

# *Engineering Notebook*

The Bionic Tigers - FTC 10464



# *What is an Engineering Notebook?*

- The engineering notebook is a documentation of the team's robot design and records the time spent doing research, outreach, team meetings, and plans for growth

# *Why we need a Notebook?*

- Throughout the process of designing and building a robot, teams will come across obstacles, lessons learned, and the need to draw ideas out on paper
- One of the goals of FIRST and FIRST Tech Challenge is to recognize the engineering design process and the **journey** that a team makes.
- Judges review a team's engineering notebook to better understand the **journey**, design, and team as a whole.
- Notebooks track a team from the beginning of the season and throughout the competition season

# Notebook Requirements

- Teams may only have one notebook at a competition
- Team number and team name must appear on the outside cover
- Must have a summary page in the front of the engineering notebook
- The engineering notebook must be divided into multiple sections:
  - Engineering section (that includes design process)
  - Team section (that includes information about the team and outreach activities)
  - Business/strategic plan (not required, but needed for specific awards)

# Summary Page

- One page
- Include team number
- Include a concise narrative about the team
- Bulleted highlights of the team's season
- List of pages in the engineering notebook the team would most like the judges to consider

## Hello, we are team 10464 The Bionic Tigers!

"Team 10464 is dedicated to expanding STEM education in the classroom and in the community while spreading the knowledge of FIRST anywhere they can."

- **Education**

- Hamilton County Superintendent Meeting - Presented at the Hamilton County Board of Superintendents encouraging them to pursue **FIRST** Robotics programs within their school due to the immense benefits it has on students.

- **Community Connection**, please see pages **1-45** within the Community Outreach section in the Engineering Notebook for more details. Here are just a few:

- HAMvention - May 19th, 2018
- The Amazing Race- June 16th, 2018
- Ohio State Fair- August 4th, 2018
- P&G Day - August 3rd, 2018
- Legion Dinner - November 11th, 2018
- Girl Scout Robotics Badges - Monthly
- iSpace Day- October 6th, 2018
- Chamber of Commerce- November 15th, 2018
- Loveland Scrimmage- November 18th, 2018
- FLL Mentoring - Weekly
- Hive13 Open House - October 20th, 2018
- Symmes Library Open House - July 7th - July 14th- August 11th, 2018

- **World Connection**, please see page **47** in the Engineering Notebook for more details
  - Twitter- collaboration with FTC teams across the nation
  - Website- ability to spread information fast and easy

- **Sponsorship**, please see pages **49-52** in the Engineering Notebook for more details
  - Thanks to our wonderful sponsors we have been able to obtain parts and supply necessary to compete in any FTC competition
  - We have also been able to host many different Outreach events throughout our community

- **What Makes The Bionic Tigers Stand Out?**

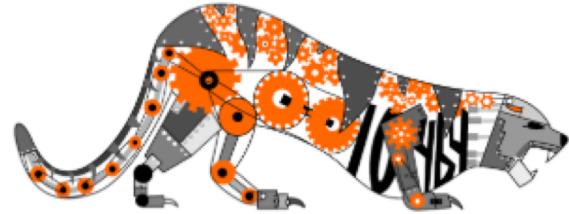
- They are made up entirely of people who are dedicated and excited to learn more about the fast paced STEM careers in the world
- Our Struggles and how we overcame them, please see Build Process and Development pages **1-74** in the Engineering Notebook for more details
- Our amazing Autonomous and TeleOp programs, please see pages **1-30** in the Engineering Notebook for more details

Thank you for your time!

# ***Business/Strategic Plan***

- Unique for every team
- May touch on the following needs:
  - Direction the team wants to take
  - Outlining team goals
  - Type of outreach team wants to focus on
  - Creating a team budget
  - Fundraising needs
  - Seeking out sponsors
- Explains steps to be taken by team to reach goals

**The Bionic Tigers**



**Team 10464**

**Business Plan  
2019-20**



**Team Contact**

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# ***Business/Strategic Plan***

- Use as a guide for team
- Layout team goals—short or long term
  - Fundraising
  - Outreach
  - Competition
- Include a plan for team sustainability
  - Plan explains how the team plans to grow and stay competitive when students graduate from the program.
  - May include plans to recruit sponsors, new mentors, or team members.

