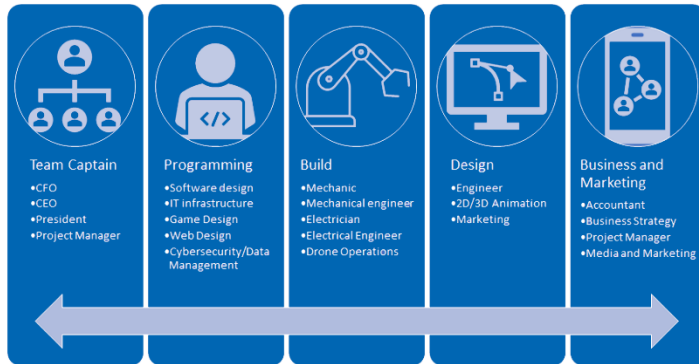


FIRST® Robotics Competition Learning Toolkit



The mission of *FIRST*® is to provide life-changing robotics programs that give young people the skills, confidence, and resilience to build a better world. With a vision to transform our culture by creating a world where science and technology are celebrated and where young people dream of becoming science and technology leaders.

Many *FIRST*® Robotics Competition team members have various roles that help the team progress and improve to achieve this mission and vision. Implementing a system where students progress in their skills while supporting their team increases

engagement and helps students identify future career paths.

Using this Toolkit, *FIRST* Robotics Competition students can achieve their goals by:

- Building competencies with introductory skills through advanced skills that align with industry certifications and career pathways.
- Integrating work-based learning through job roles in a team where skill development results in increased technical skills and teamwork creating more impact for your team.
- Using industry technology and experts that provide experiences to students of projects they see in future industries.
- Providing pathways for students to explore their career interests by defining their own learning goals and steps to accomplish those goals.

This guide is a progression of skill learning in the different team roles you might find on a *FIRST* Robotics Competition team. Many of these roles can help students gain work-based learning credit along with pursuing industry certifications. Some skills may be replicated in multiple job roles, and students may end up completing skills in different roles. The tools for student progression of skills are a menu of options and not necessarily a prescriptive program.

In each area, you will find resources and ideas for students to apply their learning to develop skills utilizing the *FIRST* resources and some third-party resources. They can assist teachers, coaches, and mentors to guide students to continue skill development, whether they are building a robot for competition or working with a mentor to gain industry skills.

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FIRST® Core Values and Workforce Skills

FIRST Core Values emphasize friendly sportsmanship, respect for the contributions of others, teamwork, learning, and community involvement. The FIRST Community expresses the FIRST philosophies of *Gracious Professionalism*® and *Coopertition*® through our Core Values:

- **Discovery:** *We explore new skills and ideas.*
- **Innovation:** *We use creativity and persistence to solve problems.*
- **Impact:** *We apply what we learn to improve our world.*
- **Inclusion:** *We respect each other and embrace our differences.*
- **Teamwork:** *We are stronger when we work together.*
- **Fun:** *We enjoy and celebrate what we do!*

By applying these Core Values, students strengthen essential workforce competencies that align directly with the Career Ready Practices established by Advance CTE. These practices outline the knowledge, skills, and dispositions all learners need to be successful in both education and careers. Through FIRST participation, students:

- CRP-1 Demonstrate responsibility through *Gracious Professionalism*.
- CRP-2 Cultivate interpersonal communication skills
- CRP-3 Promote inclusion during teamwork
- CRP-4 Demonstrate creativity and innovation
- CRP-5 Evaluate impact of decisions
- CRP-6 Exercise critical thinking and perseverance
- CRP-7 Model integrity, leadership, and time management
- CRP-8 Leverage technology to enhance productivity
- CRP-9 Prioritize personal health and well-being
- CRP-10 Integrate academic and technical skills

Students' skills and learning outcomes can be communicated to schools through standards alignments this guide aligns with [ISTE](#), [ITEEA](#), [NIMS](#), and [NBEA](#) standards.

How to Use This Toolkit

Work-based learning through Career and Technical Education aligns classroom learning with workplace experience, helping students apply technical and employability skills in a professional setting. This guide is designed to help teams utilize their *FIRST* participation for work-based learning credit. Although credit recognition varies by school district, these tools are highly effective for building students' foundational workforce competencies.

