

# REBEL ROBOTICS

TEAM #18139

ENGINEERING PORTFOLIO 2025



# TEAM OVERVIEW

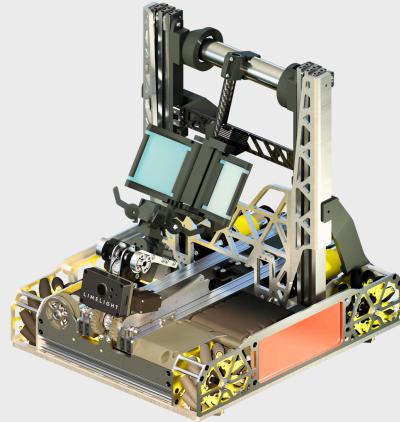
REBEL  
ROBOTICS



**WE'RE FTC #18139, THE REBEL ROBOTICS.**

- LOCATED IN NORFOLK, NE
- ESTABLISHED IN 2016
- SELF-FUNDED, PRIVATE, COMMUNITY-BASED
- 3RD PLACE DIVISIONAL INSPIRE WORLDS 2024
- 1ST PLACE DIVISIONAL THINK WORLDS 2023

**SURGE** PRESENTED BY  BD



**SURGE: OUR SLEEKEST, SMARTEST, AND MOST POWERFUL ROBOT EVER.**

## JUDGED CATEGORY HIGHLIGHTS

### CONNECT

WE HAVE PRIORITIZED CREATING CONNECTIONS WITH LOCAL STEM EXPERTS TO LEARN FROM THEIR EXPERIENCE.

- 6 TOTAL MENTORS THIS SEASON (CAD DESIGN, MACHINISTS, PHYSICISTS, BUSINESS DEVELOPMENT).
- NOT ONLY DO THEY HELP US, BUT THEY ARE NOW ADVOCATES FOR FIRST (ONE EVEN NOW COACHES FLL)!

### DESIGN

WE SPENT 3 MONTHS IN THE CAD DESIGN PHASE OF THE DESIGN PROCESS BEFORE WE BUILT ANYTHING, AND IT SHOWS. EVERY ASPECT OF OUR ROBOT IS WELL THOUGHT OUT. WE METICULOUSLY ENSURED THAT EVERY DETAIL, FROM THE WIRING TO THE CENTER OF GRAVITY, WAS EXACTLY RIGHT FOR OPTIMAL SCORING.

### INNOVATE

OUR ROBOT IS NOT YOUR TYPICAL INTO-THE-DEEP BOT. MANY OF OUR DESIGN CHOICES ARE NOT TYPICAL AND STAND OUT AS UNIQUE. OUR MOST INNOVATIVE ATTRIBUTE IS OUR OMNICLAW, WHICH TAKES INSPIRATION FROM A HUMAN HAND AND ITS TENDONS. IT CAN QUICKLY PICK UP A SPECIMEN IN ANY ORIENTATION - AND THE TRANSFER IS LIGHTNING QUICK.

### THINK

WE BELIEVE OUR HIGHLY DETAILED PORTFOLIO, WITH DETAILED ROBOT DESIGN PROCESS, TELLS OUR STORY.

### MOTIVATE

FROM THE BEGINNING OF THE SEASON, WE DEFINED TEAM GOALS AND CREATED A COMPREHENSIVE SEASON PLAN.

- \$16,650 IN SPONSORSHIPS THIS SEASON.
- MENTORED 10 FIRST TEAMS, ASSISTED 9 ADDITIONAL.
- STARTED 7 FIRST TEAMS.
- HOSTED & RAN 4 FLL CAMPS, ONE FOR SPECIAL NEEDS.
- TRAVELED TO WASHINGTON, DC TO MEET WITH OUR CONGRESSMAN TO DISCUSS STATEWIDE FTC FUNDRAISING PLANS.
- WORKING TO SECURE CORPORATE SPONSORS FOR NE FTC.

### CONTROL

OUR HIGH-SCORING AUTONOMOUS AND TELEOP PROGRAMS WORK CONSISTENTLY BECAUSE OF OUR ADVANCED PROGRAMMING. WE UTILIZE MANY SENSORS AND ENCODERS THAT PROVIDE REAL-TIME DATA TO OUR SOPHISTICATED ALGORITHMS. THIS ALLOWS THE ROBOT TO KNOW ITS LOCATION ON THE FIELD, FOLLOW ADVANCED AUTO PATHS, AND SELF-ADJUST ITS POSITION IF MOVED.

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# MOTIVATED TO ACHIEVE GOALS

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THIS YEAR, OUR TEAM TOOK THE STRENGTHSFINDER ASSESSMENT. WE LEARNED ABOUT EACH OTHER'S TOP STRENGTHS, AND DISCOVERED HOW, AS A TEAM, WE POSSESS ALMOST EVERY STRENGTH ON THE LIST.

## INDIVIDUAL GOALS/STRENGTHS

### EMMETT - SENIOR - 9TH YEAR IN FIRST

COMPETITION, ACHIEVER, RELATOR, STRATEGIC, FUTURISTIC

- ROLE: TEAM CAPTAIN / LEAD DESIGNER
- ✓ GOALS: GROW LEADERSHIP SKILLS AND ADVOCATE FOR FIRST

### CALEB - JUNIOR - 9TH YEAR IN FIRST

COMPETITION, FUTURISTIC, STRATEGIC, IDEATION, INPUT

- ROLE: LEAD PROGRAMMER, FLL OUTREACH LEAD
- ✓ GOALS: CAMERA VISION + ODOMETRY FOR WORLDS PLAYOFFS

### JOSIE - JUNIOR - 3RD YEAR IN FIRST \*DEANS LIST FINALIST\*

COMPETITION, ACHIEVER, DISCIPLINE, LEARNER, INPUT

- ROLE: LEAD PRESENTATION / DOCUMENTATION CREATOR
- ✓ GOAL: PLAY A LARGE ROLE IN TEAM OUTREACH

### BRADEN - JUNIOR - 6TH YEAR IN FIRST

WOO, DELIBERATE, INDIVIDUALIZATION, ANALYTICAL, FUTURISTIC

- ROLE: FUNDRAISING TEAM
- ✓ GOAL: CREATE AND EXECUTE FUNDRAISING PLAN

### NOAH - JUNIOR - 9TH YEAR IN FIRST

SELF-ASSURANCE, ACHIEVER, RELATOR, ANALYTICAL, STRATEGIC

- ROLE: LEAD BUILDER & PROTOTYPER
- ✓ GOAL: DESIGN MULTIPLE PARTS ON FINAL ROBOT

### ZACHARY - JUNIOR - 3RD YEAR IN FIRST

COMMAND, DELIBERATE, ACHIEVER, ANALYTICAL, STRATEGIC

- ROLE: BUILD TEAM
- ✓ GOAL: CONTRIBUTE MORE IN PIT INTERVIEWS

### NICK - JUNIOR - 8TH YEAR IN FIRST

RESPONSIBILITY, HARMONY, CONNECTION, DEVELOPER, FUTURISTIC

- ROLE: FUNDRAISING TEAM / DOCUMENTATION
- ✓ GOAL: FOCUS ON GREAT DOCUMENTATION

## TEAM GOALS

✓ DEEPEN RELATIONSHIPS WITH SPONSORS, MENTORS, AND STEM LEADERS

✓ BUILD OUR MOST ADVANCED ROBOT YET

✓ HAVE A MUCH MORE ROBUST DESIGN PROCESS

✓ PEDAL-TO-THE-METAL ON STATEWIDE OUTREACH EFFORTS

WIN THE 1ST PLACE INSPIRE AWARD AT WORLDS

CliftonStrengths®



### STRENGTHSFINDER COLOR KEY

EXECUTING, INFLUENCING,  
RELATIONSHIP BUILDING,  
STRATEGIC THINKING.

AS A TEAM, WE COVER 19 DIFFERENT STRENGTHS. THESE ALL-Across-THE-BOARD STRENGTHS MAKE US FAR MORE POWERFUL AS A TEAM THAN AS INDIVIDUALS.