## 1.0 Introduction

The Bionic Tigers, Team 10464, is a fifth year **FIRST** Tech Challenge (FTC) team out of Loveland High School in Loveland, Ohio. The team is heavily dedicated to spreading STEM and robotics amongst their community and beyond. In 10464's history, they have competed in Ohio, Kentucky, West Virginia, Maryland, and Pennsylvania.

### 1.1 FIRST Tech Challenge (FTC)

**FIRST** was founded by Dean Kamen as a non-profit organization whose main goal is to inspire young people's interest and participation in science and technology. Along with informing them about STEM and aligning them with a career path, it also teaches them skills in problem solving, teamwork, and innovation. **FIRST** accomplishes this through their programs: **FIRST** Lego League Jr (FLL Jr), **FIRST** Lego League (FLL), **FIRST** Tech Challenge (FTC), and **FIRST** Robotics Competition (FRC). Through these programs, **FIRST** is able to teach both children and adults about STEM and everything it has to offer them in their everyday lives.

Dean Kamen is an entrepreneur, inventor, and tireless advocate for science and technology. His passion and determination to help young minds discover the excitement and rewards of science and technology created the cornerstones of **FIRST** (For Inspiration and Recognition of Science and Technology).

The **FIRST** Tech Challenge is an annual challenge held between competing teams, connecting schools and communities across the globe. Teams are responsible for designing, building, and programming their robot. Awards are given to teams for outstanding performance in aspects such as programming, the engineering notebook, interaction with their community, and general robot performance. Each competition provides teams with multiple tasks to be completed during a match. Teams are awarded points for the different tasks they accomplish. The game itself changes from year to year, allowing the students to continue growing in their problem solving and innovative ideas.



# *Business/Strategic Plan*

- Things to do include:
  - Overview of FTC and the game
  - Team history
  - Outreach
  - Team involvement in community
  - Sponsorship details
  - Budget
  - Team goals
  - Sustainability

## 1.3 History of The Bionic Tigers

The Bionic Tigers are a part of Loveland Robotics, which is a program in the Loveland City School District that is composed of three FLL Junior, four FLL, three middle school VEX, five high school VEX, and two FTC robotics teams. Loveland Robotics is dedicated to spreading **FIRST** and the ideas of STEM throughout the community. Team 10464, The Bionic Tigers were established in 2015, when many students of Loveland High School had a heavy interest in STEM. In the 2015-2016 season, Res-Q, the newly formed 10464 advanced to the Ohio State Championship and finished as a part of the finalist alliance, a huge accomplishment after the program had undergone so much growth and learning.



In the 2016-2017 season, Velocity Vortex, it was a year of even more growth for the team, as it was the first time that The Bionic Tigers had traveled out of state with competing at the Kentucky State Championship bringing new and exciting challenges, the team was able to see a whole new level of competition. In the 2017-2018 season, both teams traveled far and had many successes. Not only did both teams travel to West Virginia, 10464 also traveled to Pennsylvania to compete at the qualifying level. Loveland Robotics has made new headway within a whole new level of competition, this being the second time Team 5040 traveled to both the North Super Regional Competition and World Championship. Both 10464 and 5040 won or placed in every award category throughout the season, not only making this one of the most successful seasons yet, but also one of the most memorable.

In the 2018-2019 season, both teams continued their pattern of excellence. One especially notable competition was the Cincinnati Qualifier, where 10464 and 5040 cooperated, with 10464 as the Alliance Captain, first selecting 5040, and becoming the Winning Alliance. Both teams also competed at the West Virginia State Championship, with Team 10464 winning the Connect Award, Team 5040 being the Winning Alliance Captain and earning an advancement to the World Championship. Team 10464 competed at the Pennsylvania State Competition, being on the finalist alliance. At Ohio State, Team 10464 was on the Semifinalist Alliance, and Team 5040 was on the Winning Alliance, for the second year in a row. At the World Championship, Team 5040 was fifth seed in their division and was nominated for the Design Award.

