FIRST Robotics: The Farm Team for Tech

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Introduction

- Who are you?
  - Has anyone NOT heard of FIRST?
  - Who has seen a “robot games” video?
  - Who has a child in FIRST?
  - Who has been to a competition?
  - Who has volunteered for FIRST in any capacity?

Introduction

- Who am I?
  - Engineer and consultant
  - Volunteering as a FIRST judge since 2014
    - Totally blown away by what these young people can do!
  - Mission: share this story
    - A whole lot more than just robot games

Introduction

- Purpose of talk
  - So that you can recognize what a FIRST alumnus brings to the table
    - Enlightened self-interest
  - To encourage support for the FIRST programs
    - Corporate
    - Personal

Fun & Games...

- Competitions drive technological advancement
  - Schneider Trophy seaplane races

1925: Curtiss RC3-2

1931: Supermarine S.6B

...Until Things Get Hot!

- Racing engineers switch to warplanes

Curtiss P-40 Warhawk

Supermarine Spitfire

Competitions & Challenges

- 1913 – 1931: Schneider Trophy
- 1995 – Present: “X Prize” Foundation
- 2004 – 2007 DARPA Grand Challenge
- 2012 – 2015 DARPA Robotics Challenge

Competitions & Challenges

- 1913 – 1931: Schneider Trophy
- **1989 – Present: FIRST Challenges**
- 1995 – Present: “X Prize” Foundation
- 2004 – 2007 DARPA Grand Challenge
- 2012 – 2015 DARPA Robotics Challenge

FIRST is...

- “For Inspiration and Recognition of Science and Technology”
- Invented by Dean Kamen in 1989
- A youth program
- “A sport for the mind”

FIRST® LEGO® LEAGUE JR. | FIRST® LEGO® LEAGUE | FIRST® TECH CHALLENGE | FIRST® ROBOTICS COMPETITION

- FIRST Lego League Jr.
  - Grades K – 3, 40k+ participants
- FIRST Lego League
  - Grades 4 – 8, 233k+ participants
- FIRST Tech Challenge
  - Grades 7 – 12, 51k+ participants
- FIRST Robotics Competition
  - Grades 9 – 12, 78k+ participants

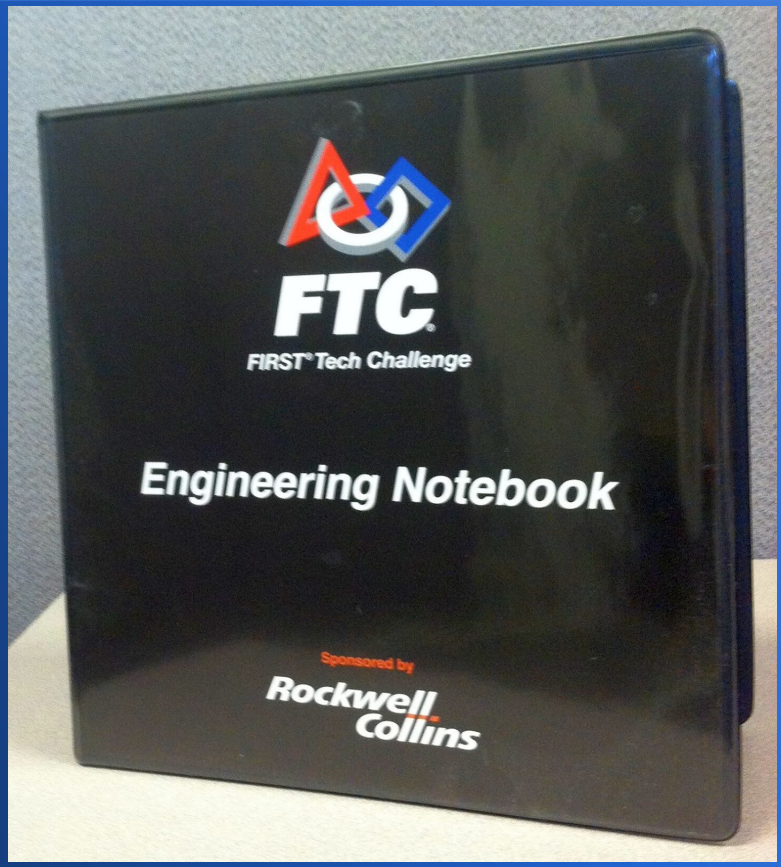
The FIRST Calendar

- Competition activities
  - Challenge release date
  - “Build” interval
  - Scheduled competitions
- “Off” time
  - Skills training
  - Outreach, business development
  - Sustainability

