# Engineering Notebook

FTC 7347

October 7, 2014

Matt Iverson
2014-09-16
Brainstorming

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| This week, I calculated the space we'd need for a scissor lift / conveyor belt mechanism. | The mechanism will fit and reach high enough, but it'll take up a lot of space. |

I measured our team's conveyor belt to be 2.5 inches thick. Our robot can be up to 18 inches tall, so we can fit up to 7 layers of the conveyor belt on our robot. We'll need about 2.5 inches on each side of the conveyor belt for tubing to move balls between belt layers, so the belt can be up to 13 inches long. 13 inches at a 45 degree angle is approximately 9.2 inches up and to the side, meaning our scissor lift could reach up to 64 inches (163 cm). This is well above the top of the center goal (120 cm), but I think the system will likely collapse under its own weight at that height.

Ben Trout
2014-09-19
Brainstorming, Designing, and Promoting FTC

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| Brainstorming | We started our brainstorming by making three subsystems for scoring blocks: Intake, Lifter, and Scorer. We had a bunch of designs down and ideas flowing. As a team we we're able to list pros and cons of all the designs mentioned and narrowed it down to just a few quality designs. |
| Designing | Once we had our ideas pinpointed that we thought would be best for accomplishing the challenge we started to design different components of the robot. Me, Nick, and Alex mainly focused on the intake method of picking up balls. |
| Promoting FTC and FIRST | I went to a lego robotics meeting with my FRC team for recruiting Lego Robotics coaches for the FLL league at liberty that we're starting up. We wanted to promote all three levels of FIRST. We had old lego robots for demo, I brought a ball shooting FTC robot I built and my FRC team brought their worlds robot from last year. We demo'd all the robots and got the kids exited for robotics, hopefully they will move up in the FIRST levels and be on the Liberty FTC team in the future. |

## Brainstorming

Ways to play the game:

- Tip rolling goal onto ramp. Shuttle balls up and down ramp
- Grab rolling goal and drive around with it putting balls in
- Put balls into center goal

Subsystems:

- Intake
  - scooper

  - rotating brush
  - conveyor belt
  - suction
  - rotating wheels
- Lifter
  - batched
  - continuous feed
- Scorer
  - active dumper
  - passive dumper
- Goal attachment
  - claw
- Drive base

Lifter/Scorer:
Trio of Archimedes Screw
Conveyer belt Tri belt Pulley system
Guided launcher mechanism
Ball sorter
Scissor lift with conveyer belt to bring balls up
Spring Shot with guided tube
Pulley system
surgical tubing sling shot with guided tube

## Designing

As a team we finalized on rotating brushes to intake the balls, a surgical tubing sling shot with a guided tube into the goals, and a passive dumper. Our main idea for scoring is using claws to attach to the base of the goal and carry it around with as we launch balls up a tube and deflected into the goal. We have rotating brushes that intake the balls into a slingshot that launches the balls into a guided tube that is extended and retracted by a pulley system. The only part of our brainstorming that we have designed is our intake:

The balls flow under our robot where one rotating brush brushes up a wall bring the balls up into the robot and deflected onto a ramp that leads the balls into the slingshot. The odds of surpassing the five ball limit is low so we aren't going to incorporate a sensor yet. We did a lot of calculations like how many balls we'll pick up per second, size of balls, and if different ideas like a scissor lift will fit in our Robot. I wasn't in charge of calculating, but other team members like David and Matthew were.

## Promoting FIRST

At the meeting put on by my FRC team our main goal was to get Lego Robotics coaches for the starting lego robotics program at Liberty. We want to get young students excited for robotics

