YEAR 10 ISTEM PROGRAM

2020

Abstract

The following program was developed as a collaboration with the STEM Industry School Partnerships (SISP) program and TAS teachers from Cessnock High School. It has been designed to meet the localised needs of the school and as an Academy of STEM Excellence.

Term 1 Remix – 10 iSTEM – Stage 5 Program

Summary

A core aspect of the iSTEM curriculum vision is to simulate and emulate real world employment skills through applied learning experiences. To achieve this students are exposed to a wide variety of industry skillsets, knowledge and equipment with a focus on an iterative design process. Throughout the Year 10 iSTEM program, students will reinforce previous learning and develop an understanding of both connected concepts but also the value of extending and modifying prototypes. STEM industries and careers rarely abandon a valuable concept therefore the REMIX unit will provide opportunities for students to revisit and extend previous projects in Aerodynamics and Mechatronics. The opportunity to showcase student achievement at community events, such as Newcastle Show, and or competitions will also be available. Students should be encouraged to retain all prototypes and portfolios in year 10 which can be used for career portfolios and end of year school-based showcases.

Duration

7 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

5.4.1 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
5.6.1 selects and uses appropriate problem solving and decision making techniques in a range of STEM contexts
5.6.2 will work individually or in teams to solve problems in STEM contexts
5.7.1 demonstrates an appreciation of the value of STEM in the world in which they live
5.8.1 understands the importance of working collaboratively, cooperatively and respectfully in the completion of STEM activities

Core & Elective Module Outcomes

C2.1 STEM principles (strength of materials, material properties, fluid mechanics, electricity & magnetism and thermodynamics)
C2.2 fundamental mechanics (basic units, prefixes, statics, dynamics & modelling)
C2.3 problem solving (nature of, strategies to solve, evaluation & collaboration)
C4.1 mechatronics and control technology (logic gates, mechanical and electrical actuation systems & motors)
C4.2 programming & computations (algorithms, calculating distance, trigonometry, circle geometry & input/output systems)
C4.3 design mechatronic solutions for a range of applications
E5.1 research and exploration (interpreting and analysing data, quantitative and qualitative research, surveys, interviews, observation & testing and experimenting)
E5.5 aerodynamic design solutions
E6.1 electronics (circuitry, motors & generators, fault detection, prototypes, making models & practical applications)
E6.2 technologies related to motion (gyroscopes, accelerometers & sensors)
E6.3 energy (energy sources, motors, electric vehicles & motion)
E6.4 motion calculations (velocity, acceleration, inertia, circular motion & momentum)
E6.5 developing projects related to motion

E12.3 space vehicles and experiments using STEM design methodologies (engineering requirements, circuit diagrams, electricity, radio and other waves, thermal conductivity, spectra & motion in 3D)

E12.5 experimental design solutions to space related applications

E13.2 technologies related to statistical analysis (computer software for simulations & computer software for design and analysis)

E13.4 analyse, interpret, evaluate statistical information & communicate statistical findings

Optional

E8.1 CAD/CAM (3D drawing on an x, y & z axes in planes. CAM processes)

E8.2 technologies related to CAM (Additive and Subtractive manufacturing, Computer Numerical Controls, CNC, mills, routers & lathes)

E8.3 CAD/CAM operations (rapid prototyping, 3D CAD operations, Computer Aided Manufacturing (CAM), 3D modelling)

E8.4 3D environments Computer Numerical Control

E8.5 CAD/CAM

Unit overview

Students will briefly revisit the mathematical, scientific, technological and engineering principles of Aerodynamics and Design for Space iSTEM modules. Students will apply the iSTEM process to iteratively improve both their rocket launch pad and bottle rockets from last year. Attending and showcase students’ Aeronaut and Up & Beyond projects from Year 9 at community events is highly recommended to reinforce communication and presentation skills. Showcasing achievement can also provide opportunities for students to engage in relevant Aerospace industry experiences and career investigations.

In the REMIX unit, students will expand their Mechatronics and Robotic design skills using the Tetrix Prime and Max platforms. Previously students controlled their Tetrix design solutions using manual RC functions, this year students will extend the computer programming skills and knowledge of Arduino micro-controllers (Sense-sational Unit Year 9) by introducing automated control of robotic functions with the opportunity to design custom robotic parts using CAD/CAM equipment. Working in collaborative teams, students will need to complete a series of both construction and coding challenges to solve industry related problems relevant to local and regional careers. Students will also have the opportunity to further extend their mechatronic skills and design solutions for entry into the SISP Tetrix Maxed competition or the Newcastle Show Bot Battle events.

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

- 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
- Filming and statistical recording equipment (optional)
- CAD / CAM equipment & software (optional)
- Wind tunnel testing equipment (optional)

Websites

- Pitsco Tetrix Resource Site
- How to build a water rocket
- What are wind tunnels (NASA)
- COSPAR – Committee on Space Research Assembly Event
- Arduino – website and Integrated Development Environment
- IP legislation – IP Australia
- What is an Explainer video and how to make one?
- SISP Rocket Launcher Portfolio – iSTEM Process Challenge

Videos

- Principles of flight
- Pitsco Tetrix How To Videos
- Controller Pairing with Tetrix Max/Prime
- What is an Arduino and can I use it for my project?
- Tetrix Prime with EV3 Module
- World of Robotics – Pitsco Tetrix Prime with Pulse
- Introducing the Tetrix Pulse Robotics Controller
- Expanding you Bot with Tetrix Max Expansion Controllers
- What is Intellectual Property? – Canadian Example
- Understanding Copyright, Public Domain and Fair Use – United States Example

