STEM Research Project

STEM Theme

The world needs the students of today to become the scientists, engineers, and problem-solving leaders of tomorrow. The Engineering process presents us with new breakthroughs and challenges, creating greater opportunities for problem-solving through technology. The solutions to these problems could help change the world, and technology-based problem solvers will be the people to make it all possible.

The study of robotics is strongly anchored in the study of science, technology, engineering, and math (STEM). Many decisions engineers make concerning how to construct a robot are based on the three laws of robotics as set forth by Isaac Asimov in his 1942 Science Fiction short story "Runaround".

The "Laws of Robotics" as devised by Isaac Asimov are:

- A robot may not injure a human being or, through inaction, allow a human being to come to harm.
- A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
- A robot must protect its own existence if such protection does not conflict with the First or Second Laws.

These laws are similar to the professional codes of ethics that you will find in all scientific and engineering professional societies which are fundamental to how engineers and scientists approach their work. A list of some of the organizations and their Professional Code of Ethics can be found at the end of this document.

Each season, one STEM subject is the primary focus of the VEX IQ STEM Research Project. This year the STEM Research Project theme focuses on **Robotics Engineering and Ethics**. Students are encouraged to think about how ethical decisions effect engineering choices while constructing robots. All professional organizations hold their members to strong codes of ethics which guide their research and work.

Teams will develop an area of study of solving an engineering problem in robotics that interests them while keeping in mind the three Laws of Robotics and with a strong emphasis on the codes of professional ethics found in the practice of science and engineering. The following list provides some suggestions that teams may use to narrow down their research topic, or come up with their own specific topic:

- **How** robots are engineered to be used in the care of elders
  - Distribution of medication, surgical procedures, and as companions
- **How** robots are engineered for farming, and the food production industry
  - How to engineer a mechanical apple sorting system
- **How** robots are engineered to perform rescue missions
  - How engineering choices may lead to rescue more victims
- **How** robots are engineered to assist people with special needs
  - How choices of different engineering solutions may positively affect those being served
- **How** robots are engineered to perform dangerous tasks
  - How the military applications can save lives

Steps

Engineers use a method called the **Engineering Process** to solve challenges. The Engineering Process uses three key steps; **Think** – think of ideas, **Do** – build prototypes, **Test** – test the solutions, and repeat this process until the problem is solved.

For more information on the Engineering Process, see the VEX IQ Curriculum:
https://www.vexrobotics.com/vexiq/education/iq-curriculum/your-first-robot/learning-design-process

This process and the following suggested steps can help your team solve your challenge.

- Involve all your team members in some way.
- Document your methods, decisions, and conclusion in a notebook.
- Talk to engineers in your community to explore what challenges exist and how your team can solve these challenges by applying robotics technology.
- Identify one challenge topic that your team can solve by using robotic technology focusing on ethical decisions needing to be made.
- Narrow your focus so your team can effectively share your results in four (4) minutes or less.
- Research your challenge topic using a variety of reliable sources, such as engineering and scientific journals and publications, electronic resources from various professional organizations, and experts in the area you are researching. Ask your librarian for help!
- Identify possible solutions that have already been proposed or tried for your challenge.
- Record your bibliography, a list of the sources that your team used in your research and show how those resources helped you in your project.
- Organize, study, and explain the research that your team completed.
- Explain the ethical choices your team had to balance, and what the trade-offs are you possibly had to make
- Apply your research and creativity to develop your proposed solution (your "hypothesis"). Which can be sketches or a simple prototype.
- Test your solution to make sure it works, consider consulting engineers
- If your solution does not work well, consider modifying your solution and testing it again.
- Share the results of your research through:
  - A presentation of up to four (4) minutes to VEX IQ Challenge event judges. Your team will have up to four (4) additional minutes to answer questions and share more information on your research, for a total judging session of up to eight (8) minutes. Only students are allowed in the judging room with the judges unless:
    - An adult is requested as a chaperone when only one judge is present.
    - An adult is needed to support student(s) with special needs.
  - A display at your team's table in the Team Pit Area (event practice area).
  - You are encouraged to present your results to your team's community and beyond.
- **Students do the research**, choose the challenge and solution, make the decisions, and select the format to share their research results. Adults may offer guidance.

Presentation

Explore *all* of the creative ways that your team can share the solution to your challenge. Choose the format that works best for your team.

Written Formats – Set up and presented by your team in **up to 4 minutes.**

- Share a copy of pages from your notebook, which documents how you developed the solution to your challenge.
- Create a newspaper story or blog about your research and the solution to your challenge.
- Design a one-page advertisement that promotes the solution to your challenge.
- Develop a laboratory-type report, which may include the following sections:
  Title, Question, Introduction, Methods, Results, and Discussion.
- Any creative written format that your team chooses.