1. Have students take the [Career Planning Toolkit Course](#) to identify their career interests and learn more about job roles and how they can help them in their career.
2. Students should review the [job role clusters](#) and identify which ones they would like to focus on within their team.
3. Refer to the information on [Why Industry Certifications](#) and determine if they are of value for your students to pursue.
4. Mentors or teachers can use the possible learning activities within this guide or provide their own.
5. Fill out the student training plan for the job role with the student name, grade level, and the mentor that will be evaluating them throughout the season.
 - Go over the competencies for the team role with the student including the career-ready practices so they understand competencies for the job.
6. Have them create goals for themselves at the bottom of the sheet.
7. At the end of the season, mentors evaluate student performance and meeting competencies using the following rating criteria:
 - 4 – **Highly Skilled**: Student can teach others about the task.
 - 3 – **Skilled**: Student can perform the standard independently as a team lead.
 - 2 – **Moderately Skilled**: Student can perform the competency with assistance.
 - 1 – **Introduced**: Student was taught the skill from a team lead or mentor.
 - N – **No Exposure**: Student has no experience or knowledge of this task.
8. Students and mentors should complete a reflection on what they accomplished and next steps, for instance, work toward achieving an industry certification.
9. Use the form to submit as a record of learning to your school or workforce development board.

Business and Leadership Development

Developing a comprehensive business plan and mastering project management are critical professional skills. Engaging the entire team in the planning process fosters shared ownership and ensures every member understands how their specific role contributes to the team's long-term sustainability and success.

LEARNING RESOURCES AND OBJECTIVES	
Best Practices Goals PowerPoint Goal Setting	Conduct brainstorming sessions to set measurable goals for improving team practices and eligibility. Analyze award criteria to identify team strengths
Team Business Plan Business Plan Worksheet Business Plan Template	Author and execute a strategic plan covering professional development, community outreach, and financial sustainability.
Example Budget Budget Template How to Sponsor Relations	Design a team budget and sponsorship recruitment strategy. Learn to monitor and forecast financial resources to ensure season-long stability.
Fundraising Toolkit Fundraising Guide Fundraising 101	Implement fundraising programs that enable your team to meet your financial goals and sustainability.
Effective Leadership How to Organize a Team	Synthesize leadership best practices to cultivate an effective team culture. Apply expert strategies for conflict resolution, group communication, and professional mentorship.
Project Management	Implement industry-standard frameworks to mitigate risks, manage timelines, and streamline team decision-making.
Team Management Resources	Develop and execute a comprehensive marketing suite, including recruitment materials and brand identity assets, to build team awareness and stakeholder engagement.
Awards Worksheet Impact Award Worksheet Awards Webpage Impact Award Resources	Execute an awards strategy that helps you achieve team goals through the technical and business development aspects of the team. Evaluate samples from other teams to design a successful Impact Presentation.
FRC Guided Experience	Utilize lessons within the <i>FIRST</i> Robotics Competition Guided Experience to take a deeper dive into executing your team and robot implementations.

Standards Alignments

ISTE	ITEA
1.1.a, 1.1.c, 3.3.c, 4.4.a, 4.4.d, 6.6.a, 6.6.b, 7.7.a, 7.7.b, 7.7.c, 7.7.d	3J, 4G, 4H, 5F, 6E, 7H, 7I, 8I
NIMS	NBEA
MMS, Planning Benchwork & Layout, Quality & Continuous Improvement, Lean Principles, Workforce Readiness, Workforce Communication, Customer & Stakeholder Awareness	Entrepreneurship I.A, Entrepreneurship III.A, Management I.C, Management II.A, Management II.B, Management III.A, Marketing I.A, Marketing III.A, Communication II.A, Communication III.A, Business Analysis I.B, Career Development I.B

Business and Leadership Development Student Training Plan

NAME		GRADE-EXPERIENCE LEVEL		MENTOR	
Mentors evaluate students' performance using the following rating criteria (see page 4 for criteria details):					
4 – Highly Skilled		3 – Skilled	2 – Moderately skilled	1 – Introduced	N – No exposure
RATING	COMPETENCIES	RATING	CAREER READY PRACTICES		
	Contribute to the strategic development of a formal business plan, defining the team's mission, organizational hierarchy, and measurable short- and long-term goals.		Demonstrate responsibility through <i>Gracious Professionalism</i> .		
			Cultivate interpersonal communication skills		
	Facilitate team communications, including project management workflows, goal setting, and constructive conflict resolution.		Promote inclusion during teamwork		
			Demonstrate creativity and innovation		
	Execute a comprehensive SWOT analysis for the team or sub-team, utilizing the findings to drive continuous improvement and strategically market team achievements.		Evaluate impact of decisions		
			Exercise critical thinking and perseverance		
	Cultivate community partnerships and involvement by delivering sponsor presentations, promoting STEM, and producing multimedia promotional content.		Model integrity, leadership, and time management		
			Leverage technology to enhance productivity		
	Demonstrate leadership, communication and strategic implementation skills while executing on award strategies team development.		Prioritize personal health and well-being		
			Integrate academic and technical skills		
GOALS		INDUSTRY CERTIFICATIONS			
<ul style="list-style-type: none"> ● ● ● ● 		<ul style="list-style-type: none"> ● Certiport: Entrepreneurship & Small Business ● Certiport:Communication Skills for Business ● Certiport:PMI Project Management Ready 			

Marketing and Outreach

Developing materials for marketing and outreach can include elements such as creating promotional materials, connecting with community partners, presenting to sponsors, and sharing the team’s impact.

