MAITLAND GROSSMANN HIGH SCHOOL

iSTEM SCHOOL DEVELOPED BOARD ENDORSED COURSE
STAGE 5 TEACHING AND LEARNING PROGRAM
Year 10 2015

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iSTEM TEACHING AND LEARNING PROGRAM

Rationale

Science, technology, engineering and mathematics are fundamental to shaping the future of Australia. They provide enabling skills and knowledge that increasingly underpin many professions and trades and the skills of a technologically based workforce. The iSTEM program utilises these knowledge sources in application to Skills, Technology Engineering and Mechanics.

Australia's graduation rates in science, technology, engineering and mathematics are low by international standards. Yet a high output in these disciplines is seen to be a critical underpinning for the future of innovative economies. Policies are emerging around the world that focus on these fields and seek to grow the supply of graduates with the skills and knowledge developed through a quality education in STEM subjects. The reason is straightforward, the world's dependence on knowledge and innovation will grow and not diminish and to be ahead in the race, a community needs the skills to anticipate rather than follow.

In the United States (U.S.), it is estimated that scientific innovation has produced half of all economic growth in the last 50 years. The science, technology, engineering and mathematics fields and those who work in them are critical engines of innovation and growth, according to one recent estimate, the STEM workforce accounts for more than fifty percent of sustained economic growth in the U.S.

The economic value of STEM cannot be underestimated with 1 in 18, or some 7.6 million workers in the United States being employed in STEM based careers as a technician, technologist, engineer or scientist. Projected growth in STEM based occupations is 17% between 2008 to 2018, compared to 9.8% for non-STEM occupations. STEM workers earn on average 26% higher wages than their non-STEM counterparts and more than two-thirds of STEM workers have at least a University degree, compared to less than one-third of non-STEM workers. A STEM degree means higher wages regardless of what area they are employed.

The recommendations from the report, Mathematics, Engineering & Science, in the National Interest, from the of the Chief Scientist, May 2012, states that "teachers, have the greatest influence on the choices students make and we need to ensure that the school sector maximises interest and provides opportunities for all students to study high quality mathematics and science courses leading to careers in those disciplines and in engineering. i The Smarter Schools National Partnerships, in particular, the National Partnership Agreement on Improving Teacher Quality, both concur with many of the objectives discussed above.

According to the Australia Bureau of Statistics, in Australia the proportion of mathematics and science students in schools still goes down and in universities (as with engineering) it is virtually flat. Albert Einstein's definition of insanity is "doing the same thing over and over again and expecting different results", something different has to be done demanding a paradigm shift in our schools.

There are a number of highly successful STEM based intervention programs in operation across Australia, some international and national programs include; F1inSchools, the ME program, Science and Engineering Challenge, RoboCUP, Electric Vehicle Festival, Solar Car Challenge, Pedal Prix, Science and Technology Education Leveraging Relevance (STELR) program, and many others. The challenge for schools has been integrating these programs into their existing curriculum.

At Maitland Grossmann High, we are currently involved in the following STEM intervention programs; ME, F1inSchools, the Science and Engineering Challenge, RoboCUP, Electric Vehicle Festival, and STELR. Many of these programs are run partially within, but mainly outside the current school curriculum. The development of the iSTEM course is in part as a result of the need for the school to provide a more structured approach to gaining the most out of these intervention programs. Although components of the Board of Studies NSW, design & technology, graphics technology and industrial technology – engineering, syllabuses can be adapted to accommodate some parts of these STEM programs, none are suitable to implement the full program of study.

The proposed iSTEM program utilises a practical integrated approach with engineering and technology being used to drive interest in science and mathematics, through the development of technical skills and mechanical engineering knowledge. Its purpose is to increase the numbers of students studying STEM based subjects in the senior years and ultimately the number of student matriculating to tertiary study in the STEM areas.

Pure mathematics and science topics are not included in this course proposal, it is not intended as being a vehicle to increase the number of hours in which students study pure science or mathematics in Stage 5. Instead students learn about technological and engineering concepts which by their very nature are scientific and mathematical. Great effort has been taken to ensure that no specific content that appears in the upcoming science or mathematics NSW syllabuses incorporating the Australian Curriculum have been repeated in this course.

In the recent review of Science, Mathematics and Engineering (2012) by the Office of the Chief Scientist of Australia, it was commented that teaching needs to be high quality and inspirational while science and mathematics based content was generally seen as … “irrelevant to life after school.” and “Content based teaching is seen as boring because so much is seen as knowledge transmission of correct answers with neither time nor room for creativity, reflection or offering opinions”.

The development of effective and attractive STEM curricula and teaching methods, - are at the heart of the drive to make STEM studies and careers a more popular option for young learners. Inspiring students to engage with mathematics and science can be best achieved by teachers who are passionate about the subject and have the knowledge and confidence to present the curriculum imaginatively.

According to Sanders the integrative STEM education pedagogical model is best practice when delivered through technology education. In addition over the past two decades, the technology education literature has been heavily populated with articles describing instructional materials designed to integrate technology, science, and mathematics and articles addressing issues associated with the integration of STEM concepts and practices. There is strong evidence to suggest that the approach taken in this course is “best practice” and will lead to advantageous outcomes for students.

This stage 5 iSTEM School Developed Board Endorsed Course is our attempt to provide an innovative and imaginative curriculum which will inspire students to take up the challenge of a career in Technology or Engineering.

School Situation

Maitland Grossmann High School is a coeducational comprehensive High School in the Maitland district located in the lower Hunter Valley. The student enrolment stands at approximately 1300 and has been growing steadily over the past few years. The school has a strong tradition within Maitland being one of the oldest schools in New South Wales.

Resources

The school currently has seven PC based computer labs with an ethernet network and Internet access via broadband line. These labs utilise Windows operating systems, using a large cross section of application software which can be utilised by engineering studies students. The Industrial Arts faculty has a number of mechanical testing devices, a technology lab at the back of A110, a large array of textbooks. Other resources include three 3D printers, a laser cutter, a wind/smoke tunnel, wind tunnel and smoke tunnel, CNC router and two laptop trolley have strengthened the resources to enable improved teaching and learning opportunities. Access to iPAD technologies are also available through a swap deal with the Music faculty. In addition in 2015 we purchased a rocketman bottle rocket launcher and a power anchor aeronautical testing device.

Course Structure

This School Developed Board Endorsed Course covers a number of modules in the fields of technology and engineering, they include; Engineering Fundamentals, Aerodynamics, Motion, Mechatronics and the Major Research Project. These specific modules are not reflected together in any Board Syllabus document.

There are five compulsory modules of which Module 1 is to be completed first as the knowledge and skills developed in this module are applied and enhanced in subsequent modules. Module 2 (50 hours) and Modules 3 and 4 (25-30 hours each) can be taught in any order, however, module 5 (40-50 hours) should be completed concurrently, with module(s) 3 and 4 totalling 50 hours. This is to maximise the use of resources and provide adequate time for students to complete quality work.

Individual modules provide specific content related to CNC, mechatronics, aerodynamics, computer controlled machining, computer integrated manufacture, product modelling and testing which will be developed in the key areas of; Skills, Technologies, Engineering Principles and Processes and Mechanics.