Documentation

- Internalizing the process
- Team memory
- Tool for team evaluation

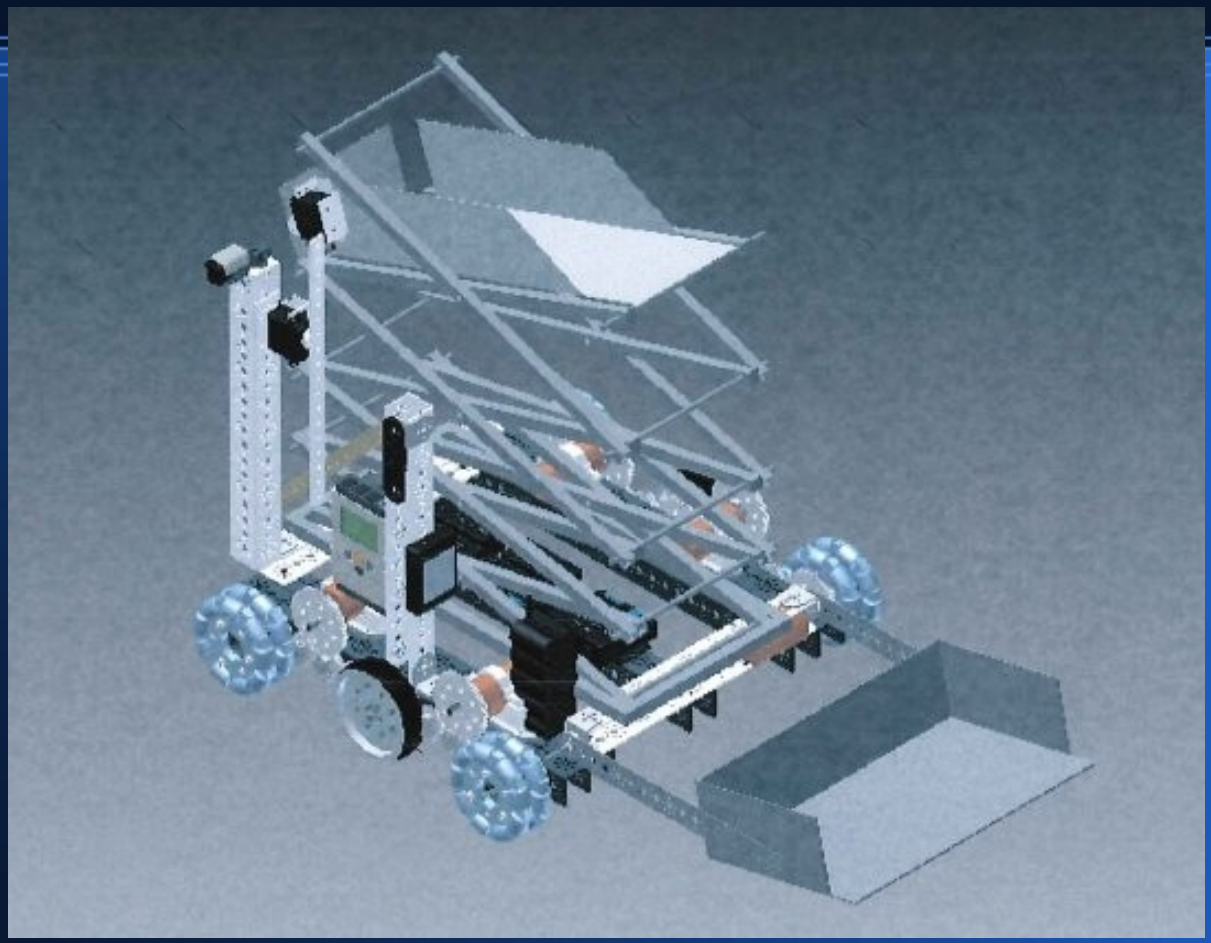
> "The only difference between screwing around and science is writing it down."
>
> – Adam Savage in MythBusters



Notebook Credits

- Team 4250: “Lightsabers”
- Team 365: “Miracles of Engineering” (MOE)
- Team 5037: “Got Robot?”
- Team 6134: “Black Frogs”

FIRST Can CAD



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Brainstorming - Design

FTC #6134 Black Frogs

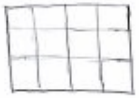
Session # 49 Date: 2/5/15

Task	Reflections
Protyping a new bucket design	- We had 3 ideas for a new bucket design. The first design is the bucket with an axis on it. The axis will be powered by a wheel on the floor. On the axis there would be a scooper that will turn with the wheel. Here is a drawing of it.  The second idea we had was basically the first idea, but instead of the scooper we used zip-ties.  The last idea we had was a frame with rubberbands across it. So when you pushed it down the balls would push through it. 

Recorded by: Anne George

FTC #6134 Black Frogs

Session # 49 Date: 2/5/15

Task	Reflections	
	PRO's	Con's
Bucket with axle 	• Balls would be "scooped" in • wheel can easily turn it • continuous turn • uses same bucket	• only uses 1/3s length of bucket • wheel could get run over + destroyed • can't get balls from edges
Bucket with zipties 	• Balls will be pushed in • wheel goes contin. • zipties keep them in • uses same bucket uses whole length	• zipties may not be strong enough • wheel could get run over • can't get balls from walls
Frame with rubber bands 	• balls will not fall back out • balls will easily go through the rubber bands • can get many balls at once • rubber bands are easily replaceable • can get big & small balls	• can't get balls from walls • rubber bands could break durring match • rubber bands can move • balls get stuck between rubber bands.