# BUSINESS & SUSTAINABILITY PLAN

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AS A PRIVATE TEAM, ALL OF OUR FUNDS COME FROM OUR GENEROUS SPONSORS. EVERY TEAM MEMBER ACTIVELY SPENDS TIME SEEKING OUT, CALLING, AND MEETING WITH POTENTIAL SPONSORS.

## OUR SPONSORSHIP STRATEGY

1. CALL/EMAIL POTENTIAL SPONSOR
2. MEET IN PERSON, SHOWCASE ROBOT, AND DISCUSS FIRST
3. ASK SPONSOR FOR MORE ACTIVE INVOLVEMENT THROUGH MENTORSHIP
4. FOLLOW UP WITH SPONSOR TO SHARE SEASON RESULTS, WHAT WE LEARNED, AND TO THANK THEM.
5. RETAIN SPONSOR FOR NEXT YEAR AND SEEK GREATER ENGAGEMENT

## 2025 TEAM SPONSORS - \$16,650 RAISED

BD MFG

BEHLEN MFG

ADM MFG

KIWANIS

WALKER BROS. ROOFING

APPLIED CONNECTIVE

McMILL

COLUMBUS CREDIT

JTK LIGHTING

KASTL FAMILY EYECARE

KUCHAR CHIROPRACTIC

KNIGHTS OF COLUMBUS

WARREN GARAGE DOORS

DINKELS IMPLEMENT CO

UNITY EYECARE

PINKLEMAN'S

CLAUSEN HVAC

## Season Cost Breakdown

\$3,500 - Regular Season

- Transportation
- Registration
- Hotel Rooms

\$4,120 - Robot

- Raw Materials/COTS Parts
- Electronic Components

\$10,030 - Worlds

\$16,650 Needed  
+\$16,650 Raised  
\$0 Remaining



PLATINUM

\$1500

SPONSORSHIP TIERS

GOLD

\$1000

SILVER

\$500

BRONZE

\$250

## PRESENTING SPONSOR - BECTON DICKISON - \$5000



BD IS A MEDICAL TECHNOLOGY COMPANY THAT DEVELOPS, MANUFACTURES, AND SELLS A WIDE RANGE OF MEDICAL SUPPLIES, DEVICES, LABORATORY EQUIPMENT, AND DIAGNOSTIC PRODUCTS

## SUSTAINABILITY GOALS

### OUR TEAM

- DEVELOP NEW TEAM MEMBERS FOR LONG-TERM SUSTAINABILITY
- BUILD EXCITEMENT IN COMMUNITY FOR FIRST THROUGH OUTREACH, WORKSHOPS, AND PUBLICITY
- MAINTAIN PERSONAL RELATIONSHIPS WITH MENTORS AND SPONSORS

## SPONSOR MEETING

WE MET WITH THE KIWANIS CLUB IN OCTOBER TO SHOW THEM OUR ROBOT AND EXPLAIN OUR ROLE IN THE COMMUNITY. THEY LIKED OUR PRESENTATION SO MUCH THAT THEY GAVE \$1500 TO OUR TEAM. THIS WAS A GREAT OPPORTUNITY FOR US TO MAKE CONNECTIONS.



# MOTIVATING & MENTORING NEBRASKA

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“ REBEL ROBOTICS HAS MAINTAINED AN ONGOING PARTNERSHIP, SHARING A GREAT DEAL OF TIME AND EXPERIENCE THAT HAVE PROVEN INVALUABLE.

- JOE LASER, (PROFESSIONAL ENGINEER) NUCOR TEAM COACH ”

## MENTORED 10 FIRST TEAMS

- FLL TEAM 26606 - MEGA SEA PICKLES
- FLL TEAM 26607 - PLATTE COUNTY TEAM 1
- FLL TEAM 32374 - PLATTE COUNTY TEAM 3
- FLL TEAM 68155 - LEGO LEGENDS
- FLL TEAM 63321 - CODE HUSKERS
- FLL TEAM 28695 - BEAT BOTS
- FTC TEAM 26037
- FTC TEAM 42411
- FTC TEAM 16049

## STARTED 7 FLL TEAMS

- FLL TEAM 26606 - MEGA SEA PICKLES
- FLL TEAM 26607 - PLATTE COUNTY TEAM 1
- FLL TEAM 32374 - PLATTE COUNTY TEAM 3
- FLL TEAM 68155 - LEGO LEGENDS
- FLL TEAM 31391 - BYTE SIZE
- FLL TEAM 65858 - METAL MINDS
- FLL TEAM 67335



## ASSISTED 9 ADDITIONAL FIRST TEAMS

- FTC TEAM 26014
- FTC TEAM 13356
- FTC TEAM 6916
- FTC TEAM 17426
- FTC TEAM 23814
- FTC TEAM 9854
- FTC TEAM 9784
- FTC TEAM 9791
- FTC TEAM 26870



### AWARDED ADVOCATE

AT THE NEBRASKA FLL CHAMPIONSHIP, WE RECEIVED A SURPRISE AWARD FOR OUR WORK IN SUPPORTING FIRST. HERE'S WHAT THEY SAID:



“ REBEL ROBOTICS HAS MADE A SIGNIFICANT IMPACT IN NEBRASKA THROUGH THEIR DEDICATION TO ADVANCING STEM EDUCATION. THEIR EFFORTS HAVE NOT ONLY FOSTERED LOVE FOR ROBOTICS AMONG STUDENTS, BUT ALSO BUILT STRONG COLLABORATIONS WITH EDUCATIONAL INSTITUTIONS AND INDUSTRY LEADERS... THEY HAVE BEEN A HUGE MENTOR AND A GREAT PARTNER IN THE COMMUNITY. THEIR WORK HAS LEFT A LASTING LEGACY IN NEBRASKA, INSPIRING FUTURE GENERATIONS OF INNOVATORS AND LEADERS.

BRANDY SCHULZE - NEBRASKA FLL LEADER (PDP)

## GROWING FTC PLAYBOOK

### 4 MAIN OBJECTIVES:

#### INCREASE STUDENT EXPOSURE & INTEREST

- PRESENTED TO MANY NEBRASKA SCHOOLS. NOT JUST THE ADMINISTRATORS, BUT STUDENTS AS WELL
- FULL GYMNASIUM, ROBOT DEMONSTRATIONS, ETC
- GROWING FLL AS A FEEDER PROGRAM

#### PERSUADE SCHOOLS & TRAIN COACHES

- PRESENTED TO 50+ SCHOOL ADMINISTRATORS
- WORKED WITH iHUB TO CREATE COACHING CURRICULUM
- CREATED MULTIPLE FTC BEGINNER-FRIENDLY VIDEOS ON YOUTUBE

#### MAKE SPONSORSHIPS FAST & STREAMLINED

- WORKING TO SECURE CORPORATE SPONSORS FOR THE PROGRAM IN NEBRASKA

#### CREATE A PIPELINE BETWEEN ROBOTICS STUDENTS AND NEBRASKA SCHOOLS.

- DISCUSSED W/ NE ENGINEERING DEAN
- DISCUSSED W/ CONGRESSMAN FLOOD TO CREATE ROBOTICS SCHOLARSHIP

# ADVOCACY THAT INSPIRES A STATE

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“ REBEL ROBOTICS HAS WORKED TIRELESSLY OVER RECENT YEARS TO HELP IMPACT AND GROW HIGH SCHOOL ROBOTICS PROGRAMS. THESE CONTRIBUTIONS TO COMMUNITIES ACROSS NEBRASKA’S FIRST CONGRESSIONAL DISTRICT ARE PART OF WHAT MAKES NEBRASKA THE BEST PLACE IN THE WORLD.

- MIKE FLOOD, UNITED STATES HOUSE OF REPRESENTATIVES



## SEEKING CONGRESSIONAL HELP

WE WERE INVITED TO WASHINGTON, DC TO MEET WITH US REPRESENTATIVE MIKE FLOOD, WHO GAVE US SOME GUIDANCE, AND SOME CONNECTIONS TO COMPLETE OUR AMBITIOUS GOAL TO FIND BIG CORPORATE SPONSORS FOR FIRST IN NEBRASKA. HE ALSO CONGRATULATED US ON OUR ACCOMPLISHMENTS AT WORLDS LAST YEAR, INVITED US TO LUNCH IN THE CONGRESSIONAL DINING ROOM, AND BROUGHT US DOWN ONTO THE HOUSE FLOOR.