100 Hours		**100 Hours**	
Module 1 Engineering Fundamentals 25 Hours	**Module 2** Aerodynamics 25 Hours	**Module 4** Motion 25 Hours	**Module 5** Mechatronics 25 Hours
Module 3 3D CAD/CAM 50 Hours		**Module 6** Research Project 50 Hours	

Inquiry-Based Learning

To satisfy the requirements of the course students must undertake a range of inquiry-based learning activities which occupy the majority of course time. Inquiry-based learning assists students to actively pursue and use technological knowledge rather than experience it as pre-packaged and complete – to be accepted and practised. Thus in the course structure there are many points at which students raise questions and explore ideas.

Aims

The aim of the iSTEM course is to promote the areas of science, technology, engineering and mathematics through the study of technology, engineering, skills and mechanics.

Students will learn to use a range of tools, techniques and processes, including relevant technologies in order to develop solutions to a wide variety of problems relating to their present and future needs and aspirations.

iSTEM aims to reverse these lowered participation rates by inspiring and enabling secondary school students to appreciate the role and potential of science, technology, engineering and mathematics in the world in which they live, and to learn from their journey of technological inquiry, the essence of evidence-based critical thinking.

One of the aims of the iSTEM course is to increase the number of students studying physics, chemistry, engineering, design and technology, computing and mathematics subjects at the upper secondary school level. This is to be achieved through an integrative technology and engineering course structure, which give practical relevance to scientific and mathematical concepts.

Secondary aims of the iSTEM course include;

1. Improve the level of technological and engineering literacy and understanding in the community,
2. Prepare students to engage with engineering ideas and be knowledgeable about the way engineers and technologists work,
3. Increase the number of students choosing science and engineering careers to address the shortage of science and engineering graduates,
4. Increase students’ awareness of careers in STEM areas including trades,
5. Improve the quality of classroom teaching practices and enable teachers to develop confidence and skills that will assist them in delivering the Australian Curriculum,
6. Improve teaching quality through a cross-curriculum approach to programming and lesson delivery.

Maitland Grossmann High School
Mechatronics – Module 5

Unit Title: Mechatronics	**Time:** 25 Hours
Description: Select one or more related areas as a theme for an introduction to the engineering concepts related to Mechatronics. Possible examples include: Robotics, Lego Mindstorms, PLC's, Pneumatic & Hydraulic systems, etc. In this module students will utilise inquiry-based learning strategies to design & develop solutions to problems associated with combined mechanical and electrical systems.	
Objectives:	**Outcomes:**
• inquiry-based learning skills appropriate to technological and engineering practice • knowledge and understanding of scientific and mechanical concepts through investigations of technology and engineering • knowledge and understanding of technological and engineering principles and processes • skills in solving technology based problems using mechanical, graphical and scientific methods • problem-solving skills in a range of technological and engineering contexts	5.1.1 develops ideas and explores solutions to technological and engineering based problems 5.2.2 applies and transfers acquired scientific and mechanical knowledge to subsequent learning experiences in a variety of contexts 5.3.2 identifies and uses a range of technologies in the development of solutions to engineering problems 5.4.1 uses mathematical, scientific and graphical methods related to technology and engineering 5.4.2 develops skills in using mathematical, scientific and graphical methods whilst working as a team 5.6.2 will work individually or in teams to solve problems in technological and engineering contexts

Key:	**Resources:**
NUM – Numeracy ICT – Information and Communication Technologies LIT – Literacy AB ED – Aboriginal Education FOR – Focus on Reading IBL – Inquiry Based Learning **Quality Teaching Model Key:** ***Intellectual Quality***: DK – Deep Knowledge; DU – Deep Understanding; PK – Problematic Knowledge; HOT – Higher-Order Thinking; M – Metalanguage; SC – Substantive Communication ***Quality Learning Environment***: EQC – Explicit Quality Criteria; E – Engagement; HE – High Expectations; SS – Social Support; SSR – Students' Self-Regulation; SD – Student Direction ***Significance***: BK – Background Knowledge; CK – Cultural Knowledge; KI – Knowledge Integration; I - Inclusivity; C - Connnectedness; N – Narrative **Evidence of Learning** - Highlighted in Red **Assessment** - Highlighted in Grey **Assessment** **Pre-Assessment:** Mechatronics Quiz **Progressive Assessment:** Hunter Valley Electric Bike Entry and Folio, Mechanics Questions **Assessment:** Mechatronics/Robotics Assessment, Mechanics, Electric Bike Portfolio	**Websites** *http://www.lego.com/enus/mindstorms/?domainredir=mindstorms.lego.com* http://www.ebikes.ca/product-info/grin-products/cycle-analyst-3.html http://www.hunterevfestival.net/ **Resources** iPAD Bank Computer Bank or BYOD equipment Rochford, J., (2013) *Engineering Studies – a student's workbook.* Published by KJS Publications. (With accompanying electronic presentation chapter summaries) Unit 7:- Electricity and Electronics Rochford Electronic Presentation SELR Science Kits Robotic Arms Programmable Quad Copter Cycle Analyst Aduino

Students learn about:	Students learn to:	Level 1		Level 2		Level 3	
		Pre-Knowing	Knowing	Understanding	Applying	Evaluating	Creating
SKILLS							
5.5.1 mechatronics - building mechatronic components - programming logic - writing macros - fault finding	- build mechatronic components using a variety of electrical, and mechanical componentry - use a range of equipment to carry out experiments and construct projects in relation to mechatronic systems - use a programming language to control mechatronic devices - write macros to complete a variety of operations involving mechatronics	**Robotic Arms** P1: ***Teacher*** to demonstrate how to program logic operations using robotic arms. **(KI, DK, M)**		**Robotic Arms** A1: ***Students*** to experiment with the use of logic software to code mechatronic/robotic operations. **(DU, HOT, KI) (ICT, NUM)**		**Robotic Arms** E1: ***Students*** to solve a range of problems using logic software to operate robotic systems. E.g. To pick up a cup and move to another location using a robotic arm. **(DU, HOT, KI, SSR) (ICT, NUM)**	
		Robotic Arms - Macros P2: ***Teacher*** to demonstrate how to program logic operations to produce macros to simplify the use of robotic operations. **(KI, DK, M)**		**Robotic Arms - Macros** U2: ***Students*** to experiment with the use of macros to code mechatronic/robotic operations. **(DU, HOT, KI) (ICT, NUM)**		**Robotic Arms - Macros** E1: ***Students*** to solve a range of mechatronic/robotic problems using logic software and macros. **(DU, HOT, KI, SSR) (ICT, NUM)**	
		Fault Finding P3: ***Teacher*** to model and demonstrate how to fix hardware and software issues related to the use of robotic equipment. **(M, KI, DK) (ICT, NUM)**		**Fault Finding** U3: ***Students*** to experiment with solving problems with hardware and software issues related to robotic systems. **(DU, KI, SSR) (ICT, NUM)**		**Fault Finding** E3: ***Students*** to problem solve and use troubleshooting processes to find and correct faults in robotic systems. **(HOT, PK, SD) (ICT, NUM)**	
		Robotic Arms P4: ***Teacher*** to demonstrate how to construct mechatronic/robotic solutions to problems. **(DK, BK, KI, C) (ICT, NUM)**		**Robotic Arms** A4: ***Students*** to experiment with the construction of simple mechatronic apparatus and/or robotic systems to solve a range of simple problems. **(DU, BK, KI, C) (ICT, IBL, NUM)**		**Robotic Arms** C4: ***Students*** design and construct simple mechatronic/robotic solutions to set problems. **(DU, KI, M) (IBL, ICT, NUM)**	