Recorded by: Sydney Grassmyer & Anne George

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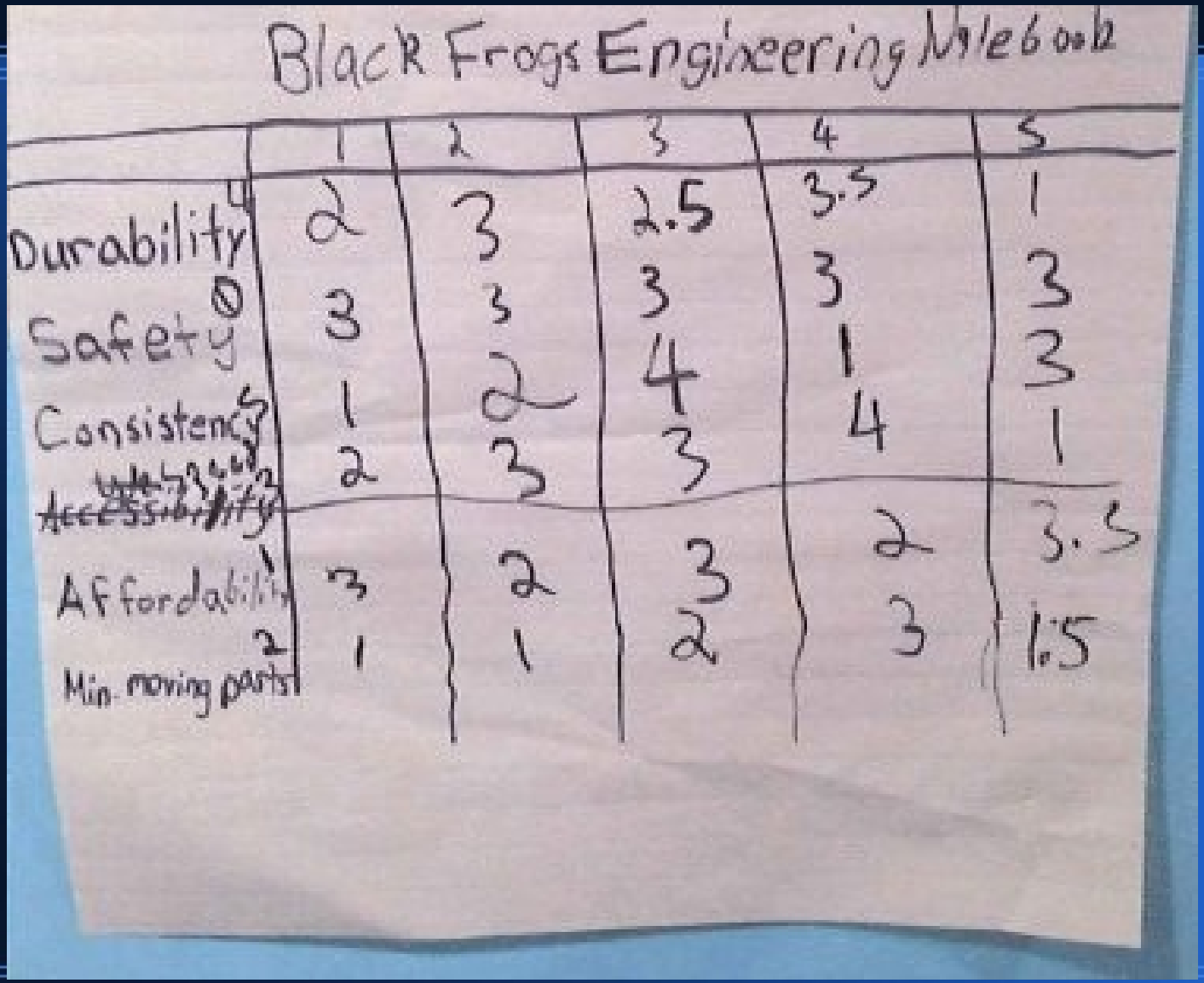
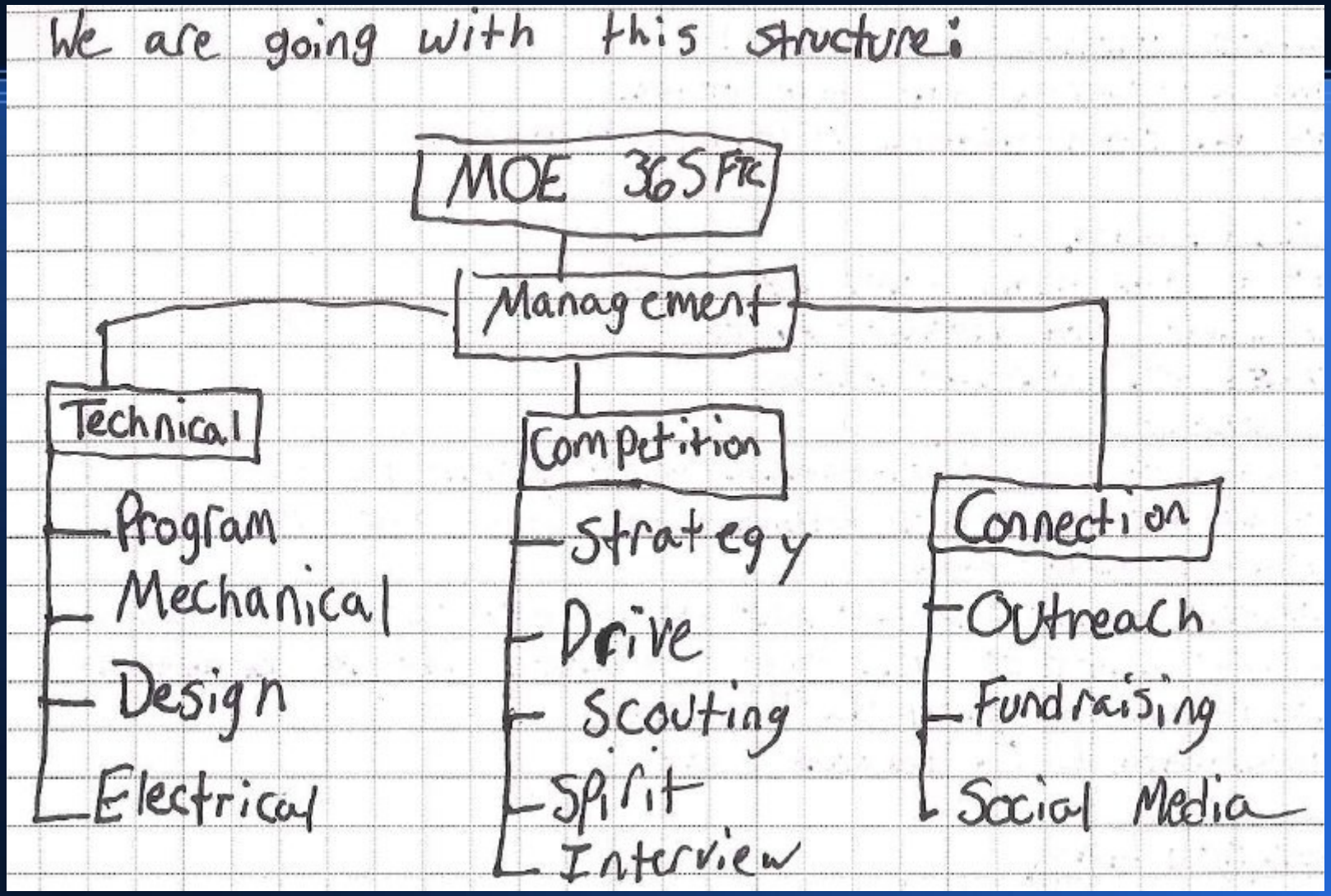
Design Evaluation



```
                motor[bucket_lift] = 10;
                driveForward(65, 5);
                wait1Msec(WAIT);
                gentleTurn(60, RIGHT);
                wait1Msec(WAIT);
                driveForward(100, 36);
                motor[IR_lift] = 0;
                wait1Msec(1300);
                gentleTurn(45, RIGHT);
                wait1Msec(WAIT);
                driveForward(60, 12);
                motor[bucket_lift] = 0;

                break;

                        }
        default: {                              //movements for emergeney situation
                        motor[IR_lift] = -30;
                        wait1Msec(2500);
                        motor[IR_lift] = 0;
                        gentleTurn(360, LEFT);
                        wait1Msec(WAIT);
                        break;
                }
        }
        return;
}
////////////////////////////////////////////////////////////

// the following block holds the turn sub-program

void gentleTurn(int turnDegrees, int turnDirection){
        int countsToTravel;

        countsToTravel = turnDegrees * CPD;

        nMotorEncoder[leftMotors] = nMotorEncoder[rightMotors] = 0;

        while (abs(nMotorEncoder[leftMotors]) < countsToTravel){
                if (turnDirection == RIGHT){
                        motor[leftMotors] = -100;
                        motor[rightMotors] = 100;
                }
                else {
                        motor[leftMotors] = 100;
                        motor[rightMotors] = -100;
                }
        }
        motor[leftMotors] = motor[rightMotors] = 0;
        eraseDisplay();
        nxtDisplayCenteredTextLine(0, "%d", abs(nMotorEncoder[leftMotors]));
}
////////////////////////////////////////////////////////////////////////////

// the following block holds the drive sub program

void driveForward(int power, int targetDistance){
        long totalEncoders, speedAdjust;
        long targetCounts;
        int encoderDiff;
        int distanceTraveled, robotSpeed, stallTimeHandle;
        long stallTime, d1, d2, runTime;
```

