4134 VTA – ENERGY AND CONTROL

Industrial Systems and Control – Unit of Work

Griffith UNIVERSITY

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CONTENTS

RATIONALE

This proposed unit of work is intended for implementation within a year-long work program for Year 8 students. There is an assumption that this program is to be used as an introduction to Technology within a traditional Year 8-12 school. For these schools, which are yet to adopt the Middle School/Senior School division, Year 8 usually requires students to participate in a full range of subjects. Particular subjects are then chosen for the Year 9 and 10 programs. It is hoped that this project helps students to foster enthusiasm for the subject and encourage them to pursue Technology in subsequent years.

A further intention is that schools currently providing traditional lock-step project work can adopt this unit of work. The subject matter can help provide a transition to industrial systems and control learning and problem solving in the Technology environment.

The work program and this nested unit of work are designed to satisfy Level 4 outcomes as described in *the Industrial Technology and Design Education Subject Area Syllabus and Guidelines, 2001*, subsequently referred to as *ITDE Syllabus*.

The ITDE Syllabus provides a level statement for each level of each strand of the syllabus. For Industrial Systems and Control, Level 4:

> "Students investigate the use of systems and control within industrial technology and design industries. They understand the logic of systems and sub-systems. They refine, modify and create industrial systems. They use technology practice as described at Level 4 to develop industrial systems."
>
> (ITDE Syllabus, 2001, p. 18)

It is expected that students should typically be demonstrating Level 4 outcomes at the end of Year 7 (ITDE Syllabus, 2001, p. 39). This is why Year 8 has been targeted for this unit of work.

A Year 8 introductory course of study is one of the options suggested in the ITDE Syllabus. As an introduction to the subject area, the course of study would typically be planned from a small number of Level 4/5 learning outcomes (ITDE Syllabus, 2001, p. 37). Typically, for the purposes of planning and assessment, students demonstrating Level 4 outcomes are at the end of Year 7 (ITDE Syllabus, 2001, p. 39)

The syllabus outcomes provide a framework of planning and assessment by:

- describing what it is that students should know
- describing what it is that students should do with what they know.

(ITDE Syllabus, 2001, p. 37)

AIMS AND OBJECTIVES

At the completion of this unit of work students should know (and understand):

- What the strand of Industrial Systems and Control from the ITDE Syllabus relates to and the type of subject matter that they may encounter in further units of work or work programs in this strand.
- How to implement the design process effectively by sketching, experimentation and discussion and planning within a group.
- How to research and gather information to help them reach a design solution.
- How to select the most appropriate tools, equipment, materials and shaping & forming techniques to construct a design solution.
- How to make and assemble components to produce workable and effective solutions.
- The types of mechanisms available to perform tasks and improve function in design.
- The concept of systems, energy and control.

At the completion of this unit of work, students should be able to do with what they know:

- Work in a Design Technology environment safely and responsibly.
- Identify and understand a range of tools and equipment used to produce their specific design solution.
- Collaborate with peers to develop a design solution.
- Choose appropriate materials, and shape and join them appropriately to construct and meet their design specification.
- Know how to find out correct construction methods.
- Use mechanical advantage to maximise results.
- Test, measure and evaluate their design solution and its effectiveness.

BACKGROUND

Technology is one of the eight key learning areas identified nationally and adopted for Queensland schools curriculum as one of the five subject areas focussed on for lower secondary curriculum choice and specialisation. It is referred to as Industrial Technology and Design Education. (ITDE Syllabus, 2001, p. 1). The Queensland curriculum for the compulsory years of schooling is based on an outcomes approach (ibid). All students are expected to demonstrate essential learning (core learning outcomes), and some to demonstrate learning beyond what is essential for a particular level (discretionary learning outcomes).

The syllabus document defines industrial technology and design generally as the creation (design and manufacture) of products to solve real-world problems, satisfy human needs and wants, and to capitalise on opportunities (ITDE Syllabus, 2001, p. 4). It identifies industries that are indicative of the nature of the subject – manufacturing, construction, architecture, drafting and graphics.

Three subject area strands are identified in the syllabus for the purposes of planning and assessment. They are:

- Industrial Systems and Control
- Graphical Communication
- Product Design and Manufacture.

