Term 2 iBot – 9 iSTEM – Stage 5 program

## Summary

## Mechatronics engineering combines the fundamentals of mechanical, electrical and computer science to develop autonomous systems, such as robotic solutions which can be found in a range of industries. This unit introduces students to a variety of innovation projects and Robotics using Pitsco’s Tetrix construction systems to deliver Mechatronics 1 (Core Module 3) and Motion (Elective Module 6) of the Stage 5 iSTEM syllabus. The iBot unit sets the foundations of engineering principles and using circuit boards and remote control systems to manually control actuators.

## Using inquiry and project based learning, students apply an iterative design process to develop, test and evaluate engineered robotics solutions while exploring ethical considerations related to the robotics industry, including the impacts and limitations of artificial intelligence. By applying engineering principles, students will build robotics solutions and integrate manual control to navigate obstacles. Through extension, an opportunity exists to experiment with sensors and computer coding to achieve automated movement, a concept which will be later explored in Year 10 as part of the Mechatronics 2 unit using the Tetrix platforms.

## Students will simulate industry skills and knowledge through both individual and collaborative tasks. This unit aims to strengthen students critical and creative thinking skills, as well as cognitive flexibility in solving construction problems. Preceding units in both Year 9 & 10 will build upon the fundamental skills of robotics, electric circuits and computer science developed in this unit.

## Duration

8 weeks

Outcomes

**5.1.1** develops ideas and explores solutions to STEM based problems
**5.1.2** demonstrated initiative, entrepreneurship, resilience and cognitive flexibility through the completion of practical STEM based activities

**5.2.1** describe how scientific and mechanical concepts relate to technological and engineering practice

**5.2.2** applies cognitive processes to address real world STEM based problems in a variety of contexts

**5.3.1** applies a knowledge and understanding of STEM principles and processes

**5.3.2** identifies and uses a range of technologies in the development of solutions to STEM based problems

**5.4.1** plans and manages projects using an iterative and collaborative design process

**5.4.2** develops skills in using mathematical, scientific and graphical methods whilst working as a team

**5.5.1** applies a range of communication techniques in the presentation of research and design solutions

**5.5.2** critically evaluates innovative, enterprising and creative solutions

**5.6.2** will work individually or in teams to solve problems in STEM contexts

**5.8.1** understands the importance of working collaboratively, cooperatively and respectfully in the completion of STEM activities

## Core & Elective Module Outcomes

**C1.1** STEM investigations (systematic observation, measurement, experiment formulation, testing and modification of hypotheses)
**C1.2** the use of STEM in developing solutions to problems (hardware & software)
**C2.1** STEM principles (strength of materials, material properties, fluid mechanics, electricity & magnetism and thermodynamics)
**E5.1** research and exploration (interpreting and analysing data, quantitative and qualitative research, surveys, interviews, observation & testing and experimenting)
**E5.2** technologies related to aerodynamics (wind tunnels, smoke tunnels, computational fluid dynamics (CFD)
**E5.3** aerodynamics principles (dynamic, static friction, drag ratios, lift, drag, weight, thrust, Finite Element Analysis (FEA) & flight)
**E5.4** aerodynamics forces (lift, drag, weight, thrust, simple vectors & efficiency)
**E5.5** aerodynamic design solutions

[Stage 5 iSTEM](https://sispprogram.schools.nsw.gov.au/stem/istem_stage_4.html) © NSW (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2019

## Unit overview

## Students will explore a range of local, national and global innovation solutions before developing fundamental skills of mechatronics. Using an engineering design process (iSTEM Process) and the Pitsco Tetrix platform, students will collaboratively build robotic prototypes to meet specifications and solve a variety of construction challenges. Students investigate the scientific principles of motion as the experiment, with a variety of actuators to develop an understanding of manual remote control of robotic functions and movement. While computer coding is not a specific goal of this unit, an opportunity to apply or develop coding skills (block or text based) to include sensor inputs and outputs for movement control exists for high achieving students. Students continue to develop communication, collaboration and critical thinking skills to overcome construction and design challenges.

## Resources overview

### The resources and links listed below are referenced within the program but is not an exhaustive list of resources available. Teachers can add to these resources as needed.

### Physical resources

* Tetrix Comp in a Box robotics kit (mats, ping pong balls, walls, barrels, etc).
* Pitsco Tetrix Prime Remote Control and Engineering Student and Teacher Resource Booklets (Tetrix Prime Engineering Mobile. Robotics & Tetrix Max Mobile Robotics).
* Pitsco Tetrix Prime and Max robotics kits.
* Projector or Smartboard, laptops or tablets.