Alex Iverson
2014-09-22
Strategizing and Brainstorming

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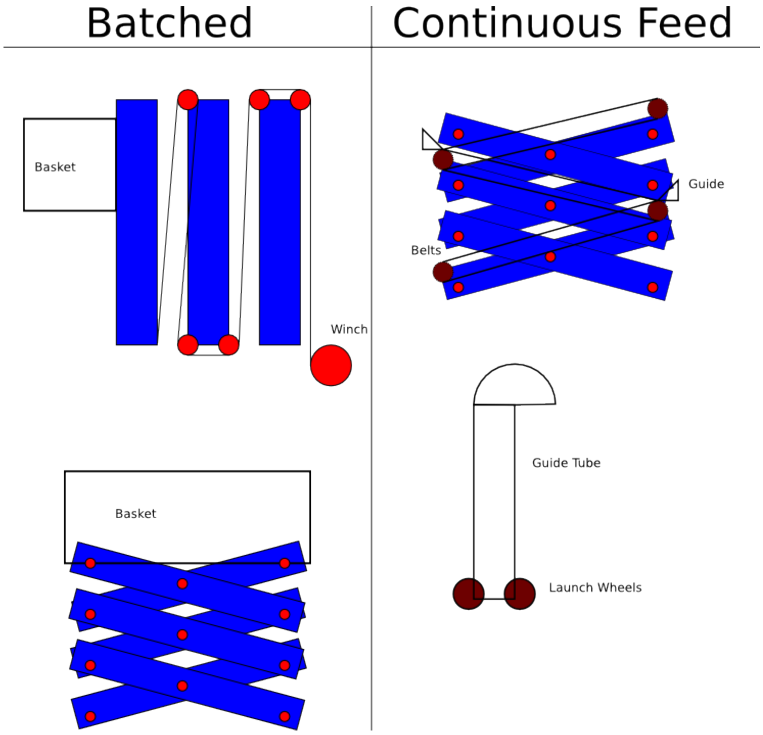
| I worked on Identifying ways to play the game. | I think we were fairly thorough. I do not anticipate seeing any major strategy elements at the tournaments we have not anticipated. I do, however, expect to encounter a combination or variation that we have not considered. |
| I helped brainstorm types of players we could build. | I would have liked to have come up with more possibilities, but I can not think of anything to add. However, it is taking a long time to analyze the ideas we have because some of the team members need to be trained how to do so; Having too many more ideas may take too much time. |

The first thing we did was try to identify what interactions with the field elements were involved in playing the game. Then we looked at how these interactions could be combined into strategies.

The first major challenge was to organize the brainstorming. Because I have more experience with designing for the FIRST competitions, I led the effort. I had difficulty conveying the distinctions between subsystems and mechanisms for the purposes of strategizing. Subsystems are categories for how the robots can interact with the field and gameplay elements, for example, a batched scorer versus a continuous feed scorer, or a rolling goal pusher versus a rolling goal grappler. They are relevant to strategy because those distinctions affect what the robots are able to do on the field. A mechanism is an implementation of a subsystem, and is largely irrelevant to strategy, because how a robot plays is much more dependent on what it can do rather than how it does it, for example, whether the robot uses a scissor lift or a forklift style pulley system to lift the balls is not important because as they are both batched scoring systems they are subject to very similar performance and limitations.




We tried to estimate the performance of various subsystems to determine the effectiveness of the strategies. A batched lifter and scorer system is limited because it needs to be in a down position while collecting balls and a raised position while scoring, so its scoring rate is reduced by its travel time. A continuous feed lifter and scorer system, on the other hand is limited by needing to have a goal on hand and its requirement to handle balls in single file (this is a simplifying approximation that we assume will be proven wrong at some point.). We computed the average density of the balls based on the assumption that they would be uniformly scattered across the field area. That density allowed us to estimate the rate at which an intake of a given width would encounter balls. These calculations allowed us to estimate the scoring potentials and limiting factors of each potential design, so that we can make an informed decision about what type of robot we want to build.

Ben Trout
2014-09-24
Brainstorming, Calculating

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| Brainstorming | We established our intake last week so we went over our lifter/scorers and went over what path we want to pursue using pros and cons of all the ideas the team had. |
| Calculating | We started by doing a bunch of calculations to see if it is even possible to launch a ball to the correct height. Alex is in charge of the calculations but Filip and I helped him with measurements. See Alex's notebook for calculation |

# Brainstorming

As a team we went through all the pros and cons of our four lifter/scorers: **Batched:**

Pros: possible, easy, reliable, simpler Cons: unreliable

**Continuous Feed:** Pros: faster than batched Cons: unreliable

**Scissor lift with conveyor belts:** Cons: complex mechanically, take up a lot of room, require a lot of power to run, slower than a shot, Gear system to reverse direction of belts: difficult to build

Pros: continuous feed, multiple balls traversing mechanism at once, possible with the parts that we have at hand, store balls along conveyor belt and score balls in end game.