(ITDE Syllabus, 2001, p. 14)

The subject area combines theoretical understandings with practical applications, and involves understanding of the appropriateness of products, social and ethical issues relating to material use and disposal, safety and design considerations such as function, aesthetics and ergonomics (ITDE Syllabus, 2001, p. 4).

The subject strand of Industrial Systems and Control focuses on ways of organising components of industrial systems and their sub-systems so that they work together to process inputs into outputs (ITDE Syllabus, 2001, p. 15). Students are shown that:

- Components of industrial systems may be human or non-human.
- The inputs, processes and outputs of systems can be controlled.
- There are observable and related components and energy sources.

(ibid)

Students work with different types of systems such as:

- Mechanical (levers, cams, gears, springs)
- Electrical (switches, motors, lights)
- Electronic (sensors, solar)
- Pneumatic (hydraulic jack, brakes, hydraulic machinery)
- Computer control (CONC. lathe, engine management system)

(ibid)

UNIT OF WORK TOPIC

The unit of work introduces Year 8 students to mechanisms and motion as part of their study in Industrial Systems and Control. The aim is to allow students to become conversant with basic mechanisms, forces and controls as a precursor to later studies in which more complex systems (machines, etc.) and more specialised controls and energy outputs (pneumatics, hydraulics, etc.) are investigated. The focus of the unit is problem solving effected by experimentation and testing rather than computational methods.

Students are introduced to the concepts and terminology of mechanisms and industrial systems. Examples from everyday life are cited and exhibited to the students. A primary task is then undertaken by small groups of students to allow them to demonstrate what they know and can do with what they know in the Industrial Technology and Design Education Subject Area (ITDE Syllabus, 2001, p. 14).

Further assessment throughout the unit of work includes a small research task that must be presented during class time (300 words with accompanying diagrams, etc.; 2 – 3 minute oral presentation), a graphical communication task related to the primary task, and a short written test to gauge knowledge and understanding.

PRIMARY TASK

The project requires the students to use a "simple vehicle kit" provided to them. The kits, plus extra parts and components, can be purchased from Scorpio Technology in Victoria. Initial outlay for the kits and extra components is offset by the fact that the kits and parts are recyclable and can be used in subsequent student groups. Scorpio Technology has a range of resources marketed specifically for schools (see Appendix G). They are one of the many companies that can provide cost effective materials with supporting documentation for teachers and students. They have a website and will supply to schools on a school purchase order, without the prior establishment of an account. Goods are therefore available at short notice.

It should be noted that there are a number of companies from which educational kits and components are available. It is up to the individual teacher to assess the various products available for their suitability, quality and cost before running the unit of work. Any simple drive system could be adapted as long as it has the provision for changing gear ratios. Another option is to buy bulk quantities of the components required from Scorpio Technology. This will reduce the cost for each assembly, but must be offset by the convenience of supplying each student with a packaged kit.

The simple vehicle kit supplied by Scorpio Technology is quite adequate and affordable. It comprises a gear case, components and motor that can be assembled in different ways to provide different drive gear ratios. A range of alternative gear wheels is provided. Also supplied are a two-way switch (forward/reverse), a battery holder (2 x AA=3V), and axles and wheels. The gearbox can be assembled in two options:

- Option A (low speed, high torque)
    - 1:150
    - 1:125
    - 1:100

- Option B (high speed, low torque)
    - 1:16.7
    - 1:13.9

For this project, the kit is used as a power source rather than as a vehicle. It may therefore be prudent to supply kits to the students with the wheels removed to discourage theft or loss. (The wheels themselves are very serviceable with soft plastic tyres on hard plastic rims, and could be used for other projects. Axle material to suit the wheels is available separately from the supplier.)

Students are given instruction about:

- Systems generally – inputs, outputs and processes, systems and sub-systems.
- Types of mechanisms and control - pulleys, levers, drive belts and chains, etc.
- Energy sources – manual, electricity, pneumatics, stored energy, etc.
- Concepts relating to mechanisms - torque versus speed, mechanical advantage, friction and efficiency, etc.

They are then required to apply this knowledge and experimentation to making choices about their simple vehicle constructions and the incorporation of their simple vehicles into a mechanism that will perform the stated task of the project.

It is envisaged that the students will undertake the work in groups of three. If class number does not allow neat division, assign some pairs. This will promote teamwork and cooperation skills and reduce the necessary workshop time required for the project.