Students learn about:	Students learn to:	Level 1		Level 2		Level 3	
		Pre-Knowing	Knowing	Understanding	Applying	Evaluating	Creating
				TECHNOLOGIES			
5.5.2 technologies related to robotics - sensors and transducers - manipulators - PLC's - actuators (pneumatic & hydraulic)	- apply and understand the uses of a range of sensor and transducer technologies - incorporate mechatronic hardware to complete a variety of problem solving tasks - use a programmable logic controller to actuate a pneumatic or hydraulic device - utilise and program devices to perform a variety of control or monitoring tasks.	**Sensors and Transducers** P1: ***Teacher*** to demonstrate how to use sensors and transducers. ***Teacher*** to demonstrate the use of a range of mechatronic/robotic systems. **(DK, BK, KI, C) (ICT, NUM)**		**Sensors and Transducers** U1: ***Students*** to complete experimentation on a range of sensors and transducers using a variety of mechatronic/robotic equipment. **(DK, DU, KI)**		**Sensors and Transducers** C1: ***Students*** design and construct a simple mechatronic system using a variety of robotic hardware and software. **(EQC, SSR, KI, C)**	
		Manipulators P2: ***Teacher*** to use interactive notes from Rochford to explain the operation of electric motors. ***Students*** to watch video on how motors work and complete notes on its operation. **(DK, BK, KI, C) (ICT)**		**Manipulators** A2: ***Students*** to experiment with using a range of manipulators including motors. ***Students*** to work in groups and are to be challenged to complete the tasks using manipulators. **(DU, PK, BK, KI, C) (ICT, IBL)**		**Manipulators** C2: ***Students*** to design and construct a simple mechatronic system using a range of robotic systems. **(DU, KI, M) (IBL, ICT, NUM)**	
		PLC's P3: ***Teacher*** to demonstrate how to use Programmable Logic Circuits. **(DK, BK, KI, C) (ICT, NUM)**		**PLC's** A3: ***Students*** to experiment with operating mechatronic equipment using Programmable Logic Circuits. **(DU, BK, KI, C) (ICT, NUM)**		**PLC's** C3: ***Students*** to design and construct simple mechatronic systems using Programmable Logic Circuits. **(DU, KI, M) (IBL, ICT, NUM)**	
		Actuators (Pneumatic & Hydraulic) P4: ***Teacher*** to detail how to use a mechatronic control systems in conjunction with mechanical, hydraulic or pneumatic systems. **(DK, KI, BK, C) (ICT)**		**Actuators (Pneumatic & Hydraulic)** U4: ***Students*** to complete research on how to construct a mechatronic system which incorporate pneumatics and hydraulics. ***Students*** to produce a high quality mini report.. **(DU, PK, HOT, KI, C) (LIT, NUM)**		**Actuators (Pneumatic & Hydraulic)** C4: ***Students*** to design, plan, experiment, construct, test and evaluate a mechatronic system and produce a high quality mini report. **(HOT, E, KI) (IBL, LIT, NUM)**	

Students learn about:	Students learn to:	Level 1	Level 2	Level 3
		Pre-Knowing / Knowing	Understanding / Applying	Evaluating / Creating
		ENGINEERING PRINCIPLES & PROCESSES		
5.5.3 mechatronics - logic gates - mechanical and electrical actuation systems - motors	- plan solutions to problems using logic gates - design, construct and evaluate motorised mechatronic systems which solve identified problems. - use a variety of mechanical and electrical actuation systems to solve every day problems - develop programming skills to manipulate sensors, motors, and actuators.	**Explicit Teaching** P1: **Logic Gates** ***Teacher*** to demonstrate basic digital logic and how to interpret logic gate problems. **(DK, BK, KI, C)**	**Logic Gates** A1: ***Students*** to complete exercises in order to solve logic gate problems. ***Students*** to use computer programs to solve logic gate problems. **(DU, HOT) (NUM, ICT)**	**Logic Gates** C1: ***Students*** to produce creative solutions to logic problems using logic gates in the written and electronic form. **(HOT, PK) (NUM, ICT)**
		Electric Bike - Cycle Analyst P2: ***Teacher*** to demonstrate how to use 'Cycle Analyst' hardware and software to determine optimum conditions for electric bike racing. **(DK, M) (ICT, NUM)**	**Electric Bike - Cycle Analyst** P2: ***Students*** to experiment with 'Cycle Analyst' hardware and software to determine optimum conditions for electric bike racing. ***Students*** to install a 'Cycle Analyst' system on a test bike for the electric bike festival. **(DU, SD, HOT, E, KI, BK, E, C) (ICT, IBL, NUM)**	**Assessment** C2: ***Students*** to work in groups to produce an entry for the Hunter Valley Electric Bike Festival and use a range of technologies including 'Cycle Analyst', to develop design solutions. ***Students*** to complete a portfolio of work including team identity, pit display, project management, etc. **(HOT, SSR, KI, E) (ICT, IBL, LIT, NUM)**
		Electric Vehicles Motors K3: ***Students*** to research how electric motors work? ***Teacher*** to discuss the different types of motors which can be used for the hunter valley electric Vehicle Festival. **(DK, DU, PK, M)**	**Electric Vehicles Motors** U3: ***Students*** to experiment with electric vehicle motors to produce an electric bike which can perform at peak efficiency. **(DU, KI, SD) (NUM, IBL)**	**Electric Vehicles** E3: ***Students*** to break into groups to produce an entry in the Hunter Valley Electric Bike Festival. ***Students*** to make decisions on the best type of motor and the best location for mounting the motor. **(HOT, SSR, KI)**
		Programming Skills Aduino P4: ***Teacher*** to demonstrate the use of aduino and to program basic mechatronic functions using sensors, motors and actuators. **(DK, E, C) (ICT, NUM)**	**Programming Skills Aduino** A4: ***Students*** to experiment with the use of aduino systems and to program basic mechatronic functions using sensors, motors and actuators. **(DU, KI, SD) (ICT, IBL, NUM)**	**Programming Skills Aduino** C4: ***Students*** to solve simple problems using aduino systems and to program basic mechatronic functions using sensors, motors and actuators. **(DU, KI, SD) (ICT, IBL, NUM)**