Content	Teaching and learning	Evidence of learning	Adjustments and registration

Week 1 - 2
• Review aerodynamic principles and the iSTEM process.
• Apply iterative design processes to modify Aeronaut (Bottle Rocket) and Up & Away (Rocket Launcher, Design my Space) prototypes.
• Develop collaboration, communication and presentation skills.
	Teacher
	• Outline classroom expectations and lesson organisation.
	• Review the importance of essential skills or soft skills such as collaboration, communication, creative problem solving and critical thinking skills as well as resilience / grit as desirable foundations and employability skills.
	• Review aerodynamic principles
	• Introduce the unit by discussing the importance of the iterative design process with emphasis on how industries spend a great deal of time and resources developing and modifying prototypes to meet specific needs.
	• Outline the COSPAR-K event and facilitate student attendance and entry into Aerospace challenges using previous projects.
	Students
	• Critically evaluate and modify as needed Bottle Rocket and Rocket Launcher projects for showcase at events. (Some students may have taken the opportunity to extend Rocket & Launcher designs over the summer holidays).
	• Optional: Students to setup Design my Space habitats and or collect portfolios/presentation materials for showcase at events.
		• Students articulate an understanding of:
		  ○ Aerodynamic principles
		  ○ iSTEM process
		• Students collate materials and / or modify projects for showcase events.
		• Students apply an interactive design process and demonstrate cognitive flexibility in the modification of prototype designs.
		• Students demonstrate collaboration, communication and presentation skills.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
Week 3 - 7 ● Recall and apply mechatronics, motion and robotics principles. ● Extend construction and problem solving skills to collaborative design robotics solutions to specification challenges. ● Explore the principles of motion using automated control of robotic functions using sensor imputs and line based computer programming skills. ● Develop an inquiry based mindset. ● Investigate Australian Copyright Laws and develop an understanding of international copyright restrictions and allowances for global innovations. ● Apply communication, collaboration, creative problem solving and critical thinking skills to design mechatronic solutions to meet industry simulated specifications.	**Teacher** ● Review the types of robots and the Pitsco Tetrix Prime and Max platforms. ● Introduce computer control of robotics by demonstrating manual vs automated control. ● Review input and output devices in Mechatronics and Arduino (draws on knowledge and skills from iBot & Sense-sational Units in year 9). ● Introduce the Tetrix Max & Prime Arduino boards. ● Demonstrate the Arduino Integrated Development Environment and explain the difference between Arduino compatible hardware and Arduino as a programming language. ● Allocate groups, distribute Prime = Pulse/Max = Prizm kits based on student abilities and facilitate challenge tasks. **Prime can also be used with EV3 Lego Robotics controllers for lower ability students* ● Outline the requirements of the SISP Tetrix Maxed Competition. ● Outline Assessment Task 1 requirements (Industry based prototype & explainer video; see below for details. ● Introduce copyright and intellectual property types using international examples 1 and 2; STEM innovation is a global market with restrictions and allowances that vary from Australian laws.	● Students are able to recall and apply previous knowledge and skills in mechatronics, motion and computer programming.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
• Produce an Explainer Video to demonstrate learning and highlight group prototypes.	**As a Class** • Class discussion (present a different question at the start of each lesson; questions could be used as a Ticket out the Door strategy) – 1. How have your opinions about robotics changed? 2. Why do we simulate bionic or humanoid functions in robots? 3. What mechatronic skills do you want to improve this year? 4. Why do Tetrix Max & Prime kits use different types of bolt systems, power supplies and sizes for construction components? 5. How is Arduino coding similar or different to other types of coding you have completed in the past? 6. What circumstances or scenarios would be better or worse for using code to control a robot? 7. What is copyright and intellectual property? 8. Why is it important not to infringe on intellectual property (IP)? 9. Why is it important to understand international copyright restrictions and allowances? 10. How does Australian copyright laws differ from other countries? 11. What custom parts could you design to improve your robot function and why?	• Students responses demonstrate an understanding of: ○ Differences between Arduino hardware and software ○ Applications of bionic and humanoid robots ○ Types of robots and mechatronic requirements used in various industries ○ Appropriate use for manual and automated robotic control ○ Copyright and Intellectual Property ○ Allocated kits for prototype construction.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	● Watch the following videos to support assessment task completion: 1. What is IP? 2. Understanding Copyright 3. What is an explainer video **Students – in Groups (3 - 4)** ● Apply self-directed learning to complete activities based on allocated Tetrix kits: 1. Prime + EV3 Controller – Use Tetrix Prime and EV3 Student work booklets (EV3 Block Builder: block – based coding); Industry application AgriTech • Activity 1: Select and Sort • Activity 2: Shake and Fall • Activity 3: Smart Harvester. 2. Prime + Pulse Controller – Use Tetrix Pulse Robotics Student work booklets (Ardublockly: block based coding); Industry application autonomous vehicles & transport • Activity 6: Build the Pulse Codee Bot • Activity 7: Drive forward • Activity 8: Drive in a circle • Activity 9: Drive in a square • Activity 11: Drive to a line and stop • Activity 12: Follow a line • Activity 13: Drive toward a wall and stop • Activity 14: Avoiding obstacles • Activity 15: Combining sensors.	• Students demonstrate knowledge of engineering principles and the iterative design process to construct industry related mechatronic prototypes. • Students work collaboratively to develop processes to solve set problems related to construction, motion, sensors and automated control of mechatronic solutions.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	3. Max + Prizm Controller – Use Competition in a Box Student work booklet (Arduino: line based coding); Industry application Environmental Science & Humanitarian Services • Activity 1: Design and Build a Prototype • Activity 2: Test and Analyse • Activity 3: Redesign and Improve • Optional: Competition 1 – Landfill Clean up • Activity 4: Navigation Systems • Activity 5: Lift Systems • Activity 6 – Grippers and Scoops • Activity 7: Making Modifications • Activity 8: Combining Sensors Revisited • Activity 9: Which Way? • Activity 10: Nothin' but a hound dog • *Optional:* Competition 3 – Rescue Robots • Test robot designs in the Competition in Box arena and make modifications as needed to improve mechatronic functions and computer code. • Seek teacher assistance as needed to trouble shoot computer coding and robotic construction challenges. • Research the industry application based on allocated kits (Prime + EV3 Controller – AgriTech, Prime + Pulse Controller – Autonomous vehicles & Transport & Max + Prizm Controller – Environmental Science & Humanitarian Services) to address the following inquiry based question(s)		

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	1. How has robotics changed or impacted the ‘insert’ industry? 2. What are the positives and negatives of robotics in ‘insert’ industry? 3. What type of robots are used in ‘insert’ industry? ● Create an explainer video addressing: 1. the above questions. 2. video snippets of prototype constructions. 3. a brief outline of the what challenges and achievement the group experienced. 4. profiles of each team member. 5. Videos should have appropriate: • animated introduction • title screens • transitions • content (images, background music or sound effects); all content should be student created or royalty free in accordance with copyright laws • credits (Video duration 2 – 4 minutes). ● Investigate Australian copyright laws, intellectual property types and source royalty free content for use in project work. ● Submit an industry based prototype and explainer video for Assessment Task 4 (due Week 7 or 8, Term 4).	• Students apply computational thinking skills and demonstrate cognitive flexibility to solve find and solve computer programming problems using appropriate debugging strategies. • Students use multiple sources to research mechatronics. • Students demonstrate communication and creative thinking skills in the development of an Explainer Video to highlight project achievements. • Students articulate the importance of preserving intellectual property and select appropriate content for inclusion in assessment tasks.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	Optional Adjustment ● Reduce the number of activities to be completed and shift remaining activities to a lunch time and or after school robotics club. **Optional Extension** ● Students use CAD/CAM software and equipment to design custom parts to improve their industry robotic prototype; record design development using the iSTEM process. ● Students invited to join or try out for the Tetrix Maxed Competition team (Term 2).		

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.

Term 2 Bio-Design – 10 iSTEM – Stage 5 Program

Summary

STEM technologies, such as Computer Aided Design and Computer Aided Manufacturing, have enabled many industries to utilise rapid prototyping to solve a wide variety of problems. Biomedical science fields are at the forefront of STEM innovation providing students with a platform to engage in social design projects using skills and technology that underpin many career opportunities in the Hunter Region. Throughout the Year 9 iSTEM Stage 5 course, students developed the foundation skills needed to undertake a larger inquiry based investigation and design project using science and engineering principles to design and manufacture prosthetic limb prototypes.

