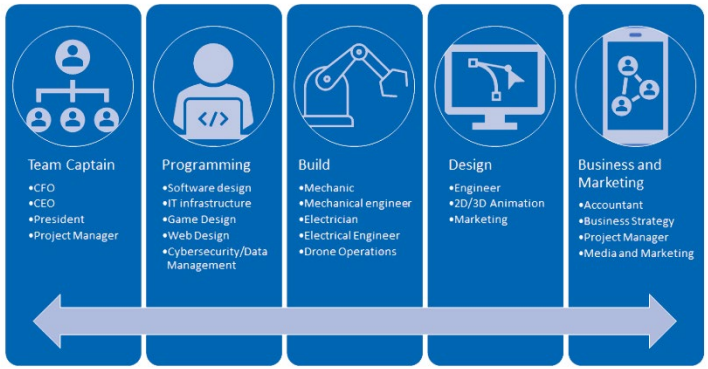
FIRST® Robotics Competition Work-Based Learning or Independent Learning Toolkit



FIRST® is *More Than Robots*® "We are not using kids to build robots. We are using robots to build kids." – *FIRST* Founder Dean Kamen

The mission of *FIRST* is to inspire young people to be science and technology leaders and innovators, by engaging them in exciting mentor-based programs that build science, technology, engineering, and math (STEM) skills, inspire innovation, and foster well-rounded life capabilities including self-confidence, communication, and leadership.

Some *FIRST*® Robotics Competition teams may have 25-100 members on a team, but not all these students may have an opportunity to be involved in the design and building of a robot or other team projects. Utilizing a system where students can progress in their skills while helping their team can increase team engagement and help students find their future career path.

Using this Toolkit, you can help your *FIRST* ® Robotics Competition students achieve their goals by:

- Building competencies with introductory skills to advanced skills that work towards jobs and industry certifications
- Integrating work-based learning through job roles on 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 that you might find on a *FIRST* Robotics Competition team. Many of these roles can help students gain work-based learning skills and along with pursuing industry certifications. Some skills may be replicated in multiple job roles, and students may end up completing skills in multiple 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 be used to assist teachers, coaches, and mentors to guide students to continue skills 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 CTE Career-Ready Practices

The *FIRST* Core Values emphasize friendly sportsmanship, respect for the contributions of others, teamwork, learning, and community involvement and are part of our commitment to fostering, cultivating, and preserving a culture of equity, diversity, and inclusion.
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!*

If we compare the Career Technical Education (CTE) Career-Ready Practices as defined by Advance CTE, many of their Career-Ready Practices apply to these Core Values of *FIRST*:

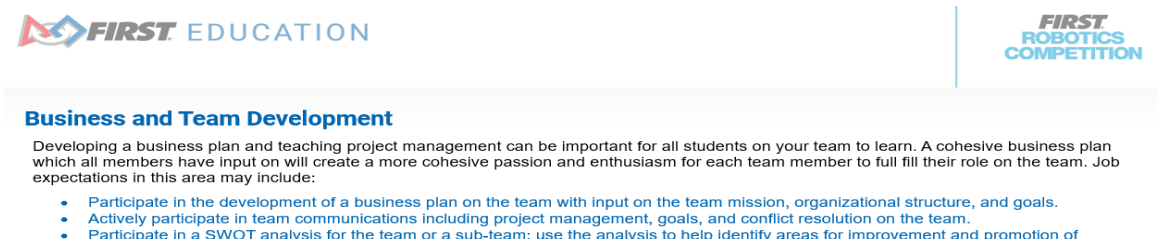
CRP-1 Showing responsibility through *Gracious Professionalism*
CRP-2 Applying interpersonal communication skills
CRP-3 Using inclusion during teamwork
CRP-4 Demonstrating creativity and innovation
CRP-5 Considering impact of decisions
CRP-6 Critical thinking and perseverance
CRP-7 Modeling integrity, leadership, and time management
CRP-8 Using technology to enhance productivity
CRP- 9 Considering personal health and well-being
CRP-10 Applying academic and technical skills

Students develop Career-Ready Practices by applying *FIRST*'s Core Values on their team and how they identify themselves as contributors within a workplace environment. The job roles available to team members span the following Career Clusters aligned to the Common Career Technical Core Clusters: Business Management and Administration, Manufacturing, Science, Technology, Engineering & Mathematics, Marketing Informational Technology.

How to Use This Toolkit

Effective work-based learning opportunities involve alignment of classroom and workplace learning, application of academic, technical, and employability skills in a work setting, and support from classroom or workplace mentors. This guide contains tools to help a teacher, or a student use their *FIRST* experience as a work-based learning credit. Credit availability should be determined by the school they are hoping to acquire credit through and requirements for each district can vary. After the process for credit is defined:

1. Students should review the job role clusters and identify which ones they would like to pursue and work on.
2. Identify the job expectations they would like to focus on. Using the following example a student might be focused on Business and Team Development. They then may choose the bullet points in blue as their job expectations.



3. Identify the Career Ready Practices based upon the Common Career Technical Core they would like have as a focus in their job role.
4. Mentors or teachers can use the possible learning activities within this guide or describe their own. The ones in this guide are aligned to the Common Career Technical Core Clusters in Business Management and Administration, Manufacturing, Science, Technology, Engineering & Mathematics, Marketing, and Informational Technology.
5. Fill out the training agreement, found in page 31 of this guide.
6. Mentors evaluate their performance and evidence (Observed or Portfolio) on meeting the criteria using the following rating criteria:
    a. 4- **Highly Skilled**- student can teach others about the task
    b. 3 - **Skilled,** student can demonstrate the standard independently as a team lead
    c. 2 - **Moderately skilled,** student can demonstrate task with assistance from mentors or team captain
    d. 1 - **Introduced**, student was taught the skill from a team lead or mentor
    e. N - **No exposure**, student has no experience or knowledge of this task
    f. O - **Observed**
    g. P - **Portfolio**
7. Students complete a reflection and build a portfolio of their accomplishments in their job role.