The students are provided with a simple scenario (see Appendix C). They are required to design and manufacture a lifting and moving device. The weight to be lifted is not specified – it is up to the students to design a mechanism to move a maximum weight as quickly as possible. This will require them to make judgements about gearing (torque versus speed) for their set-up, and methods of construction to provide strength and ability while reducing weight and friction (mechanical advantage). The completed mechanism is assessed on workmanship, workability and efficiency.

Efficiency is based on a calculated performance index. The concept of efficiency and performance indexes will be introduced during a classroom-based lesson. In this case, the performance index is:

Mass lifted, M (grams) ÷ Time taken A to B, T (seconds)

This is a rather arbitrary and simple index formula and is used to show students that lifting and moving a specified mass in a certain time, will produce the same index as lifting and moving half that weight in half that time. This is to illustrate that in a specified time interval in a real life situation, the total quantity moved will be the same.

UNIT OF WORK STRUCTURE

The unit of work is generically planned to run for 4 weeks, with 4 x 40 minute periods per week. The proposed total time to be spent on the unit therefore is 640 minutes (approximately 10.6 hours). Naturally, this system of division can be modified to suit particular class timetabling at different schools.

The intention is that the unit of work would consume half a school term. It is therefore assumed that the program can be extended (extra workshop time, extension of the graphical communication task, an additional theory lesson (content added to the written test), or a theory review lesson. Extra material time added to the basic unit of work duration must then be offset by downtime (holidays, special school activities, teacher absences, etc.)

There may also be the requirement to build some safety related material into the unit of work. As this is dependent on student prior knowledge and experience, and school policy, it has not been included here. Refer to Appendix J for pertinent safety related material that can be included in the unit of work.

The program is structured to make use of both a classroom environment and a workshop environment. This will of course depend on the availability of both spaces, but the unit of work will not be unduly affected if it must be run exclusively in a workshop. Theory content could be carried out readily in a workshop, if there is suitable access to audiovisual equipment (overhead projector or data projector). A venue with seating and drawing facilities should be sought out for the sketching workshop and the written test, and hopefully also for the initial design and sketching phase, and the drawing task (if it is started during class time).

An attempt has been made to intersperse theory (classroom) time with practical (workshop) time. Some 40-minute periods are also split into separate activities, the assumption being that any lost time in moving and set-up will be offset by retaining student focus and involvement during the theory component.

TIME PLAN – UNIT OF WORK

<table>
<tr><th>Week 1</th><th>Week 2</th><th>Week 3</th><th>Week 4</th></tr>
<tr><td rowspan="2">1 – Classroom
• Introduction to unit – aims, tasks & assessment
• Systems & sub-systems
• Inputs, outputs & processes
• Mechanisms and control
• Energy sources
• Real world examples</td><td>5 (a) – Classroom
• Design options
o Lifting
o Levering
o Cranes
o Gantries
• Perform. indexes</td><td>9 (a) – Workshop
• Access to materials and parts
• Progress assessment of groups</td><td>13 (a) – Workshop
• Manufacture
• Introduction of supplementary task to students finished their primary task</td></tr>
<tr><td>5 (b) - Classroom
• Further experimentation
• Design phase</td><td>9 (a) – Workshop
• Research task presentations</td><td>13 (b) – Workshop
• Introduce graphical communication task</td></tr>
<tr><td>2 (a) – Classroom
• Pulleys and mechanical adv.
• Class activity – lifting weights with pulleys</td><td rowspan="2">6 – Classroom
• Design and experimentation</td><td>10 (a) – Workshop
• Research task presentations</td><td>14 (a) – Classroom or workshop
• Time as needed for manufacture or class time spent on the graphical comm. task</td></tr>
<tr><td>2 (b) – Classroom
• Levers and mechanical adv.
• Introduce research task
• Provide student handout</td><td>10 (b) – Workshop
• Allocation of materials
• Manufacture</td><td>14 (b) – Either venue
• Revision of material for written test.
• Handout of poss. Assessment items
• Questioning</td></tr>
<tr><td>3 (a) – Classroom
• Simple vehicles
• Torque v speed
• Reducing friction</td><td rowspan="2">7 – Classroom
• Sketching workshop</td><td rowspan="2">11 – Workshop
• Manufacture</td><td>15 (a) – Classroom
• Written test</td></tr>
<tr><td>3 (b) – Classroom
• Class activity – investigate effects of drive speed and gear ratio</td><td>15 (b) – Workshop
• Testing and evaluation
• Completion of manufacture</td></tr>
<tr><td>4 (a) – Classroom
• Class activity – investigate effects of drive speed and gear ratio
• Discussion of findings.</td><td>8 (a) – Classroom
• Design and experimentation</td><td rowspan="2">12 – Workshop
• Manufacture
• Introduction of supplementary task to students finished their primary task</td><td rowspan="2">16 – Workshop
• Testing and evaluation</td></tr>
<tr><td>4 (b) – Classroom
• Introduce primary task
• Set up student groups
• Provide student handout</td><td>8 (b) – Classroom
• Construction materials
• Construction methods
• Chemical and mechanical joints</td></tr>
</table>