Duration

14 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)
C2.2 fundamental mechanics (basic units, prefixes, statics, dynamics & modelling)
C2.3 problem solving (nature of, strategies to solve, evaluation & collaboration)
C3.1 mechatronics (building mechatronic components, programming logic, writing macros & fault finding)
C3.2 technologies related to robotic sensors and transducers, manipulators, PLC's, actuators (pneumatic & hydraulic)
C4.1 mechatronics and control technology (logic gates, mechanical and electrical actuation systems & motors)
C4.2 programming & computations (algorithms, calculating distance, trigonometry, circle geometry & input/output systems)
C4.3 design mechatronic solutions for a range of applications
E8.1 CAD/CAM (3D drawing on an x, y & z axes in planes. CAM processes)
E8.2 technologies related to CAM (Additive and Subtractive manufacturing, Computer Numerical Controls, CNC, mills, routers & lathes)
E8.3 CAD/CAM operations (rapid prototyping, 3D CAD operations, Computer Aided Manufacturing (CAM), 3D modelling)
E8.4 3D environments Computer Numerical Control
E8.5 CAD/CAM
E14.1 Biomedical Innovation (applying processes, designing, researching, investigating, communicating, managing projects, evaluating)
E14.2 Biotechnologies (range of technologies used in biotechnology)
E14.3 Biomedical Innovation concepts (biomedical innovations, design and engineering, processes, environmental health, molecular biology, forensics, bioengineering, scope and nature of biomedicine)
E14.4 Analysis (statistics, using data to develop, evidence based arguments and conclusions)
E14.5 Designing solutions to biomedical problems

Unit overview

In the Bio-Design unit, students will investigate the biology and physiology of prosthetic limb design and production. This deep dive unit will expose students to both hydraulic and bionic control mechanisms to simulate human hand movement. Students will explore national and global social design projects aimed at improving the quality of life and biological function for amputees and limb disabled individuals with an opportunity to expand and apply CAD/CAM skills to the design and manufacture of prosthetic limb prototypes. Students will apply the iSTEM process to iteratively improve prosthetic hands to meet various specifications using rapid prototyping techniques such as 3D printing. Students will also briefly investigate Bioengineering careers and education pathways. Students will expand and apply their critical thinking skills through research and critical reflection about the ethics of bioengineering and sustainability of rapid prototyping.

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

- Projector or Smartboard, laptops or tablets
- Hydraulic Arm Kits (syringes, tubing, glue, scissors, templates, etc)
- CAD / CAM equipment (3D Printers & Laser Cutter) & software (Fusion 360 or TinkerCAD)
- Phoenix Hand Parts
- Hand Held 3D Scanner (Lending Library)
- Print filaments (PLA or ABS depending on the type of 3D printer used)

Websites

- Cardboard Hydraulic Arm - Templates & Instructions
- Simplified Hydraulic Arm – Instructions
- Enabling the Future – Phoenix Hand Project
- e-Nable Phoenix Hand V2 – Thingiverse STL files and instructions
- How to become an e-Nable maker/ volunteer – Instructables
- Open Bionics Hero Arm
- Reasons for different types of 3D Printers
- Prosthetic Drummer Breaks World Record
- Injured animals get second chance with 3D Printed Limbs
- University of Newcastle Medical Engineering Degree
- Envision Hands Project – Australia is turning bottle caps into recycled 3D filament for prosthetic hands

Videos

- Hand Anatomy Tutorial
- The importance of rapid prototyping
- How does a laser cutting work?
- The History of Prosthetics Explained
- Engineers created a new bionic arm that can grow with you – Hero Arm
- How to assemble the unlimited Phoenix Hand
- Will a robotic arm ever have the full functionality of a human limb?
- Playing a piano with a mind-controlled robotic arm
- Hairdresser turns old shampoo bottles into 3D-printed prosthetic limbs
- Making prosthetic limbs with 3d printing – intro video
- Adobe Illustrator Tutorial Video – review of basic tools
- Breakthough: 3D Printing the Human Heart
- 3D Printing Human Tissue (13 minutes)
- Fusion 360 Tutorial for Absolute Beginners

Content	Teaching and learning	Evidence of learning	Adjustments and registration
Week 8 - 11 (Term 1) • Review and apply knowledge, skills and understanding of the safe operations of a laser cutter. • Review CAM software tools and features to modify and label hydraulic arm parts. • Develop an understanding of the biology and physiological components and function of the human hand. • Simulate human hand function the design, construction, testing and modifying of a hydraulic hand prototype.	**Teacher** • Introduce the unit by discussing social or community driven design, such as University of Newcastle COVID 19 ventilator, Life Straw and Enabling the Future projects. STEM skills are the core of each of these projects with people from all backgrounds coming together to collectively design a solution in response to an urgent or ongoing community problems. • Outline the unit learning activities and goals for a deep dive style unit (14 weeks of learning in multiple phases). ○ *Overall Goal:* Design a prosthetic limb prototype for the Enable the Future: Phoenix Hand project with either hydraulic or Arduino integrated control. ○ *Phase 1 (end of term 1):* Simulate hand function with a hydraulic arm prototype ○ *Phase 2:* Prosthetic Limb & biomedical investigations ○ *Phase 3 (Group Work – midterm 2):* Designing a prosthetic limb CAD prototype ○ *Phase 4 (Group Work - end of term 2):* Prosthetic limbs with integrated control systems. • Demonstrate how to use Adobe Illustrator; software used for CAM designs for laser cutting and labelling hydraulic arm parts; Guided demonstration on	• Students to describe the importance of design to meet human needs.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	downloading and modifying hydraulic arm parts in Adobe Illustrator for export to laser cutter. ● Demonstrate laser cutter function (small sample showing cutting and engraving features) and outline safe operation guidelines of equipment. ● Demonstrate a working hydraulic arm; outlining the importance of minimising air bubbles. **As a Class** • Watch the following videos to support Phase 1 learning: o Hand Anatomy Tutorial (pause to allow note-taking) o How does a laser cutting work? **Students** • Take notes during the hand anatomy tutorial in a Google document or student work booklet. • Follow along with Adobe Illustrator video to review the selection, shape, tracing and text tools. • Take a photo of the front/back of his/her hand or trace hands on paper; using Adobe illustrator label the parts of the hand; including surfaces, bones/joints, muscles and ligaments (each topic area should be a new image of a hand); include illustrations in the Google document or student work booklet. • Use Adobe Illustrator and the laser cutter to cut out materials and label (engrave) hydraulic arm parts with student name and part numbers.	• Students create 2D drawings using Adobe Illustrator for the purpose of the laser laser cutting. • Students articulate an understanding of: o Community and or social design movements and or projects o Biological components of the human hand o Physiological function of the human hand o Hydraulic control of simulated human hand movement. • Students apply knowledge of CAM software (Adobe Illustrator) to modify designs and demonstrate safe use of CAM equipment available at Cessnock High.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	• Follow along with the tutorial to construct, test and modify hydraulic arm prototype as needed. **Optional Adjustments** • Use simplified hydraulic arm tutorial. • Construct hydraulic arms out of cardboard versus laser cut materials.	• Students construct a hydraulic gripper to simulate human hand function. • Students apply an iterative design process and demonstrate cognitive flexibility in the modification and troubleshooting of hydraulic prototype designs.	