THIS WAS AN INCREDIBLE EXPERIENCE FOR ALL OF US ON THE TEAM, AND HAS INSPIRED ALL OF US TO WORK EVEN HARDER IN OUR EFFORTS.



## INSPIRING NE LEADERSHIP TO SUPPORT ROBOTICS



### KEY HIGHLIGHTS

- MULTI-YEAR ADVOCACY EFFORT BRINGING TOGETHER LEADERS FROM BUSINESS, INDUSTRY, EDUCATION, AND POLITICS - TO BECOME SUPPORTERS OF FIRST IN NEBRASKA
- KEY SUPPORTER NUCOR STARTED FIVE TEAMS AMONG EMPLOYEE-BASE'S STUDENTS IN NORFOLK
- INSPIRATION FOR NORFOLK'S \$7M iHUB BUILDING TO SUPPORT YOUTH ROBOTICS
- PARTNERED WITH NEBRASKA CHAMBER OF COMMERCE TO GROW CTE INVESTMENT IN NEBRASKA
- LEADING MAJOR FUNDRAISING EFFORT TO GAIN FINANCIAL SUPPORT FROM KEY BUSINESSES STATE-WIDE.

“ IT'S REALLY IMPRESSIVE TO SEE THESE YOUNG PEOPLE IN ACTION AND IT MAKES ME REALLY OPTIMISTIC FOR THE FUTURE ”

- MIKE BOYLE, PRESIDENT, KAWASAKI MOTORS USA

DATE	KEY EVENTS
5/16	MANUFACTURING NEBRASKA'S FUTURE EXHIBIT
7/9	WASHINGTON DC - US CONGRESSMAN MEETING
7/29	RAN FLL EXPLORE CAMP
7/30	RAN FLL CHALLENGE CAMP
7/31	RAN FLL SPECIAL NEEDS CAMP
8/11	RAN FLL CHALLENGE CAMP IN ALBION
8/25	RAN FLL INFO / PARENT NIGHT
10/31	NE CHAMBER OF COMMERCE TECH COMMITTEE
11/13	RECEIVED LETTERS FROM INDUSTRY LEADERS
1/8	LAUNCH FTCNEBRASKA.ORG
1/18	RAN FLL MINIPLAY EVENT IN NORFOLK WITH iHUB
3/8	FIRST COMMUNITY SHOWCASE
3/22	VOLUNTEERED/PRESENTED AWARD @ FLL

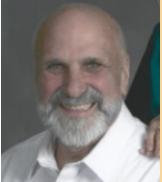
# CONNECTING WITH STEM EXPERTS

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OUR TEAM HAS DEVELOPED RELATIONSHIPS WITH A GROWING NUMBER OF STEM EXPERTS, WHO HAVE HELPED US OVER THE YEARS AND HAVE ALSO LEANED INTO SUPPORTING FIRST ON A BROADER SCALE.

## THIS YEAR'S MENTORS (AND WHAT THEY TAUGHT US)



### DR. TIMOTHY BURGESS, ALABAMA PHYSICS PROFESSOR

- ADVICE ON BATTERY DRAW ISSUES, BEST MATERIAL FOR SLIDE STRINGS, AND MITIGATING ELECTROSTATIC BUILDUP
- JOSIE RECRUITED HER PHYSICS PROFESSOR PERSONALLY



### LUKE WESTPHAL, PROFESSIONAL ENGINEER, VATALAB

- REVIEWED CAD MODELS & PROVIDED GENERAL DESIGN ADVICE
- ESTABLISHED A FEEDBACK LOOP
- EMMETT RECRUITED FROM INTERNSHIP



### MIKE BOYLE, PROFESSIONAL ENGINEER, VATALAB

- REVIEWED CAD MODELS & PROVIDED GENERAL DESIGN ADVICE
- STARTED HIS OWN FLL TEAM
- EMMETT RECRUITED FROM INTERNSHIP



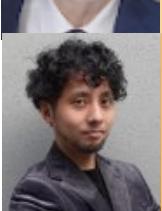
### JON SIEGERT, VP ENGINEERING & PRODUCTION, WEILAND

- ADVICE ON CREATING MANUFACTURING DRAWING DOCUMENTS
- ADVICE ON SETTING UP FILES FOR LASER CUTTING
- EMMETT RECRUITED DURING ULTIMATE GOAL (SPONSOR)



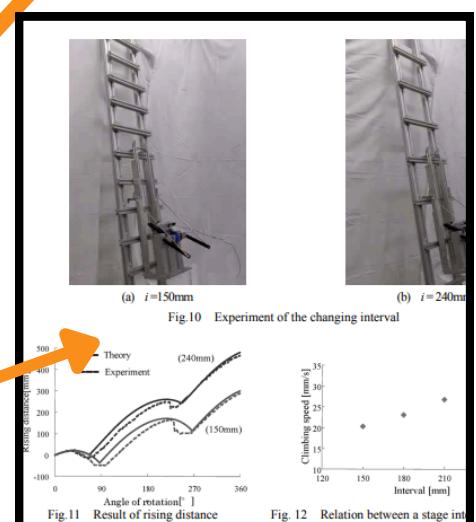
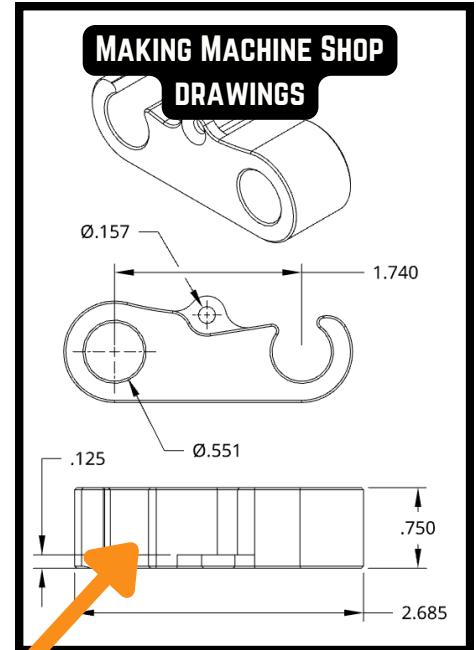
### GORDON CARLSON, RETIRED COMPUTER ANALYST

- WIRING DOCUMENTATION ADVICE
- GANTT CHART OVERVIEW
- JOSIE REACHED OUT THROUGH A RELATIVE



### YASUYUKI YAMADA, DESIGN ENGINEER (JAPAN)

- WALKED US THROUGH HIS LADDER-CLIMBING ROBOT DESIGN
- HELPED US TO BRAINSTORM LEVEL 3 HANG
- CALEB REACHED OUT ONLINE AFTER WATCHING YOUTUBE



## NON-MENTORING STEM & BUSINESS EXPERTS

IN ADDITION TO OUR MENTORS, WE HAVE RELATIONSHIPS WITH MANY EXPERTS WHO DON'T MENTOR US, BUT THEY PLAY A VERY IMPORTANT ROLE HELPING US SPREAD FIRST. HERE'S A SHORTENED LIST:

- LEAH BARRETT, PRESIDENT, NORTHEAST COMMUNITY COLLEGE
- LANCE PEREZ, DEAN, UNL SCHOOL OF ENGINEERING
- CHANDA BARRY, HR/RECRUITER, NUCOR
- SCOTT VOLK, PRESIDENT, NEBRASKA MANUFACTURING ALLIANCE
- MIKE BOYLE, PRESIDENT, KAWASAKI MFG
- MIKE JOHNSON, COO, NEBRASKA CHAMBER OF COMMERCE

A LARGE NUMBER OF CORPORATE SPONSORS FOR NEBRASKA FLL WERE STEM LEADERS, FIRST INTRODUCED TO THE PROGRAM BY OUR TEAM. NOTABLY, KAWASAKI, THE PROGRAM'S LARGEST SPONSOR, SUPPORTS AS A DIRECT RESULT OF OUR OUTREACH EFFORTS.