Running the Enterprise



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Managing a Big Team

To do this we completed a 3-phase approach:

1. Individual Assessments
2. Multiple Team Approach
3. One Team Merge

It was modeled after the MIT 2.009 Product Engineering Process Class that Woodie Flowers referred to in Aug 29, 2014 Ask an Expert YouTube video @27:30. https://www.youtube.com/watch?v=wwkbNqMYPgc

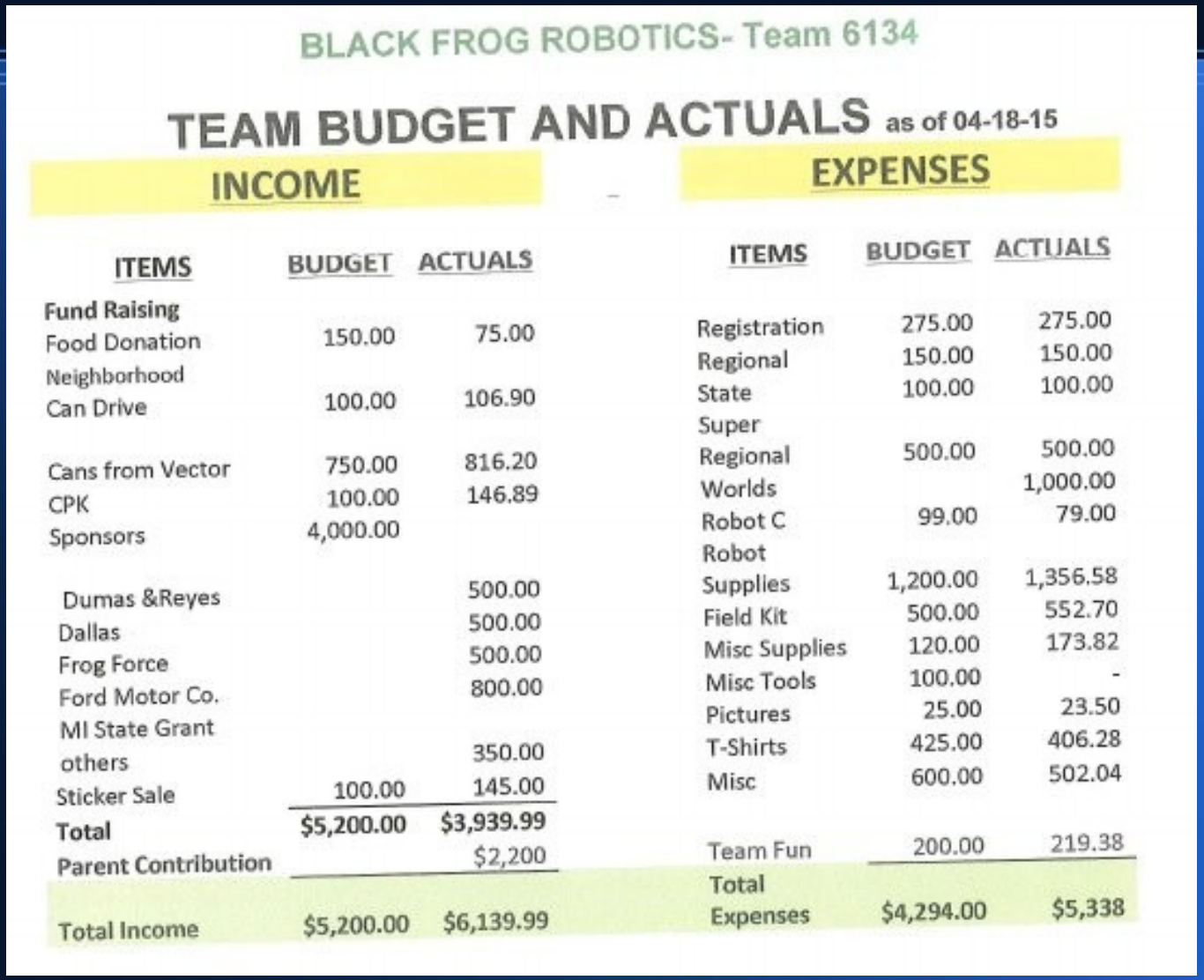
Individual Assessments:

In August, before the start of the season, each student and core mentors completed an assessment process. We wanted a system to help place each student in the key roles of our team: Designer, Builder, Programmer, Graphic Artist, Driver, Public Communicator, and Captain. Coach Vince developed an assessment that included 5 separate surveys:

1. Gallup STRENGTHSFINDER®
2. O*NET® Interest Profiler
3. Characteristics Self-Assessment
4. Personal Experience History Log
5. Personal Ranking of Interest in Team Roles

After completing the assessments, we realized we were missing a key role-Spirit! Some students had skills for connecting with others. They were interested in having fun as a team and were strong in the relationship-building strength domain according to the Gallup STRENGTHSFINDER® assessment. "Spirit" was added as one of our team roles. Appendix B contains the skills assessments.

Managing Finances



BLACK FROG ROBOTICS- Team 6134

TEAM BUDGET AND ACTUALS as of 04-18-15

INCOME

ITEMS	BUDGET	ACTUALS
Fund Raising		
Food Donation	150.00	75.00
Neighborhood Can Drive	100.00	106.90
Cans from Vector	750.00	816.20
CPK	100.00	146.89
Sponsors	4,000.00	
Dumas &Reyes		500.00
Dallas		500.00
Frog Force		500.00
Ford Motor Co.		800.00
MI State Grant		
others		350.00
Sticker Sale	100.00	145.00
Total	**$5,200.00**	**$3,939.99**
Parent Contribution		$2,200
Total Income	$5,200.00	$6,139.99

EXPENSES

ITEMS	BUDGET	ACTUALS
Registration	275.00	275.00
Regional	150.00	150.00
State	100.00	100.00
Super Regional	500.00	500.00
Worlds		1,000.00
Robot C	99.00	79.00
Robot Supplies	1,200.00	1,356.58
Field Kit	500.00	552.70
Misc Supplies	120.00	173.82
Misc Tools	100.00	-
Pictures	25.00	23.50
T-Shirts	425.00	406.28
Misc	600.00	502.04
Team Fun	200.00	219.38
Total Expenses	$4,294.00	$5,338

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Enterprise Continuity

4.2 Sustainability

This is MOE FTC's eighth season. We are under the parent umbrella of First State Robotics as a non-profit organization. Our team raises all funds through direct sponsors, volunteer funds, team fund raising events and small team dues.