Week 1 - 3
• Recall and apply CAD / CAM design principles.
• Select appropriate CAD / CAM software to design bioengineered solutions.
• Apply research skills to explore the applications and technology of Bioengineering.
• Investigate Bio Medical and/or Bioengineering study pathways and or career opportunities.
• Apply communication, collaboration, creative problem solving and critical thinking skills to design CAD/CAM solutions to meet project specification.
	Teacher
	• Outline Phase 2 of the unit (Prosthetic Limb and Rapid Prototyping investigations).
	• Introduce the Enable Phoenix Hand Project and mission; provide an overview of the website and encourage class discussion about the project.
	• Organise and purchase of phoenix hand parts and 3D printing filaments.
	• Outline Assessment Task 2 requirements prosthetic limb prototype and iSTEM process portfolio.
	• Allocate groups (students working in pairs).
	As a Class
	• Watch the following videos to support unit learning (choose a different video for the start of each lesson); students should be encourage to critically analyse and share perspectives on the content presented:
	  ○ The importance of rapid prototyping
	  ○ The History of Prosthetics Explained
		• Students apply critical thinking skills to investigate the applications of bioengineering and articulate related responses	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	○ Engineers created a new bionic arm that can grow with you ○ Will a robotic arm ever have the full functionality of a human limb? ○ Playing a piano with a mind-controlled robotic arm ○ Hairdresser turns old shampoo bottles into 3D-printed prosthetic limbs ○ Breakthough: 3D Printing the Human Heart ○ 3D Printing Human Tissue (13 minutes) **Students – in Groups (2 - 3)** • Conduct research and summarise finding related to: 1. types of prosthetic limbs; choose two different types of prosthetic limbs suited for different purposes to outline and compare (PMI – Plus, Minus & Interesting) features; students will later compare their prototype to these designs as well. 2. history of prosthetic limbs; Use Adobe Spark or Lucidchart online software to create a timeline of significant prosthetic limb development. 3. Investigate the biomedical applications of CAD / CAM; Answer the inquiry questions: a. How do we use CAD / CAM to bio-engineer the human body? Include at least three non-limb examples. b. What career or further study opportunities are available in biomedical engineering?	• Student select appropriate tools and varied research material or sources to investigate the history and emerging developments of Bioengineering. • Students use a variety of multimedia tools to communicate research findings and document design prototypes. • Students are able to recall and apply previous knowledge and skills in CAD / CAM design, equipment and software.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	c. How and why do materials differ for various bioengineered solutions? Give specific examples. d. Are the benefits of rapid prototyping over shadowed or outweighed by sustainability concerns associated with rapid prototyping materials? Address both sides of the debate and formulate a written or voice recorded supported by evidence. • Setup the group iSTEM process folio to document project prototype development. • Brainstorm a theme / design concept for a child’s prosthetic limb; use Lucid Charts or MindMup software and include a screenshot in the group iSTEM process folio. • Create Thumbnail sketches for each of the brainstorm concepts; label the sketches with colour choices, parts and important features; take photos or scan drawings into a digital format for inclusion in the iSTEM process folio. • Critically analyse thumbnail sketches (PMI recommended); select and justify a design concept. • Using Adobe Illustrator, create professional 1:1 scale isometric illustrations of the chosen design concept. **Optional Adjustment** • Use Splat 3D tool to hand draw isometric representation of prototype concept.	• Students demonstrate a thorough understanding of the iSTEM process to document design concepts and prototype development • Students effectively use a variety of visual illustrations techniques, including traditional and digital tools • Students critically analyse design ideas and select the most suitable design for further development • Apply mathematical skills for measurement and proportion to create scaled drawings	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	Optional Extension • School excursion to University of Newcastle Medical Engineering department or incursion visit.		
Week 4 - 6 • Apply an understanding of human biology and physiology in design of a prosthetic limb solution • Select appropriate CAD/CAM software and equipment to design bioengineered solutions • Read and interpret plans • Modify and customise CAD/CAM files to suit a chosen theme • Extend construction and problem solving skills to collaboratively design bioengineered solutions to specifications	**Teacher** • Outline phase 3 of the unit (Prosthetic Limb prototype designs and 3D printing). • Demonstrate the different types of 3D printers available for use; outline the features of each and identify ideal applications for each; Reasons for different types of 3D Printers; review safety guidelines for each printer. • Review / demonstrate 3D design software (Fusion 360, TinkerCAD or Google Sketchup); depending on student experience and software chosen, guided demonstrations for the development and modification of specific prosthetic parts may be required. • Demonstrate how to import STL files into a chosen 3D development software for modification; e-Nable Phoenix Hand V2 – Thingiverse STL files and instructions. • Lead discussion on the limitations and possibilities of prosthetic 3D printed limbs using the following articles: 1. Prosthetic Drummer Breaks World Record 2. Injured animals get second chance with 3D Printed Limbs		

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	As a class • Class discussion – 1. How does a desired function impact on prosthetic design? 2. Is bioengineering the human body ethical? Why or why not? 3. What are the challenges of using rapid prototyping tools such as 3D printers to design prosthetic limbs. **Student – in Groups (2 - 3)** • Import STL files into CAD software (Fusion 360, TinkerCAD, etc) and modify design to suit prototype concept. • Read and interpret design specifications; follow along with tutorial videos and or teacher demonstrations to design and print 3D Parts. • Experiment with printer types, settings and materials to produce 3D printed parts. • Construct, test and adjust prosthetic hand parts as needed. **Optional Adjustment** • TinkerCAD is a less complex 3D modelling software package; Fusion 360 is an industry standard and more complex 3D modelling software; select software to suit student learning needs.	• Students demonstrate knowledge of engineering principles and the iterative design process to construct a biomedical prototype. • Students read and interpret instructions and schematics. • Students articulate the features, limitations, benefits and safety procedures of each 3D printer available at Cessnock High School. • Students apply mathematical skills for measurement to modify prosthetic parts. • Student work collaboratively to develop processes to solve set problems related to CAD/CAM production. • Students demonstrate communication and creative thinking skills in the development of a prototype concept.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	Optional Extension • Design a bionic feature that extends normal human capacity as attachment to a prosthetic limb; see Prosthetic Drummer Breaks World Record. • Use 3D scanning tools (Lending Library) to scan student hands and take accurate measurements for 3D modelling. • Students to create a 3D production club (lunch time or after school) to design and build prosthetic limbs for distribution via the e-Nable Phoenix Hand project. • Students conduct fundraising to purchase equipment for recycling bottle caps to produce recycled 3D print filament or coordinate a campaign to collect and send bottle caps to the Australian Envision Hands project.		
Week 7 - 10 • Critically analyse and collaboratively select a control mechanism for prototype integration. • Recall hydraulic and mechatronic control system (Arduino sensors, motors and coding) principles. • Modify existing prosthetic hand designs to incorporate a chosen control mechanism.	**Teacher** • Outline phase 4 of the unit (Prosthetic Limb modification and control mechanism integration). • Facilitate project /group work. • Assist with troubleshooting as needed. **Student – in Groups (2 - 3)** • Apply critical thinking skills in the selection of a control mechanism. • Use an iterative design process to conceptualise prototype adjustments.	• Students compare and analyse control system (hydraulic or Arduino mechatronics) for integration into prosthetic limb prototypes. • Students articulate the changes and modifications required to integrate a chosen control mechanism.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
• Present a design portfolio thoroughly demonstrating the iSTEM process for a prosthetic limb prototype. • Demonstrate communication skills in the showcasing a prototype design.	• Modify design files to integrate a chosen control mechanism and reprint 3D parts as needed. • Apply self-directed learning skills to collaborative manage the development of the modified prosthetic limb design. • Demonstrate the operation of prosthetic limb prototype using a chosen control mechanism. • Finalise and present the iSTEM process folio to showcase group designs and prototypes (recommend setting up projects in the library for showcase or for showcase at a parent/teacher night). • Provide constructive feedback to peers on the design and function of prosthetic limb prototypes and iSTEM process folios.	• Students apply project management techniques to modify prosthetic prototypes and thoroughly document project development. • Students justify design choices and selection of control mechanisms. • Students produce a high quality and thorough portfolio for showcase.	