Students learn about:	Students learn to:	Level 1		Level 2		Level 3	
		Pre-Knowing	Knowing	Understanding	Applying	Evaluating	Creating
MECHANICS							
5.5.4 programming & computations - algorithms - calculating distance - trigonometry - circle geometry - input/output systems	- solve practical logic problems with applications to mechatronics using algorithmic functions - make predictions involving, time, distance, speed, velocity with robotics - use trigonometry to determine efficient pathways - use circle geometry to understand movement in order to solve problems.	**Algorithms** P1: ***Teacher*** to demonstrate how to write algorithms to solve logic based problems. **(M, DK) (NUM)**		**Algorithms** U1: ***Students*** to write algorithms to solve logic based problems. **(DU, M, DK) (NUM)**		**Algorithms** E1: ***Students*** to use algorithms to solve logic based problems in the completion of engineering based projects. **(DU, SSR, HOT, KI) (NUM)**	
		Calculating Distance P2: ***Teacher*** to demonstrate how to calculate time, distance, speed, and velocity problems related to mechatronic systems. **(KI, DK, M) (NUM, ICT)**		**Calculating Distance** U2: ***Students*** to experiment with mechatronic systems in order to accurately predict time, distance, speed and velocity. **(PK, HOT, KI, DU) (NUM, ICT)**		**Calculating Distance** C2: ***Students*** to accurately predict time, distance, speed, and velocity in solving practical engineering based problems using mechatronic systems. E.g. HV Electric Bikes, Aduino and Robotic Arms. **(C, E, HOT, KI) (NUM, IBL, ICT)**	
		Trigonometry K3: ***Teacher*** to demonstrate how to use trigonometry to determine efficient pathways for mechatronic systems. **(M, DK, KI) (NUM, ICT)**		**Trigonometry** U3: ***Students*** to experiment with mechatronic systems and trigonometry to accurately determine efficient pathways for mechatronic systems. **(M, DK, KI) (NUM, ICT)**		**Trigonometry** E3: ***Students*** to use trigonometry in order to solve practical engineering based problems using mechatronic systems. E.g. HV Electric Bikes, Aduno and Robotic Arms. **(C, E, HOT, KI) (NUM, IBL, ICT)**	
		Circle Geometry K4: ***Teacher*** to demonstrate how to use circle geometry to determine efficient pathways for mechatronic systems. **(M, DK, KI) (NUM, ICT)**		**Circle Geometry** U4: ***Students*** to experiment with mechatronic systems and circle geometry to accurately determine efficient pathways. **(M, DK, KI) (NUM, ICT)**		**Circle Geometry** E4: ***Students*** to use a range of ICT's to solve circle geometry problems related to mechatronic and robotic systems. **(C, E, HOT, KI) (NUM, IBL, ICT)**	
		Input/Output Systems P5: ***Teacher*** to define input/output systems and discuss the principles of simple control systems using sensors, actuators. **(M, DK, KI) (NUM, ICT)**		**Control Systems** A1: ***Students*** to research the nature and purpose of input/output systems and the function of feedback. **(DU, SSR, BK) (NUM, ICT)**		**Electric Bike** C5: ***Students*** to utilise input/output systems in their production of an efficient Electric Bike. **(HOT, E, C) (NUM, ICT)**	

Students learn about:	Students learn to:	Level 1		Level 2		Level 3	
		Pre-Knowing	Knowing	Understanding	Applying	Evaluating	Creating
PROBLEM SOLVING & DESIGN							
5.2.5 design mechatronic solutions for a range of applications	- design solutions to various mechatronic applications to meet set criteria(s) - produce peripheral enhancements to mechatronic devices to provide additional functions - use innovative processes to create mechatronic devices which meet societal needs in the near future.	**Electric Bike Festival** K3: ***Students*** to investigate the rules and regulations for the Hunter Valley Electric Vehicle Festival. http://www.hunterevfestival.net/ **(DK, KI, C, E)**		**Electric Bike Festival** U1: ***Students*** to work in groups to 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. ***Students*** to develop a design portfolio of the work. **(DU, EQC) (ICT)**		**Assessment** C1: ***Students*** to use a range of technologies to design solutions to problems related to electric bikes. ***Students*** to complete a portfolio of work including team identity, pit display, project management, etc. **(HOT, SSR, KI, E) (ICT, IBL, LIT, NUM)**	
		Design Process P2: ***Students*** to investigate the design processes used for the successful completion of an engineered solution related to mechatronics. **(DK, EQC, M) (ICT)**		**Design Process** A2: ***Students*** to document the design processes used to develop an engineered solution by producing a comprehensive design portfolio for the electric bike entry in the Hunter Valley Electric Bike festival. **(EQC, KI) (ICT)**		**Design Solutions** E2: ***Students*** to use a range of mechatronic technologies (e.g. aduino systems, cycle analyst) and materials to produce creative solutions to engineering problems related to the Electric Bike Festival. **(PK, EQC, E, HE, SSR, BK, KI) (ICT, IBL)**	
		Mechatronic Systems P1: ***Teacher*** to define systems and discuss the principles of simple mechatronic systems using sensors, actuators and controllers. E.g. Production processes, robots, washing machines, servo brakes. **(DK) (ICT)**		**Mechatronic Systems** U1: ***Students*** to research the nature and purpose of mechatronic systems and the function of feedback in a control system. **(DU, SSR, BK) (ICT)**		**Mechatronic Systems** C1: ***Students*** to produce code to control various mechatronic/robotic equipment including aduino systems, robotic arm systems and/or programmable quad copters. **(HOT, E, C) (ICT, NUM)**	

Maitland Grossmann High School
Motion –Module 4

Unit Title: Motion	**Time:** 25 Hours

Description: Select one or more related areas as a theme for an introduction to the engineering concepts related to motion. Possible examples include: solar powered cars, **electric vehicles**, wind powered devices. In this module students will utilise inquiry-based learning strategies to develop solutions to problems associated with motion.

Objectives:	**Outcomes:**
• inquiry-based learning skills appropriate to technological and engineering practice • knowledge and understanding of scientific and mechanical concepts through investigations of technology and engineering • knowledge and understanding of technological and engineering principles and processes • skills in solving technology based problems using mechanical, graphical and scientific methods • problem-solving skills in a range of technological and engineering contexts	5.1.1 develops ideas and explores solutions to technological and engineering based problems 5.1.2 designs and investigates different approaches in the development of engineered solutions 5.2.2 applies and transfers acquired scientific and mechanical knowledge to subsequent learning experiences in a variety of contexts 5.3.2 identifies and uses a range of technologies in the development of solutions to engineering problems 5.4.1 uses mathematical, scientific and graphical methods related to technology and engineering 5.4.2 develops skills in using mathematical, scientific and graphical methods whilst working as a team 5.6.2 will work individually or in teams to solve problems in technological and engineering contexts

Key:

NUM – Numeracy	ICT – Information and Communication Technologies
LIT – Literacy	AB ED – Aboriginal Education
FOR – Focus on Reading	IBL – Inquiry Based Learning

Quality Teaching Model Key:

Intellectual Quality	***Quality Learning Environment***	***Significance***
DK – Deep Knowledge	EQC – Explicit Quality Criteria	BK – Background Knowledge
DU – Deep Understanding	E – Engagement	CK – Cultural Knowledge
PK – Problematic Knowledge	HE – High Expectations	KI – Knowledge Integration
HOT – Higher-Order Thinking	SS – Social Support	I - Inclusivity
M – Metalanguage	SSR – Students' Self-Regulation	C - Connnectedness
SC – Substantive Communication	SD – Student Direction	N – Narrative

Evidence of Learning - Highlighted in Red **Assessment** - Highlighted in Grey

Assessment

Pre-Assessment: Motion Quiz
Progressive Assessment: Electric Bike Entry and Folio
Assessment: Electric Bike Entry and Portfolio, Mousetrap Powered Car

Resources:

Websites
http://www.hunterevfestival.net/
http://www.hunterevfestival.net/teachers-ev-prize-resource-kit.html
http://electricbikebuilding.com/
HMS Illustrious gyroscopes
https://www.youtube.com/watch?v=EZ5geiAkekY