Our team is dedicated to building long term relationships with our sponsors by actively engaging them through the season. We have done employee demonstrations and events at Axalta, Boeing and Dupont. In addition, we ensure their logos are prominently displayed on our robot and team shirts.

We attract students from various schools and home school organizations. MOE FTC actively seeks new students before the season. The team usually has 2-3 new students every year to ensure a balance of experience that can be passed from more senior team members to new team members.

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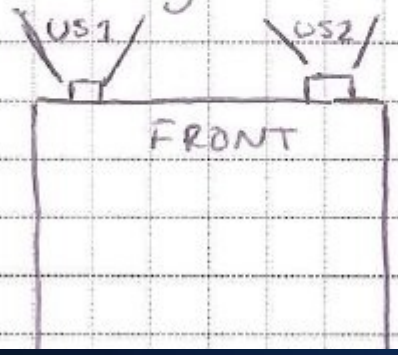
Building Capabilities

Programming Summer Work - Sensors!

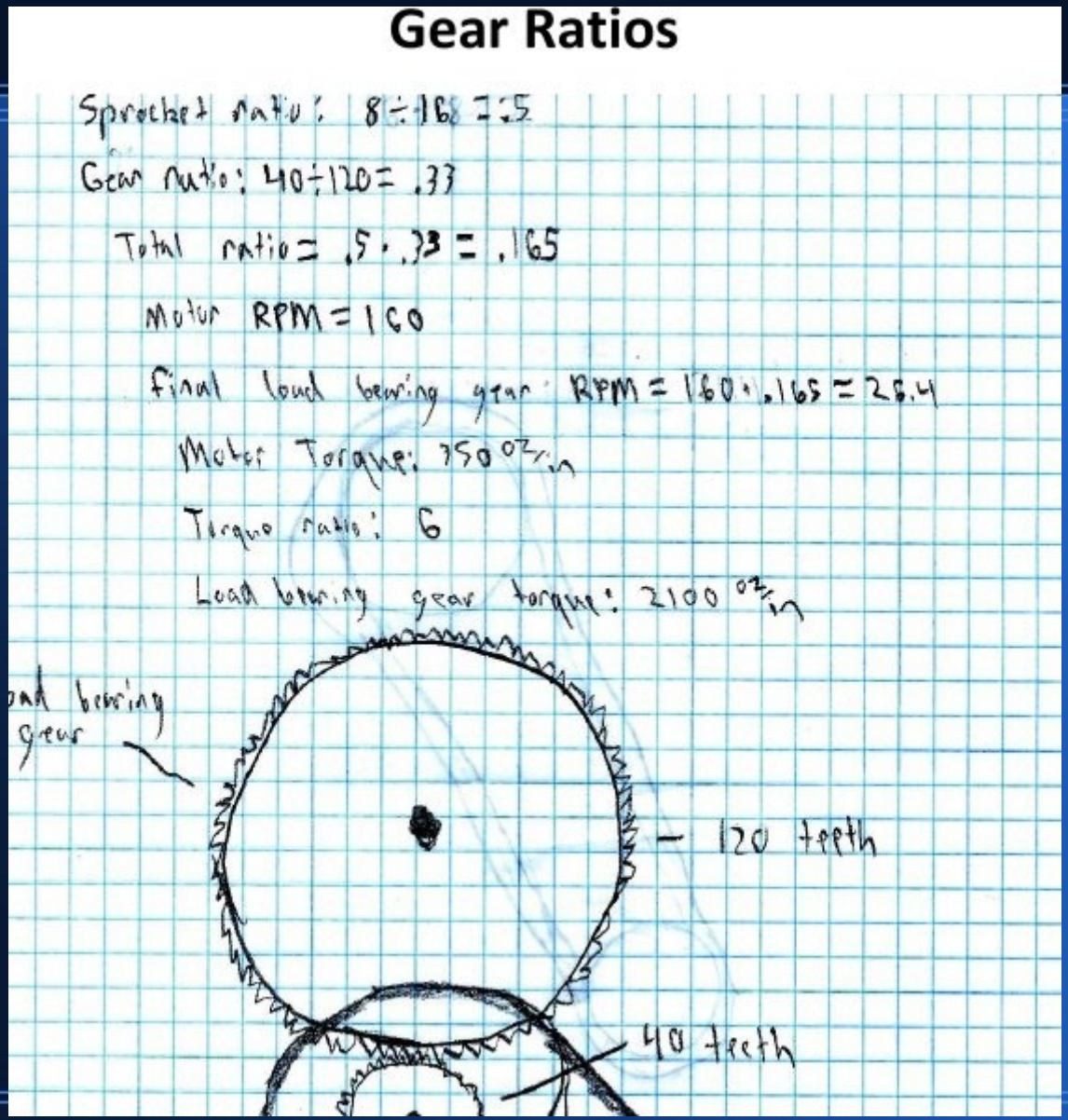
Over the summer, I have been testing out various sensors that can be used in next year's game. Mainly, I have been working with the LEGO-ULTRASONIC and HITECHNIC-ACCELEROMETER sensors. Along with our own custom code, our team uses "Xander's Drivers", which are a set of drivers with custom functions made by Xander Soldaat, and can be found on GitHub. Xander's Drivers give us more freedom and flexibility we can use to greater enhance our robot's functionality.