# *What to Include Overview*

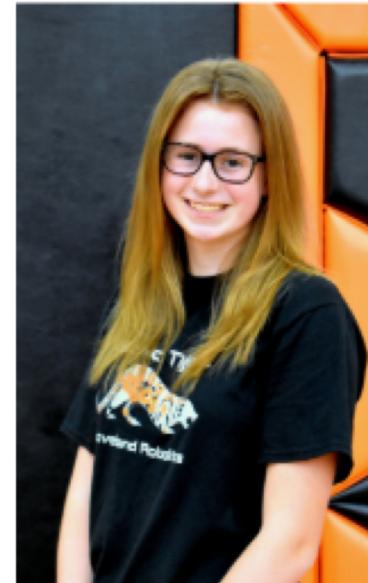
- Sections and subsections
  - Team
  - Business/strategic plan
  - Outreach
  - Engineering (design process)
  - Programming
  - Meeting entries
- Table of contents
  - Makes it easier for judges to find documentation

# *Team Section*

- Team member bios
  - School year
  - Interests
  - Activities outside of robotics
  - Team role
  - Future plans
  - What got them interested
- Mentor bios
  - Career
  - Team involvement
  - Personal history
- Information about team
  - Hometown
  - Age
  - School

## **Erin Dickman: Business Team**

Erin Dickman is a junior at Loveland High School. She is a member of the business team and works on sponsorship for the team and the engineering notebook. This is her first year on Team 10464, she is excited to learn how robotics works in the upcoming season. Outside of robotics, Erin is captain of the golf team and is a member of the creative writing club. Through robotics, Erin is able to learn how to connect with professionals, organize events, and build a professional notebook. She plans on majoring in political science at either the University of Washington or Xavier University.



# Outreach Section

- Entry for each event/experience
- Photos of the event
- Explain the significance and impact
- Give many details
- Include takeaways

## 4th of July

Community Outreach - 07/04/19

Team Members	Time	People Reached
4	4:00pm-6:30pm	150

The 4th of July outreach event was held in Niabit Park during Loveland's Independence Day parade. Loveland robotics was represented by both 10464, and 5040. 10464 brought its outreach bot, while 5040 brought its competition bot, and its x-drive demonstration bot. Both teams had VEX claw bots which, along with the x-drive demonstration, and the outreach bot were open to the public for driving. During the event we had team members talking to those who were interested, and explaining the various FIRST programs, and how to get involved with them. We had 5040's competition bot, the awards won by the two teams, and information boards set up on a display table, where people could approach us, and ask us about the FTC program.



Throughout the day, we had a constant stream of people who wanted to learn about FIRST and participate in driving the different robots. A lot of the kids who drove the claw bots were intrigued, and inspired. They had lots of fun using the robots to interact with objects around the field, and occasionally, other robots. Some of the kids even asked how they could become part of a robotics team, and so we would tell them or their parents about FLL, FLL Jr. Most of the parents were also intrigued, and would ask questions about the robots, competitions, and how their kids could become a part of FIRST. We also told kids about our high school, and middle school VEX teams, that they could also become a part of.

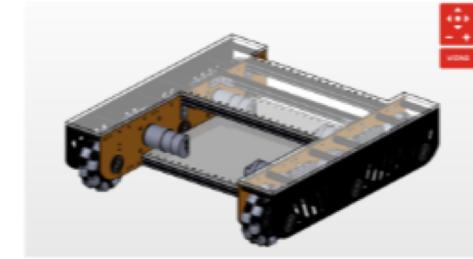
The 4th of July outreach event reached a lot of people that we might not normally be able to reach. Because of the Independence day celebration, the park was crowded with hundreds of people. Any of them that saw our flag, or our outreach banner, and came over to our booth were informed of FIRST and what they do. We were also able to spread awareness of Loveland robotics, and open ourselves up to possible sponsorship opportunities if any of those that we reached are, or know someone who is in a position to give sponsorships. We reached approximately 150 people, in 2 and a half hours. Hopefully, some of those people will look into their local robotics programs, and join them.

# *Engineering (Design) Section*

- Very important and large section
- Include every thought about the robot from the game reveal to the last competition
- Include many visuals from napkin sketches to photos to CAD drawings, math equations, and etc
- Journey to your current robot design
- Each part of robot has own part of section--its iterations

## CAD and Calculations

We designed our drivetrain in Solidworks. Using the data collected from our prototype, we designed our own custom side panels. We made two identical drive pods and connected them together using REV extrusion. We chose to use VEXPro colson and omni wheels for the drivetrain because they are low friction, high quality, and have a  $\frac{1}{8}$  inch hex bore for the shaft. The  $\frac{1}{8}$  inch hex shaft means that we didn't have to use any shaft collars or hubs on the drive shafts. This allowed us to eliminate all worries of slippage in the drivetrain.