TIME PLAN - WEEK 1

1	Classroom • Introduction to unit of work. Explanation of Industrial Systems and Control as a part of the ITDE syllabus subject area. • Systems and sub-systems. Definition OHT; spanner, torch and pump demonstration. • Mechanisms. OHTs and explanations of: the lever, the linkage, the crank, the pulley, and the gear. Brief note on the cam & the screw. • Controls. OHTs and explanations of: cable control, pneumatic control, and hydraulic control. Examples of each. • Friction, efficiency and bearings. OHTs and demonstration of pulling a block along: rough surface, smooth surface, axles and solid wheels, and, axles and roller bearings. Use of a spring balance to measure effort. • Energy sources – inputs and outputs. • Real world example. Class activity to analyse a car (system) and its sub-systems. 40 mins
2 (a)	Classroom • Pulleys and mechanical advantage. Further OHTs of options. • Class activity – pulleys. Groups are to set up pulleys in different arrangements (following set-up guidelines) and measure resultant efforts. 20 mins
2 (b)	Classroom • Levers and mechanical advantage. Explanation of Class 1, 2 & 3 levers (OHTs). • Introduce research task. OHTs of handout. Explanation of the task. Provide handouts to students (see Appendix B). 20 mins
3 (a)	Classroom • Introduction to the simple vehicle kit as a power source. Sample pack. • OHTs of the Scorpio Technology Teaching Unit material. (See Appendix H) • Torque versus speed. OHTs of 4WD (highway, off road, gear sticks). • Explanation of the class activity. 20 mins
3 (b)	Classroom • Class activity – investigate the effects of drive speed and gear ratio. Five separate simple vehicle kits are to be assembled in the different gear ratio options, each mounted to a different board. The boards can be clamped to different tables as workstations. In five class groups (1 per workstation) students are to experiment and observe different performances. Students are to drag different weights across the tabletops. Speed can be timed and forces measured with spring balances. • Students are to individually record their observations and results in workbooks. 20 mins
4 (a)	Classroom • Continuation of class activity from 1C (b). Same groups at different workstations • Discussion of findings. Sharing of results on board. Conclusions drawn. 30 mins
4 (b)	Classroom • Introduction of the primary task – lifting mechanisms. OHTs of the handout. Explanation of the task. Provide handouts (see Appendix C). Discussion. • Set up student groups. Names-in the-hat to select, 3 per group (or 2). 10 mins

TIME PLAN - WEEK 2

5 (a)	Classroom • Provide students with information on options for designs – OHTs of cranes (swing jib type, boom jib type), gantries, lifting devices (forklifts). • OHTs of the Scorpio Technology Teaching Unit material. (See Appendix H) • Torque versus speed. OHTs of a 4WD car on the highway and in the bush. OHT of gear select diagram from a car manual. • Similar explanation of bicycles (OHTs). Explanation that going up a slope in different gears expends the same overall energy (generally) over a set distance, but at each pedal push, less force is needed in a lower gear. • It is necessary to keep the concepts simple for the age group. Examples are non-computational and avoid specific definitions of force, torque, friction loss, etc. 20 mins
5 (b)	Classroom • Design phase – sketching and group discussions. • Further experimentation. • Groups supplied with their simple vehicle kits; issuing to be recorded on roll. 20 mins
6	Classroom • Design and experimentation. 40 mins
7	Classroom • Sketching workshop. Basic freehand sketching techniques are covered. • Using diagrams and symbols. • Documenting ideas both graphically and with notes. • Simple orthographic views and using 5 mm square A4 grid paper. • Simple pictorial views and the using 5 mm isometric graph paper. • Students to participate in example sketching for each of the above stages. 40 mins
8 (a)	Classroom • Design and experimentation. 20 mins
8 (b)	Workshop • Available construction materials and their strengths and weaknesses. • Construction methods – cutting and shaping materials, moving parts, tolerances. • Joining methods – hot glue guns, PVA glue, epoxy glues, mechanical fixings (nails, screws, bolts, etc.). 20 mins