Business and Team Development

Developing a business plan and teaching project management can be important for all students on your team to learn. A cohesive business plan which all members have input on will create a more cohesive passion and enthusiasm for each team member to full fill their role on the team. Job expectations in this area may include:

- Participate in the development of a business plan on the team with input on the team mission, organizational structure, and goals.
- Actively participate in team communications including project management, goals, and conflict resolution on the team.
- Participate in a SWOT analysis for the team or a sub-team; use the analysis to help identify areas for improvement and promotion of accomplishments.
- Participate in the promotion of your team through community involvement in activities such as sponsor presentations, promoting STEM in your community, and/or development of multimedia promotional materials.

Mentor Performance Rating

4 - **Highly Skilled**- student can teach others about the task
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O- **Observed** or P-**Portfolio**

Career Cluster

Business Management and Administration

Industry Certifications

Tableau Desktop Specialist Certification

Google Analytics Individual Qualification

Standard	Description	Mentor Performance Rating	Business and Team Development Possible Learning Opportunity
BM-MGT 7.3	Develop business plans to meet company needs.		Team Business Plan; Team Organization Describe the nature and types of business organizations to build an understanding of the scope of organizations. If your team does not have a business plan create an initial draft of that plan these are your initial thoughts. Then use the remaining resources in this section to continue to improve that plan and create goals for improvement.
BM-MGT 7.4	Plan for future company growth to guide company operations.		
BM-MGT 7.5	Design organizational structure to facilitate business activities.		
BM-MGT 8.1	Develop and implement strategic plan.		
BM-MGT 8.2	Analyze strategic plans.		
BM-HR 5.13	Contribute to organizational development to change the beliefs, attitudes, values, and structure of organizations so that they can better adapt to new technologies, markets and challenges.		
BM-HR 7.1	Implement strategic planning processes to guide human resources management decision-making.		
BM-HR 7.2	Evaluate organization's strategic planning and policy-making processes to guide decision-making.		
BM-BIM 1.1	Apply knowledge of business contracts to establish business relationships.		Fundraising Toolkit; Fundraising; Budget; Understand tools, strategies, and systems used to maintain, monitor, control, and plan the use of financial resources. Use the fundraising toolkit to develop a team budget and Sponsor recruitment to ensure financial sustainability of your team. Create a budget, and write sponsorship letters to acquire needed funding.
BM-ADM 2.5	Select document type and layout to produce business letters.		
BM-ADM 2.6	Select appropriate writing method to produce a variety of reports.		
BM-BIM 2.3	Implement suitable internal accounting controls to ensure the proper recording of financial transactions		
BM-MGT 5.1	Manage business risks to protect a business's finances.		
BM-MGT 5.2	Manage financial resources to ensure solvency		
BM-HR 2.1	Communicate with staff to clarify workplace expectations and benefits.		Effective Leadership; Effective Team Management Explore from the experts on best practices and details of effective team management.
BM-HR 3.1	Model behaviors and actions to effectively motivate and lead people.		

Standard	Description	Mentor Performance Rating	Business and Team Development Possible Learning Opportunity
BM-HR 3.2	Model behaviors and actions to effectively motivate and lead change.		Use the video to help develop a goal for team management considering team building, communication, and conflict management.
BM-HR 3.3	Model behaviors and actions to effectively motivate and promote the use of teamwork in the workplace.		
BM 4.2	Utilize technology to facilitate customer relationship management and workplace communication		*FIRST* Robotics Competition 1816 Outreach; Outreach for 100; *FIRST* Impact Award Explore the resources to develop strategies for your team to make an impact. Conduct a team brainstorming session to create your own plan for how you might make an impact in your community and the *FIRST* Community. How might you increase documentation and create a presentation about your team.
BM 5.1	Explain the nature and scope of knowledge management practices within a business.		
BM 5.2	Use knowledge management strategies to improve the performance and competitive advantage of an organization.		
BM 6.1	Explain the nature and scope of quality management practices within a business.		
BM 6.2	Identify management principles utilize for continuous quality improvement.		
BM-ADM 2.1	Perform scheduling functions to facilitate on-time, prompt completion of work activities.		Team Attribute Awards; Judging Process; Best Practices Explore the links above to learn more about how you can apply and position your team for awards. Conduct a team brainstorming session to develop goals for how you might improve practices to make your team more eligible for awards.
BM-ADM 2.2	Manage business records to maintain needed documentation.		
BM-ADM 2.3	Prepare documentation of business activities to communicate with internal/external clients.		
BM-ADM 2.4	Utilize information technology tools to manage and perform work responsibilities.		
BM-ADM 2.6	Select appropriate writing method to produce a variety of reports.		
BM-MGT 7.4	Plan for future company growth to guide company operations.		Recruitment Explore the Recruitment tab in on the website. Develop a recruitment flyers and recruitment materials for your team.
BM-HR 5.2	Develop programs to assist in meeting needs of separated and transitional employees.		
BM-HR 5.4	Plan talent-acquisition activities to guide human resources management decision-making.		
BM-BIM 2.2	Manage risk to protect a business's well-being.		Data management and Scouting with Tableau
BM-BIM 3.1	Enhance usability of computer system operations.		

Standard	Description	Mentor Performance Rating	Business and Team Development Possible Learning Opportunity
BM-BIM 3.2	Use database software to create databases that facilitate business decision-making.		Become a Tableau expert in no time and on your own schedule. These tutorials were designed by *FIRST* students for *FIRST* students. Cover everything from data entry to advanced dashboarding for competition. Have students use Tableau to data entry techniques and apply them on your team and gain career skills.
BM-BIM 3.3	Use data entry techniques to enter information in databases		
BM-BIM 3.4	Use commands to retrieve data and create reports from databases.		
BM-BIM 3.5	Apply data mining methods to acquire pertinent information for business decision-making.		
BM-BIM 3.7	Use technology to support business strategies and operations.		

Build Team Resources

Chassis and Drive System

Learning resources for building, design, and fabrication of the drive system. Use the resources to guide you in getting a Kit bot chassis up and running then learning how to customize the chassis for your own criteria then learn tools to create your own chassis design. Job expectations in this area may include:

- Follow proper safety procedures for tool use and fabrication.
- Assemble a chassis using guides provide or design your own with other vendor supplies.
- Apply tips and best practices to ensure proper tolerances and frictions are minimized.
- Modify the design of a chassis to fit the game strategy.
- Create custom parts or frame for the chassis using industry standard fabrication processes including additive manufacturing, milling, drilling, cutting and welding.
- Analyze how modifications to a chassis and robot manipulators affect the drive system.
- Analyze different types of drive systems and chassis requirements for each type.
- Design and build a custom drive system to achieve design criteria constraints.
- Repeat design process for different types of drive systems.

