STATIONARY HIGH-GOAL-STACKER AND INTERDICTOR

Design Plan for VRCC 2012-2013

Edward Zhang
Alumni, Exothermic Robotics
Columbia University Class of 2016
31 December 2012

This plan is specifically meant for the VEX College competition. Its usefulness for the high school competition is limited by dimensional restraints (more difficult to build) and qualifying round structure (specialist robots all require some luck). Read Brian Culver's *Game Breakdown, Diagnosis, and Robot Design* paper for a great introduction to point scoring analysis for the 2012-2013 game. I will be following some of the simplifying assumptions he advocates for ease of scoring calculations.

I cannot reconcile myself (or keep a straight face) to using the official name of this year's competition, nor its eponymous scoring objects. I will refer to them as the "2012-2013 VRC game" and "objects."

FUNCTIONAL OVERVIEW

The design concept hinges on the point-counting mechanics of the VRC 2012-2013 game. Objects scored in the high goal are worth roughly twice as much as objects scored in the trough.

If "our" team is able to put the opponent high goal out of commission, by blocking access to it for the duration of the match, the opponents can only score into their two troughs. The maximum object capacity of a trough is around 60, a "single-goal equivalent". If "our" team is further able to effectively lower the scoring area of the opponent's troughs by one trough equivalent through passive and active interdiction, it follows that the opponent's total scoring area can only support 300 points, given more than 60 objects. If "our" team were able to score 30 objects into their own high goal, that would also be equal to 300 points. Now suppose "our" team can hoard 30 sacks, removing them from opponent play in addition to the 30 that are stacked and protected in "our" high goal. The opponents have less than 42 objects left to score in their single trough equivalent area. The math does not bode well for the opponent's ability to win the match, especially concerning in the fact that "our" team doesn't even require trough scoring in two open troughs to win.

DESIGN REQUIREMENTS

Scorer requirements:

- Semi-stationary: Anchors to scoring position through a combination of static friction and mechanical support.
- Continuous outtake: An outtake and scoring system that does not actuate and instead moves objects continuously with a belt.
- High-goal stacking: Places objects into high goal in a kinetically stable layout as to allow 25-35 objects to stay scored.
- High-goal defense: Blocks opponent high goal with angled plate on a flip-up mechanism.
- Hoarding: Can store 20-40 objects on or in robot.
- *Additional features: Can block or semi-block one trough, can divert scoring to trough.

Loader requirements:

- Highly-mobile: A robot with 60 to 80 percent of motor power devoted to drive base, can displace opponent robots.
- High-speed pickup: Feed system optimized for pickup at maximum forward speed.
- Quick offloading: Fast elevation and dropping of scoring objects into scorer's loading tray [perhaps a motor-wound tension actuated system]
- Interdictor: Robot maneuvering and arm mechanisms to de-position opponent robots and to remove scored opponent objects.
- *Additional features: Can score in troughs, gear shifter.

HYPOTHETICAL LAYOUT

The scorer is a 25-inch-cubed robot consisting of a double-wide, vertically-unfolding, 40-inch total length top-bottom belt mechanism, one end elevated 10 inches above high goal height, with a bottom section consisting of a loading tray that can sort objects to drop onto the belt. This scoring mechanism is mounted on a high-speed base. The scorer includes a pneumatic or trigger-sprung set of anchoring mechanisms against the floor, the trough supports, the troughs, and the high goal. A flip up mechanism that obstructs access to opponent high goal is also necessary. The scorer may additionally have a trough blocker/descorer, and a gear shifting system to divert base power to elevation and belt power.

The loader is a 12-inch-cubed robot consisting of an unpowered spatula pickup feed tray with capacity of between 15 and 20 objects and 12 inch quick dump height on a flip-out 45-degree-holonomic base powered by 8 or more motors. The pickup tray also functions as a descoring mechanism. The loader is more of an empty slate in terms of design possibilities.

POSSIBLE GAMEPLAY

The match starts with the scorer driving straight out to the center of the field, lining up with the goals and anchoring itself, while elevating and folding out its double-wide belt mechanism and high goal blocker. The loader fills its tray with between 10 and 20 objects. 10 seconds have passed. The loader dumps its objects into the scorer's tray, while the scorer scores its preload onto the high goal to begin organized stacking. The scorer sorts objects from the tray on to the belt (pneumatically actuated ramp diverter) such that objects are staggered horizontally on the belt in order to offset their stacking positions when scored onto the high goal. By the time of the loader's second dump, 30-40 seconds have passed since the start of the match. The loader will make one to two more dumps, then play full-interdiction mode by the last 40 seconds of the game. Realistic endgame score, 320 to 280, but with scoring room over "our" point count, and no more scoring room over opponent's point count.

CONCLUSION

Thank you for reading this plan. Essentially, this post was born out of my inability to complete the design formally in CAD early on (this idea originated in July 2012), and the complications I saw in trying to plan a long-distance logistically-organized college team. I really loved my many high-school hours of VRC, but so far college academics are turning out to be quite the time commitment. I think my robotics completion days may be over for all but these musings.

Having built and been burned by many infeasible designs, but also having successfully implemented a couple very structurally miraculous designs, I would say that this design is very feasible. Actuation and proper function is completely possible with conservative estimates for motor and pneumatic force, without any dependence on elastic tension or "cross your fingers and hope that this works when built" type-issues. People have done far crazier feats of VEX engineering. This is totally doable. I hope this was helpful.