**repeating sling shot:** Cons: requires large rates of fire, needs to be super reliable, needs to be able to handle a failed shot, wearing out the surgical tubing (loses elasticity over time)

Pros: Faster feed, lower transit times (to not get penalized for carrying more than 5 balls), reliable, easy to build, shoots straight up, more consistent than spring shot, faster reset time than spring shot

**Spring shot:** Back up plan if slingshot fails

**Belt variant:** Cons: very slow (but not as slow as scissor lift) balls could fall off easily, hard to build, unreliable

Pros: see pros of scissor lift

Guide tube with pulley system: hard to build a telescoping tube, manufacture the plastic tubing very precisely. and integrate pulley system.

**Best Idea:** Sling shot

We are going to split our group into two teams: One to prototype the intake system and one to prototype the sling shot. We are going to design them first and get a bill of materials.

We split of into two groups for the two prototypes: Intake: Mat, David, Alex Slingshot: Ben, Filip, Nick

## Math

Me, Nick, and Filip helped Alex calculate whether or not we can actually launch the balls 120cm with the surgical tubing we have. See Alex's enginering notebook for all math calculations.

Alex Iverson
2014-09-29
Designing Mechanisms

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| Analyzed pros and cons of various mechanisms | Although fairly straight forward, this discussion was also hampered by miscommunications regarding Mechanisms and Subsystems |
| Began computing requirements for mechanism | This is much slower progress than it should be. Most team members' lack of prior math and physics training means that each calculation has to be accompanied with lessons and explanation |

We have decided that the mechanisms we want to attempt to build first are a rotating brush intake and a slingshot based lifter. We have divided up into two teams. I am drifting between them, helping explain what we need to do to design them and figure out what parts we need to order before we go out and buy them. My brother is working on the intake; he needs very little guidance. The lifter team, however, has not yet completed a physics class; given how slowly the design and calculations are progressing right now, I will probably have to switch from showing them how to do the calculations to showing them by doing the calculations. I am confident that once we have designs and materials, the other team members will be much more productive.

Motor load current draw = 0.91A
Motor voltage = 12V
Motor power = 0.91A $\cdot$ 12V = 10.92W
Mass of large ball = 28.9g = 0.0289kg
Density of polycarbonate = $1.22\frac{\mathrm{g}}{\mathrm{cm}^3}$
Thickness of plastic = 0.125in = 0.3175cm
Diameter of large ball = 2.8in = 7.112cm
$\Delta$height = 120cm = 1.2m

$$\Delta U = mg\Delta h = 0.34\mathrm{J}$$

$$t = \frac{\Delta U}{P} = 0.031\mathrm{s}$$

$$f = \frac{1}{t} = 32\mathrm{Hz}$$

What we are doing now would ideally qualify as prototyping, however, it is being executed far too slowly and ponderously to be call it such. The scarcity of materials for our team means that we can't just put together a wood and cardboard mockup to sanity check the ideas. The rest of the team would much rather tinker, and I want to agree, but we do not have all the components required for our ideas on hand, and if we just start buying things without a reasonable idea of what we need then we are likely to run out of money before being able to finish our robot.

our team name has not been decided yet.

Filip Lewulis
2014-10-01
Designing

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| Designing | We considered the lifting mechanisms from looking at last year's FTC competition, but our calculations for intake appear to remain viable. Alex has written the LaTeX for the maximum rate of fire while introducing us to the syntax. I am following the PTC Robotalk tutorial for using CREO. Ben is researching the materials we can use in accordance with the rules for the robot's components. The launch mechanism is being designed by Matt, David, and Nick. And in accord, our team name is **Children of the Matrix**, which is nice, I guess. |

We're all working independently, but next week we plan to reconcile our efforts and begin actual construction of the robot.