Mentor Performance Rating

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O- **Observed** or P-**Portfolio**

Career Cluster

Manufacturing
Science, Technology, Engineering & Mathematics

Industry Certifications

OSHA Safety Certification

Standard	Description	Mentor Performance Rating	Chassis and Drive System Possible Learning Opportunity
ST 3.1	Apply appropriate safety and health practices when developing plans, projects, processes or solving complex problems.		UL Safety Learning Portal; Safety Manual Learn important details of how to stay safe while working on and building your robot. Safety Manual Training, Fire Extinguisher and Safety Awareness, Hand and Power Tool Safety Awareness, Hazard Communication – Safety Data Sheets, Personal Protective Equipment (PPE) Awareness, Recognizing Electrical Hazards Awareness, Lockout/Tagout Awareness, Hearing Conservation Awareness
ST 3.2	Use appropriate safety techniques, equipment, and processes in planning and /or project applications.		
ST 3.3	Identify potential and existing hazards to plans, projects, or processes where safety, health, and environmental issues may be affected.		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		Robot Quick Build Instructions Use the zip files and start with the Required Materials to learn how to set up your work environment, Use the AM14U4 Chassis Base Kit guide from AndyMark to build the largest configuration of the chassis. Then use the Installing Electrical Board RQBS for choosing/determining how you will mount the electronics. Use the How to Wire a Robot file to finish wiring the drive system. Use the instructions to assemble a frame using predesigned configurations. Assemble gearboxes according to instructions with appropriate lubrication and tolerances. Construct a timing belt system with the proper tension and spacing to ensure efficiency and proper operation.
ST-ET 3.1	Use knowledge, techniques, skills and modern tools necessary for engineering practice.		
ST-ET 6.6	Apply and create appropriate models, concepts, and processes for an assigned situation, and apply the results to solving the problem.		
ST-SM 1.3	Use the skills and abilities in science and mathematics to integrate solutions related to technical or engineering activities using the content and concepts related to the situations.		
ST-SM 2.1	Demonstrate the ability to recognize cause and effect when faced with assigned projects or issues.		
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		*FIRST* Robotics Competition Drivelines Considered; *FIRST* Robotics Competition Drivetrains Learn lessons in robot design theory including wheelbase, center of gravity, chain theory, sprocket, and gear ratios and robot speed.
ST-ET 3.1	Use knowledge, techniques, skills, and modern tools necessary for engineering practice.		
ST-ET 3.4	Illustrate the ability to characterize a plan and identify the necessary engineering tools that will produce a technical solution when given a problem statement.		

Standard	Description	Mentor Performance Rating	Chassis and Drive System Possible Learning Opportunity
ST-ET 5.2	Demonstrate the ability to evaluate a design or product and improve the design using testing, modeling, and research.		Apply the robot design theory to understand the kit bot chassis configuration and how you can modify them to fit your design needs.
ST-ET 6.1	Apply the use of algebraic, geometric, and trigonometric relationships, characteristics, and properties to solve problems.		
ST-ET 5.1	Apply the design process using appropriate modeling and prototyping, testing, verification, and implementation techniques.		Technical Resources Page Explore the technical resources page to learn the importance of how to build bumpers for your robot. Consider the design of bumpers, how can you improve your design to increase functionality in hardware, frame perimeter, and meet the criteria set out in the game manual. Design different options in CAD so that you can have different bumper options.
ST-ET 5.2	Demonstrate the ability to evaluate a design or product and improve the design using testing, modeling, and research.		
ST-ET 4.3	Describe design constraints, criteria, and trade-offs in regard to variety of conditions (e.g., technology, cost, safety, society, environment, time, human resources, manufacturability).		
MN 6.1	Demonstrate the planning and layout processes (e.g., designing, print reading, measuring) used in manufacturing.		C2SN Fabrication Part 1 Use the review material and guide to learn about what is a chassis, how to use technical drawings including dimensions, and tolerance. Create a custom fabricated part for a robot, including a technical drawing with tolerances and dimensions.
MN 6.2	Summarize how materials can be processed using tools and machines.		
MN 6.3	Describe various types of assembling processes (e.g., mechanical fastening, mechanical force, joining, fusion bonding, adhesive bonding) used in manufacturing.		
MN 6.1	Demonstrate the planning and layout processes (e.g., designing, print reading, measuring) used in manufacturing.		Brackets and Plates Look at this plate from Andymark. Identify the types of machining used in creating the part analyze the CAD file and technical drawing file associated with the part. What tolerances and dimensions were used in creating the part. Work with the design team to fabricate a custom part using proper tolerances and dimensions.
MN 6.2	Summarize how materials can be processed using tools and machines		
MN 6.4	Explain finishing processes (e.g., types of finishing materials, surface preparation, methods of application) used in manufacturing.		
MN 6.1	Demonstrate the planning and layout processes (e.g., designing, print reading, measuring) used in manufacturing.		C2SN Fabrication Part 2 Create a custom fabricated part for a robot, that required you to cut, drill or bend a component to specific dimensions.
MN 6.2	Summarize how materials can be processed using tools and machines		

Standard	Description	Mentor Performance Rating	Chassis and Drive System Possible Learning Opportunity
MN 6.4	Explain finishing processes (e.g., types of finishing materials, surface preparation, methods of application) used in manufacturing.		Use the material to understand how to fabricate motor mounts, utilizing skills including cutting, drilling, filing, reading and interpreting drawings, and bending aluminum
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		Drive System Designs ; Prototyping Watch the video to learn the pro and cons of different drive systems including turning radius, maneuverability and fabrication possibilities. Have students research each of the robot systems, if materials are available create ideas of different prototypes and test them.
ST-ET 3.1	Use knowledge, techniques, skills and modern tools necessary for engineering practice.		
ST-ET 3.4	Illustrate the ability to characterize a plan and identify the necessary engineering tools that will produce a technical solution when given a problem statement.		
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		Intro to Kinematics and Chassis Speed Understand the difference between kinematics, odometry and how data is collected in different drive systems. Conduct a brainstorming session where drive and control discuss the possibilities of different drive systems and how each one can be designed and executed with skills that are on the team.
ST-ET 3.1	Use knowledge, techniques, skills and modern tools necessary for engineering practice.		
ST-ET 3.4	Illustrate the ability to characterize a plan and identify the necessary engineering tools that will produce a technical solution when given a problem statement.		