LEARNING RESOURCES AND OBJECTIVES	
Awards Worksheet Awards Webpage	Analyze the awards available to <i>FIRST</i> Robotics Competition teams to architect a competitive strategy for awards that are given for outreach and community involvement.
Fundraising Toolkit Sponsor Relations Sponsor Packet Sponsor Management	Develop a comprehensive marketing and communications plan. Apply industry standards for community analysis, stakeholder presentations, and long-term sponsor relationship management.
FIRST Branding Standards	Enforce brand consistency by applying <i>FIRST</i> branding standards across all digital and print communication assets.
Imagery for FIRST Teams Imagery Worksheet	Launch and manage a team brand and that can be used in professional communication platforms, ensuring all social media and web content aligns with branding guidelines.
Inventive Outreach Hows and Whys of Outreach	Implement high-impact outreach strategies to cultivate meaningful community relationships and expand the team’s local footprint.
Outreach Worksheet Community Engagement	Design and execute a community impact plan. Facilitate brainstorming sessions to improve team documentation and create compelling narratives for public presentations.
Award Summary Game and Season	Evaluate award criteria to identify growth opportunities. Establish measurable team goals to increase eligibility for technical and community-based awards.
Team Management Resources	Produce a professional recruitment package, including flyers and digital materials, to drive team growth and member engagement.
FRC Guided Experience	Utilize lessons within the <i>FIRST</i> Robotics Competition Guided Experience to take a deeper dive into executing your team and robot implementations.

Standards Alignments

ISTE	ITEEA
1.1.a, 1.1.c, 3.3.c, 6.6.a, 6.6.b, 7.7.a, 7.7.c, 7.7.d	3J, 4G, 4H, 5F, 6E, 7H, 8I
NIMS	NBEA
Workforce Readiness, Workforce Communication, Quality & Continuous Improvement, Planning Benchwork & Layout	Entrepreneurship I.A, Entrepreneurship III.A, Management I.C, Management II.A, Management III.A, Marketing I.A, Marketing III.A, Communication II.A, Communication III.A, Business Analysis I.B, Career Development I.B

Marketing and Outreach Student Training Plan

NAME		GRADE-EXPERIENCE LEVEL		MENTOR	
Mentors evaluate students' performance using the following rating criteria (see page 4 for criteria details):					
4- Highly Skilled		3 – Skilled	2 – Moderately skilled	1 – Introduced	N – No exposure
RATING	COMPETENCIES	RATING	CAREER READY PRACTICES		
	Facilitate a comprehensive SWOT analysis to build a strategic communications and budget plan, specifically defining sponsor engagement and team-wide goal alignment.		Demonstrate responsibility through <i>Gracious Professionalism</i> .		
			Cultivate interpersonal communication skills		
	Produce professional branding assets that articulate the team's mission, organizational hierarchy, and strategic objectives for internal and external stakeholders.		Promote inclusion during teamwork		
			Demonstrate creativity and innovation		
			Evaluate impact of decisions		
	Utilize industry-standard digital tools to design and produce high-impact multimedia assets (graphic, video, and web) tailored for technical award submissions.		Exercise critical thinking and perseverance		
			Model integrity, leadership, and time management		
	Spearhead community outreach initiatives, including sponsor presentations and STEM advocacy programs, to expand the team's local impact and brand footprint.		Leverage technology to enhance productivity		
			Prioritize personal health and well-being		
			Integrate academic and technical skills		
GOALS		INDUSTRY CERTIFICATIONS			
<ul style="list-style-type: none"> ● ● ● ● 		<ul style="list-style-type: none"> ● Certiport: IT Specialist - HTML and CSS ● Certiport: Adobe Certified Professional in Visual Design ● Certiport: Unity Certified User ● Autodesk: Certified User Maya and 3ds Max 			

Drivetrain Team

Use these learning resources for building, design, and fabrication of the drive system. Utilize the guides to help you build a chassis then learn how to customize the chassis for your own criteria.