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.

Term 3 Let's Get Moving – 10 iSTEM – Stage 5 Program

Summary

Electrical energy has been promoted as a more efficient energy source for the powering of many machines particularly in transport. Elon Musk's Tesla has shown that electric vehicles can be a commercially viable alternative to internal combustion powered vehicles. The generation and storage of electrical energy is a major issue related to electrically powered vehicles and will be investigated in this unit. Alternative energy sources such as solar which is created by the heat & light of the sun which Australia has an abundance is showing great promise as a source of renewable energy. As a nation, we are well positioned to harness the power of the sun to create innovative products and emerging career opportunities. In Let's Get Moving, students will further explore the Elective Module Motion by working collaboratively to apply the science and potential of solar technology to transport design. Specifically, students will experiment with solar cells to power an electric vehicle. In this unit students may also have an opportunity to work collaboratively as a team to produce a battery powered electric bicycle as an extension activity to compete at the Hunter Valley Electric Vehicle Festival.

Duration

7 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

5.4.1 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
5.6.1 selects and uses appropriate problem solving and decision making techniques in a range of STEM contexts
5.6.2 will work individually or in teams to solve problems in STEM contexts
5.7.1 demonstrates an appreciation of the value of STEM in the world in which they live
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)
C2.3 problem solving (nature of, strategies to solve, evaluation & collaboration)
E6.1 electronics (circuitry, motors & generators, fault detection, prototypes, making models & practical applications)
E6.2 technologies related to motion (gyroscopes, accelerometers & sensors)
E6.3 energy (energy sources, motors, electric vehicles & motion)
E6.4 motion calculations (velocity, acceleration, inertia, circular motion & momentum)
E6.5 developing projects related to motion
Optional
E8.1 CAD/CAM (3D drawing on an x, y & z axes in planes. CAM processes)
E8.2 technologies related to CAM (Additive and Subtractive manufacturing, Computer Numerical Controls, CNC, mills, routers & lathes)
E8.3 CAD/CAM operations (rapid prototyping, 3D CAD operations, Computer Aided Manufacturing (CAM), 3D modelling)
E8.4 3D environments Computer Numerical Control
E8.5 CAD/CAM

Unit overview

In the Let's Get Moving, students will expand knowledge of electrical circuits in the design of a solar powered vehicle with the opportunity to design custom parts using CAD/CAM equipment. Working in collaborative teams, students will need to complete a series of construction challenges, explore the science of solar energy and investigate environmental science careers. Students may also have the opportunity to further extend their solar design skills by joining a team for entry into the Hunter Valley Electric Vehicle Festival.

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

- Mini EV Solar Vehicle kits
- Mini EV sprint and pursuit track
- Rochford's Unit 7 Electricity and Electronics interactive DVD
- Electric bike supplies (battery, bike frame, soldering irons, solar cells, etc)
- Cycle Analyst
- Projector or Smartboard, laptops or tablets

Websites

- How do solar panels work?
- Hunter Valley Electric Vehicle Festival
- Innovative University of Newcastle Printed Solar Panels

- Kite Magic – Solar Cars & Boats
- How Solar panels work – TED ED Lesson
- What is solar power? – National Geographic
- 8 Surprising Facts about Solar – Energy Australia
- Solar leads Australia's energy transition as renewables set new record

Videos

- How Suspension Works (contains satire)
- How Does Air (pneumatic) Suspension Work?
- Hydraulic Shock Absorbers
- Hunter Valley Electric Vehicle Festival
- University of Newcastle Printed Solar Explainer Video
- How do solar panels work?
- Physics of Solar Cells
- Electricity and Magnetism - Science Asylum Electrodynamics
- What is Electric Charge? - Science Asylum Electrodynamics
- What are magnets? - Science Asylum Electrodynamics
- Energy doesn't Flow the way you think! - Science Asylum Electrodynamics
- Does electricity really flow? - Science Asylum Electrodynamics
- Where does light come from? - Science Asylum Electrodynamics
- Turning magnetism into electricity – Science Asylum Electrodynamics
- How special relativity fixed electromagnetism - Science Asylum Electromagnetism
- Egg Drop Challenge – Practical example of suspension
- Design a toy car with magnetic suspension