Performance Formats – Set up and presented by your team in **up to 4 minutes.**

- Consider a case study on how ethical choices effect engineering choices
- Consider an issue within your school or community where ethical engineering choices play a major role
- Prepare and present a news broadcast that reports the solution to your challenge.
- Develop and present a teaching segment, which demonstrates how you conducted your research to develop a solution to your challenge.
- Design and present a skit or a play that shares how you solved the challenge.
- Create a video or a movie that shows your team in action solving the challenge.
- Any creative performance or media format that your team chooses!

TIP: Consider a less technical format. The presentation time cannot be rescheduled or extended if technical difficulties occur. If equipment is required to deliver the presentation, it must be provided and set up by the students, within the allotted time frame.

Award Criteria

- Identifies a challenge topic of interest that relates to the STEM theme for the season
- Completes research and collects evidence using reliable sources
- Demonstrates a well-organized and documented process to study and explain research findings
- Describes how the research findings were applied to develop and test the solution
- Shares the solution in an effective and creative presentation
- Students demonstrate an understanding of the research process
- Students demonstrate teamwork and effective communication skills

Professional Organizations Codes of Ethics Resources

The following list is a starting point, there are many other professional engineering societies and organizations around the world, and within each of these organization many working groups will have additional codes of ethics and conduct as it relates to their work.

- Association for Computing Machinery (ACM) ACM Code of Ethics: http://www.acm.org/about-acm/acm-code-of-ethics-and-professional-conduct
- Institute for Electrical and Electronics Engineers (IEEE),   IEEE code of conduct https://www.ieee.org/about/ieee_code_of_conduct.pdf Joint ACM and IEEEE-CS code of ethics: https://www.computer.org/web/education/code-of-ethics
- American Society for Mechanical Engineers (ASME), ASME code of Ethics: https://www.asme.org/getmedia/9eb36017-fa98-477e-8a73-77b04b36d410/p157_ethics.aspx
- American Association for the Advancement of Science (AAAS) AAAS has a whole working group dedicated to the Scientific Responsibility which can be found here: https://www.aaas.org/program/scientific-responsibility-human-rights-lawInternational Society for Optics and Photonics (SPIE) SPIE Code of Ethics: http://spie.org/x13231.xml
- National Society of Professional Engineers (NSPE) https://www.nspe.org/resources/ethics/code-ethics

STEM Research Project Rubric

Students will share the results of their STEM Research Project with VEX IQ Challenge event Judges in a creative and effective four (4) minute presentation, including setup. Judges will then have up to four (4) minutes to ask questions of the students to learn more about their project.

Team Name: _____ **Team Number:** _____ ☐ **Elementary** ☐ **Middle Judges:** _____

For details, review the STEM Research Project and Awards Appendix on www.roboticseducation.org/vex-iq-challeng/viq-current-game/

Directions: Mark the descriptor that best describes the team's performance for each criterion.

Criteria	Expert (3 points)	Proficient (2 points)	Emerging (1 point)	Points
Identifies a challenge topic of interest that relates to the STEM theme for the season	Challenge topic clearly identified, with a strong connection to the STEM theme for the season	Challenge topic identified, with some connection to the STEM theme for the season	Topic not identified and/or limited connection to the STEM theme for the season	
Completes research and collects evidence using reliable sources	Provides evidence of thorough research using 3-5 reliable and credible sources	Provides evidence of research using 1-3 reliable sources	Provides evidence from no reliable sources	
Demonstrates a well-organized and documented process to study/explain research findings	Demonstrates highly organized and well documented process to study and explain the research data	Demonstrates some organization and documentation of the project	Demonstrates little to no documentation of the project	
Describes how the research findings were applied to develop and test the solution	Demonstrates an in-depth understanding of the application of the research to develop and test the solution	Demonstrates some under-standing of the application of the research to develop and test the solution	Demonstrates little to no application of research to develop and test the solution	
Shares the solution in an effective and creative presentation	Presentation and visual aids provide clear, effective, and creative explanation of how solution was developed and how it works	Presentation provides adequate explanation of how the solution was developed and how it works	Presentation lacks detail needed to understand the team's solution	
Students demonstrate an understanding of the research process	All students demonstrate mastery of the research process	Most students demonstrate some understanding of the research process	Students demonstrate little or no understanding of the research process	
Students demonstrate teamwork and effective communication skills	All students demonstrate high levels of cooperation, courtesy, enthusiasm, confidence, accuracy and clarity	Most students demonstrate some cooperation, courtesy, enthusiasm, confidence, accuracy and clarity	Students demonstrate little or no cooperation, courtesy, enthusiasm, confidence, accuracy and clarity	
Describe the best features of this presentation and discussion with the Judges (continue on back of sheet):				**Total Points**

NOTE: This is a confidential judging document. It should not leave the Judges room after a competition. Return to the Judge Advisor for disposal.