LEARNING RESOURCES AND OBJECTIVES	
Safety Training Safety Manual	Execute professional workshop safety standards with a primary focus on Personal Protective Equipment (PPE) . Master the selection and proper use of eye protection, hand protection, and hearing conservation tools during the fabrication and assembly of robot hardware.
Game and Season Technical Resources	Analyze seasonal game constraints to architect a custom robot structure. Utilize specialized build guides to select and develop a chassis that meets specific scoring and mobility requirements.
Kitbot Resources	Utilize the kitbot guides to build your robot chassis to learn the fundamentals of building, a chassis using basic tools and fabrication techniques.
Robot Chassis and Drivetrain	Evaluate drivetrain specifications, including maneuverability and motor performance. Research diverse drivetrain designs to optimize mechanical efficiency and robot responsiveness.
Drivetrain Simulator	Analyze the dynamic performance of a drivetrain using simulation data to make informed design and gearing decisions.
Game Manual	Audit Robot Construction Rules to ensure compliance. Strategically apply constraints regarding COTS parts, motor limits, and sizing boxes to the design and build process.
Onshape for Robotics CAD Resources Solidworks Resources	Implement Computer-Aided Design (CAD) for rapid prototyping. Execute complex assemblies, facilitate digital collaboration, and prepare files for professional-grade manufacturing.
Manufacturing Custom Parts	Engineer custom components using advanced fabrication techniques. Design and 3D print functional parts, such as connectors and guards, to enhance chassis durability and performance.
Robot Bumpers	Design and fabricate bumpers for the robot using specific design specifications and aligning them to the robot design requirements.
FRC Guided Experience	Utilize lessons within the <i>FIRST</i> Robotics Competition Guided Experience to take a deeper dive into executing your team and robot implementations.

Standards Alignments

ISTE	ITEEA
1.a, 1.1.c, 3.3.c, 4.4.a, 4.4.b, 4.4.d, 5.5.a, 5.5.b, 7.7.c	20, 3J, 4H, 6E, 7H, 7I, 8H, 8I
NIMS	NBEA
Measurement, Materials & Safety (MMS), Job Planning Benchwork & Layout, Drilling, Layout, Milling I, Turning I, Additive Manufacturing, Quality & Continuous Improvement, Safety	Career Development I.A, Career Development I.B, Management III.A, Operations I.A, Operations I.B

Drivetrain Build Team Student Training Plan

NAME		GRADE-EXPERIENCE LEVEL		MENTOR	
Mentors evaluate students' performance using the following rating criteria (see page 4 for criteria details):					
4- Highly Skilled	3 – Skilled	2 – Moderately skilled	1 – Introduced	N – No exposure	
RATING	COMPETENCIES		RATING	CAREER READY PRACTICES	
	Execute professional workshop safety standards, prioritizing the correct use of Personal Protective Equipment (PPE) during all tool operation and fabrication tasks.			Demonstrate responsibility through <i>Gracious Professionalism</i> .	
	Construct a structural chassis by following technical guides or Engineering a custom solution using industry-standard vendor components.			Cultivate interpersonal communication skills	
	Optimize mechanical efficiency by applying precision tolerances and implementing friction-reduction techniques across all drivetrain components.			Promote inclusion during teamwork	
	Iterate on chassis design to align with specific game strategies, ensuring the build supports required mobility and scoring objectives.			Demonstrate creativity and innovation	
	Fabricate custom structural components utilizing industry-standard processes, including Additive Manufacturing , precision drilling, and specialized cutting.			Evaluate impact of decisions	
	Analyze how modifications to a chassis and robot manipulators affect the drive system.			Exercise critical thinking and perseverance	
	Assess various drivetrain architectures to determine the optimal chassis configuration for specific technical requirements.			Model integrity, leadership, and time management	
				Leverage technology to enhance productivity	
				Prioritize personal health and well-being	
				Integrate academic and technical skills	
GOALS			INDUSTRY CERTIFICATIONS		
<ul style="list-style-type: none"> ● ● ● ● 			<ul style="list-style-type: none"> • Onshape: Certified Associate • Autodesk: Certified Associate CAD for Mechanical Design-Fusion • OSHA: 10 Hour Safety Training • Autodesk: Certified Associate in CAM for 2.5 Axis Milling • Haas: Basic Mill Operator, Basic Lathe Operator • Mastercam: 2D Mill, 3D Mill, Lathe, Multiaxis, and Core • SME: Lean Bronze Certification (Foundational for Lean practitioners) 		

Mechanical Team

Designing manipulators requires understanding of how to best interact with game objects and fabricating the needed items to achieve that interaction.