Designing Manipulators

Designing manipulators requires understanding how to best interact with game objects and then how to fabricate the needed items to achieve that interaction. Job expectations in this area may include:

- Demonstrate quick prototyping techniques and data collection to drive design decisions.
- Explore different types of manipulators used in *FIRST* Robotics Competition, weigh the pros and cons of each type of manipulator and its application to a game strategy.
- Safely perform to industry standards fabrication processes including additive manufacturing, milling, drilling, cutting and welding.
- Apply the fundamental physics of simple machines, gear ratios, sprocket and belt design to design manipulators to achieve a game strategy.
- Analyze motor specifications and performance data to choose the best actuator for a design criterion including motors and pneumatics.
- Analyze the required electrical inputs and outputs for an actuator and communicate performance needs to the programming team.
- Use analytical geometry and advanced physics concepts to refine and improve the design of a manipulator.
-

Mentor Performance Rating

4 - **Highly Skilled**- student can teach others about the task

3 - **Skilled,** student can perform the standard independently as a team lead
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N - **No exposure**, student has no experience or knowledge of this task

O- **Observed** or P-**Portfolio**

Career Cluster

Manufacturing

Science, Technology, Engineering & Mathematics

Industry Certifications

SME Certified in Robotics Fundamentals
SME-Certified Manufacturing Associate
Mastercam -2D Milling, 3D Milling
Haas Certification Program
NREC Manufacturing and Robotics Certification (CMU)

Standard	Description	Mentor Performance Rating	Designing Manipulators Possible Learning Opportunity
ST-ET 3.4	Illustrate the ability to characterize a plan and identify the necessary engineering tools that will produce a technical solution when given a problem statement.		Prototyping Behind the Lines;, Prototyping How to develop mechanisms using quick prototypes. Refine those designs over time and improve the performance of mechanisms through prototyping and testing. Have students practice quick prototyping with objects. Use data from the prototype to refine and develop a design.
ST-ET 4.2	Explain the elements and steps of the design process and tools or techniques that can be used for each step.		
ST-ET 5.1	Apply the design process using appropriate modeling and prototyping, testing, verification and implementation techniques.		
ST-ET 5.2	Demonstrate the ability to evaluate a design or product and improve the design using testing, modeling and research.		
ST-ET 5.3	Demonstrate the ability to record and organize information and test data during design evaluation.		
ST-ET 6.1	Apply the use of algebraic, geometric, and trigonometric relationships, characteristics, and properties to solve problems.		*FIRST* @ Home Free and Flexible STEM Activities Sessions 4, 5,6,10, 11, and 12 are a series of lesson where students build an escape room using principles of electricity, simple machines, gear ratios, and encryption which can all be transferred to building a robot. Have students complete the lessons and build manipulators for the escape room that could also be used on a robot.
ST-ET 6.2	Apply the process and concepts for science literacy relative to engineering and technology.		
ST-ET 6.3	Exhibit the ability to select, apply and convert systems of measurement to solve problems		
ST-ET 6.4	Apply basic laws and principles relevant to engineering and technology.		
ST-ET 6.6	Apply and create appropriate models, concepts, and processes for an assigned situation, and apply the results to solving the problem.		
ST 2.2	Use modeling, simulation, or visual reproduction to effectively analyze, create, and/or communicate to others regarding plans, projects, problems, issues, or processes.		Pick a Motor; Change Motor Torque or Speed Understand how to choose the right motors for your robot based on application, motor qualities, and specifications. You'll then

Standard	Description	Mentor Performance Rating	Designing Manipulators Possible Learning Opportunity
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		learn the fundamentals for getting the most out of your selected motors by choosing the right reductions and gearboxes. Have students watch the video on motor and gearbox selection, then have them use the motor performance data to choose the right motor for a manipulator design.
ST-ET 1.2	Develop the active use of information technology applications.		
ST-ET 1.3	Use computer applications to solve problems by creating and using algorithms, and through simulation and modeling techniques.		
ST-ET 3.2	Describe the elements of good engineering practice (e.g., understanding customer needs, planning requirements analysis, using appropriate engineering tools, prototyping, testing, evaluating and verifying).		
MN-MIR 4.1	Coordinate preparation for the installation, customization, or upgrading of equipment.		Pneumatics Manual Understand how to connect a pneumatics circuit, and how to determine the correct size actuator for manipulator. Have students explore the manual and create a benchtop system to build and test a pneumatics circuit. Then have them use the reference data to choose the correct actuator for a manipulator design.
MN-MIR 4.2	Obtain machine information from vendors related to proper installation, customization, or upgrade.		
MN-MIR 4.6	Test the equipment to ensure proper function after installation, customization, or upgrading.		
MN-PPD 2.4	Set up and program equipment for new processes.		
MN-PPD 2.5	Schedule and test new processes.		
MN-MIR 4.1	Coordinate preparation for the installation, customization, or upgrading of equipment.		REV Ion Technical Resources Use the resources to understand how to use REV resources for transmitting and transforming motion. As students learn about different methods for transmitting a transforming motion, have them prototype their own method with different materials that could be found at home or in the robotics lab.
MN-MIR 4.2	Obtain machine information from vendors related to proper installation, customization, or upgrade.		
MN-MIR 4.6	Test the equipment to ensure proper function after installation, customization, or upgrading.		
MN-PPD 2.4	Set up and program equipment for new processes.		
MN-PPD 2.5	Schedule and test new processes.		