Texts/Materials
ATSE STELR *Core Program Student Book 2nd Edition*
Lynch, B. *Maths In Technology*
Electric Bike Parts
Laser Cutter
3D Printers
Digital CRO
Electricity and Electronics Interactive Notes Rochford
Flasher Notes Dick Smiths
Rocketman Bottle Rocket Launcher

Students learn about:	Students learn to:	Level 1		Level 2		Level 3	
		Pre-Knowing	Knowing	Understanding	Applying	Evaluating	Creating
SKILLS							
5.4.1 Electronics - circuitry - motors & generators - fault detection **Prototypes** - making models - practical applications	- design and construct basic electronic circuitry related to electric vehicles - develop basic motors and generators - use fault diagnosis techniques to isolate problems - use multimeters to test circuits and components - use continuity testers/multimeters in the production and testing of practical projects - develop prototypes using a variety of materials to simulate motion - produce models in order to solve engineering problems related to motion	**Comprehension** K1: ***Teacher*** to demonstrate to use of Rochford's Unit 7: Electricity and Electronics interactive notes. ***Teacher*** to model summarising strategies for Voltage, Current and Resistance notes. ***Teacher*** to continue to model summarising strategies for other areas as required before all students are able complete task independently. **(KI, C, M, DK) (ICT, FOR, LIT)**		**Comprehension** U1: ***Students*** to access Rochford's Unit 7: Electricity and Electronics interactive notes and complete a comprehensive summary of the following slides; Series and parallel circuits, electricity generation DC methods to rotate generators, other methods to producing electricity, electric & electronic components **(DU, M) (ICT, FOR, LIT)**		**Comprehension** E1: ***Students*** to identify the most important concepts related to Electricity and Electronics through their demonstration of the comprehension strategy of summarising. **(DU) (ICT, FOR, LIT)**	
		Soldering Practice P2: ***Teacher*** to demonstrate the correct method of soldering. ***Teacher*** to use elmo digitizer to display soldering demonstration. ***Students*** to complete comprehension sheet on correct soldering technique and safety. **(DK, E, KI) (ICT, LIT)**		**Soldering Practice** A2: ***Students*** to complete a practice soldering activity. ***Students*** to demonstrate mastery of soldering by completing engineering projects which require soldering. E.g. wiring an electric bike motor and controller. **(DU, EQC, E, KI)**		**Soldering Evaluation** E2: ***Students*** to complete an evaluation sheet on the quality of their practice soldering based on a quality marking criteria. **(HE, EQC, HOT, M, C) (LIT)**	
		Fault Detection P3: ***Teacher*** to demonstrate a range of model making techniques using available technologies. ***Teacher*** to demonstrate how to fault find in electronic circuits using a multimeters and CRO's. **(DK, KI) (ICT)**		**Fault Detection** U3: ***Students*** to use a multimeter and Cathode Ray Oscilloscope to find common faults on circuits. **(DU, M) (ICT)**		**Practical Applications** E3: ***Students*** to create a flasher circuit and evaluate it success via the use of a self-evaluation tool. **(BK, C, HE, HOT)**	
		Motors and Generators P4: ***Teacher*** to demonstrate how to build a model electric motor. **(BK, C, E)**		**Motors and Generators** U4: ***Students*** to use a kit to produce an electric motor. **(DU)**		**Motors and Generators** C4: ***Students*** to attempt to produce a motor with a double winding and evaluate the success of the process. **(HOT, EQC)**	

Students learn about:	Students learn to:	Level 1		Level 2		Level 3	
		Pre-Knowing	Knowing	Understanding	Applying	Evaluating	Creating
TECHNOLOGIES							
5.4.2 technologies related to motion - gyroscopes - accelerometers - sensors - CRO	- describe how various technologies related to motion function - apply various motion technologies to the design of student projects.	**Gyroscopes** P1: ***Teacher*** to 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 **(DK, BK, KI, C) (ICT)**		**Gyroscopes** U1: ***Students*** to complete experimentation related to gyroscopes. E.g. Boomarang, spinning tops, spinning bike wheel. ***Students*** to research the contributions to modern technology which were made by Australian Aboriginal culture. **(DU, SD, KI) (ICT, AB ED)**		**Gyroscopes** E1: ***Students*** to research how gyroscopes work and evaluate their impact on modern society and electronics. ***Students*** to use a range of technologies which use gyroscopes and evaluate their usefulness. E.g Parrot Drone, iPAD, iPhone, remote controlled helicopter. **(DU, KI, M) (IBL, ICT, NUM)**	
		Accelerometers K2: ***Students*** to research how accelerometers work? ***Students*** identify where they are currently used and how they may be used in the future. **(DK, E, C) (ICT, LIT)**		**Accelerometers** U2: ***Students*** complete a range of experiments related to motion using the USB accelerometer which is part of the bottle rocket kit. **(DU, BK, PK) (ICT, IBL)**		**Accelerometers** E2: ***Students*** to analysis results from motion experiments in order to improve performance in engineering design projects. E.g. Electric Bikes **(DU, PK HOT) (IBL, ICT)**	
		Sensors K3: ***Teacher*** to demonstrate how to use a range of simple sensors using Lego Mindstorm robotics and comparing it to a Parrot Drone Quad Copter. ***Students*** to research how various sensors work? **(DK, BK, KI, C) (ICT)**		**Sensors** U3: ***Students*** to complete experimentation on a range of sensors using lego mindstorms, parrot drone and other scientific equipment. ***Students*** identify where they are currently used and how they may be used in the future. **(DU, KI) (ICT)**		**Sensors** C3: ***Students*** design, construct and test simple systems utilising sensors in the complete of engineering problem solving projects. E.g. Acceleration, speed, distance of electric bikes during the Hunter Electric Bike Festival **(DU, KI, M) (IBL, ICT, NUM)**	
		Cathode Ray Oscilloscopes K4: Teacher to demonstrate the basic operations of a CRO and how it can be used to find faults in electronics circuits. **(DK, KI) (ICT, LIT)**		**Cathode Ray Oscilloscopes** U4: ***Students*** to research how CRO's function? ***Students*** undertake experiments on a range of electronic circuits to determine faults. **(DK, E, PK, KI, EQC, IBL)**		**Cathode Ray Oscilloscopes** E4: ***Students*** to identify where CRO's are used and evaluate their significance to the electronics industry. Students to use CRO's to identify problems using electric bikes. **(PK, KI, C, HOT) (ICT, IBL)**	