LEARNING RESOURCES AND OBJECTIVES	
Safety Manual ; Safety Training Suggested Tools Common Hardware	Execute professional workshop safety standards with a focus on Personal Protective Equipment (PPE) . Maintain a professional safe environment while utilizing hand and power tools for subsystem fabrication.
Game and Season Technical Resources Manufacturing Worksheet	Analyze game-specific scoring elements to identify necessary manipulator functions. Use seasonal build guides to architect subsystems that meet specific criteria and constraints.
Game Piece Intakes Presentation	Evaluate various intake architectures. Analyze mechanical advantage and grip patterns to design a system that maximizes game-piece acquisition speed and reliability.
Indexers Presentation	Evaluate various indexing architectures. Analyze transition patterns to design a system that maximizes game-piece storage and organization.
Launchers and Placers Presentation	Research and test different mechanisms for launching and placing game objects. Apply engineering principles to optimize trajectory, precision, and release timing.
Actuators	Categorize and select appropriate actuators (brushed motors, brushless motors, or pneumatics) for specific robotic mechanisms by evaluating their mechanical properties, such as rotational vs. linear motion, torque-to-speed ratios, and system complexity.
Extenders	Evaluate and differentiate between various robotic extension mechanisms—including single/multi-stage elevators, telescoping arms, and linkages—to select the optimal design based on specific game requirements such as reach, height limits, and center of mass.
Prototyping 101 Prototyping Worksheet Mechanisms Worksheet	Execute an iterative prototyping process by moving from low-fidelity mock-ups (Level 0) to high-fidelity functional models (Level 2), using quantitative data collection to validate whether a mechanism meets specific game strategy requirements.
Haas Manufacturing Haas Certification	Safely operate CNC and manual machining tools to produce high-precision robot components by translating CAD designs into physical parts through proper tool selection, feed and speed calculations, and quality control inspections.
Onshape for Robotics CAD Resources Mechanical Engineering Joints	Master Computer-Aided Design (CAD) for subsystem modeling. Use assemblies and digital collaboration to ensure seamless integration between the manipulator and the chassis.
FRC Guided Experience	Utilize lessons within the <i>FIRST</i> Robotics Competition Guided Experience to take a deeper dive into executing your team and robot implementations.

Standards Alignments

ISTE	ITEEA
1.1.a, 1.1.c, 3.3.c, 4.4.a, 4.4.b, 4.4.d, 5.5.a, 5.5.b, 7.7.c	20, 3J, 4H, 6E, 7H, 7I, 8H, 8I
NIMS	NBEA
Measurement, Materials & Safety (MMS), Job Planning Benchwork & Layout, Drilling, Layout, Milling I, Turning I, Additive Manufacturing, Quality & Continuous Improvement, Safety	Career Development I.A, Career Development I.B, Management III.A, Operations I.A, Operations I.B

Mechanical Team Training Plan

NAME		GRADE-EXPERIENCE LEVEL		MENTOR	
Mentors evaluate students' performance using the following rating criteria (see page 4 for criteria details):					
4- Highly Skilled	3 – Skilled	2 – Moderately skilled	1 – Introduced	N – No exposure	
RATING	COMPETENCIES		RATING	CAREER READY PRACTICES	
	Execute professional workshop safety standards, prioritizing the correct use of Personal Protective Equipment (PPE) during subsystem fabrication.			Demonstrate responsibility through <i>Gracious Professionalism</i> .	
	Implement rapid prototyping techniques and utilize data-driven analysis to inform and justify critical design decisions.			Cultivate interpersonal communication skills	
	Optimize mechanical efficiency in subsystems by applying precision tolerances and minimizing mechanical friction.			Promote inclusion during teamwork	
	Iterate on manipulator designs to align with specific game strategies, ensuring subsystems support efficient game-piece acquisition and scoring.			Demonstrate creativity and innovation	
	Fabricate custom manipulator components using industry-standard processes, including Additive Manufacturing , precision drilling, and specialized cutting.			Evaluate impact of decisions	
				Exercise critical thinking and perseverance	
	Evaluate the systemic impact of manipulator geometry and weight distribution on overall robot stability and drive performance..			Model integrity, leadership, and time management	
	Assess various intake and delivery mechanisms to determine the optimal subsystem architecture for specific game piece requirements.			Leverage technology to enhance productivity	
	Architect and build custom mechanical subsystems that meet specific performance criteria and spatial engineering constraints.			Prioritize personal health and well-being	
				Integrate academic and technical skills	
GOALS			INDUSTRY CERTIFICATIONS		
<ul style="list-style-type: none"> • • • 			<ul style="list-style-type: none"> • Onshape: Certified Associate • Autodesk: Certified Associate CAD for Mechanical Design-Fusion • OSHA: 10 Hour Safety Training • SME Robotics Fundamentals and Manufacturing Certification • SME Additive Manufacturing Fundamentals Certification • AMTEC Emerging Technicians Certification • MSSC: Certified Production Technician (CPT) 4.0 (Covers Safety, Quality, Processes, and Maintenance) 		