# BUILDING AWARENESS FOR FIRST

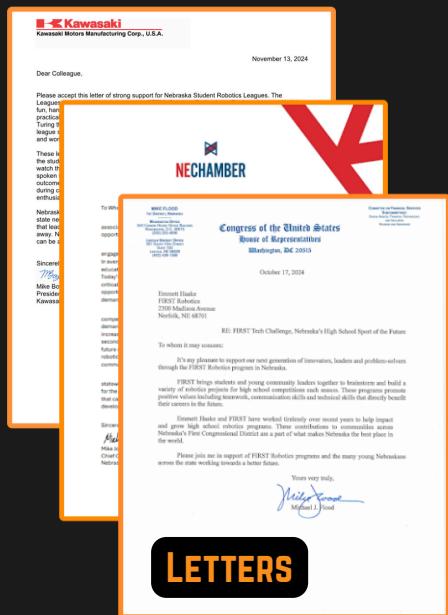
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“ REBEL ROBOTICS IS EVANGELIZING ROBOTICS IN NEBRASKA MORE THAN ANYONE. THANKS IN PART DUE TO THEIR EFFORTS, MORE STATE FUNDING IS GOING TOWARD CTE EDUCATION PROGRAMS STATEWIDE.

- MIKE JOHNSON, COO, NE CHAMBER OF COMMERCE

”

## AQIRING LETTERS OF SUPPORT



AT THE BEGINNING OF THE SEASON, WE DECIDED TO ACQUIRE LETTERS OF SUPPORT FROM SOME OF OUR MOST INFLUENTIAL CONNECTIONS.

EACH LETTER RECOMMENDS FTC STRONGLY AS A WAY TO ENSURE THAT NEBRASKA WILL BRING UP A GENERATION OF SMART PROBLEM-SOLVERS.

WE THEN CREATED A 2-PAGE INFOGRAPHIC, SIMILAR IN STYLE TO THIS PORTFOLIO, WHICH DETAILS ALL OF THE REASONS THAT COMPANIES SHOULD BECOME CORPORATE SPONSORS. WE'RE USING THIS PACKET WITH THE INFOGRAPHIC AND THE LETTERS AS A WAY TO GET INTO THE DOOR AND SECURE A MEETING.



## CONSTRUCTION OF IHUB CONTINUING



LAST YEAR, AFTER WORKING WITH NORTHEAST COMMUNITY COLLEGE AND GOVERNMENT OFFICIALS TO ENCOURAGE THEM TO INVEST IN ROBOTICS, THEY BROKE GROUND ON THE IHUB, A STATE-OF-THE-ART FACILITY THAT WILL HOUSE UP TO 10 FLL AND FTC TEAMS.

THEY ARE CURRENTLY ERECTING STEEL AND WILL OPEN ONE YEAR FROM THIS MONTH!

BETWEEN NOW AND THEN, WE ARE PARTNERING WITH THE IHUB ON TRAINING AND HOSTING ROBOTICS EVENTS - SUCH AS OUR COLLABORATION WITH THE RECENT FLL MINI PLAY.

“ THANK YOU REBEL ROBOTICS FOR REMINDING US HOW IMPORTANT IT IS TO CREATE OPPORTUNITIES FOR STUDENTS TO EXPLORE THE FIELDS OF STEM AND ENCOURAGING US TO INVEST IN YOUNG PEOPLE!

- LEAH BARRETT, PRESIDENT, NECC

## DEVELOPED & LAUNCHED NEBRASKA'S FTC WEBSITE

WE KNEW HOW IMPORTANT HAVING AN ONLINE PRESENCE WAS TO GROW FTC IN OUR STATE. SO WE TOOK THE INITIATIVE, AND WITH APPROVAL FROM OUR PDP, WE DEVELOPED, DESIGNED AND LAUNCHED THE SITE [WWW.FTCNEBRASKA.ORG](http://www.ftcnebraska.org). WE EVEN USED TEAM FUNDS TO PAY FOR THE DOMAIN NAME AND HOSTING.

“ THIS LOOKS REALLY GOOD! THANK YOU SO MUCH! I'M GOING TO START USING THIS AS I REACH OUT TO SCHOOLS.

- RANDY VEACH, FTC NEBRASKA PDP



## PRESENTING **SURGE**, OUR SLEEKEST, SMARTEST, AND MOST POWERFUL ROBOT EVER.



### KEY ROBOT PARTS

1. INNOVATIVE "OMNICLAW" INTAKE ASSEMBLY
2. TWO-STAGE 25" HORIZONTAL EXTENSION
3. FULLY CUSTOM ALUMINUM ROBOT BODY
4. THREE-STAGE VERTICAL DEPOSIT ASSEMBLY
5. HANG ASSEMBLY

WE HAVE DEVELOPED AN EFFICIENT DESIGN PROCESS. EVERY ASPECT OF OUR ROBOT HAS BEEN CAREFULLY CONSIDERED AND TESTED. WE PRIDE OURSELVES ON OUR PROFESSIONAL DESIGN THAT SEAMLESSLY JOINS FUNCTION AND FORM.



### COMMITMENT TO INDUSTRIAL DESIGN STANDARDS

A RECURRING THEME IN THIS PORTFOLIO IS OUR COMMITMENT TO INDUSTRIAL DESIGN. EVERY PART OF OUR ROBOT HAS A PURPOSE, AND WE KEEP EVERYTHING AS SIMPLE AS POSSIBLE TO ENSURE RELIABILITY.

WE'VE DONE OUR BEST TO MAKE THIS PART OF THE PORTFOLIO AS DETAILED AS POSSIBLE. HOWEVER, THERE ARE STILL LOTS OF DESIGN CONSIDERATIONS AND FEATURES THAT WE HAD TO LEAVE OUT. IF YOU HAVE ANY QUESTIONS, WE'RE MORE THAN HAPPY TO ANSWER DURING PIT INTERVIEWS.



### HOW WE USE BLENDER

BLENDER IS AN ADVANCED 3D MODELING SOFTWARE USED TO MAKE VISUAL EFFECTS AND REALISTIC RENDERS.

WHILE OUR TEAM HEAVILY RELIES ON ONSHAPE FOR 3D CAD, WE TYPICALLY START WITH BLENDER TO ILLUSTRATE CRUDE CONCEPTS. THEN AFTER WE FINISH THE ONSHAPE MODEL, WE RENDER THE FINAL ROBOT IN BLENDER TO GET THE REALISTIC FEEL OF WHAT THE ROBOT WILL LOOK LIKE.

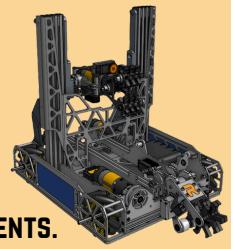
# SEASON DESIGN JOURNEY

**REBEL  
ROBOTICS**

## DESIGN GOALS

- COMPLETE EVERY TASK ON THE BOARD
- REASONABLY SMALL FOOTPRINT, FAST DRIVING
- ACTIVE INTAKE, FAST RELIABLE TRANSFER
- FULLY CUSTOM DESIGN
- SIMPLE AS POSSIBLE TO PROGRAM, REMOVE POINTS OF FAILURE

OUR INITIAL ROBOT CLOSELY RESEMBLES OUR ROBOT HERE AT WORLDS, BECAUSE ITS DESIGN WAS VERY SOUND. WE'VE BEEN MAKING VERY INCREMENTAL IMPROVEMENTS.



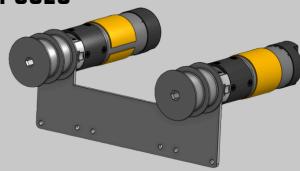
2 MONTHS

## INITIAL DESIGN/LEAGUE MEETS



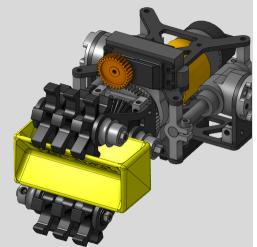
**INTAKE**  
OUR INTAKE FEATURED A PAIR OF HORIZONTAL ROLLERS ON TOP OF EACH OTHER

**VERTICAL LIFT**  
STRING-DRIVEN, SLOW 2 SPOOLS



## 3-AXIS ACTIVE DEPOSIT

- FULLY METAL CONSTRUCTION.
- HEAVY
- LOTS OF CONTROL



## CHANGES MADE

### QUALIFIER 1

- SWAPPED METAL DEPOSIT PARTS FOR CARBON FIBER
- MADE NEW SET OF SILICONE LOWER INTAKE ROLLERS WITH GROOVES FOR IMPROVED GRIP ON SAMPLE
- ADDED 2 COLOR SENSORS TO HEAD OF INTAKE
- CHANGED PULLEY DESIGN TO MAKE IT MORE SHALLOW TO PREVENT UNSTRINGING
- ADDED SET OF PANELS TO PREVENT STUCK SAMPLES
- COUNTER SPRING INTAKE WRIST
- REMOVE HEAVY HANG MECHANISM

## ANALYSIS

### WORKED WELL:

- NEW CARBON OUTTAKE WAS MUCH LIGHTER.
- COUNTER SPRINGING MADE CYCLES FASTER.