Students learn about:	Students learn to:	Level 1	Level 2	Level 3
		Pre-Knowing / Knowing	Understanding / Applying	Evaluating / Creating
ENGINEERING PRINCIPLES & PROCESSES				
5.4.3 energy - energy sources - motors - electric vehicles - motion	- identify and describe a range of energy sources including renewables and non-renewables - utilise electric motors to develop a project related to motion - select and use a range of components and hardware in the development and production of a practical project related to motion.	**Energy Sources – Global Warming** P1: ***Teacher*** to pose the following concepts for ***students*** to discuss:- What do you think global warming is? What causes it? Why is global warming a hot issue? What will global warming mean for us as we get older? What will it mean for our children? How will it affect people in other countries? Is there anything we can do about it? What do we need to know before we can make decisions? **(DK, PK, E, C)**	**Energy Sources – Global Warming** U1: ***Students*** to watch global warming video from STELR DVD and complete worksheet. ***Students*** to design a concept map to show how various aspects of global warming are related to each other. Incorporating the following key words into their concept map. (Global warming, Energy from the Sun, Methane Ice cores, Greenhouse gases, The greenhouse effect, The enhanced greenhouse effect, The atmosphere, Extreme weather events, Refugees, Rising sea levels, Flooding Carbon dioxide, Temperature). **(DU, DK) (ICT, LIT)**	**Energy Sources – Global Warming** E1: ***Students*** to evaluate the effects on global warming of society today and in the future. ***Students*** to produce a report on the significance of global warming on the environment and economy in the future. **(HOT, KI, PK, C, M) (LIT)** 
		Motors P2: ***Teacher*** to explain how an electric motor works. ***Teacher*** to use Rochford notes to explain the major types of electric motor. **(DK, BK, C)**	**Motors** U2: ***Students*** to open a small DC motor and identify the parts. ***Students*** to use motors to complete a range of engineering problem solving. **(DU, C, E) (IBL)**	**Motors** C2: ***Students*** to use a range of motor types in the preparation of an electric bike for the Hunter Valley Electric Bike Festival. **(KI, C, E, HOT) (ICT, IBL)**
		Electric Vehicles K3: ***Students*** to research how electric vehicles work? ***Teacher*** to discuss Tesla car manufacture and performance motor bikes. **(DK, DU, PK, M)**	**Electric Vehicles** U3: ***Students*** to experiment with electric vehicles to produce an electric bike which can perform at peak efficiency. **(DU, KI, SD)**	**Electric Vehicles** E3: ***Students*** to break into groups to produce an entry in the Hunter Valley Electric Bike Festival. ***Students*** to create innovative and creative soltions to problems involving electric vehicles. **(HOT, SSR, KI)**
		Motion K4: ***Teacher*** to discuss the physics of motion in regards to motor sports. ***Students*** to research various aspects of motion related to the Cameron Park Bike track. **(DK, C, KI, E)**	**Motion** U4: ***Students*** to complete a range of experiments related to motion. During the HV Electric Bike festival practice day, ***students*** to optimise bike performance by completing a range of motion experiments. **(HOT, E)**	**Motion** C4: ***Students*** to select and use a range of components and hardware in the development and production of a practical project related to motion. E.g Electric Bike. **(KI, SD, BK)**

Students learn about:	Students learn to:	Level 1		Level 2		Level 3	
		Pre-Knowing	Knowing	Understanding	Applying	Evaluating	Creating
MECHANICS							
5.4.4 Motion - velocity - acceleration - inertia - circular motion - momentum	- apply units to concepts of engineering mechanics - utilise metric prefixes related to every day technologies - complete basic calculations related to engineering statics - describe the difference between a static and a dynamic - simulate mathematical problems using appropriate modelling techniques.	**Scientific Experimentation** P1: ***Teacher*** to define velocity, acceleration, inertia, circular motion and momentum. ***Teacher*** to introduce motion terminologies. **(M, DK) (NUM)**		**Scientific Experimentation** U1: ***Students*** to complete a range of scientific experiments related to motion. E.g Bottle rocket experiments, inertia karts, pendulums, etc. **(DU) (NUM)**		**Scientific Experimentation** E1: ***Students*** to solve a range of scientific problems related to velocity, acceleration, inertia, circular motion and momentum. **(BK, KI, DU) (NUM)**	
		Mathematical Calculations P2: ***Teacher*** to explain how to complete mathematical calculations related to velocity, acceleration, inertia, circular motion and momentum**.** **(M, DK) (NUM)**		**Mathematical Calculations** U2: ***Students*** to complete a range of mathematical exercises related to velocity, acceleration, inertia, circular motion and momentum. **(M, DU) (NUM)**		**Problem Solving** C2: ***Students*** to utilise scientific and mathematical knowledge of velocity, acceleration, inertia, circular motion and momentum is the producing solutions to practical engineering problems. **(KI, DU) (NUM)**	
		Scientific Experimentation P3: ***Teacher*** to demonstrate how simple machines can be utilised to produce motion. **(DK, KI, C, E)**		**Scientific Experimentation** U3: ***Students*** to experiment to simple machines such as springs in order to transfer energy from potential to kinetic. Mouse trap cars, catapults, etc. **(DU, PK, KI**		**Engineering Problem Solving** E3: ***Students*** apply knowledge of motion to determine the the best angle to fire a bottle rocket to produce the greatest distance. **(HOT, M, DU) (NUM, ICT)**	

Students learn about:	Students learn to:	Level 1		Level 2		Level 3	
		Pre-Knowing	Knowing	Understanding	Applying	Evaluating	Creating
PROBLEM SOLVING & DESIGN							
5.4.5 Developing projects related to motion	- apply problem solving techniques to identified problems related to motion - plan, implement and evaluate a sequence of operations for the completion of design projects related to motion.	**Electric Bike Festival** P1: ***Students*** to investigate the rules and regulations for the Hunter Valley Electric Vehicle Festival. http://www.hunterevfestival.net/ **(DK, DU, PK, M) (ICT)**		**Electric Bike Festival** U1: ***Students*** to work in groups to unpack the specifications for the design of the electric bike. Using the specifications provided develop a number of design solutions to the given problem. ***Students*** to develop a design portfolio of the work. **(DU, EQC) (ICT)**		**Assessment** C1: ***Students*** to use a range of technologies to design solutions to problems related to electric bikes. ***Students*** to complete a portfolio of work including team identity, pit display, project management, etc. **(HOT, SSR, KI, E) (ICT, IBL, LIT, NUM)**	
		Design Process P2: ***Students*** to investigate the design processes used for the successful completion of an engineered solution related to motion. ***Students*** to investigate project management techniques, such as creating gannt charts. **(ICT, DK, EQC, LIT, M)**		**Design Process** A2: ***Students*** to document the design processes used to develop an engineered solution by producing a comprehensive design portfolio for the electric bike entry in the Hunter Valley Electric Bike Festival. **(HE, EQC, KI) (ICT)**		**Design Solutions** C2: ***Students*** to use a range of technologies (e.g. 3D printers, Laser Cutters, CNC lathe) and materials to produce creative solutions to engineering problems related to the Electric Bike Festival. **(PK, EQC, E, HE, SSR, BK, KI) (ICT, IBL)**	
		Mousetrap Powered Car K2: ***Students*** to use an appropriate process to design a mousetrap powered car which will achieve the longest distance. **(DU, HOT, BK, SSR) (IBL)**		**Mousetrap Powered Car** U3: ***Students*** to utilise a range of testing equipment to assess the performance of the mousetrap powered car. ***Students*** to modify design solutions and re-test design to improve performance. **(DU, HOT, EQC, E, SSR, KI, HE) (NUM, ICT, IBL)**		**Assessment** E3: ***Students*** to complete final testing of solutions to design problems using a range of technologies. ***Students*** to evaluate the success of their designs in their design portfolio's. **(DU, HOT, EQC, E, SSR, KI, HE) (NUM, LIT, IBL)**	

