity, ensuring that teams of all skill levels are able to compete and enjoy the game.

### **Did you use the Game Design Challenge Element in your concept?**

Yes

#### **If yes, how?**

A key scoring method in "Harvest", and the only way to earn the silo ranking point, is through hoisting pallets of three hay bales off the ground. This is achieved by pulling down on a chain with a large ring at the end, as shown in the game animation. Five chains run through the center of the silo - across pulleys of different heights to prevent them from colliding - and lift the pallets on the opposite side. We wanted to incorporate chains in a way in which they would be the ideal element for the circumstances, rather than

shoehorning them into a situation in which a rope would work just as well or better. As part of the silo, the chains allow for simple field assembly (no annoying knots or frayed ropes), are strong enough to transfer bucketloads of mechanical energy, and are more durable than rope (no replacing halfway through a competition, causing delays).

After discussing many different ways to incorporate a chain into our game, including as an endgame climb or even chaining robots to each other, we decided on this use of the chain because of its relative simplicity and unique challenge. Pulling the chains to hoist the pallets serves as the “high goal” of our game, requiring teams to reach up and pull down with significant force. Because the chain that hoists a given pallet is on the opposite side of the silo, teams are encouraged to work together to load hay bales onto pallets, then hoist the pallets. Furthermore, the more moving parts a game field has, the more engaging the game will be. We implemented the chain in such a way that pulling a ring on one side of the silo causes a pallet on the other side to move.