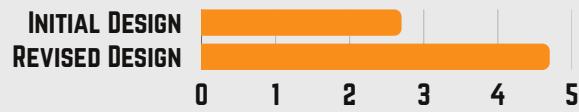


### NEEDS IMPROVEMENT:

- INTAKE CAN'T GRAB SAMPLES VERTICAL TO ROBOT.
- TRANSFER ISN'T RELIABLE-- SAMPLES FALL OUT.

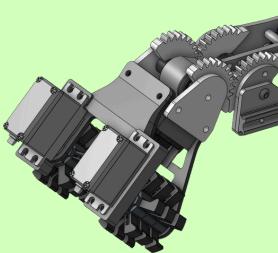


### MEET VS QUAL. 1 ● SAMPLES/MIN



### QUALIFIER 2

- SWITCHED INTAKE DESIGN TO TWO SEPARATE VERTICAL ROLLERS
- ADDED A DISTANCE SENSOR TO THE INTAKE, REMOVED ONE COLOR SENSOR
- ADDED A RETURN STRING TO THE VERTICAL SLIDE MECHANISM FOR FASTER CYCLES
- ADDED A TRANSFER ASSIST RAMP IN THE MIDDLE OF THE ROBOT TO REDUCE TRANSFER ERRORS



### MAJOR UPGRADE

OPTIMIZED SPOOL/RETURN STRING

- 95% REDUCTION IN STRING FAILURE



### WORKED WELL:

- VERTICAL INTAKE PROVIDES LARGER "ANGLE OF VIABILITY" FOR SAMPLES

### NEEDS IMPROVEMENT:

- CAN'T INTAKE HORIZONTAL SAMPLES



### QUAL. 1 VS QUAL. 2 ● SAMPLES/MIN

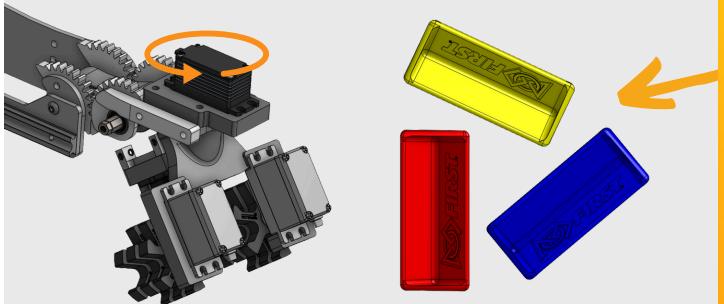


# SEASON DESIGN JOURNEY - CONTINUED

REBEL  
ROBOTICS

## STATE

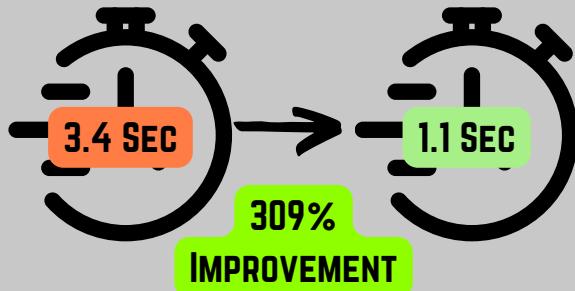
- REDESIGNED INTAKE WITH PIVOT, ALLOWING FOR EASIER PICKUP OF SAMPLES AT VARIOUS ANGLES



## WORLDS

- SWITCHED FROM STRING-DRIVEN SLIDES TO BELTED SLIDES
- DEVELOPED OMNICLAW AS AN ALTERNATIVE TO AN ACTIVE INTAKE
- PHASED OUT ACTIVE DEPOSIT IN FAVOR OF A PASSIVE DESIGN

## BELTED SLIDES - SIGNIFICANTLY FASTER



## HUGE IMPROVEMENT

! QUAL. 2 VS STATE ● SAMPLES/MIN

INITIAL DESIGN  
REVISED DESIGN

0 2 4 6 8

THIS DESIGN CHANGE LEVELED UP OUR GAME A TREMENDOUS AMOUNT, AS WE NO LONGER HAD TO BE AS PICKY ABOUT WHAT SAMPLES TO GRAB FROM THE SUB.



## NEEDS IMPROVEMENT:

- INTAKE REQUIRES HIGH AMOUNT OF DRIVER PRECISION.
- 3D PRINTED DESIGN ISN'T VERY ROBUST.

## DEPOSIT ARM SWAP

- SHED 1.5LB, RESULTING IN A 53% WEIGHT REDUCTION, ALLOWING FOR FASTER EXTENSION AND SIGNIFICANTLY LESS SWAY IN THE AIR.

## OMNICLAW IMPLEMENTATION:

- PASSIVE INTAKE WITH ACTIVE INTAKE BENEFITS.
- ONLY REQUIRES 1 SERVO TO PICK UP IN ALL DIRECTIONS

## PASSIVE DEPOSIT IMPLEMENTATION

- 98% REDUCTION IN MISSED BUCKETS. THIS DESIGN CREATES NO HORIZONTAL VELOCITY COMPONENT, KEEPING BUCKET SCORES ACCURATE

## THOUSANDS OF HOURS OF WORK

THE 2 PREVIOUS PAGES DETAIL 1,104 HOURS OF WORK OVER THE LAST 8 MONTHS. DURING THIS PROCESS, OVER 510 PARTS WERE DESIGNED, WITH AROUND 28% OF THOSE BEING FABRICATED. COME TO OUR PIT TO SEE ALL OF THE PARTS WE'VE 3D PRINTED THIS YEAR, AND ALL VERSIONS!

## DESIGN PROCESS ACCELERATION TECHNIQUES

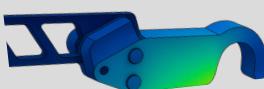
### TEST-BENCH PROTOTYPE METHOD

- CREATE THE FUNCTIONAL PART OF A MECHANISM IN REAL-LIFE TO ENSURE THAT IT WORKS AS INTENDED



### STRESS ANALYSIS

- USING SIMULATION TECHNIQUES TO DETERMINE POSSIBLE FAILURE POINTS.



### FULL CAD POLICY

- BEFORE WE BUILD ANYTHING, WE DESIGN THE ENTIRE THING IN CAD BEFOREHAND, INCLUDING SCREWS. THIS ENSURES NO HICUPS.

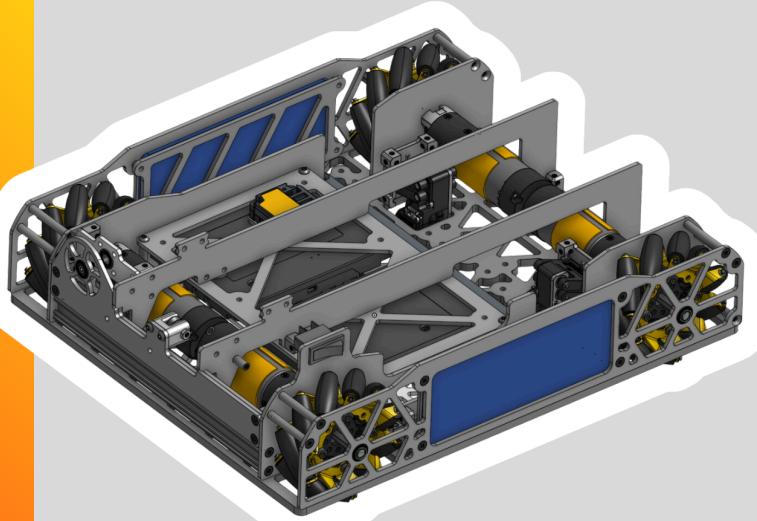
# ROBOT CHASSIS: BUILT LIKE A TANK

REBEL  
ROBOTICS



THE CHASSIS IS THE FOUNDATION OF THE ROBOT. IT MAY NOT BE AS GLAMOROUS AS THE OTHER PARTS, BUT IT'S CRITICAL THAT THE CHASSIS IS COMPACT, INCREDIBLY STRONG, AND FAST.