Standard	Description	Mentor Performance Rating	Designing Manipulators Possible Learning Opportunity
ST-ET 6.1	Apply the use of algebraic, geometric, and trigonometric relationships, characteristics and properties to solve problems.		MIT Simple Machine Geometry An MIT Lesson on kinematics to design mechanisms. Have students use the simple machine geometry lesson to understand how to best plan spacing and execution of designing different manipulators.
ST-ET 6.2	Apply the process and concepts for science literacy relative to engineering and technology.		
ST-ET 6.3	Exhibit the ability to select, apply and convert systems of measurement to solve problems.		
ST-ET 6.4	Apply basic laws and principles relevant to engineering and technology.		
ST-ET 6.5	Explain relevant physical properties of materials used in engineering and technology.		
ST 2.2	Use modeling, simulation, or visual reproduction to effectively analyze, create, and/or communicate to others regarding plans, projects, problems, issues, or processes.		Robot Mechanisms by Siemens Explore the lessons designing mechanisms in CAD using SolidEdge on 4 Bar Mechanisms, Crank and Sliders, Scotch Yoke, Cam Mechanisms and other types of advanced mechanisms with resources created by Siemens Have students use the principles in the CAD tutorials to understand how different types of mechanisms are created.
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		
ST-ET 1.3	Use computer applications to solve problems by creating and using algorithms, and through simulation and modeling techniques.		
ST-ET 2.2	Read and create basic computer-aided engineering drawings.		
ST-ET 3.1	Use knowledge, techniques, skills and modern tools necessary for engineering practice.		
MN 6.1	Demonstrate the planning and layout processes (e.g., designing, print reading, measuring) used in manufacturing.		CAD for Robotics and Manufacturing Learn about designing for 3D Printing, laser cutting and manufacturing with this lesson from Onshape.
MN 6.2	Summarize how materials can be processed using tools and machines.		

Standard	Description	Mentor Performance Rating	Designing Manipulators Possible Learning Opportunity
MN 6.1	Demonstrate the planning and layout processes (e.g., designing, print reading, measuring) used in manufacturing.		Haas CNC Certification Program Use the Haas CNC Videos to learn how to use CNC machinery and pursue a certification with the Haas Foundation.
MN 6.2	Summarize how materials can be processed using tools and machines.		

Electrical

Use these resources build the correct communication pathway on your *FIRST* Robotics Competition robot through correct transmission of the electrical current as well as way to reduce communication loss through good wiring techniques. Custom electronic circuits can allow you further develop electronic skills. Further your skills by understanding the fundamentals of how some of the electronic components such as the PCM and voltage regulator are created. Job expectations in this area may include:

- Use the *FIRST* Robotics Competition Control system with industry connectors including Wago to complete the electrical path for the drive system, motors and pneumatic actuators.
- Understand and ensure polarity transfer of electrical wire connections including PWM, CAN and Power.
- Correctly wire control system components including the power distribution panel, PCM CAN Interface, Voltage Regulator Module, Motor Controllers, Relays, Servo Modules,
- Properly crimp, solder and insulate connections to ensure electrical current transfer with the proper polarity,
- Understand needed electrical current input and output of sensors, motor controllers, robot controller, PCM CAN, and Voltage Regulator Module.
- Analyze an electrical schematic from a manufacturer to identify how the electrical current is transferred in the circuit, properly identify common schematic symbols.
- Apply fundamentals of electronics including ohms, amps, resistors, circuit breakers, op amps, NTC and PTC Thermistors
- Create a basic circuit using a breadboard that meets a needed design criterion
- Identify the programmable logic controllers in the control system and create a flow chart of the logic used in the system.

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N - **No exposure**, student has no experience or knowledge of this task

O- **Observed** or P-**Portfolio**

Career Cluster

Science, Technology, Engineering & Mathematics

Industry Certifications

SME Certified in Robotics Fundamentals
SME-Certified Manufacturing Associate
FESTO Industry 4.0

Standard	Description	Mentor Performance Rating	Electrical (large scale) Possible Learning Opportunity
ST-ET 5.2:	Demonstrate the ability to evaluate a design or product and improve the design using testing, modeling and research.		WPI: How to wire and *FIRST* Robotics Competition Robot Wiring Essentials Video Learn how to utilize connectors including Wago, Motor Power Controllers, Weidmuller Connectors. Understand how the voltage regulator module power is distributed to each of the components. Utilize old kits of parts and circuits to develop benchtop test for students to wire and configure. Research the types of connectors they are utilizing and how they are used in industry. Why are they are engineered in the way they are? What solution to a problem does it solve?
ST-ET 6.2	Apply the process and concepts for science literacy relative to engineering and technology		
ST-ET 6.4	Apply basic laws and principles relevant to engineering and technology.		
ST-ET 6.5	Explain relevant physical properties of materials used in engineering and technology.		
ST-SM 1.3	Use the skills and abilities in science and mathematics to integrate solutions related to technical or engineering activities using the content and concepts related to the situations.		
MN-MIR 3.1	Gather equipment information and history that can assist in identifying and diagnosing problems.		Wiring Best Practices Troubleshooting Quick Reference Understand the importance of reducing vibration and shock on connections, increasing redundance, port savers and wire management and strain relief. Have students do an analysis of the current robot and determine if there are any areas where wiring best practices could be improved.
MN-MIR 3.2	Isolate system and component failure following diagnostic procedures.		
MN-MIR 3.3	Identify root cause of problem using diagnostic procedures.		
MN-MIR 3.4	Develop corrective action plan to fix the problem.		
MN-MIR 3.5	Execute corrective action plan.		
MN-MIR 3.1	Gather equipment information and history that can assist in identifying and diagnosing problems.		Explore Driver Station Log Viewer Explore the Driver Station Log Viewer and the information it can provide about your robot and errors or failures. Identify logs where your robot was operating normally to collect baseline data for parameters such as current and battery voltage.
MN-MIR 3.2	Isolate system and component failure following diagnostic procedures.		
MN-MIR 3.3	Identify root cause of problem using diagnostic procedures.		
MN-MIR 3.4	Develop corrective action plan to fix the problem.		