### Websites

* [Pitsco Tetrix Resource Site](https://www.pitsco.com/AU/Shop/TETRIX-Robotics)
* [Tetrix Prime RC Sample Activity](https://asset.pitsco.com/sharedimages/resources/prime_rc_stemunit_samplestudentactivity_44591.pdf)
* [Life Straw](https://www.lifestraw.com/pages/how-our-products-work)
* [Amp Control](https://www.ampcontrolgroup.com/ampcontrol-designs-lifesaving-ventilators/) & [Newcastle University COVID 19 Ventilator Project](https://www.newcastle.edu.au/newsroom/featured/university-expertise-sees-lifesaving-ventilator-prototype-secure-state-backing?fbclid=IwAR0r6eJ6w3Cd-QtFEg_OpbUHRbe5r87JMjx_fe94li_N8_e1ZmV3mTQG1Fw)
* [Aussie Educator List of STEM challenges](http://www.aussieeducator.org.au/competitions/competitions%3D2.html)
* Careers with STEM
* [STEMJobs](https://www.stemjobs.com/future-stem-careers/)
* [National STEM Education Resource Toolkit](https://www.education.gov.au/national-stem-education-resources-toolkit/why-stem-important-0)
* [KForce Top 5 STEM Emerging Careers](https://www.kforce.com/stem-guide/)
* [Australian Defence STEM Careers](https://www.dst.defence.gov.au/careers/stem-careers)

#### Videos

* [Pitsco Tetrix How To Videos](https://video.pitsco.com/default.aspx?gID=65)
* [Controller Pairing with Tetrix Max / Prime](https://video.pitsco.com/default.aspx?vID=865&gID=65)
* Industry Innovation videos – iTeach STEM
* [What is GDP](https://youtu.be/hBqWRayc1kE)? and [How to measure the size of an economy?](https://youtu.be/iLom1WlqwS0)

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| **Content** | **Teaching and learning** | **Evidence of learning**  | **Adjustments and registration** |
| **Week 1*** Explore local, regional, national and global STEM innovation.
* Identify the positives and negatives of innovation in multiple contexts.
 | **Teacher*** Introduce the unit by discussing the use of STEM and technology as a driving element of innovation to meet the needs of society. Engineers across various disciplines solve both simple and complex problems to meet the needs of different societal groups or industry goals; innovation can be viewed positively and negatively in relation to the values and traditions of a given generation, culture or society.

**As a Class*** Class discussion –
	+ - What is innovation?
		- Is progress or innovation always a good thing?

**Teacher*** Gives verbal feedback and elaborates on content raised by students.
* Introduce the [Life Straw](https://youtu.be/NqZlq7m56yI) video as an example of an innovation project started in 2005.

**As a class*** Class discussion –
	+ - What problem is the Life Straw attempting to solve?
		- Does the problem in 2005 still exist or has it changed?
		- Can the Life Straw be used to solve local, regional, national or global problems?

**Teacher*** Gives verbal feedback and elaborates on content raised by students. Teacher suggests possible classifications or examples of how the device can be used in a local, regional, national and global context.

**Students – Pairs*** Investigate and research the Life Straw website to answer the following questions:
	+ - What was the original problem Life Straw was trying to solve and why?
		- How have Life Straw products changes to address a different problem? Give at least two examples.
* Share research with the class (Teacher to prompt group sharing of answers to the above questions).

**Teacher*** Expand through discussion - STEM solutions have specific functional requirements that differ depending on the nature of the problem and society the solution seeks to serve. Identify examples of local, regional, national and global innovation projects.

**Student*** Complete brainstorm of issues important to them.
* Complete classification of brainstorm ideas / issues into local, regional, national or global concerns.

**Teacher*** Coordinate an industry presenter(s) for an incursion, class visit, virtual meeting or panel presentation of an industry based innovation (local and or regional) ie: Tamburlaine Organic Wines, Amp Control ([Covid 19 Ventilator Project](https://www.ampcontrolgroup.com/ampcontrol-designs-lifesaving-ventilators/)), Elite Robotics ([self-driving lawnmower](https://diyodemag.com/columns/going_pro_elite_robotics)), AusSTEM ([Kookaberry Microboard](http://kookaberry.auststem.com.au/)), Nuts & Bolts ([Splat 3D Tool](https://splat3d.com/)), etc to address the following;
	+ - problem needing to be solved
		- challenges / obstacles
		- process of design
		- skills or qualifications of presenter(s).

**As a Class*** Students ask presenter questions about the product or problem.

**Optional Adjustment*** Provide written, short case study videos or articles with examples of local, regional, national, & global innovation projects with questions (5W’s & H) to answer for each category example.