## CHASSIS OVERVIEW



### KEY FEATURES



STRONG CONSTRUCTION USING 100% CUSTOM 7075 ALUMINUM.



HATCH ON BOTTOM OF ROBOT TO EASILY ACCESS CONTROL HUBS



SOLID MOUNT FOR ODOMETRY WHEELS IN BACK OF ROBOT



EASILY ACCESSIBLE SLOTS FOR INTERCHANGEABLE NUMBER PLATES

### ROBOT BOTTOM PLATE

THE BACKBONE OF OUR ROBOT IS OUR CUSTOM 1/4 INCH BOTTOM PLATE. THIS PART WAS PROFESSIONALLY CNC MACHINED, AND IS RESPONSIBLE FOR OUR ROBOT'S INCREDIBLE DURABILITY. WE STRATEGICALLY DESIGNED TRIANGULAR POCKETING HOLES INTO IT TO KEEP STRENGTH WHILE SIMULTANEOUSLY CUTTING WEIGHT. ADDITIONALLY, THESE HOLES FUNCTION TO BRING THE ROBOT'S CENTER OF MASS CLOSER TO ITS PHYSICAL CENTER, AIDING IN ACCURACY.

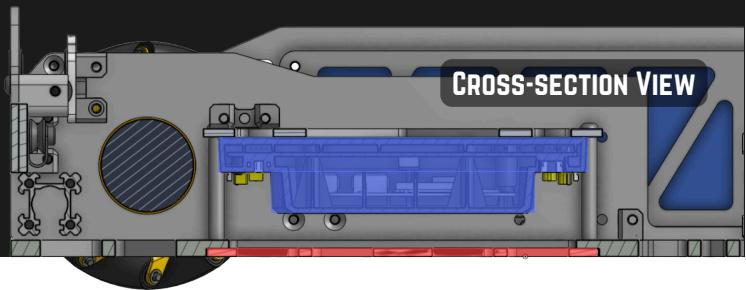


### IN-HOUSE MANUFACTURING

OUR TEAM INVESTED IN A CNC MACHINE TO BE ABLE TO RAPIDLY PROTOTYPE NEW IDEAS AND CONCEPTS. THIS HAS ALLOWED US TO QUICKLY MAKE QUALITY PARTS, WHEN THERE ISN'T ENOUGH TIME TO USE AN EXTERNAL MANUFACTURING SERVICE. IT'S ALSO CONSIDERABLY CHEAPER TO MANUFACTURE CARBON FIBER PARTS.

### STRATEGIC HUB PLACEMENT

OUR HUBS ARE MOUNTED FACE-DOWN ABOVE AN ACCESS PLATE. THIS ALLOWS EASY ACCESS TO THE WIRES, AND ALSO KEEPS THE HUBS IN A HIGHLY PROTECTED ORIENTATION.



CROSS-SECTION VIEW

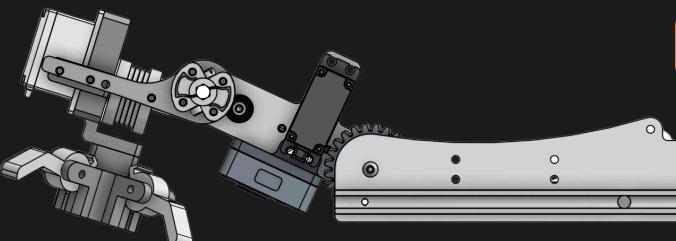
### SIMPLER IS BETTER

OUR ROBOT'S MECHANUM WHEELS ARE DIRECTLY ATTACHED TO THEIR MOTOR. THIS STRAYS FROM THE MORE COMMON FTC DESIGN, WHERE WHEELS ARE CONNECTED TO THEIR MOTORS VIA A TIMING BELT. THIS DESIGN MINIMIZES BACKLASH, IS SPACE EFFICIENT, AND MAKES OUR AUTONOMOUS PROGRAM MUCH MORE CONSISTENT.



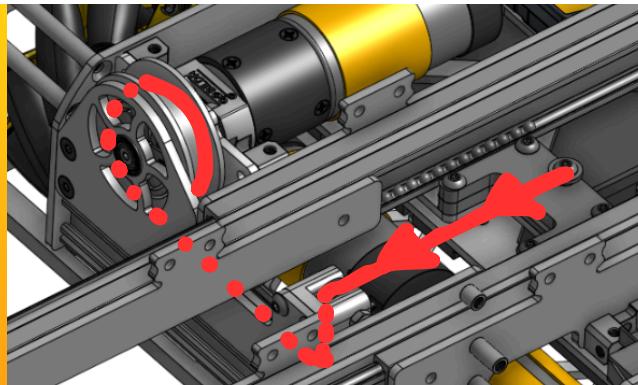
# INTAKE/HORIZONTAL EXTENSION

REBEL  
ROBOTICS



## LOW-PROFILE HORIZONTAL EXTENSION

25"



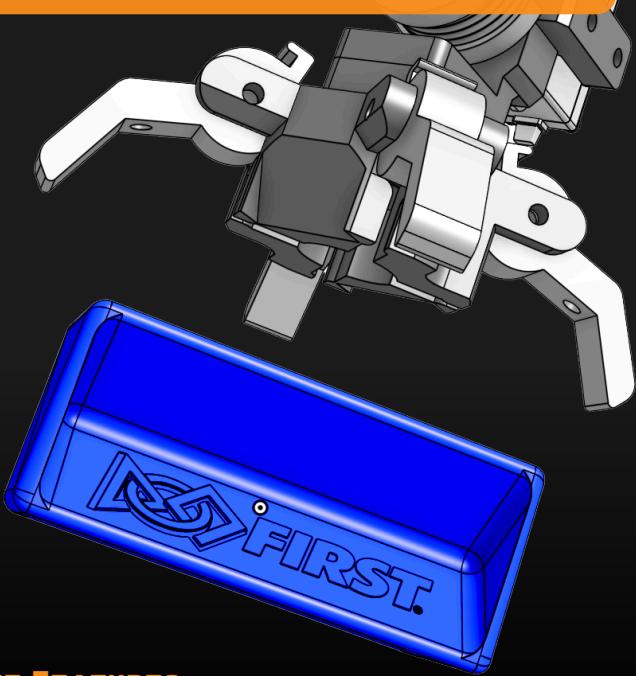
### EXTENSION POWERTRAIN

THE EXTENSION IS POWERED USING A SINGLE 435 RPM MOTOR, WHICH IS ATTACHED TO A KEVLAR STRING THAT PULLS THE SLIDES FORWARD. THIS STRING IS COUNTERED BY A CONSTANT-FORCE SPRING, WHICH PULLS THE SLIDES BACK. THIS TUG-OF-WAR MECHANISM ENSURES THE SLIDES ARE ALWAYS IN THEIR PROGRAMMED POSITION.

### HORIZONTAL EXTENSION FEATURES

- SUPER LONG 25 INCH EXTENSION, ENABLING US TO REACH ACROSS MOST OF THE SUBMERSIBLE.
- 100% 7075 ALUMINUM CONSTRUCTION, WITH NO 3D PRINTED SLIDE COMPONENTS.
- VERY THIN PROFILE MEASURING 3 INCHES ACROSS, ALLOWING EASY ACCESS TO CORNERS.
- FAST VELOCITY, FULL EXTENSION IN .26 SECONDS.

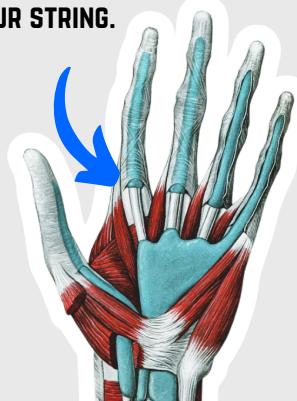
## INNOVATIVE “OMNICLAW” INTAKE



### TAKING INSPIRATION FROM MEDICINE



BECAUSE OUR OMNICLAW FUNCTIONS IN A SIMILAR WAY TO A HUMAN HAND, WE DECIDED TO TAKE INSPIRATION FROM HUMAN TENDONS, SPECIFICALLY THE [EXTENSOR DIGITORUM TENDON](#), TO DETERMINE AN APPROPRIATE STRENGTH FOR OUR STRING.