Standard	Description	Mentor Performance Rating	Electrical (large scale) Possible Learning Opportunity
ST-ET 6.4	Apply basic laws and principles relevant to engineering and technology.		Compass Alliance Electrical Explore the basics of electricity and the electrical system, including crimping, soldering, PWM and CAN setup. Have students use the guidance to analyze their robot system and determine how to use CAN bus to make their system more efficient.
ST-ET 6.5	Explain relevant physical properties of materials used in engineering and technology.		
ST-SM 1.3	Use the skills and abilities in science and mathematics to integrate solutions related to technical or engineering activities using the content and concepts related to the situations.		
MN-MIR 3.4	Develop corrective action plan to fix the problem.		C2SN Electrical Foundations Micro Credentials Electrical Foundations covers basic wiring and electrical tasks commonly performed by technicians on robotics systems. Develop skills to understand wiring and circuits, parallel and series circuits, voltage and current: Motors, Controlling Signals and Sensors. Use the knowledge and apply for the Electrical Foundations Micro-Credentials.
ST-ET 6.4	Apply basic laws and principles relevant to engineering and technology.		
ST-ET 6.5	Explain relevant physical properties of materials used in engineering and technology.		
ST-SM 1.3	Use the skills and abilities in science and mathematics to integrate solutions related to technical or engineering activities using the content and concepts related to the situations.		
ST-ET 6.4	Apply basic laws and principles relevant to engineering and technology.		Motor Basis REV; Vex Pro Motors Understand brushless motor application including power, torque and performance. Have students apply data from the website and create a chart that allows them to better understand their own motors, and how to achieve the best performance of their motors.
ST-ET 6.5	Explain relevant physical properties of materials used in engineering and technology.		
ST 2.2	Use modeling, simulation, or visual reproduction to effectively analyze, create, and/or communicate to others regarding plans, projects, problems, issues, or processes.		
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		
ST-ET 1.3	Use computer applications to solve problems by creating and using algorithms, and through simulation and modeling techniques.		

Standard	Description	Mentor Performance Rating	Electrical (large scale) Possible Learning Opportunity
ST 2.3	Apply a currently applicable computer programming language to a process, project, plan or issue as assigned.		Digikey Understand electronic circuits including voltage regulators, Back EMF soldering basics, amp hours, fans, stepper motors and breadboards. Have students view the Teaching moments resources from Digikey, then ask them to look at their kit of parts and apply the knowledge by analyzing the application on the robot and how it helps it achieve its function. Improve the program of their robot through improving the calculations for electrical efficiency of their motors.
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		
ST 2.3	Apply a currently applicable computer programming language to a process, project, plan or issue as assigned.		UpVerter. Learn the basics of schematic layout. And create circuit layouts in a digital environment using UpVerter. Have students complete the course through UpVerter education with the basics of electronic circuits and schematics, PCB layout and PCB manufacturing. Have students look at the schematics from the kit of parts for 1 or 2 electronic parts and apply knowledge from UpVerter to it.
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		
ST 2.3	Apply a currently applicable computer programming language to a process, project, plan or issue as assigned.		PLC Basics Learn about the history of programmable logic controllers (PLC), history and basics to help you choose a programmable logic controller. Complete the online PLC training through Automation Direct.
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		

Business and Marketing

Business and marketing tools can help you promote your team, students can use it as an opportunity for them to apply skills that are frequently used in business and industry. Use the tools below to help your team develop a business and marketing plan and the materials needed to achieve that plan. Students can use other industry resources to further develop their skills in the production of the materials. Job expectations in this area may include:

- Lead a SWOT analysis and use it to create a plan for communication, budgeting and team goals.
- Develop a communication plan for communicating with sponsors needs and benefits based upon the SWOT analysis.
- Develop materials to communicate to team members and your community your team mission, organizational structure and goals.
- Understand, apply, and develop team materials to communicate the best practices of what to do and not do during a sponsor presentation, and maintaining sponsor relations.
- Develop a communications plan for improving relationships with your *FIRST* Community, current sponsors, mentors, future sponsors and STEM advocacy in your community.
- Participate in development of materials using industry tools (graphic design, audio, video and website development) to be used for award promotion from a sub-team (Awards, Animation, Safety, Scouting and Strategy, Media, Design, or Website)
- Use data analytics tools in development of materials to help communicate the team's goals for outreach, impact and an action plan.
- Organize and develop presentation materials including scripts, letters, handouts, and media tools.

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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

Career Cluster

Marketing

Industry Certifications

Apple Certified Pro-Final Cut Level 1

Standard	Description	Mentor Performance Rating	Business and Marketing Possible Learning Activity
MK 2.4	Determine needed resources for a new marketing project or business venture.		Fundraising Toolkit; Fundraising; Use the *FIRST* Fundraising toolkit to learn about Fundraising 101, Community Analysis, Team Documentation, Organizing Presentations, Maintaining Sponsor Relations, Fundraising Best Practices Work through each of the sections. As you work with each section customize and develop a full marketing and communications plan for your team.
MK 4.8	Explain marketing research activities to develop or revise marketing plan.		
MK 8.2	Generate product ideas to contribute to ongoing business success.		
MK 9.1	Acquire a foundational knowledge of promotion to understand its nature and scope.		
MK 10.4	Utilize marketing information to develop a marketing plan.		
MK 9.4	Discuss the use of public relations activities to communicate with targeted audiences.		
MK-COM 5.4	Explain the use of social media in marketing communications to obtain customer attention and/or to gain customer insight.		Using Social Media Develop marketing materials using social media, be sure to incorporate digital literacy skills awareness of copyright awareness in your materials.
MK-COM 1.5	Manage internal and external business relationships in marketing communications.		
MK-COM 3.5	Utilize information-technology tools to manage and perform marketing communications responsibilities.		
MK-COM 5.3	Use direct marketing strategies to attract attention and build brand.		
MK 9.6	Manage promotional activities to maximize return on promotional efforts.		Marketing Resources Explore the marketing resources tab on the website. Consider the *FIRST* branding standards as well as Imagery for *FIRST* Teams develop your team logos and branding guide for your own team.
MK-COM 4.4	Position products/services to acquire desired business image.		
MK-COM 5.14	Utilize publicity to inform stakeholders of business activities.		