Our drivetrain uses a belt drive that has a single belt between each motor and the two closest wheels to it. This allows us to drive all wheels, drive both motors on each side to the center wheel, and drive both motors on each side in synchrony. To find the optimal belt length and pulley diameter, we created a calculation sheet and using that, determined the best option was to use 60T belts and 24T pulleys.

Timing Belt Calculations			
	Poly (Diameter in)		
Actual Center-to-Center Distance (in)	1.750	1.764	1.769
Radius (in)	0.875	0.882	0.885
Polymer Center Distance (in)	0.875	0.882	0.885
Polymer Center Distance (mm)	22.190	22.220	22.235
Polymer Center Distance (cm)	2.219	2.222	2.223
Poly (Diameter mm)	14.729	14.736	14.739
Poly (Diameter cm)	1.4729	1.4736	1.4739
Poly (Diameter in)	14.730	14.737	14.740
Poly (Diameter mm)	14.730	14.737	14.740
Poly (Diameter cm)	1.4730	1.4737	1.4740

Best Options		
Actual Center-to-Center Distance (in)	Belt (60T) Options	Actual Center-to-Center Distance (cm)
14.730	60T 60T	14.730
14.737	60T 60T	14.737

Suggested Equations			
Suggested	Poly (Diameter in)	Poly (Diameter mm)	Poly (Diameter cm)
Center-to-Center Distance (in)	14.730	14.737	14.740
Actual Center-to-Center Distance (in)	14.730	14.737	14.740
Actual Center-to-Center Distance (mm)	14.730	14.737	14.740
Actual Center-to-Center Distance (cm)	14.730	14.737	14.740

Equations		
Actual Center-to-Center Distance =	Belt Length - Poly (Diameter * pi) / 2	Actual Center-to-Center Distance =

# Programming Section

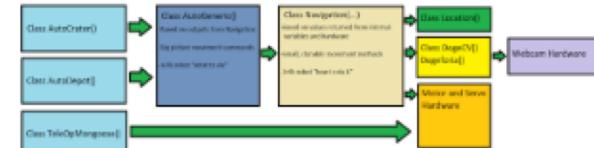
- Overview of programming process
- Reasons for a specific process
- Implications of a sensor
- Flowcharts and diagrams
- Controller setup
- Configuration of motors and servos
- DO NOT PRINT OUT ALL OF YOUR CODE!
  - Only parts that you want to explain or showcase

## Autonomous

This following chart depicts our team's Autonomous goals, in order of importance.

- Accurate, consistent drive methods
- Deposit our team marker into the depot
- End autonomous in the crater parking area
- Accurately sample or double sample based on our needs, using computer vision
- Start hanging and consistently drop in a repeatable position
- Object Oriented Programming (OOP) integration and code portability
- Internally track robot position and update drive methods real-time
- Code clarity and elimination of repetitive code

A diagram of our final class hierarchy is featured below:



Our code is broken into several “levels” of classes. At the start of this hierarchy, we have several classes that initialize the robot for different strategies. This was a necessity since the FTC app does not allow any data to be parsed upon the launch of Autonomous. These classes extend the LinearOpMode, overriding runOpMode as the class’ sole method.

Because every drop from the lander and sampling is close to identical, we decided to go with a single method for all possible starting positions and strategies, known as AutoGeneric. Each of the prior classes calls AutoGeneric with a defined enumerator for starting in the crater, in the lander, and variations for strategies such as double sampling. This allows us to keep our Autonomous code neat, organized, and most importantly, easy to write. After a basic program skeleton is set up, the only thing that should ever need changed between paths and strategies for Autonomous are gameState goals. This allows us to spawn child programs in a matter of minutes, giving us the ability to adapt to nearly any situation competition managers to throw at us. The AutoGeneric java class consists of calls to a driver class, Navigation, which handles detailed robot-interfacing methods such as drivetrain control, motor and servo control, gyroscope tracking, and computer vision (Vuforia, DogeCV).