THE TENSILE STRENGTH OF THE EXTENSOR DIGITORUM TENDON IS APPROXIMATELY 65 MPa. TO MATCH THIS, WE USE A NYLON STRING AS OUR “TENDON” TO MIMIC THE VERY SLIGHT STRETCHINESS, BUT STRENGTH OF A HUMAN TENDON.

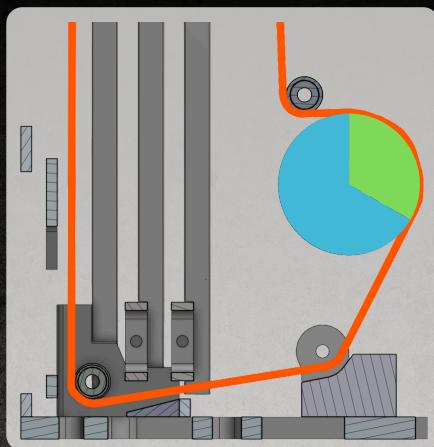
### INTAKE FEATURES

- CLAW INTAKE W/ BENEFITS OF ACTIVE INTAKE.
- 4 “FINGERS” ALLOW PICKUP IN ANY ORIENTATION.
- CONTROLLED USING “TENDONS” WRAPPED AROUND A RETRACTION SPOOL.
- BUILT-IN COLOR/DISTANCE SENSORS FOR MORE ACCURATE AUTONOMOUS.

# TRANSFER/DEPOSIT/HANG

REBEL  
ROBOTICS

## BELT-DRIVEN SLIDES



OUR BELT-DRIVEN SLIDES ALLOW FOR LIGHTNING-FAST VERTICAL MOTION WITH MINIMAL FRICTION AND ALMOST NO FAILURE POINTS.

THE IMAGE TO THE LEFT SHOWS THE PATH OF THE BELT AS IT TRAVELS AROUND THE ACTUATOR PULLEY. WE AIMED FOR AROUND 120 DEGREES OF CONTACT AREA, WHICH IS THE PERFECT BALANCE BETWEEN ENOUGH CONTACT AREA AND TOO MUCH FRICTION.

AFTER TUNING THE SLIDES AND LOCKING THE TENSION, THE SLIDES HAVE NEVER FAILED.

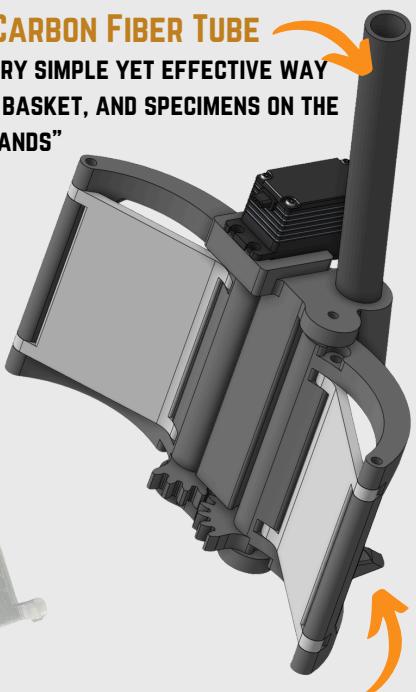
## DESIGN SPOTLIGHT

OUR CUSTOM METAL SLIDE INSERTS ARE MACHINED FROM 7075 ALUMINUM, MAKING OUR SLIDES SOME OF THE STRONGEST IN THE WORLD.



## DEPOSIT CLAW

OUR DEPOSIT CLAW IS A VERY SIMPLE YET EFFECTIVE WAY TO SCORE SAMPLES IN THE BASKET, AND SPECIMENS ON THE SUBSTATION BARS. THE "HANDS" HAVE GRIPS MADE OUT OF CUSTOM-MOLDED SILICONE, SHOWN DIRECTLY BELOW. THIS ALLOWS TRANSFERS WHEN THE SAMPLE IS IN ALL ORIENTATIONS.



SMALL FINGERS ON THE BACK OF THE DEPOSIT ALLOW FOR EASY SPECIMEN MANIPULATION

OUR LIFT INITIALLY USED CONCAVE PULLEYS, WHICH LED TO BELT MISALIGNMENT DUE TO A LACK OF LATERAL CORRECTIVE FORCE. WE TRANSITIONED TO CONVEX PULLEYS, LEVERAGING THE SELF-CENTERING BEHAVIOR CAUSED BY DIFFERENTIAL BELT TENSION.

THE FORCE IMBALANCE  $\Delta T \propto \Delta R$  CREATES A RESTORING MOMENT THAT RE-CENTERS THE BELT.



## HANG MECHANISM

OUR VERTICAL SLIDE MOTORS ARE VERY HIGH SPEED, SO THEY ARE NOT ABLE TO LIFT THE WEIGHT OF THE ENTIRE ROBOT. TO SOLVE THIS ISSUE, WE ADDED AN ADDITIONAL MOTOR TO THE ROBOT, WHICH HAS A SPOOL ATTACHED TO IT. THE SPOOL HAS A KEVLAR STRING ON IT, WHICH ATTACHES TO THE FIRST STAGE OF OUR VERTICAL SLIDE. THIS EXTRA POWER GETS US OFF THE GROUND SUPER QUICKLY, ALLOWING FOR A LEVEL 2 HANG WITHIN THE LAST 2.5 SECONDS OF THE MATCH.



## CARBON FIBER VS 7075 ALUMINUM

### CARBON FIBER BENEFITS

- SIGNIFICANTLY LIGHTER THAN ALUMINUM, WHICH IS IMPORTANT FOR A MECHANISM SUSPENDED 4 FEET IN THE AIR ON SLIDES.
- LESS RISK FOR ELECTROSTATIC ISSUES FOR DELICATE SERVO MOTORS.
- LOOKS COOL
- HIGH STRENGTH MATERIAL. USING IS NOT A COMPROMISE.

CF - TENSILE STRENGTH 5,000MPA

CF - MASS 1.6G/CM<sup>3</sup>

ALUMINUM - TENSILE STRENGTH 600MPA

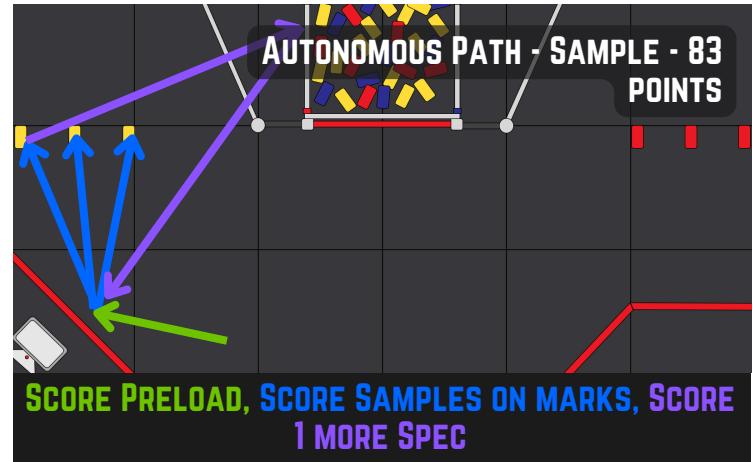
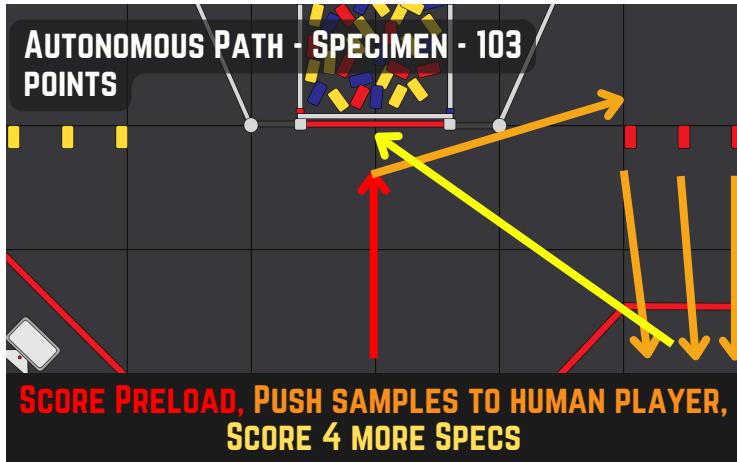
ALUMINUM - MASS 2.81G/CM<sup>3</sup>