TIME PLAN - WEEK 3

9 (a)	Workshop • Access to materials and parts. Students to begin assembling their materials and cutting to size, etc. • Progress assessment of groups (to be continued in 10 (b)). Drawings and documentation to date to be reviewed. Questioning of each group to gauge understanding and confidence of their chosen mechanism type, construction methods chosen, gear ratios selected and justification. 20 mins
9 (b)	Workshop • Research task presentations. Each student is to discuss their chosen item, what type of lever system it is and show their diagrams and drawings. Duration 1 to 2 mins. 20 mins
10 (a)	Workshop • Research task presentations. Each student is to discuss their chosen item, what type of lever system it is and show their diagrams and drawings. Duration 2 to 3 mins. 20 mins
10 (b)	Workshop • Primary task manufacture. • Continuation of progress assessment of groups. 20 mins
11	Workshop • Primary task manufacture. 40 mins
12	Workshop • Primary task manufacture. • Introduction of supplementary task (see Appendix F) to students finished their primary task. These students are to work individually (not in their group) to complete the task using the reference material provided. 40 mins

TIME PLAN - WEEK 4

13 (a)	Workshop • Primary task manufacture and testing. • Introduction of supplementary task (see Appendix F) to students finished their primary task. These students are to work individually (not in their group) to complete the task using the reference material provided. 25 mins
13 (b)	Workshop • Introduction to the Graphical Communication task. Students are given the handout (see Appendix D). Requirements for the task are reiterated verbally. • Students are given the opportunity to sketch and measure their mechanism. 15 mins
14 (a)	Classroom or workshop • Time as needed for manufacture and test, or class time spent on the graphical communication task. 30 mins
14 (b)	Classroom or workshop • Revision of topics that may be covered in the written test. • The class group are questioned to generate knowledge and understanding. 10 mins
15 (a)	Classroom • Written test (see Appendix E). 20 mins
15 (b)	Workshop • Testing and evaluation. • Each group is to show their mechanism in action. Mass and time taken are to be recorded, the performance index calculated and recorded in the mark book 20 mins
16	Workshop • Testing and evaluation. • Each group is to show their mechanism in action. Mass and time taken are to be recorded, the performance index calculated and recorded in the mark book 40 mins

SYLLABUS OUTCOMES

This unit of work has been structured to satisfy the broad subject area outcomes and the more specific learning outcomes of the Industrial Systems and Control strand of the ITDE Syllabus.

Subject area outcomes

Although pertinent to all the subject area outcomes listed (ITDE Syllabus, 2001, p.14), specific outcomes are targeted:

- Select and manipulate a range of industrial materials to meet industrial technology and design challenges.
- Dismantle, analyse, modify, maintain and create industrial systems.
- Organise and manage time, materials and production resources into a logical and structured sequence of operation.

Central learning outcomes

> "Central learning outcomes describe those learnings, which are considered fundamental for the development of a course of study based on a subject area syllabus and guidelines. They describe what students know and can do with what they know as a result of planned learning experiences. . . . Students should be provided with multiple opportunities to demonstrate these learning outcomes."
>
> (ITDE Syllabus, 2001, p.16)

ISC 4.1 Students investigate the systems and sub-systems used within industrial technology and design industries.

Specific aspects of the unit of work that satisfy ISC 4.1 include:

- Week 1, Lesson 1, 2 & 3. Students are introduced to the concepts, terminology and principles of systems and sub-systems, mechanisms and control. They see and help analyse real examples (Lesson 1), and investigate further pulleys, vehicles, simple motors as power sources, and the principles of torque, speed and mechanical advantage.
- Students choose and analyse a system (levers) as a research task.
- Students are introduced to and investigate further lifting mechanisms used within industrial technology and design industries.
- Students experiment, research, design, manufacture, test, and evaluate a system/mechanism as their primary task.

ISC 4.2 Students identify and explain the logic of systems and sub-systems.