Control System and Electrical Team

Use these resources to understand your robot control system and develop electrical skills while building your *FIRST* Robotics Competition robot. Wiring the robot includes ensuring correct transmission of the electrical current as well as reducing communication loss through good wiring techniques.

LEARNING ACTIVITIES	
Safety Manual Safety Training Battery Basics	Execute professional electrical safety standards, prioritizing Personal Protective Equipment (PPE) and the safe handling of lithium-polymer batteries and powered circuits.
Electrical Theory; Analog vs Digital, I2C Communication, Logic Levels	Apply fundamentals of electrical theory and communication protocols. Evaluate the differences between analog and digital signals to optimize sensor integration and data accuracy.
Introduction to FRC Wiring	Integrate the FRC control system by interconnecting the roboRIO, Power Distribution Hub, and motor controllers using standardized wiring techniques and ESD mitigation strategies to ensure reliable power distribution and signal integrity.
Wiring Best Practices	Optimize robot reliability by implementing best practices, including vibration isolation, redundant power paths, and rigorous strain relief, while maintaining comprehensive system documentation and labeling to facilitate efficient troubleshooting.
CAN Wiring	Construct a high-speed CAN communication network by implementing a daisy-chain topology between control components and verifying proper bus termination to ensure reliable data transmission and system diagnostic feedback.
CTRE Pneumatics Wiring REV Pneumatics Wiring	Configure and wire an pneumatics subsystem by correctly interfacing a compressor, pressure switch, and solenoids with either a PCM or Pneumatic Hub, ensuring proper voltage jumper settings and CAN bus integration to maintain regulated system pressure.
Diagnostics	Evaluate robot system health by interpreting visual status light patterns across core control components to perform rapid real-time diagnostics, identify hardware faults, and verify communication integrity during pre-flight checks and troubleshooting.
Robot Troubleshooting	Troubleshoot complex electrical systems. Use diagnostic tools and professional logic to identify and resolve wiring, connectivity, or wireless configuration bottlenecks.
Preemptive Troubleshooting	Perform preemptive robot inspections by executing mechanical stress tests, verifying electrical connection torque, and validating system software versions to mitigate hardware fatigue and prevent intermittent power or communication failures during competition.

Standards Alignments

ISTE	ITEEA
3.3.c, 4.4.a, 4.4.d, 5.5.a, 5.5.b, 7.7.a, 7.7.c	20, 3J, 4H, 5F, 7H, 8H, 8I
NIMS	NBEA
Measurement, Materials & Safety (MMS), Job Planning Benchwork & Layout, Electrical – Control Wiring, Electrical – Print Reading, Quality & Continuous Improvement, Safety, Industrial Technology Maintenance Awareness, Workforce Readiness	Career Development I.A, Career Development I.B, Operations I.A, Operations I.B, Management II.B, Management III.A, Business Analysis I.B

Electrical and Control System Student Training Plan

NAME		GRADE-EXPERIENCE LEVEL			MENTOR	
Mentors evaluate students' performance using the following rating criteria (see page 4 for criteria details):						
4- Highly Skilled	3 – Skilled	2 – Moderately skilled	1 – Introduced	N – No exposure		
RATING	COMPETENCIES		RATING	CAREER READY PRACTICES		
	Execute professional electrical safety standards, prioritizing Personal Protective Equipment (PPE) and the safe handling of lithium-polymer batteries.			Demonstrate responsibility through <i>Gracious Professionalism</i> .		
	Evaluate electronic theory and signal types to optimize sensor integration and ensure reliable data communication protocols.			Cultivate interpersonal communication skills		
	Audit electrical connections and wire terminations to ensure high-precision integrity. Evaluate crimps, solder joints, and insulation for consistent current transfer and proper polarity alignment.			Promote inclusion during teamwork		
				Demonstrate creativity and innovation		
	Engineer an electrical layout that incorporates ESD mitigation strategies to protect sensitive control components from static interference.			Evaluate impact of decisions		
	Integrate the control system using industry-standard connectors and wiring techniques to establish a robust electrical path for all motors and sensors.			Exercise critical thinking and perseverance		
				Model integrity, leadership, and time management		
	Calculate power distribution requirements for sensors, motors, and servos to prevent circuit overloads and ensure peak performance.			Leverage technology to enhance productivity		
				Prioritize personal health and well-being		
	Optimize wireless communication reliability by analyzing signal frequencies and implementing strategies to minimize network interference.			Integrate academic and technical skills		
GOALS			INDUSTRY CERTIFICATIONS			
<ul style="list-style-type: none"> ● ● ● 			<ul style="list-style-type: none"> ● OSHA: 10 Hour Safety Training ● SME Robotics Fundamentals and Manufacturing Certification ● AMTEC Emerging Technicians Certification 			