**Optional Extension*** Students to research an existing solution to a chosen example of local, regional, national and global problems listed in the class discussion. Present findings in a creative way that does not involve writing a report or making a PowerPoint slideshow.
* Students (Groups) brainstorm an idea to solve one of the problems presented. Solutions could be entered into a variety of competitions including the [Hunter Young Business Minds Awards](http://ybma.com.au/), [Google Science Fair](https://www.googlesciencefair.com/), [Imagine Cup](https://imaginecup.microsoft.com/en-us/Events?id=0), [Tech Girls are Superheroes](http://searchforthenexttechgirlsuperhero.org/home), [Young ICT Explorers](http://www.youngictexplorers.net.au/), etc.
 | * Students responses demonstrate an understanding of:
* innovation in society
* generational, cultural and / or historical perspective of innovation
* evolution of products or solutions to meet changing societal needs.
* Students actively contribute to discussion and critical analysis of a STEM solution for a specified purpose.
* Students collaboratively investigate the evolution of a STEM solution and develop ideas to apply or expand the solution in a different context.
* Students practice communication and oral presentation skills in articulating research findings with their peers.
* Students identification of ideas and issues relevant their lives in need of STEM solutions.
* Students engage with industry experts and demonstrate an understanding of:
* nature of work completed by the expert(s)
* societal context (local, regional, national and / or global) of the problem or solution presented
* skills and / or qualifications needed to pursue similar career pathways.
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| **Week 2** * Identify potential emerging STEM careers.
* Investigate multiple STEM careers with identified skills and qualification / education pathways.
 | **Teacher*** Introduce the inquiry question and requirements for Term 2.

**Assessment Task*** + Question: How has local, regional, national & international STEM innovation impacted economic growth and emerging careers?
	+ Constraints:
		1. Students randomly provided with 1 STEM career by the teacher and are allowed to choose 1 STEM career to include in their project.
		2. Students must answer the question in a creative way which does not include a written report, typical speech or slideshow.
		3. Students should be encouraged to use innovative STEM tools from the LendingLibraryand / or existing STEM skills to deliver their answer to the question.
		4. Students should include a brief outline of the emerging careers investigated and the skills / qualifications needed with specific references to impacts on economic growth and classification of local, regional, national and global opportunities for each career investigated.
		5. Assignment due 4 – 6 weeks after notification depending on school’s assessment guidelines and schedule.
		6. One class a week until submission, should be dedicated to project work and teacher mentoring with the majority of the assignment completed outside of class time.
* Introduce the concept of Emerging STEM Careers using the [5 Future STEM Careers that Don’t Exist](https://www.stemjobs.com/future-stem-careers/) Yet website; encourage class discussion on each career highlighted in the article.
* Introduce the concept of economic growth with the [What is GDP](https://youtu.be/hBqWRayc1kE)? and [How to measure the size of an economy?](https://youtu.be/iLom1WlqwS0) video.
* Outline the importance of STEM skills to the Australian GDP using the [National STEM Education Resource Toolkit](https://www.education.gov.au/national-stem-education-resources-toolkit/why-stem-important-0).
* **Challenge question:** What is the current Australian GDP?

**Students*** Research the randomly assigned STEM career using a variety of information sources.
* Students brainstorm at least 3 other emerging STEM careers and choose the most interesting career for further investigation and inclusion in their assignment.

**Optional adjustment*** Teacher to give students a list of potential STEM careers and resources to choose from (Careers with STEM Magazines, various links provided above in resource lists).
 | * Students are able to outline the requirements of the assessment task and clearly identify constraints.
* Students demonstrate idea generation techniques and apply creative problem solving in selecting, planning and developing a chosen method of presentation.
* Students demonstrate an understanding or application of:
	+ emerging STEM career pathways
	+ impacts and importance of STEM skills on national and global economies
	+ multiple research techniques and or the need for multiples sources in finding various forms of data
	+ education pathways for assigned and selected STEM careers
	+ effective time management strategies for independent and group work.
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| **Week 3 - 8*** Investigate different types of robotic solutions.
* Explore positive and negative perceptions of issues related to robotics industries.
* Understand ethical responsibilities surrounding robotics and artificial intelligence.
* Develop construction and problem solving skills to collaborative design robotics solutions to specification challenges.
* Understand the principles of motion using manual Remote Control (RC) control of actuators.
* Identify robotic components related to motion and power supply.
 | **Teacher*** Introduce the concept of [robotics vs artificial](https://youtu.be/yCXm5cgG0UA) [intelligence](https://youtu.be/yCXm5cgG0UA) and the ethical concerns of the robotics industry (1 – 2 videos at the start of each lesson, followed by brief discussion and practical robotic construction activities).
	+ [Types of robots](https://youtu.be/fqTHlnhPinE)
	+ [What is a bionic robot?](https://youtu.be/voNBzuI7IJ4)
	+ [What is Robot Ethics?](https://youtu.be/TrJMD2PBtvY)
	+ [Who is Sophia?](https://youtu.be/sO0qujufixE)
	+ [Watson Destroys Humans in Jeopardy](https://youtu.be/WFR3lOm_xhE)
	+ [What are Asimov’s Three Laws of Robotics?](https://youtu.be/xY-eUd0XuOs)
	+ [How we trained AI to be sexist](https://youtu.be/DJnIbsAVJUs)
	+ [Siri vs Hal](https://youtu.be/rlIPGx8hw7I) (AI Gender stereotypes - Satire)
	+ [Will robots take our jobs?](https://youtu.be/a-7Azih0D98)
	+ [The rise of the machines](https://youtu.be/WSKi8HfcxEk)