# *Meeting Entries Section*

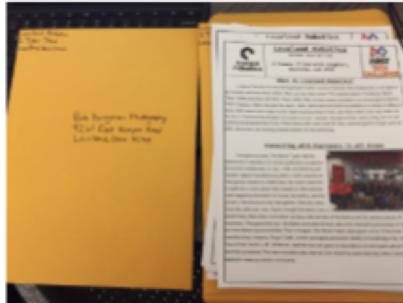
- Details about meeting
  - Date
  - Time
  - Location
  - Intentions
- What was completed that meeting
- What is ongoing



Bionic Tigers  
Meeting Date: 11/04/2018  
Business Team: [Erin](#), Mitchell, Zoe

**Tasks:**  
The business team continued planning the Legion dinner and started addressing the newsletter to potential and existing sponsors.

**Images:**

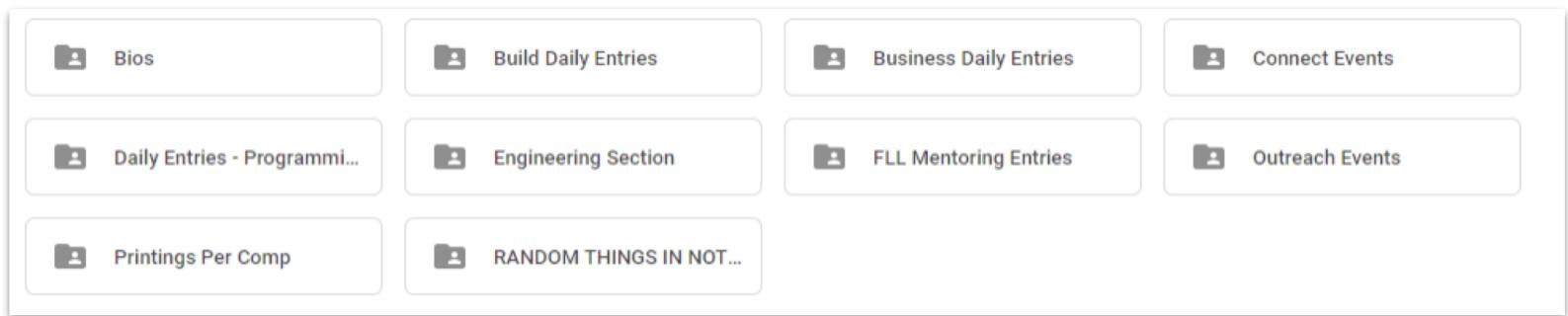


**Elaboration:**  
While planning the Legion dinner, the business team decided to include a free drink with each meal and charge people who want an additional drink. Ice water will be provided to every person who attends the dinner. Each attendee will get a drink ticket as they enter the dinner. The business team also decided on the location and time that the team is cooking for the dinner. They decided to prepare the meals on Friday night from 6-9 p.m. and [send the food home](#) with team members to cook before the event on Saturday to ensure that the food is warm. The business team also decided that every team member has to be at the Legion by 3 to set up for the dinner.

**Goals:**  
The business team's goal for the next meeting is to finish addressing the newsletters and send them on Monday night.

# Notebook Organization

- Google Drive folder for whole team
- Have a folder for each section and subsection
- Develop a template for each style of entry
- Print your notebook well ahead of time



# *Keep in Mind*

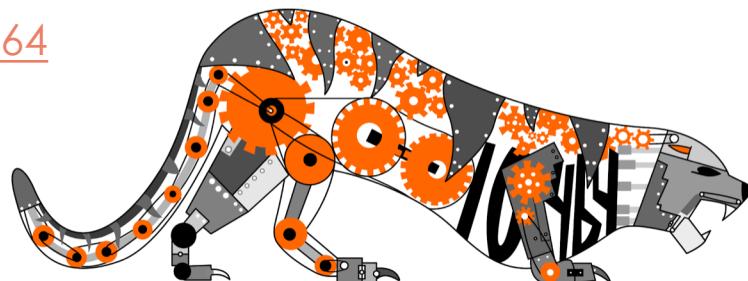
- The notebook is live document
- Main objective is to showcase your journey
- Visuals, visuals, and visuals
- Keep it consistent
- Section summaries
- Every page needs to be signed and dated by team members

# *Super helpful materials to check out:*

- FTC Team Management Documents
  - <https://www.firstinspires.org/node/5226>
- FTC Engineering Notebook Guide
  - $\beta$

# Credits

- This lesson was written by The Bionic Tigers 10464 for FTCTutorials.com
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- More lessons for FIRST Tech Challenge are available at [www.FTCtutorials.com](http://www.FTCtutorials.com)



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