Nick Vosseteig
2014-10-03
Set up, helping other teams, and finding materials.

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| Set up | One thing we did this week was set up Miktex and Github, and moved over the other engineering notebooks that we had written beforehand into the new system. We now have everything set up and engineering notebooks in the future will be easier to format/create. |
| helping other teams | Since there are two other, less experienced teams at our school, this week I also helped them set up the programs that they needed to test out some of the things they had built for their robot. Most were unfamiliar with RobotC, so I helped them to write basic programs. |
| finding materials | We decided to buy some surgical tubing this week so that we can start building a prototype of the launcher next week. |

## Miktex and Github

This week the main thing we worked on was setting up Miktex and Github so that we can format our engineering notebooks in a more consistent and better formatted.

## Helping other teams

The other thing I did this week was help the other teams program their prototypes for certain parts. This was hard because none of them had any experience with programming previously. I managed to help them write some code that allows them to control the motors on their robot with the logitech controllers.

The last thing we did was come up with a basic design for the launcher and tube mechanism that we plan to build with the surgical tubing we are going to buy.

Alex Iverson
2014-10-06
Git, LaTeX, Engineering Notebook, and Calculations

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| Setting up Git | I walked the team through the process of creating github accounts, installing git, and configuring it. This was not very smooth, and I still have work to do making sure everyone is able to use these tools well. Ideally we would have done this in the preseason. |
| Setting up LaTeX | I walked the team through installing MiKTeX. This went relatively smoothly, but there is still a ways to go before everyone is able to use LaTeXand the editing environment well. |
| Converting the Engineering Notebook. | I created the basic file structure for the Engineering Notebook and began converting the entries into LaTeX. |
| Calculations for the slingshot scorer | I ran calculations for the theoretical maximum rate of fire that could be achieved based on the motors' power output. The results suggest that the design is plausible, but it is sufficiently close that I will refrain from judgement until we have a demonstrable prototype. |

The Git Bash and MiKTeX are now installed on our team's computers. We will be writing our Engineering Notebook in LaTeXbecause it is a better system to write technical documents in than the Google Doc we started with. Git's distributed source control allows us to collaborate more effectively and reduces conflicts from concurrent editing. It will also allow us to maintain source control even when we don't have internet access like at a tournament.

Here are the calculations for the slingshot:
Motor load current draw = 0.91A
Motor voltage = 12V
Motor power = $0.91\text{A} \cdot 12\text{V} = 10.92\text{W}$
Mass of large ball = 28.9g = 0.0289kg
Density of polycarbonate = $1.22\frac{\text{g}}{\text{cm}^3}$
Thickness of plastic = 0.125in = 0.3175cm
Diameter of large ball = 2.8in = 7.112cm
$\Delta$height = 120cm = 1.2m

$$\Delta U = mg\Delta h = 0.34\text{J}$$

$$t = \frac{\Delta U}{P} = 0.031\mathrm{s}$$

$$f = \frac{1}{t} = 32\mathrm{Hz}$$

$$K = \frac{1}{2}mv^2 = 0.34\mathrm{J}$$

$$v = \sqrt{\frac{2K}{m}} = 4.9\frac{\mathrm{m}}{\mathrm{s}}$$

$$m_{\mathrm{plastic}} = (1.5 \cdot 7.112\mathrm{cm})^2 \cdot 0.3175\mathrm{cm} \cdot 1.22\frac{\mathrm{g}}{\mathrm{cm}^3} = 44\mathrm{g}$$

$$K_{\mathrm{plastic}} = \frac{1}{2}m_{\mathrm{plastic}}v^2 = 0.529\mathrm{J}$$

$$K_{\mathrm{total}} = 0.34\mathrm{J} + 0.529\mathrm{J} = 0.869\mathrm{J}$$

$$t = \frac{K_{\mathrm{total}}}{P} = 0.079\mathrm{s}$$

$$f = \frac{1}{t} = 12.5\mathrm{Hz}$$