Programming Team

Programming through the control system on the robot is a fundamental part of competing successfully with your robot. It can take time and you might use different languages. The language you choose may depend on your mentor's experience and the career pathway you are considering as a student.

LEARNING ACTIVITIES	
Programming 101	Evaluate the options for programming then choose the platform that aligns with the skills you want to develop. Learn a programming language using the suggested resources in the guide.
Introduction Zero to Robot Software Overview Installing Software	Configure your laptop with the tools needed for programming utilizing the selected programming tool. Complete the steps of Zero to Robot to get a test program running.
Networking Basics, IP Configurations and Bandwidth	Configure and troubleshoot a robust robot network by applying knowledge of IP addressing, DHCP, and mDNS to ensure reliable communication between the robot controller, driver station, and peripheral devices.
VS Code Overview Basic Programming	Apply programming concepts such as creating a program, using third party libraries, debugging, reading stack traces, using functions as data, and using Github to track and manage code.
Hardware APIs Motors, Pneumatics, Sensors CAN Devices	Configure different hardware components including motors, sensors, and solenoid APIs in your code based on your robot design. Evaluate how the hardware components are utilized in code and which options provide the most accurate data and control for your robot.
Command Based Programming	Utilize command-based programming as a design pattern for program flow. Apply commands to subsystems and utilize the command scheduler to execute code within the command-based structure.
Dashboards, Telemetry and Network Tables	Design and configure a custom robot dashboard that differentiates between high-priority driver feedback and deep-level technical telemetry, utilizing NetworkTables to visualize real-time robot states and diagnostic logs.
Kinematics and Drivetrain	Implement a modular drivetrain control system by utilizing Kinematics to convert between Chassis Speeds and individual wheel states, and Odometry to maintain a real-time estimate of the robot's field-relative position.
Vision Processing	Evaluate and implement a vision processing strategy including usage of AprilTags and OpenCV.
Intro to PID, Trajectory and Path Planning ,	Design and tune a PID controller and implement an end-to-end autonomous routine by generating smooth trajectories, characterizing drivetrain constants for feedforward control, and utilizing high-level controllers to track the robot's pose along a predefined path.

Standards Alignments

ISTE	ITEEA
1.1.a, 1.1.c, 3.3.c, 4.4.a, 4.4.b, 4.4.d, 5.5.a, 5.5.b, 6.6.a, 7.7.c ITEEA: 20, 3J, 4H, 6E, 7H, 7I, 8H, 8I	20, 3J, 4H, 6E, 7H, 7I, 8H, 8I
NIMS	NBEA
Industrial Technology Maintenance Awareness, Measurement Materials & Safety (MMS), Job Planning Benchwork & Layout, Quality & Continuous Improvement, Workforce Readiness NBEA: Information Technology I.A, Information Technology II.A, Information Technology III.A, Communication III.A, Career Development I.B, Management III.A	Information Technology I.A; Information Technology II.A; Information Technology III.A; Communication III.A; Career Development I.B; Management III.A