Specific aspects of the unit of work that satisfy ISC 4.2 include:

- In a class group, students analyse a system (car) and its sub-systems (Lesson 1).
- Students identify a lever system in everyday life and explain it (Research Task).
- In groups, students investigate, measure and analyse similar simple power sources with different gear ratios (Lessons 3 & 4).

ISC 4.3 Students incorporate feedback to refine and modify systems and/or sub-systems.

Specific aspects of the unit of work that satisfy ISC 4.3 include:

- Students use findings from a class activity (Lessons 3 & 4) as feedback to refine the design of their primary task.
- Students experiment and test during the design and manufacture stages of their primary tasks to refine and modify their system.

ISC 4.4 Students use technology practice (as described in the Level 4 core learning outcomes of the *Years 1 to 10 Technology Syllabus*) to develop industrial systems.

Technology practice Level 4 outcomes (*Years 1 to 10 Technology Syllabus*):

- **TP 4.1** Consultative methods to gather knowledge, ideas and data when researching alternatives.
- **TP 4.2** Generation of ideas through consultation and communication via detailed design proposals.
- **TP 4.3** Identifying practical expertise of others and use it as production procedures are followed.
- **TP 4.4** Gaining feedback. Meeting the needs of design briefs and users.

Specific aspects of the unit of work that satisfy ISC 4.4 include:

- Students work in groups using research, experimentation, observation, and discussion to gather knowledge, ideas and data when researching alternatives for their primary task (TP 4.1).
- Students work in groups using consultation and communication and design proposals to develop solutions for their primary task (TP 4.2).
- Students work in groups during class activity (Lesson 3 & 4), primary task and testing and evaluation of completed primary tasks. They make decisions about task allocation to utilise particular practical expertise and expedite outcomes (TP 4.3).
- Students use feedback to refine and improve solutions for the primary task (TP 4.4).

Supplementary learning outcomes

> "Supplementary learning outcomes describe what students know and can do with what they know beyond what is considered fundamental at a particular level. It is not expected that these supplementary learning outcomes will be

demonstrated by all students. The supplementary learning outcomes are included to assist teachers in broadening the understandings of those students who have already demonstrated central learning outcomes."
(ITDE Syllabus, 2001, p.17)

ISC 4.5 Students explain different energy sources and can identify their use in simple systems.

Specific aspects of the unit of work that satisfy ISC 4.5 include:

- The supplementary task (see Appendix F) that is given to students in groups that have finished their folios and manufacture for the primary task (Lessons 12 & 13).

Related learning outcomes

The unit of work also aims to realise the requirements of some Level 4 outcomes from the other strands of the ITDE Syllabus, Graphical Communication (GC) and Product Design and Manufacture (PDM).

GC 4.2 Students use accepted construction and presentation techniques to present their solutions to design challenges.

Specific aspects of the unit of work that satisfy GC 4.2 include:

- The graphical communication task done by students individually draws on the sketching workshop and discussion at the time of distributing the task (Lesson 13).

GC 4.4 Students apply techniques for transforming and transmitting information for different audiences.

Specific aspects of the unit of work that satisfy GC 4.4 include:

- Presentation of their findings of the research task during the oral presentation using sketches, drawings and diagrams to show there understanding of levers (Lessons 9 & 10).

PDM 4.3 Students employ their own and others' practical knowledge about equipment and techniques for manipulating and processing materials in order to enhance their products.

Specific aspects of the unit of work that satisfy PDM 4.3 include:

- Students work together in groups to complete the primary task.

ASSESSMENT

Research Task

	% of Research Task Mark
Written research	40%
Graphical Communication	40%
Oral Presentation	20%
Value of Research Task in the Unit of Work	**20%**

Primary Task

	% of Primary Task Mark
Folio of development drawings and sketches*	20%
Half-way progress mark*	10%
Mechanism drawing	20%
Workmanship of completed mechanism*	20%
Workability and efficiency of completed mechanism*	30%

* same mark given to each group member

Value of Primary Task in the Unit of Work	**40%**

Graphical communication Task

	% of Primary Task Mark
Content	60%
Neatness and Presentation	40%
Value of Graphical Communication Task in the Unit of Work	**20%**

Written Task	**20%**

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/pitsco2_30/finditem.cfm?itemid=430; 651; 656; 657; 658

http://scorpiotechnology.com.au (Scorpio Technology)