Maitland Grossmann High School
The Research Project – Module 6

<table>
<tr><td colspan="2">Unit Title: The Research Project</td><td>Time: 50 Hours</td></tr>
<tr><td colspan="3">Description: In this module students are to develop and realise a major scientific research project. The project involves students utilising inquiry based learning strategies to apply appropriate design, production and evaluation skills to a contemporary scientific or technological based problem. The students relate the techniques and technologies used in previous modules to those used in the development of the research project. The research project is expected to be similar to a science fair concept, popular in the United States.</td></tr>
<tr><td>Objectives:</td><td colspan="2">Outcomes:</td></tr>
<tr><td>• inquiry-based learning skills appropriate to technological and engineering practice
• knowledge and understanding of scientific and mechanical concepts through investigations of technology and engineering
• knowledge and understanding of technological and engineering principles and processes
• skills in communicating and critically evaluating
• problem-solving skills in a range of technological and engineering contexts</td><td colspan="2">5.1.1 develops ideas and explores solutions to technological and engineering based problems
5.1.2 designs and investigates different approaches in the development of engineered solutions
5.2.2 applies and transfers acquired scientific and mechanical knowledge to subsequent learning experiences in a variety of contexts
5.3.2 identifies and uses a range of technologies in the development of solutions to engineering problems
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 techniques in a range of technological and engineering contexts
5.6.2 will work individually or in teams to solve problems in technological and engineering contexts</td></tr>
<tr><td colspan="2">Key:</td><td>Resources:</td></tr>
<tr><td colspan="2">NUM – Numeracy   ICT – Information and Communication Technologies
LIT – Literacy   AB ED – Aboriginal Education
FOR – Focus on Reading   IBL – Inquiry Based Learning

Quality Teaching Model Key:

Intellectual Quality
DK – Deep Knowledge
DU – Deep Understanding
PK – Problematic Knowledge
HOT – Higher-Order Thinking
M – Metalanguage
SC – Substantive Communication

Quality Learning Environment
EQC – Explicit Quality Criteria
E – Engagement
HE – High Expectations
SS – Social Support
SSR – Students' Self-Regulation
SD – Student Direction

Significance
BK – Background Knowledge
CK – Cultural Knowledge
KI – Knowledge Integration
I - Inclusivity
C - Connnectedness
N – Narrative

Evidence of Learning - Highlighted in Red   Assessment - Highlighted in Grey

Assessment
Pre-Assessment:
Progressive Assessment: Major Research Project Portfolio and Product progressive mark
Assessment: Major Research Project Portfolio and Product</td><td>Websites
Rapid Prototyping: http://youtube/PDLOmoQj4H0
http://lib.uts.edu.au
http://nhmrc.gov.au
Texts/Materials
PTC (2012) Alphabet Soup Assembly, PTC activities
PTC How to model almost anything notes
Design and Technology Cambridge University Press
Chapter 9 Preliminary Year Design and Technology Text Book.
Research Project Guide for Students
Laser Cutter
3D Printers
CNC Router
Various Robotics
Aduino</td></tr>
</table>

Students learn about:	Students learn to:	Level 1 Pre-Knowing / Knowing	Level 2 Understanding / Applying	Level 3 Evaluating / Creating
		SKILLS		
5.6.1 design processes - identifying problems - project management - developing solutions to problems - generating ideas	- develop a research project proposal - respond to the findings of experimentation and research - follow a process to identify and solve contemporary needs of society - formulate management plans including; i) action ii) time iii) finance - manage a research project that successfully solves an identified problem - select and apply appropriate research methods to solve a scientific or technological problem - justify decisions made based on the analysis of data - identification and exploration of the research problem - areas of investigation - criteria to evaluate success	**Project Proposal** P1: ***Teacher*** to explain how to define a genuine need or opportunity to an engineering design problem. **(DK, KI, M)**	**Project Proposal** A1: ***Students*** to research different types of engineering problems. ***Students*** to form groups and brainstorm ideas for possible research projects. **(DU, PK, HOT) (LIT)**	**Project Proposal** C1: ***Students*** to produce a detailed report identifying and exploring the need, identifying areas of investigation and establishing a criteria to evaluate success. **(DU, HE, HOT, M, SC) (ICT, IBL)**
		Project Management P2: ***Teacher*** to demonstrate how to produce an action, time and finance plan using appropriate ICT's. ***Teacher*** to demonstrate how to use a spreadsheet to produce a time plan and how to use functions to produce an effective finance plan. **(DK, M) (ICT, NUM)**	**Project Management** A2: ***Students*** to use a variety of software programs to plan the completion of a major research project. ***Students*** to utilise MS word, excel and/or one note to produce professional action, time and finance plans. **(DU, E, KI) (ICT, NUM)**	**Project Management** E2: ***Students*** to evaluate the different aspects of the management plan throughout the process. ***Students*** to provide evidence of finance, time and action plans with clear evidence of their application to the major project. **(HOT, KI, PK) (ICT, NUM, LIT)**
		Research P3: ***Teacher*** to explain how to undertake research which includes both primary and secondary data. ***Teacher*** to demonstrate how to apply experimentation and testing to the research process. **(DK)**	**Research** A3: ***Students*** to undertake a range of research tasks such as; consulting journals, books, past research, trade catalogues, magazines, consulting experts, seeking out previous designs and solutions. **(DU, SSR) (ICT, NUM, LIT, IBL)**	**Research** C3: ***Students*** in groups are to thoroughly research a project of their choice and produce a research, experimentation and testing section that include design ideas, materials, tools and techniques. **(EQC, HOT, SD) (ICT, IBL, LIT)**
		Generating Ideas P4: ***Teacher*** to describe how to complete creative and innovative idea generation using a variety of techniques including; brainstorming, concept sketches and maps, modelling, interaction of hand and mind, observation, research and collaboration. **(DK, M) (LIT)**	**Generating Ideas** A4: ***Students*** to use idea-generation techniques to develop creative design solutions. ***Students*** to collaborate when developing design ideas and solutions. ***Students*** to use ICT tools to research and gather information when generating creative design ideas. **(DU, HOT, M, PK, SD) (ICT, LIT)**	**Generating Ideas** C4: ***Students*** to work in groups to produce a major research project in which creative and innovative solutions are produced. ***Students*** are to establish and document the requirements and design considerations for the major project. **(HOT, SD, PK, M, KI) (ICT, LIT, NUM)**