Standard	Description	Mentor Performance Rating	Business and Marketing Possible Learning Activity
MK-COM 5.16	Employ sales promotions activities to inform or remind customers of business/product		
MK 9.4	Discuss the use of public relations activities to communicate with targeted audiences.		Team Attribute Awards; Judging Process; Best Practices Explore the resources above to learn more about how you can apply and position your team for awards. Develop needed marketing materials such as graphic design, audio, video and website development needed for the awards.
MK 9.5	Explain the use of trade shows/expositions to communicate with targeted audiences.		
MK-COM 5.15	Utilize publicity/public-relations activities to create goodwill with stakeholders.		
MK-COM 5.2	Utilize word-of-mouth strategies to build brand and to promote products.		
IT-WD 3.1	Prepare functional specifications.		Web Design and Communication Explore courses in design and productivity through sources available such as Apple, or Adobe. Use the skills in the course to develop or produce a product for your team (Video, Website, or Published Document)
IT-WD 3.2	Prepare visual design specifications.		
IT-WD 3.3	Create final project plan.		
IT-WD 5.3	Employ basic motion graphic programming knowledge.		
IT-WD 5.4	Use basic web development skills.		

Control System and Programming

The Control System and programming the robot are a fundamental part of competing successfully with your team. It can take time and there are many different languages you might use on the robot depending on your Mentors experience and the career pathway you would are considering pursuing as a student. Job expectations in this area may include:

- Configuring the Control System and Creating a Benchtop Test
- Install programming libraries, review libraries, source code, and/or game tools in the program
- Create a robot program using a template to work and test your first program/base class (Timed Robot or Tank Drive)
- Understand and utilized different programming configurations timed robot and command based robot.
- Understand what types of actuators are available and how they handle data
- Understand and apply different algorithmic needs of motor controllers, PWM speed controllers, pneumatic solenoids, drivetrains, servos, and addressable LEDs.
- Understand and apply principles of networking to establish robot configuration and communications between the drivers station and roboRIO.
- Configure, apply and troubleshoot communication pathways through CAN Devices, IP addresses, DHCP, DNS, USB, Firewalls and Ethernet/Wireless.
- Understand how to measure bandwidth usage and conduct performance monitoring on the network.
- Pursue Courses in a specific program language to better understand the language structure including concepts such as: structure, handling variables, functions and files, debugging, data types, operators, objects and inheritance, control flow, arrays, strings, references, overloading, and exceptions.
- Utilize port forwarding to access ethernet-connected devices to forward connections to different devices.
- Utilize software tools such as Shuffleboard, SmartDashboard, PathWeaver, and RobotBuilder to improve real-time performance data collection from the robot to the driver station. This includes improving robot algorithms using trajectory, odometry and PID Control.
- Create a training manual for you team that applies concepts such as: structure, handling variables, functions and files, debugging, data types, operators, objects and inheritance, control flow, arrays, strings, references, overloading, and exceptions to the *FIRST* Robotics Competition programming environment.

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Career Cluster

Information Technology

Industry Certifications

N - **No exposure**, has no experience or knowledge of this task

NI Labview for *FIRST* Robotics Competition Programming (Badge)
roboRio Robot Control LabVIEW for *FIRST* Robotics Competition (Badge)
NI LabView for *FIRST* Robotics Competition RIO Programming (Badge)
Certified Labview Associate Developer
UpVerter
CompTIAITF+
CompTIAA+
CompTIANetwork
CompTIASecurity

Standard	Description	Mentor Performance Rating	Control System and Programming Possible Learning Activity
IT-SUP 2.1	Perform configuration management activities.		Zero to Robot Configuring the Control System and Creating a Benchtop Test. Use the zero to robot tutorial to choose and configure your robot software and create a benchtop test for your robot.
IT-SUP 2.2	Evaluate application software packages.		
IT-SUP 3.1	Identify the purpose of computer components (e.g. current and new technologies as they arrive).		
IT-SUP 3.2	Demonstrate knowledge to build or install computer system.		
IT-SUP 3.3	Demonstrate ability to couple troubleshooting skills with hardware knowledge to solve client problems.		
IT-PRG 4.1	Employ tools in developing software applications.		Programming 101
IT-PRG 4.3	Apply language-specific programming tools/techniques.		

IT-PRG 6.1	Explain programming language concepts.		Use the programming 101 resources to gain an understanding the different programming languages and an overview of some programming concepts you might use.
IT-PRG 6.2	Summarize program development methodology.		
IT-PRG 5.2	Explain computing/networking hardware and software architecture.		Intro to Programming Course Use the intro to programming course to learn the fundamentals of Java programming within VS Code using the Romi Robot. This course covers objects, methods, variables, conditionals, command-based programming and more.
IT-PRG 6.1	Explain programming language concepts.		
IT-PRG 6.3	Demonstrate proficiency in developing an application using an appropriate programming language.		
IT-PRG 6.4	Explain basic software systems implementation.		
IT-PRG 7.1	Develop a software test plan.		
IT-PRG 7.2	Perform testing and validation.		
IT-PRG 5.2	Explain computing/networking hardware and software architecture.		VS Code Overview Understand the fundamentals of code libraries using VS Code.
IT-PRG 6.1	Explain programming language concepts.		
IT-PRG 6.4	Explain basic software systems implementation.		
IT-PRG 7.1	Develop a software test plan.		
IT-PRG 7.2	Perform testing and validation.		
IT-NET 3.1	Demonstrate knowledge of the basics of network architecture.		Networking Use the WPIlib to understand and apply networking skills relating to communication between the driver station and roboRio.
IT-NET 3.2	Demonstrate knowledge of basic network classifications and topologies.		

IT-NET 3.5	Characterize network connectivity basis and transmission line applications.		
IT-NET 3.5	Characterize network connectivity basis and transmission line applications.		CAN Devices; NI CAN Overview Research what a CAN device and how they are used in industry. Identify CAN devices on your robot and complete the communication pathways for the devices to communicate to each other.
IT-PRG 2.2	Define scope of work for the programming project.		
IT-PRG 3.2	Assess the potential importance and impact of new IT technologies and emerging classes of software.		
IT-PRG 3.3	Summarize elements and types of information processing.		
IT-PRG 6.1	Explain programming language concepts.		LearnCPP Identify specific lessons to accomplish that you will use on the robot. Complete the full course to gain an understanding of the C++ programming language. Build your learning to take an Industry Certification or Credential in C++.
IT-PRG 6.2	Summarize program development methodology.		
IT-PRG 6.3	Demonstrate proficiency in developing an application using an appropriate programming language.		
IT-PRG 6.4	Explain basic software systems implementation.		
IT-PRG 6.5	Develop software requirements/specifications.		
IT-PRG 6.6	Resolve problems with integration.		
IT-PRG 6.1	Explain programming language concepts.		Code Academy; CS Awesome; Jetbrains Use these sites to learn the fundamentals of Java. Choose 4 concepts you would like to develop and apply within your VS Code. Build your learning to take the AP Java CSA exam or other Industry Certification.
IT-PRG 6.2	Summarize program development methodology.		