Ultrasonic sensors measure the distance an object is from the robot. The following code is an obstacle avoidance program, requiring 2 front-facing ultrasonic sensors (shown below):



The code "sees" an object in the left sensor, moves left until the right sensor is clear of the object, and then moves forwards again.

Running the Numbers

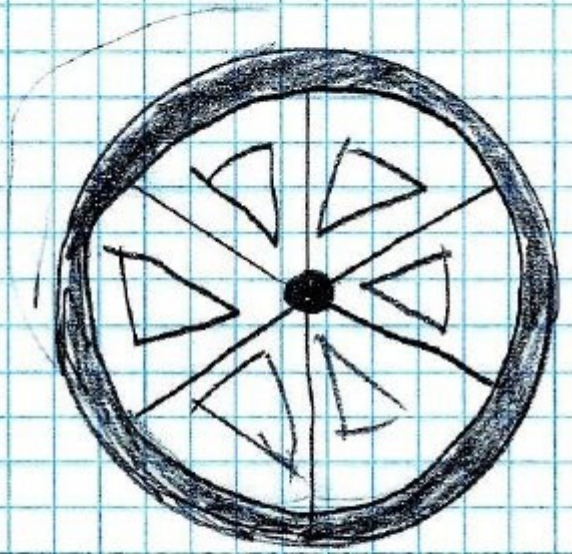


Running the Numbers

Competition bot Monster truck wheel

diameter: 5 inches

Circumference: $5 \cdot 3.14 \approx 15.7$ inches



Optimal Motor RPM = 160

1 rotation = 15.7 inches of travel

Travel rate = $160 \cdot 15.7 = 2512$ in per minute

$\frac{2512}{60} = 42$ in/sec

$\frac{2512}{12} = 209$ ft/min

$\frac{209}{5280} = .04$ miles/min

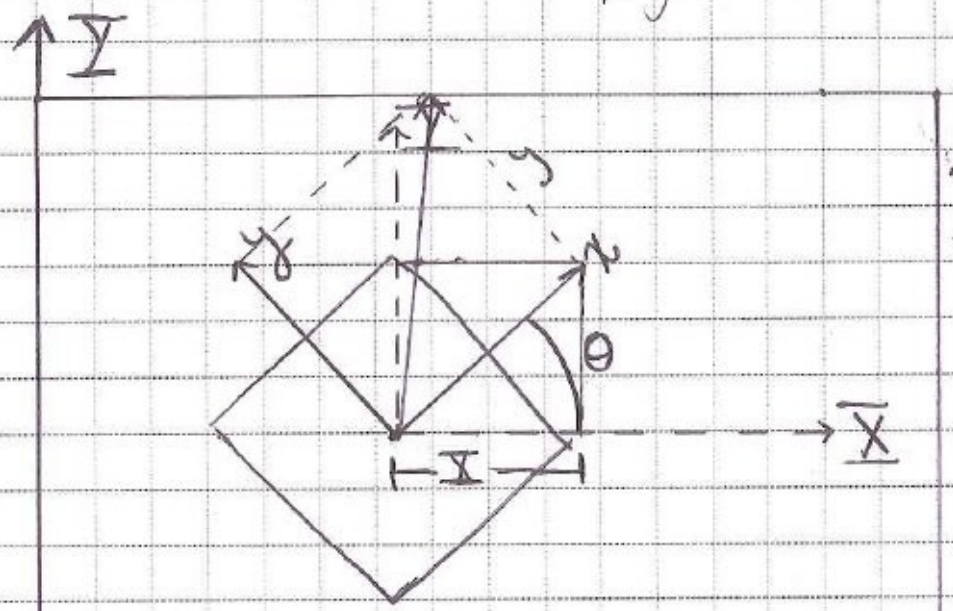
$.04 \text{ mile} \cdot \frac{60 \text{ minute}}{1 \text{ hour}} = 2.4$ mph

Lightsabers 335

High Concept

Field Centric TeleOp

With a mecanum drive, there are two types of user control. One is "robot centric" - this means forwards, backwards, right, and left are relative to the robot, and change as the robot rotates. The other is "field centric". Field centric means all directions are relative to the driver. Pushing up on the joystick should cause the robot to move away from the driver, no matter how it is rotated. This drive system is more complicated to program, but in most ways more intuitive for the driver. We used some trigonometry to perform a coordinate transformation and program this drive:



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Competitive Analysis

1. The percentage equals the amount of teams we believe are going to attempt that particular scenario.

Autonomous	90% - Easy	75% - Med.	20% - Hard	10%> - V Hard
20 pts. - Drive off ramp	X			
30 pts. - Kickstand		X		
60 pts. - Center goal				X
90 pts. - Ball in each goal				X
60 pts. - Goals in parking zone			X	

Lessons Learned

Strengths	Weaknesses
Drive train is strong Lift cone works really well CAD Accuracy of delivery Hot keys on game pads Strategy was sound Bumpers protected robot	Demo Program failed in judging Judging wasn't as receptive as hoped
Opportunities	**Threats**
All test program Proximity Sensors Fail safes Easier to remove shields Robot diagram needed for pit and notebook Ball sorting for large balls needed Goal low	Wire harness inaccessible Igus EZ Zipper needed to make it easier to service wires in lift Bumpers coming off.