Students learn about:	Students learn to:	Level 1		Level 2		Level 3	
		Pre-Knowing	Knowing	Understanding	Applying	Evaluating	Creating
TECHNOLOGIES							
5.6.2 presentation and communication technologies	- select and use appropriate communication techniques for the development of a major research project - appropriate technological processes	**Presentation Technologies** P1: ***Teacher*** to demonstrate the use of a range of presentation and communication technologies to be used in the design portfolio. ***Teacher*** to explain the range of technologies that can be used to communicate design solutions. **(DK, KI) (ICT)**		**Presentation Technologies** U1: ***Students*** to communicate all aspects of the design, production and evaluation process related to their Major Research Project including concept drawings, working technical drawings, 3D CAD, CAM, models, prototypes, videos, presentation graphics, audio recordings. **(DU, E, BK, KI) (ICT)**		**Presentation Technologies** C1: ***Students*** to use a broad range of creative and appropriate communication and presentation techniques in the completion of the major research project. ***Students*** to produce portfolio that is 'user friendly'and that flows in the correct sequence. **(DU, PK, HOT, EQC, E, HE, SD, C, KI) (ICT, LIT)**	
		CAD P2: ***Teacher*** to demonstrate the use of CREO or Google Sketchup in order to produce photo realistic representations of parts and assemblies. **(KI, DK) (ICT, NUM)**		**CAD** U2: ***Students*** to complete PTC tutorials from "Alphabet Soup" to demonstrate how to produce photo realistic renderings of products or Google Sketchup. **(DU, KI, C, E) (ICT, NUM)**		**CAD** C2: ***Students*** to create a photo realistic assembly of their name using CREO Parametric or a similar product using ICT's. **(EQC, C, E) (ICT, NUM)**	
		Rapid Prototyping Revision P3: ***Teacher*** to show Wired Video: http://youtu.be/PDLOmoQj4H0 3D printing services available and 3D scan technologies. ***Teacher*** to demonstrate how the milling machine, 3D printer and laser Cutter can be used for rapid prototyping. **(DK, BK, KI) (ICT, NUM)**		**Rapid Prototyping Revision** A3: ***Students*** to use a variety of technologies within and outside the school to produce 3D designed products. ***Students*** to use rapid prototyped product design to design, evaluate and improve products. **(DU, EQC, EQC, KI) (ICT, NUM)**		**Rapid Prototyping** C3: ***Students*** to have the opportunity to engage in rapid prototyping process by designing, manufacturing, evaluating and re-manufacturing engineered products which meet an identified need. **(DU, PK, HOT, EQC, E, HE, SD, C, KI) (ICT, NUM, IBL)**	
		Mills, Printers & Laser Cutters P4: ***Teacher*** to demonstrate the use of a range of technologies which could be used to communicate ideas or design solutions. Technologies could include; 3D CAD, 3D printers, Laser cutters, CNC Lathe, etc **(DK, KI) (ICT)**		**Mills, Printers & Laser Cutters** U4: A2: ***Students*** to experiment with the use of modern CAD/CAM technologies in order to produce models and prototypes to be used in the production of a design solution. **(DU, E, SD, SSR, KI, BK, HOT) (ICT, IBL, NUM)**		**Mills, Printers & Laser Cutters** C4: ***Students*** to become independent users of CAM equipment to produce solutions to a range of design problems. **(DU, HOT, E, C, HE, SD, KI) (ICT, IBL, NUM)**	

Students learn about:	Students learn to:	Level 1	Level 2	Level 3
		Pre-Knowing / Knowing	Understanding / Applying	Evaluating / Creating
		ENGINEERING PRINCIPLES AND PROCESSES		
5.6.3 realisation, evaluation, research methods and experimentation	- test possible solutions to research problems - use tools, materials and processes to produce a solution to an identified research problem - develop methods to communicate solutions to problems through a visual display - conduct continual evaluations throughout the design and production of the research project - evaluate the research project in terms of the identified criteria for success.	**Research Methods** P1: ***Teacher*** to describe the commonly conducted forms of research including; descriptive, historical, experimental and operational research. See Chapter 9 Preliminary Year Design and Technology Text Book. **(DK, KI, C)**	**Research Methods** A1: ***Students*** to undertake research utilising a range of research methods including interviews, surveys, data analysis, diaries, autobiographies, experiments and situational analysis to research aspects of the Major Research Project. **(DU, SSR) (ICT, NUM, LIT, IBL)**	**Research Methods** E1: ***Students*** to form groups and thoroughly research a project of their choice and produce the research, experimentation and testing sections of their design portfolios that include design ideas, materials, tools and techniques. **(HOT, SD, PK) (IBL, ICT, LIT)**
		Experimentation P2: ***Teacher*** to describe how to undertake experiments and tests to determine the most appropriate techniques (methods or processes) to use for the Major Research Project. **(DK, HE, KI) (ICT)**	**Experimentation** U2: ***Students*** to conduct experimentation and testing, preparing for the Major Research Project that includes an Aim, Method, Result and Conclusion. **(DU, KI, C) (ICT)**	**Experimentation** E2: ***Students*** to document all experimentation and testing, record all results and make sure that they write down all conclusions from all tests under the headings: Aim, Method, Results and Conclusions. **(DU, KI, C) (ICT, IBL)**
		Project Realisation P3: ***Teacher*** to explain how to document the project realisation including evidence and application of practical or research skills. **(DK, C)**	**Project Realisation** A3: ***Students*** to produce a research portfolio that clearly demonstrates the application of practical and/or research skills. **(EQC, HE, SD, KI, C) (ICT, NUM)**	**Project Realisation** E3: ***Students*** to produce a major research project that demonstrates evidence of the application of high quality practical and/or research skills. **(EQC, HE, SD, KI, C) (ICT, NUM, IBL)**
		Evaluation P4: ***Teacher*** to demonstrate how to effectively evaluate the processes and decisions made during the completion of a Major Research Project. **(DU, HOT, E, SD, KI, EQC) (ICT)**	**Evaluation** A4: ***Students*** to show evidence that evaluation has been applied to the completion of a Major Research Project. **(DU, HOT, KI, C) (ICT)**	**Evaluation** E4: ***Students*** to demonstrate that they have a clear understanding of their project's impact on society and the environment considering both local and global effects. **(HOT, EQC, HE, SD, KI, C) (ICT, IBL)**

Students learn about:	Students learn to:	Level 1		Level 2		Level 3	
		Pre-Knowing	Knowing	Understanding	Applying	Evaluating	Creating
PROBLEM SOLVING & DESIGN							
5.6.5 Creative and innovative approaches to solve problems	- demonstrate creativity and problem solving skills in the development of the research project.	**Major Research Project** P1: ***Teacher*** to explain the expectations and marking criteria for the completion of the Major Research Project. **(DK, PK, HOT, M, EQC, E, SSR, SD, BK, KI, C)**		**Major Research Project** A1: ***Students*** to work in teams of 2 - 3 to produce a Major Research Project utilising a design, plan, build, test and evaluate process. ***Students*** to identify a need as a group and produce a solution to a research or design problem. **(DK, DU, PK, HOT, M, EQC, E, SSR, SD, BK, KI, C)**		**Major Research Project** C1: ***Students*** are to forms groups of 2 – 3 students and complete a Major Research Project. The task involves students solving a research problem or producing an innovative solution to an identified need or want. ***Students*** are to produce a portfolio of their work which is broken into three main areas; 1. Project Proposal and Management 2. Project Development & Realisation 3. Evaluation In the evaluation section the contributions of all members of the group must be documented and proportions of the overall mark allocated. ***Students*** must produce a tangible product, system or environment or alternatively produce a body of experimental research which includes a physical item. E.g model, display, computer program. **(DK, DU, PK, HOT, M, EQC, E, SSR, SD, BK, KI, C) (ICT, IBL, NUM, LIT)**	
		P2: ***Teacher*** to demonstrate how to present work for marking including how to display of their work effectively for assessment. **(DK, PK, HOT, M, EQC, E, SSR, SD, BK, KI, C) (ICT, LIT)**		A2: ***Students*** to present their work for marking and display for parents, teachers and the wider community. **(DU, HOT, M, EQC, E, SSR, SD, BK, KI, C) (ICT, IBL, LIT)**			