Content	Teaching and learning	Evidence of learning	Adjustments and registration
Week 1 - 2 • Demonstrate ability to interpret sets of instructions. • Demonstrate the ability to design solutions to a mechatronic application to meet set criteria. • Design and construct basic electronic circuitry related to electric vehicles. • Demonstrate an understanding of the difference between a variety of suspension types. • Identify types of suspension and how they are applied to vehicles.	**Teacher** • Deliver a set criterion for the completion for the SISP Pursuit Solar Car Challenge. **Students (in Teams of 3 – 4)** • Investigate the rules and criteria related the SISP Pursuit Solar Car Challenge. • Work in teams to unpack the specifications for the design on their electric vehicle. • Using the iSTEM process to develop design solutions for the SISP Pursuit Solar Car Challenge. **Teacher** • Demonstrate the use of Rochford's Unit 7 Electricity and Electronics interactive notes. • Discuss voltage, current and resistance. • Demonstrate the correct method of soldering. **Students** • Complete practice soldering exercises. • Use a multimeter and Cathode Ray Oscilloscope to find common faults in circuits. **Optional Adjustment** • Students design a model solar car using the primary school program which does not require soldering. **Optional Extension** • Students produce an electric powered bike to compete in the Hunter Valley EV Festival	• Students use a range of advance manufacturing and electronics technologies to design solutions to problems related to electric vehicles • Students to identify the most important concepts related to Electricity and Electronics through their demonstration of the comprehension strategy of summarising • Students demonstrate mastery of basic soldering techniques • Students demonstrate basic fault-finding techniques • In teams students prepare an electric bike and race it for 1 hour around a 1.2km track at Cameron Park	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
Week 3 - 7 ● Explore motor types to power electric vehicles. ● Apply mathematical functions in the design of STEM solutions. ● Identify positives and negatives of solar energy to power vehicles. ● Explore how solar cells function. ● Demonstrate an understanding of electricity, magnetism and the flow of energy. ● Experiment with motion and solar technologies to collaboratively design an electric vehicle solution. ● Describe various technologies related to motion and mechatronics. ● Apply communication, creative problem solving, critical thinking and collaboration skills to develop a team identity and brand. ● Produce models in order to solve engineering problems related to motion and mechatronics.	**Teacher** • Discusses how Solar Cells Work. • Demonstrate how different combinations of gears can be used to produce a vehicle that has high torque (low speed) or one that has low torque (high speed). • Explains the difference between series and parallel circuits. • Discusses environmental variables of a solar vehicle race. E.g. sunny day versus dull/cloudy day. • Teacher to demonstrate the basic operations of a CRO and how it can be used to find faults in electronics circuits. **Students** • Experiment with various gear ratios to determine optimum. • Experiment with solar cells in both parallel and series. Using a multimeter to demonstrate volts and amps. **As a class** • Investigate the rules of the SISP Pursuit Solar Car Challenge and the Hunter Valley Electric Bike Festival. • Develop an understanding of electricity and solar power using the following videos; recommend viewing a new video each lesson followed by short classroom discussion:	• Students are able to outline the requirements of the assessment task and clearly identify constraints • Students apply the iSTEM process to demonstrate idea generation techniques and apply creative problem solving in selecting, planning and developing a prototype concept • Students demonstrate the ability to produce a design solution that can adapt to a variety of environmental variables	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	○ University of Newcastle Printed Solar Explainer Video ○ How do solar panels work? ○ Physics of Solar Cells ○ Electricity and Magnetism ○ What is Electric Charge? ○ What are magnets? ○ Energy doesn't Flow the way you think! ○ Does electricity really flow? ○ Where does light come from? ○ Turning magnetism into electricity ○ How special relativity fixed electromagnetism • Demonstrate different types of motors used in the SISP Pursuit Solar Car Challenge and in the Hunter Valley Electric Vehicle Festival. • Demonstrate how to use mathematical functions to determine efficient pathways for motion and power consumption. **Teacher** • Review previous work on aerodynamics, e.g. thrust, drag and friction as it relates to vehicle design. • Explain how an electric motor works. • Use Rochford notes to explain the major types of electric motor. • Demonstrate how to build a model electric motor. • Discuss the physics of motion in regard to motor sports.	• Students build a model electric motor.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	• Demonstrate a range of model making techniques using available technologies. • Explain how gyroscopes work and show students part of the engineering connections video from HMS Illustrious related to gyroscopes. https://www.youtube.com/watch?v=EZ5geiAkekY **Students** • Open a small DC motor and identify the parts. • Use motors to complete a range of engineering problem solving. • Research how electric vehicles work? • Research Tesla car manufacture and performance motor bikes. • Complete experimentation related to gyroscopes. E.g. Boomerang, spinning tops, spinning bike wheel. • Research the contributions to modern technology which were made by Australian Aboriginal culture. • Research how accelerometers work? • Complete a range of mathematical exercises related to velocity, acceleration, inertia, circular motion and momentum. **As a Class Group** • Students test their designs on a sprint and pursuit track before competing in a local school based challenge • Student teams compete against each other in a sprint and pursuit race.	• Students use a range of motor types in the preparation of an electric vehicle • Students demonstrate the applied knowledge of previous modules to produce rapid prototyped solutions to a range of design solutions for their solar cars • Student teams produce innovative solar powered vehicles that meet the challenge criteria and perform well under different conditions	

Content	Teaching and learning	Evidence of learning	Adjustments and registration

	Optional Extension
	• Students design custom bike parts using CAD / CAM equipment and software. E.g. custom chassis, wheels, guides, adjustable solar cell holders, etc
	Optional Extension
	• Collaboratively unpack the specifications for the design of the electric bike. Using the specifications provided students to develop a number of design solutions to the given problem.
	• use a range of technologies to design solutions to problems related to electric bikes.
	• Develop a team identity and pit display using appropriate project management and creative problem solving skills.
	• Apply iterative design and testing strategies to collaboratively produce an entry for the Hunter Valley Electric Bike Festival.
	• Experiment with a range of technologies including ‘Catalyst Analyst” to develop a solar powered design solution.
	Students – Individually
	• Research the function and impacts of Solar Power in the world in which we live:
	  ○ How do solar panels work?
	  ○ Innovative University of Newcastle Printed Solar Panels
	  ○ What is solar power?		

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	○ 8 Surprising Facts about Solar ○ Solar leads Australia's energy transition as renewables set new record • Summarise research findings in a short written report, slideshow, poem/song or news report designed to persuade solar sceptics to adopt solar technology or to encourage younger students to study Environmental Science; must include statistics and data from at least 4 of the above resources plus two additional resources found by the student. **Optional Adjustment** • Split the class into three teams (Bike Designers, Pit Designs, Promotional Video / Team Identity designs) to reduce costs and or cater to individual student needs. • Assign some or all of the videos as homework in a flipped learning method then conduct classroom discussions to share student understanding of content. **Optional Extension** • Design custom bike parts using CAD/CAM equipment and software. • Excursion to the University of Newcastle to visit Environmental Science labs and projects.		

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.

Term 4 WICKED Futures – 10 iSTEM – Stage 5 Program

Summary

A primary goal of the Stage 5 iSTEM course is to cultivate the minds and problem solvers of the future. Students with STEM experiences and knowledge are far more likely to succeed in future focused careers as they are equipped with skills to innovatively design solutions to local, national, and global problems that are difficult and complex.

The Wicked Future unit is a culmation of skills and knowledge learned throughout years 9 & 10 iSTEM. As students undertake a Major Task of their choosing, they will experiment with social driven design to address WICKED Problems. Students will also simultaneously explore potential STEM career and education pathways. To end the year on a high note, students will be provided with an opportunity to experiment with Unmanned Aerial Vehicles (UAV aka drones).

Duration

12 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

5.4.1 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
5.6.1 selects and uses appropriate problem solving and decision making techniques in a range of STEM contexts
5.6.2 will work individually or in teams to solve problems in STEM contexts
5.7.1 demonstrates an appreciation of the value of STEM in the world in which they live
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)
C2.2 fundamental mechanics (basic units, prefixes, statics, dynamics & modelling)
C2.3 problem solving (nature of, strategies to solve, evaluation & collaboration)
E10.1 processes of design (identifying problems, project management, developing solutions to problems, generating ideas)
E10.2 presentation and communication technologies
E10.3 realisation, evaluation, research methods and experimentation
E10.4 mechanical knowledge
E10.5 creative and innovative approaches to solve problems
E11.1 site risk management and WHS in surveying (common surveying workplace hazards and associated risk control, site safety plan, PPE equipment & surveying software)
E11.2 technologies related to surveying (Total Station Theodolite (TST), GPS, digital terrain models & laser scanning)
E11.3 fundamental surveying principles (cadastral surveyors, engineering surveyors, mining engineers, hydrographic engineers, geodetic surveyors, GIS & photogrammetry)

E11.4 spatial data (appreciation of spatial skills, calculating distance, trigonometry, geometry & mapping)
E11.5 problem solving (design surveying solutions to a range of applications)
Optional
E8.1 CAD/CAM (3D drawing on an x, y & z axes in planes. CAM processes)
E8.2 technologies related to CAM (Additive and Subtractive manufacturing, Computer Numerical Controls, CNC, mills, routers & lathes)
E8.3 CAD/CAM operations (rapid prototyping, 3D CAD operations, Computer Aided Manufacturing (CAM), 3D modelling)
E8.4 3D environments Computer Numerical Control
E8.5 CAD/CAM

Unit overview

A wicked problem is a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize. Students with explore a chosen WICKED problem, select appropriate STEM tools and apply an iterative design process to design an innovative prototype. Students will develop fundamental entrepreneur skills as they integrate statistical data to persuasively pitch their design concept in a Shark Tank style video. The Major Task component of this unit enables students to select elective iSTEM modules of interest as the focus of self-directed learning.