IT-PRG 6.3	Demonstrate proficiency in developing an application using an appropriate programming language.		
IT-PRG 6.4	Explain basic software systems implementation.		
IT-PRG 6.5	Develop software requirements/specifications.		
IT-PRG 6.6	Resolve problems with integration.		
IT-PRG 3.1	Identify the potential importance and impact of new IT technologies.		Machine Learning Learn how machine learning is used in *FIRST* Robotics Competition. Use the WPILib to learn more about how to program using machine learning. Use vision processing in the algorithms on your robot.
IT-PRG 3.2	Assess the potential importance and impact of new IT technologies and emerging classes of software.		
IT-PRG 3.3	Summarize elements and types of information processing.		

Design and Engineering

Design and engineering a robot require a combination of understanding mechanical engineering principles and using modeling programs to test ideas and determine the details of a final design. Use the available CAD programs from *FIRST* to advance student skills, each program has their own tutorials so you can use the program that the school may have or a mentor is familiar with. Job expectations in this area may include:

- Understand what CAD is and how spatial reasoning is used to create 3D parts from geometry.
- Use sketches and features to construct and model geometric shapes including squares, rectangles, circles, triangles, and convert them into cubes, spheres, cylinders, cones, rectangular prisms and pyramids.
- Perform sketching elements including creation, dimensions, selection and creation, editing, project edges.
- Create drawing views, base, projected, selection, detail. Include annotations, Editing Borders and Tileblocks
- Model parts through actions including fillets, chamfers, complex holes, revolves, pattern features, construction planes and axes.
- Use a CAM software to create G-Code to manufacture a part through additive or subtractive manufacturing.

- Create and manage top level assembly and sub-assemblies.
- Create a component from a body.
- Make assemblies with inferences, rigid groups.
- Conduct motion studies with parts
- Apply mechanical and electrical engineering principles to a design. Perform motion analysis within parts and use data to make design decisions.

Mentor Performance Rating

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Career Cluster

Science, Technology, Engineering & Mathematics

Industry Certifications

Autodesk Certified Associate
Certified DriveworksXpress Associate (Free)
Solid Edge Mechanical Associate (Free)
OnShape Certified Associate
Certified Solidworks Associate

3DExperience Solidworks Associate

Standard	Description	Mentor Performance Rating	Design and Engineering Possible Learning Activity
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		Design 101 Understand the fundamentals of design around a game strategy as well as how to develop manipulators through prototyping.
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with		

Standard	Description	Mentor Performance Rating	Design and Engineering Possible Learning Activity
	others on issues, plans, processes, problems, or concepts.		Identify the tips and tricks that you would like to adopt for your team to improve game strategy. Record these in a training manual for future team members.
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		SolidProfessor Use the drop down to take the Engineering Graphics and Spatial Visualization courses available. Once those courses are complete also take the courses in Dimensioning and Tolerancing. Design specific parts on the robot that focus on detailed dimensions and tolerancing.
ST 2.3	Apply a currently applicable computer programming language to a process, project, plan or issue as assigned.		
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		Autodesk Have students take the Introduction to Design for Manufacturing course. Additional courses may also be found on Solid Professor. Continue to take

Standard	Description	Mentor Performance Rating	Design and Engineering Possible Learning Activity
ST 2.3	Apply a currently applicable computer programming language to a process, project, plan or issue as assigned.		courses on the path to achieve the Autodesk Certified Associate for Mechanical Design. Use the skills to design parts for the manufacturing team to use on the robot.
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		OnShape use student resources to learn the basics of Onshape. As you learn to design parts and assemblies apply them to our robot. Gain advanced skills and content through SolidProfessor or Onshape4 *FIRST* Robotics Competition to obtain an Certified Onshape Associate Certification.
ST 2.3	Apply a currently applicable computer programming language to a process, project, plan or issue as assigned.		
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		

Standard	Description	Mentor Performance Rating	Design and Engineering Possible Learning Activity
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		Siemens Solid Edge Use the resources and the CAD fundamentals course to begin to learn Solid Edge for building and modeling your robot. Continue improving your skills and consider taking the Solid Edge Industry Certification Exam.
ST 2.3	Apply a currently applicable computer programming language to a process, project, plan or issue as assigned.		
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		Solidworks and 3DS Experience use the learning resources in 3DS Experience. As you learn to design parts and assemblies apply them to our robot. Continue improving your skills and consider taking the Certified Solidworks Associate in Mechanical Design Certification.
ST 2.3	Apply a currently applicable computer programming language to a process, project, plan or issue as assigned.		
ST 2.5	Apply a technological, scientific, or mathematical concept (use of algorithms) when communicating with others on issues, plans, processes, problems, or concepts.		

Standard	Description	Mentor Performance Rating	Design and Engineering Possible Learning Activity
ST-ET 1.1	Apply the core concepts of technology and recognize the relationships with STEM systems (e.g., systems, resources, criteria and constraints, optimization and trade-off, and controls).		

Student Work-Based Learning Training Plan

Student Name	Grade Level	Experience Level
Student Career Cluster Pathway	**Job Role**	**Mentor**
Student Goals for Learning: **Technical Skills to be Learned:**		

Core Values and Career Ready Practices	Learning Pathways
CRP-1 Showing responsibility through *Gracious Professionalism*® CRP-2 Applying interpersonal communication skills CRP-3 Using inclusion during teamwork CRP-4 Demonstrating creativity and innovation. CRP-5 Considering impact of decisions CRP-6 Critical thinking and perseverance CRP-7 Modeling integrity, leadership, and time management CRP-8 Using technology to enhance productivity. CRP- 9 Considering personal health and well-being CRP-10 Applying academic and technical skills	**Industry Certifications to Achieve (2nd or 3rd Year)**