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Presenting the Enterprise

Presenting the Enterprise

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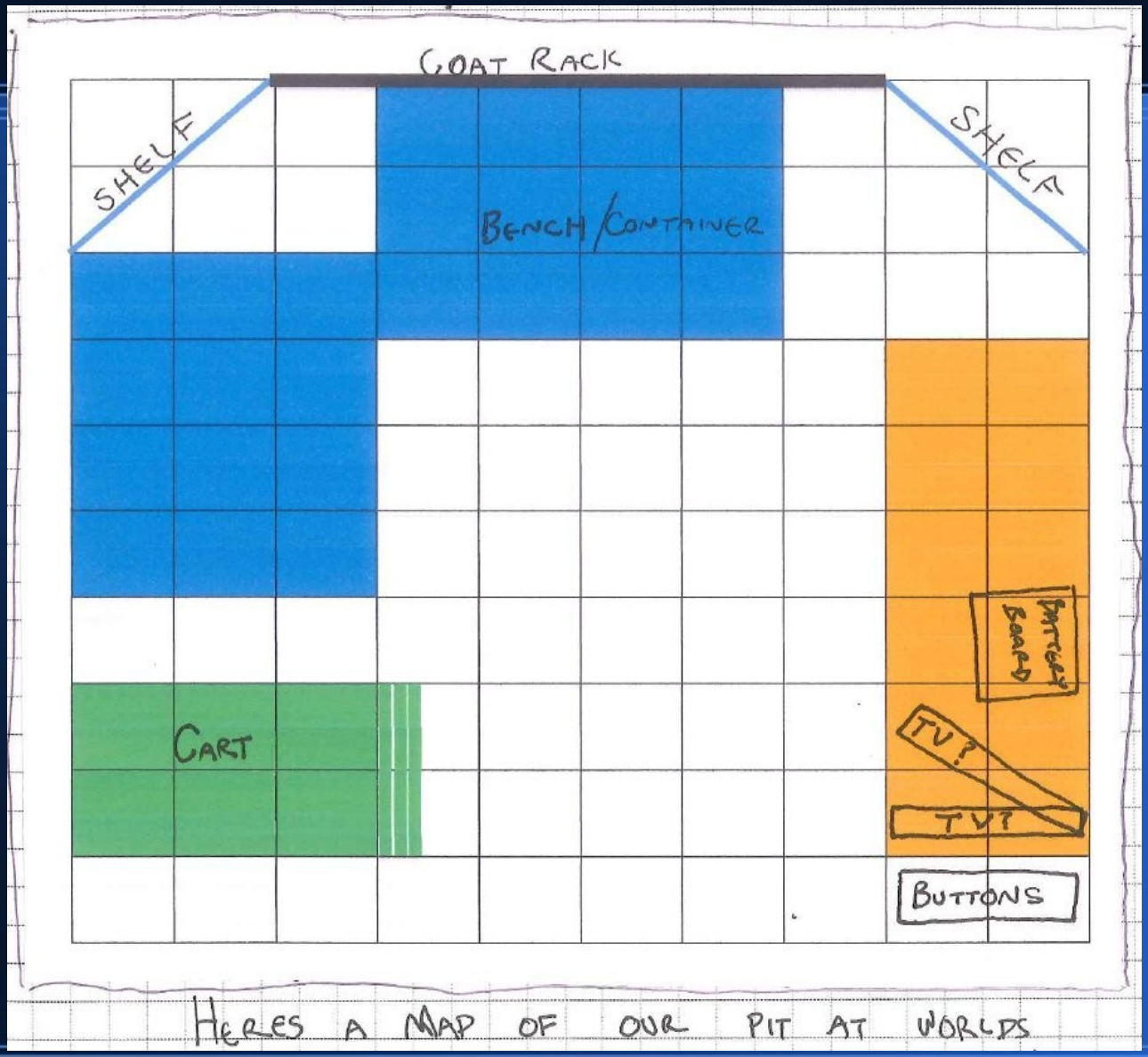
Presenting the Enterprise



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Professional Skills

- Teamwork & co-operation
- Documentation
- Strategic planning
- Mathematical analysis
- Production cycle: design, build, test, evaluate
- Skill sharpening

Professional Skills

- Presentation & salesmanship
- Mentoring relationships; both up & down
- Entrepreneurship
  - Organization
  - Financial planning & tracking
  - Sustainability

Conclusions

- A FIRST alumnus is way ahead of the game
- FIRST is worthy of your support
  - Any level of help is valuable
  - Your expertise is valuable

"The most important thing that any of us will ever do in life is to help the next generation get off to a good start."

--Joe Levy

Thank you for coming!

- Questions?
- http://www.firstinspires.org/
- joelevy@computer.org