Programming Team Training Plan

NAME		GRADE-EXPERIENCE LEVEL		MENTOR	
Mentors evaluate students' performance using the following rating criteria (see page 4 for criteria details):					
4- Highly Skilled	3 – Skilled	2 – Moderately skilled	1 – Introduced	N – No exposure	
RATING	COMPETENCIES		RATING	CAREER READY PRACTICES	
	Configure, deploy, and manage an industry-standard robot programming environment using structured development and version control practices..			Demonstrate responsibility through <i>Gracious Professionalism</i> .	
	Design, configure, and troubleshoot reliable communication systems between robot subsystems using foundational networking principles.			Cultivate interpersonal communication skills	
	Develop scalable robot software using object-oriented principles and command-based design patterns.			Promote inclusion during teamwork	
				Demonstrate creativity and innovation	
	Integrate motors, sensors, actuators, and CAN devices into software systems using appropriate APIs and control strategies.			Evaluate impact of decisions	
	Design and deploy real-time telemetry and diagnostic systems to inform driver performance and technical decision-making.			Exercise critical thinking and perseverance	
	Design, tune, and validate closed-loop motion control systems to execute precise and repeatable autonomous routines.			Model integrity, leadership, and time management	
				Leverage technology to enhance productivity	
	Implement and evaluate computer vision and advanced sensing strategies to enhance robot autonomy and environmental awareness.			Prioritize personal health and well-being	
				Integrate academic and technical skills	
GOALS			INDUSTRY CERTIFICATIONS		
<ul style="list-style-type: none"> ● ● ● 			<ul style="list-style-type: none"> ● Certiport: IT Specialist – Software Development / Java ● Certiport: IT Specialist – Software Development / Python ● Certiport: IT Specialist – Artificial Intelligence ● Python Institute: PCEP – Certified Entry-Level Python Programmer ● Python Institute: PCAP – Certified Associate in Python Programming ● Open CV: Fundamentals of Computer Vision 		

Strategy and Data Analytics

Programming through the control system on the robot is a fundamental part of competing successfully with your robot. It can take time and you might use different languages. The language you choose may depend on your mentor's experience and the career pathway you are considering as a student.

LEARNING ACTIVITIES	
Kickoff Worksheet Kickoff Breakdown	Analyze game rules and scoring structures to identify key variables, constraints, and high-value strategic opportunities.
Scoring Analysis	Deconstruct game objectives into measurable actions and define key performance indicators (KPIs) that drive match success. Evaluate scoring efficiency using quantitative metrics such as cycle time, points per second, and success rates to prioritize optimal strategies.
Effective Strategies for Design and Competition	Develop and execute competition strategies based on data analysis, alliance composition, and opponent performance trends.
Decision Making	Apply structured, data-driven decision-making frameworks to evaluate trade-offs, assess risk, and justify strategic choices.
Introduction to Scouting	Design and implement scouting systems that capture both quantitative and qualitative performance data aligned to game objectives.
Intermediate Scouting	Collect, validate, and analyze match data to identify trends, consistency, and performance variability across teams.
FRC API API Demo Tool API for Google Sheets	Synthesize scouting data to generate actionable insights that inform match strategy, alliance selection, and in-game adjustments.

Standards Alignments

ISTE	ITEEA
1.1.a, 1.1.c, 1.4.a, 1.4.b, 1.4.c, 1.5.b, 1.5.c, 1.6.a, 1.6.b, 1.7.b	20, 3J, 4H, 6E, 7H, 7I
NIMS	NBEA
Quality & Continuous Improvement, Measurement Materials & Safety (MMS), Workforce Readiness	Information Technology I.A, Information Technology II.A, Communication III.A, Management III.A, Career Development I.B

Strategy and Data Analytics Student Training Plan

NAME		GRADE-EXPERIENCE LEVEL		MENTOR	
Mentors evaluate students' performance using the following rating criteria (see page 4 for criteria details):					
4- Highly Skilled	3 – Skilled	2 – Moderately skilled	1 – Introduced	N – No exposure	
RATING	COMPETENCIES		RATING	CAREER READY PRACTICES	
	Design and utilize structured data collection systems to capture reliable qualitative and quantitative data aligned to defined objectives.			Demonstrate responsibility through <i>Gracious Professionalism</i> .	
	Define key performance indicators (KPIs) and metrics to evaluate system performance and support data-driven decision-making.			Cultivate interpersonal communication skills	
	Apply quantitative analysis techniques to evaluate efficiency, trends, variability, and performance outcomes across datasets.			Promote inclusion during teamwork	
				Demonstrate creativity and innovation	
	Develop and implement data-informed strategies by synthesizing multiple data sources and identifying patterns and relationships.			Evaluate impact of decisions	
	Build and manage datasets to ensure data accuracy, consistency, and integrity for analysis and reporting purposes.			Exercise critical thinking and perseverance	
	Create data visualizations and dashboards to communicate insights, highlight trends, and support stakeholder decision-making.			Model integrity, leadership, and time management	
	Apply structured decision-making frameworks to evaluate trade-offs, assess risk, and justify recommendations using data evidence.			Leverage technology to enhance productivity	
	Interpret and communicate analytical findings through written, visual, and verbal formats tailored to technical and non-technical audiences.			Prioritize personal health and well-being	
				Integrate academic and technical skills	
GOALS			INDUSTRY CERTIFICATIONS		
<ul style="list-style-type: none"> • • • • • • • 					