Throughout the iSTEM Stage 5 course students have been exposed to a wide variety of STEM career opportunities. The Wicked Future unit puts students in the driver seat as they begin to navigate their own career trajectory. Students will select careers for investigation based on personal interests and the project or skills they have enjoyed or excelled in the course.
In the Hunter Valley, a wide range of careers and regional employers focus on using drones to survey land and collect data. To reinforce employability skills in emerging STEM careers, students will have the opportunity to extend drone flight skills. With further study, students will have gained a competitive edge in the UAV career opportunities.

Resources overview

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

Physical resources

- Equipment will vary depending on chosen topic for student Major Tasks
- Careers Advisor

- Drone Kits (DJI & Tello)

Websites

- Wicked Problems – definition & guidelines
- Virtual STEM Career Expo – University of Newcastle
- Explore Top Career in STEM – Learn How to Become
- Get Career Basics – Careers with STEM
- STEM Career Quiz – GiST
- STEM skills vital for jobs of the future – GiST
- STEM Careers A – Z - GiST
- Career Education in STEM – GiST
- What is your STEM Career? – Careers with STEM
- STEM Potential Career Fit
- STEM Career Personality Quiz – How Stuff Works
- STEM Careers Quiz – UNSW
- How to find your STEM passion – STEM Study
  STEM Career Profiles – Careers with STEM
- STEM Career Profiles to Inspire Your Students – Presentation and Teacher Notes; STEM Learning UK (requires free login)
- All you need to know about drone surveying – DJI
- Using drones to collect data - Aurecon
- UAV Air – Drone Certification Courses
- How do Drones Fly? Physics of Course! – Wired
- How to Fly a Drone – UAV Coach
- Opendronemap Software
- Drone Photography Guide – UAV Coach
- Drone surveying careers - UAVAIR
- Most successful Shark Tank Pitches
- How to craft the perfect Shark Tank Pitch

- How to design a GANTT Chart – Lucid Charts (free student edition available via Google Drive)

Videos

- What is a wicked problem? – Study.com (requires a login, part of the Design Thinking Course; 30 day free trial)
- How to work with Wicked Problems
- What is Design Thinking?
- What is a GANTT Chart?
- Shark Tank Example: Buggy Beds

Content	Teaching and learning	Evidence of learning	Adjustments and registration
Week 9 – 10 (Term 3) • Investigate WICKED problems and impacts on local, national and global societies. • Apply the iSTEM process to generate ideas and project concepts to expand and / or address a WICKED problem. • Explore potential STEM career pathways to suit student interest and skills preferences. • Expand prior knowledge of Aerodynamics and Surveying. • Demonstrate self-directed learning and project management skills in the setup and completion of a digital portfolio to record Major Task development.	**Teacher** • Introduce the unit by discussing WICKED problems with examples. • Outline Assessment Task 4 requirements (Shark Tank Pitch) and components; Students will complete their Major Task (student chosen topic based on a WICKED Problem or area of interest from a previous project) simultaneously to a career investigation and drone extension activities. Career investigations and drone activities will not be assessed (60% of class time allocated to Major Task, 20% Career Investigation and 20% Drone Skills). • Direct students to collate previous project work and portfolios to use as evidence for career pathways and or as a basis for expansion in their Major Task. • Review the iSTEM process and direct students to setup digital portfolios including headings for each of step of the process. • Review local, regional and national STEM career opportunities; reinforce the need to continue development of essential skills, such as collaboration, communication, creative problem solving and critical thinking skills as well as Resilience / Grit as desirable foundations and employability skills. • Coordinate Flight Foundation course participants with UAV Air or similar drone course provider; confirm funding support for student participation.	• Students responses demonstrate an understanding of: ○ Drone safety regulations ○ Basic surveying and statistical connections to drone technology ○ Potential career opportunities using drone technology ○ Importance of applied mathematics in drone related careers. • Students apply self-directed learning, collaboration and communication skills in the completion of Highflyer activities. • Students practice mathematic skillsets to solve Highflyer challenge activities. • Students identify the difference between manual and automated control with the ability to outline appropriate scenarios for the use of both.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration

	• Review Aerodynamic Principles and highlight the use of drones in Surveying careers.
	As a Class
	• Class discussion (spread inquiry questions across the first two weeks or as needed when topics are introduced) –
	  ○ What is a WICKED Problem?
	  ○ How could you expand a previous project to meet the requirements of the assessment task?
	  ○ What tools will you use for project ideation and project management?
	  ○ How are the aerodynamic principles applied to drone flights?
	  ○ How do drone flights differ from other forms of flight vehicles and / or flight based animals?
	  ○ What are the benefits of using drones for surveying and data collection?
	  ○ What type of careers or industries use drones?
	  ○ Which of the STEM disciples or skills studied throughout the course have you found most interesting and Why?
	Students
	• Setup a digital portfolio using the iSTEM process headings; Complete brainstorming and / or idea generation activities to determine potential project concepts based on a WICKED Problem or the expansion of a previous iSTEM projects.
	• Identify and select the most suitable tools to communicate idea generation and selection of the most suitable or promising project concept.
		• Students engage with industry experts using or related to drone technology.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	● Identify equipment and supplies required to complete project concept(s). ● Select appropriate project management tools to outline project scope with clear identification of milestones in project completion according to deadline. (GANTT chart). ● Consult classroom teacher to seek constructive and critical feedback on project concept and GANTT chart (project scope) prior to beginning practical work; equipment and supply requirements to be approved by classroom teacher. ● Conduct research on the chosen WICKED problem or Major Task topic, including existing solutions. ● Identify examples, tools or strategies for each stage of the iSTEM process. **Optional Adjustment** • If a certification course is unavailable, simulated surveying and data collection activities can be simulated using the smaller Tello Drone Kits with classroom teacher demonstration of the larger DJI Quadcopter Drone.		
Week 1 – 10 (Major Design Task; 60% of class time) ● Define and identify examples of WICKED problems. ● Apply self-directed and inquiry	**Teacher** • Review requirements of Assessment Task 4 and outline class time structure of simultaneous tasks (60% of class time allocated to Major Task, 20% Career Investigation and 20% Drone Skills); additional time outside of class will be needed to complete some non-practical components of	• Students are able to outline the principles of Wicked Problems. • Students' responses	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
based learning skills in the • completion and project management of project work. • Develop an appreciation and understanding of the importance of statistical data. • Apply research techniques to find topic appropriate statistics and effectively communicate data in a persuasive speech format. • Apply communication skills and constructive feedback to improve prototypes and portfolios. • Select and safely use appropriate tools to complete project work and manage projects. • Demonstrates an understanding of the role innovation and collaboration play in designing WICKED solutions.	projects and classroom tasks. • Facilitate self-directed learning and conduct regular meetings/discussions with each student to scaffold problem solving and mentor project management skills. • Emphasise the importance of reliable statistics and data in student Shark Tank Pitches. **As a Class** • Watch the following videos and collaboratively investigate websites to support assessment task completion: ○ How to work with Wicked Problems (video) ○ Wicked Problems – definition & guidelines (website) ○ What is Design Thinking? (video) ○ What is a GANTT Chart? (video) ○ Shark Tank Example: Buggy Beds (video) ○ How to design a GANTT Chart (website) ○ Most successful Shark Tank Pitches (website) ○ How to craft the perfect Shark Tank Pitch (website). **Students** • Conduct regular meetings with the classroom teacher to seek constructive feedback, improve portfolio work or seek assistance with project specific skills or equipment. • Apply the iSTEM process to the design and development of prototype concepts; record photo or video evidence of each stage of the iterative	demonstrate an understanding of assessment task requirements. • Students use multiple sources of data to research a WICKED Problem. • Students are observed during practical activities using STEM construction techniques and equipment. • Students demonstrate an understanding of statistical data and apply critical thinking skills to analyse data for inclusion in a persuasive argument or justification. • Students use appropriate and varied methods of communicating design concepts, such as label drawings to demonstrate design modifications and mind maps. • Students use STEM equipment according to safety guidelines. • Students identify the need for project management tools and strategies to effectively	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	design process; portfolio is required as part of assessment submission. • Select appropriate tools and apply necessary safety procedures in the design and development of project work. • Apply self-directed learning and seek teacher guidance in acquiring additional skills required for the design and development of project work. • Research statistics and data relevant to the chosen WICKED Problem and / or Major Task topic using multiple sources of information. • Record, edit and produce an explainer video or video speech in a Shark Tank style for assessment task submission; include data and statistics in the video submission (5 – 7 minutes). **Optional adjustment** • Students work in pairs to complete various components of the assessment task • Teacher provides a specific WICKED Problem topic and or equipment for all students to use as the basis of the assessment task. • Teacher provides a blank iSTEM process portfolio as a project template.	complete projects to milestone deadlines. • Students use written and verbal communication skills to present prototype concepts. • Students actively seek and apply critical and constructive feedback. • Students apply creative problem solving in an iterative design process to manufacture a prototype.	
Week 1 – 10 (Career	**Teacher**		

Content	Teaching and learning	Evidence of learning	Adjustments and registration
Investigation; 20% of class time) • Identify potential career pathways based on student interest • Investigate chosen STEM careers • Apply communication skills in seeking career advice from teachers and / or career mentors	• Coordinate support from the school Careers Advisor to support career and education pathway knowledge and / or opportunities based on student interest. • Direct students to STEM career resources; supply links via Google Classroom: ○ Virtual STEM Careers Expo – University of Newcastle ○ Explore Top Careers in STEM – Learn How to Become ○ Get Career Basics – Careers with STEM ○ STEM Career Quiz – GiST ○ STEM skills vital for jobs of the future – GiST ○ STEM Careers A – Z - GiST ○ Career Education in STEM – GiST ○ What is your STEM Career? – Careers with STEM ○ STEM Potential Career Fit ○ STEM Career Personality Quiz – How Stuff Works ○ STEM Careers Quiz – UNSW ○ How to find your STEM passion – STEM Study ○ STEM Careers Profiles – Careers with STEM ○ STEM Career Profiles to Inspire Your Students – Presentation and Teacher Notes; STEM Learning UK (requires free login)	• Students identify potential career pathways based on interest. • Student seek STEM career and education pathway advice from appropriate mentors and school staff. • Students apply research techniques to investigate chosen STEM careers.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	Student • Complete at least two STEM Career Quizzes to determine options for further investigation: ○ STEM Career Quiz – GiST ○ What is your STEM Career? – Careers with STEM ○ STEM Potential Career Fit ○ STEM Career Personality Quiz – How Stuff Works ○ STEM Careers Quiz – UNSW ○ How to find your STEM passion – STEM Study • Identify, research and summarize two - three STEM Careers suited to student interest or personality; include the following details in a written (word document or slideshow) summary: ○ Definition of career ○ Identify essential skills and equipment used ○ Education and / or training requirements ○ Salary ○ Example profile of someone working in the career (see profile links above); address the 5W's & H (Who, What, Where, When, Why & How) ○ Justification of why the career was chosen • Present a chosen career to a peer. • Seek advice from the Careers Advisor regarding education pathways and subject selection.		

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	Optional adjustment • Teacher to ask for volunteers to present a chosen career summary to the class. **Optional extension** • Coordinate external mentors for student. • University career or student visits.		
Week 1 – 10 (Drone Pilot) • Demonstrate safe use of UAV equipment according to government regulations. • Recall Aerodynamics principles and apply knowledge to UAV flight systems. • Develop an understanding of how UAV technologies are used in local, regional, national and global industry contexts.	**Teacher** • Complete risk assessments and coordinate external course providers or schedule teacher led demonstrations of drone equipment. • Outline career pathways using drone technology: • Review the physics of how drones fly **As a Class** • Watch the following videos to support an understanding of drone technology in surveying and data collection: ○ All you need to know about drone surveying – DJI ○ Using drones to collect data - Aurecon ○ How to Fly a Drone – UAV Coach ○ Drone Photography Guide – UAV Coach • Discussion – review rules and regulations of Unmanned Aerial Vehicle use in Australia	• Student use industry standard UAV equipment safely to complete surveying and data collection activities. • Students articulate an understanding and compliance with government UAV regulations. • Students demonstrate effective research skills to further expand knowledge of Aerial Mapping & Surveying techniques, equipment and skills. • Students actively participate in UAV flight activities.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	Students - Pairs • Complete set drone flight activities as outlined in the Flight Foundation Course. • Select a topic and research two of the practical applications within the chosen topic of Aerial Mapping & Surveying: (1) Digital Cameras used in UAVs (types, CCD & CMOS sensors, Bayer filter basics, pixel size and signal to noise) (2) How shutters affect remote sensors (electromagnetic spectrum, atmospheric interactions/scattering, Instantaneous Field of View, types of resolution-spatial GSD, spectral, radiometric & temporal) (3) Geometric distortions from platform and sensor (errors caused by pitch, roll, yaw, altitude & velocity, UAV airframes related to errors caused by rolling shutter effects and lens distortion effects) (4) UAV survey design and principles (flight line orientation, overlaps, effects of terrain on overlaps, airbase / run spacing calculations, height ration, stereo imagery base, how to calculate ground sample distance, forward image movement calculations, sun angle calculations / effects, ground control design / layout and GPS air station basics) (5) Take notes on research findings in a		

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	shared digital format such as Google Docs. **Optional Adjustment** • Define each of the keywords listed in a chosen Aerial Mapping & Surveying topic • Create a historical image timeline of UAV technology		

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.