# ADVANCED AUTO PROGRAMMING

**REBEL  
ROBOTICS**

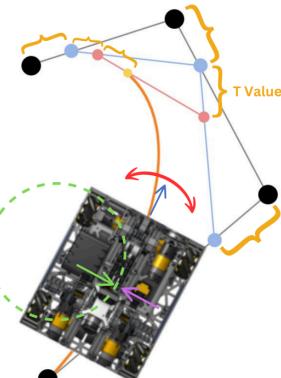


WE HAVE A HIGH-PERFORMANCE AUTONOMOUS PROGRAM THAT WE'VE SPENT WEEKS PERFECTING. THIS BRIEF PORTFOLIO PAGE CAN ONLY BEGIN TO SCRATCH AT THE SURFACE OF ITS FULL DEPTH.



## PEDRO PATHING

WE USE THE PEDRO PATHING LIBRARY, A REACTIVE VECTOR FOLLOWER THAT CREATES PATHS FROM BEZIER CURVES. WITH TWO PERPENDICULAR ODOMETRY PODS, AN IMU, AND THE GoBILDA PINPOINT COPROCESSOR, THE ROBOT CAN AUTOMATICALLY MOVE BETWEEN POINTS WITH LESS THAN .1 INCH ERROR. IT RECALCULATES DURING PATHS 1500 TIMES PER SECOND, ENSURING ACCURATE SCORING EVEN WHEN BUMPED OR PUSHED. THIS PRECISION IS ACHIEVED THROUGH EIGHT CUSTOM-TUNED PIDF LOOPS: TWO SETS EACH FOR DRIVE, LATERAL, HEADING, AND CENTRIPETAL FORCE- ONE OPTIMIZED FOR LARGE MOVEMENTS AND THE OTHER FOR SMALLER MOVEMENTS.



## BEZIER CURVE GENERATION

- START POINT P<sub>1</sub> AND END POINT P<sub>2</sub>
  - CONTROL POINTS P<sub>1</sub> AND P<sub>2</sub> SHAPE THE CURVE
- PARAMETER T:
- T IS A NUMBER BETWEEN 0 AND 1
  - T=0 IS START, T=1 IS END
  - THE MORE OFTEN T IS UPDATED, THE MORE ACCURATE THE CURVE

$$B(t) = (1-t)^3P_0 + 3(1-t)^2tP_1 + 3(1-t)t^2P_2 + t^3P_3$$



## SMART VISION USING LIMELIGHT 3A

WE USE A LIMELIGHT 3A AI-POWERED CAMERA FOR ALL OF OUR VISION PROCESSES, BECAUSE OF MANY CLEAR ADVANTAGES. IT IS COMPACT, RELIABLE, BUT MOST IMPORTANTLY, IT

PROCESSES DATA ONBOARD, WHICH SIGNIFICANTLY REDUCES COMPUTATIONAL STRAIN ON THE CONTROL HUB, ALLOWING FOR MUCH FASTER LOOP TIMES.



## PEDRO PATHING

SMOOTHER TRANSITIONS  
FASTER EXECUTION  
DYNAMIC, REAL-TIME ADJUSTMENTS



## ROADRUNNER

OUTDATED  
JERKY MOTIONS  
CAN'T REACT TO CHANGES MID-PATH

## NAVIGATION USING VISION

CALCULATING THE PHYSICAL X-LOCATION OF A PIXEL RELATIVE TO THE CAMERA (CALCULATED BY CALEB)

$$X = \left( \frac{h_c}{\tan(\theta + (\frac{H}{2} - y_{px}) \cdot \frac{\text{fov}_c}{H})} \right) \cdot \tan \left( \left( x_{px} - \frac{W}{2} \right) \cdot \frac{\text{fov}_h}{W} \right)$$

X<sub>px</sub>=HORIZONTAL PIXEL COORDINATE    h<sub>c</sub>=CAMERA HEIGHT  
 Y<sub>px</sub>=VERTICAL PIXEL COORDINATE    θ = ANGLE TO GROUND  
 W=IMAGE WIDTH  
 H=IMAGE HEIGHT  
 FOV=FIELD OF VIEW

# ADVANCED TELEOP PROGRAMMING

REBEL  
ROBOTICS

## GAMEPAD 1 (DRIVEBASE)

- TRIANGLE - HIGH BUCKET
- CIRCLE - LOW BUCKET
- SQUARE - SPECIMEN INTAKE
- CROSS - LOWER VERTICAL SLIDES
- LEFT STICK - INTAKE/DEPO OVERRIDE
- D PAD UP - WRIST UP OVERRIDE
- D PAD DOWN - WRIST DOWN OVERRIDE
- RIGHT BUMPER - ROTATE 3RD AXIS
- LEFT TRIGGER - RETRACT EXTENDO
- RIGHT TRIGGER - EXTEND EXTENDO



(GAMEPAD 2)



## INTAKE SENSING

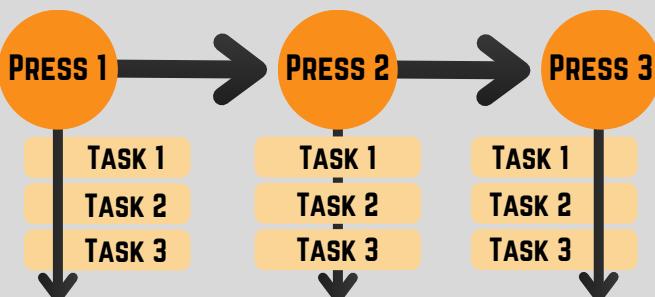
OUR INTAKE UTILIZES SENSORS TO AUTOMATICALLY REJECT THE OPPOSING ALLIANCE'S SAMPLES.



OUR DRIVER ENHANCEMENT PHILOSOPHY PRIORITIZES HUMAN FACTORS ENGINEERING, AIMING TO MAKE CONTROLS INTUITIVE, REDUCE COGNITIVE LOAD, AND ENABLE DRIVERS TO CONCENTRATE ON GAME STRATEGY.

## MACRO AUTOMATION

INSTEAD OF SIMPLY BINDING BUTTONS TO MOTORS, OUR TELEOP PROGRAM UTILIZES AUTOMATION FEATURES THAT MAKE IT WAY EASIER TO DRIVE. WITH THE PUSH OF A SINGLE BUTTON, A SERIES OF TASKS ARE EXECUTED AT ONCE. THIS REQUIRES PRECISE TIMING WITHIN THE TELEOP PROGRAM, AND REQUIRES THE USE OF MANY SENSORS TO ENSURE THE ORDER OF THE TASK SERIES EXECUTES CORRECTLY.



FOR EXAMPLE, SCORING A SAMPLE ONLY TAKES 3 TOTAL INPUTS BY UTILIZING MACRO AUTOMATION TO EXECUTE MULTIPLE TASKS WITH A SINGLE BUTTON PRESS. ALL LIMITED RANGE MOVEMENTS UTILIZE MOTOR ENCODERS AND A TUNED PID LOOP TO SNAP TO THE CORRECT POSITION, WITHOUT DRIVERS EVEN LOOKING.

## TELEOP PATHING

AN EXAMPLE OF MACRO AUTOMATION IS OUR AUTOMATIC PATHING WITHIN TELEOP BETWEEN CYCLE LOCATIONS. WITH THE PRESS OF A SINGLE BUTTON, THE ROBOT WILL AUTOMATICALLY DRIVE BETWEEN THE BUCKET AND THE SUBSTATION, OR THE HUMAN PLAYER STATION AND THE SUBSTATION. THIS SIGNIFICANTLY REDUCES THE POTENTIAL FOR DRIVER ERROR, AND SPEEDS UP CYCLE TIMES.