**As a class*** Discuss the ethical concerns of robotics and artificial intelligence (choose a different topic or video(s) for the start of each lesson).
* ***Debate*** – Robots are man’s new best friend (completed at the end of the unit, once all topics above have been explored).

**Students*** Using mindmap software, brainstorm the positives and negatives of robotics in society; find examples of robotics innovation within the following industries:
	+ Hospitality
	+ manufacturing and Production
	+ recreation / Entertainment
	+ Agriculture
	+ Transportation
	+ Security / Defence
	+ Consumer convenience products.
* Make notes in Google document or student booklet – ‘ethical concerns of robotics’ (this could be used as a scaffold for the end of unit debate outlined above).

**Teacher*** Outline the Tetrix robotics platform and scaffold self-directed learning in groups;
	+ demonstrate simple building techniques
	+ assign students into groups of 2 - 3
	+ direct students to the Tetrix RC challenge booklets
	+ explain the goal of the project; complete 3 – 4 Tetrix activities; achieve manual control of robots using RC function
	+ demonstrate a sample activity – [Tetrix Prime RC Sample Activity](https://asset.pitsco.com/sharedimages/resources/prime_rc_stemunit_samplestudentactivity_44591.pdf)
	+ allocate students into groups using either the Prime or Max kits.

**Students*** In groups – complete a series of engineering and robotics construction challenges using the Pitsco Tetrix platform;
	+ Prime Kit –
		1. Activity 1 - Think like an Engineer: Build & Run a Robot
		2. Activity 2 - Drivetrains: Build the Car Bot
		3. Activity 3 - Drivetrain modifications
		4. Optional: Drive and Speed Challenge (Students choose one of the 4 activities to complete Activity 6 -9)
	+ Max Kit –
		1. Activity 1 - Build the Robot, run the maze
		2. Activity 2 - Wave the flag
		3. Activity 6 - Inch Worm
		4. Optional: Design Challenges (Students choose between challenge 1 – 4)
	+ using a chosen robotics design, navigate an obstacle course using RC / manual control.

**Optional extension*** Students to write a summary discussing societal perceptions of robotics and artificial intelligence.
* Design an obstacle course using the Tetrix Comp in a Box kit and or the construction of obstacles using recycled materials or found objects.
* Design a bionic robot using RC manual control to simulate a biological function or movement of the chosen animal; present function to the class or create a how to construction video highlighting bionic robot function.
* To include block based coding, choose activities from either the Tetrix Prime and EV3 or Tetrix Pulse Robotics Controller booklets (This adjustment would only use the Tetrix Prime kits).
* Use Tetrix Prime board to include sensor control & computer programming to achieve simple automation.
 | * Students responses demonstrate an understanding of the ethical concerns, perceptions and classifications of robotics:
* common stereotypes
* potential risks of AI and or robotic systems
* moral responsibilities and challenges related to morality of robotics
* scope of robotic uses across various industries
* both human and robotic limitations.
* Students justify their perspectives of the ethics of robotics with articulation of supporting evidence in a robust debate format.
* Students generate ideas, research examples and record findings.
* Students ability to:
	+ effectively communicate design concepts and constraints
	+ apply creative problem solving and cognitive flexibility in overcoming construction challenges
	+ apply self-direction and appropriate time management techniques in the construction of multiple robotic solutions
	+ interpret and apply technical instructions in the construction of robotic designs to meet specifications
	+ identify and understand the function of various robotic components
	+ select appropriate tools and components, including parts specific to motion and manual control, in the safe construction of robotic solutions.
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## Evaluation

Evaluation of learning activities should be an ongoing process that happens throughout the delivery of this unit. Teachers should document their evaluation of learning activities throughout the program. The space provided below is to evaluate the overall unit of work.

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