APPENDIX A – Sample lesson plans

Lesson plans are provided for the following lessons:

LESSON PLAN – WEEK 1, LESSON 1

Year level / subject: Year 8 Industrial Technology & Design Education

Work unit / project: Industrial Systems and Control - Mechanisms

Date: **Period:** **Duration:** 40 mins

Topic: Introductory lesson

Objectives:

- Students will show general knowledge and understanding of the principles and terminology of systems and control. This will be illustrated through questioning and discussion.
- Students will be introduced to the concepts of:
  - Systems and sub-systems.
  - Inputs, outputs and processes in systems.
  - Mechanisms and controls.
  - Energy sources.

Resources:

- Prepared OHTs primarily sourced from *Design and Technology*, 1989 (Caborn, Mould and Cave).
- Spanner, large bolt in a timber block, torch and bicycle pump.
- Bicycle with gears.
- 200 x 100 x 100 rough sawn hardwood block with cup-hook and string in one end for towing, and parallel lateral grooves to house axles.
- 2 off Ø6 x 150 long steel rod axles.
- 4 off Ø40 O.D. x Ø6.5 I.D. solid plastic wheels.
- 4 off Ø12 O.D. x Ø6 I.D. roller bearings.
- 1 kg spring balance.
- Sheet of P80 abrasive paper.
- OHP and whiteboard pens

Preparation:

Clean whiteboard and check resources.

Procedure:

5 mins — Settle class, general chat, mark roll. Informal atmosphere.

20 mins — Introduce unit of work and definition of a system (OHT).
Inform students to take notes.

- Inputs, outputs and processes. Demonstrate and question with spanner, torch and bicycle pump.
- Mechanisms - OHTs and explanations of: the lever, the linkage, the crank, the pulley, and the gear. Brief note on the cam & the screw. Use bicycle to illustrate and question about different types.

- Controls - OHTs and explanations of: cable control, pneumatic control, and hydraulic control. Use bicycle to illustrate and question about different types.
- Friction, efficiency and bearings. Demonstration of pulling a block along: rough surface, smooth surface, axles and solid wheels, axles and roller bearings. Use of a spring balance to measure effort. (incline table as required). Volunteers to help in assembly, testing and holding abrasive paper down.
- Energy sources – inputs and outputs (verbal only).

10 mins Real world exercise – analysing a car (system), and sub-systems:

- OHT of car on screen, then draw car shape on board.
- Question students then annotate on board some sub-systems, their components (inputs, etc.), mechanisms, controls and energy sources.
- Students to copy into workbook.

5 mins Revision of information and questioning:

Close.

Assessment:

- Gauge class understanding through questioning and discussion.
- Check attention and understanding of quiet and less academically successful students by directing questions at them.
- Ask disruptive or apparently inattentive students to show their workbook notes at the end of the class.

LESSON PLAN – WEEK 1, LESSON 4

Year level / subject: Year 8 Industrial Technology & Design Education

Work unit / project: Industrial Systems and Control - Mechanisms

Date: **Period:** **Duration:** 40 mins

Topic: **-** Classroom activity (cont'd) – drive speed and gear ratios.
- Introduction of the primary task.

Objectives:

- Students will able to show record of their experimentation with simple vehicle kits assembled with different gear ratios (notebooks) and demonstrate some understanding (when questioned informally).
- Students will be introduced to the primary task. It will be explained to them and discussed.

Resources:

- 5 simple vehicle kit workstations. Each kit is assembled with one of the different gear ratio set-ups and affixed to a board. Each workstation must be clearly labelled with the gear ratio used.
- 5 quick action clamps.
- 5 weight boards – 150 x 150 x 2 ply with hole in one corner and string attached.
- Assorted weights.
- Assorted spring balances of different capacities.
- 5 stopwatches.
- OHTs of the primary task handout.
- All student names already written on slips of paper and a box to hold them.

Preparation:
Clean whiteboard and check resources.

Procedure:

15 mins Class activity.

- Re-establish groups and assign new workstations.
- Students are to continue with the activity started in the previous lesson. They are to experiment and observe the effect of gear ratio on weight dragging capacity across a table surface, and the speed at which different weights can be dragged.
- Students in their groups from the previous lesson are to now use a different workstation assigned by the teacher (see over).
- Students are to record findings in their workbooks.
- Teacher to circulate, check workbooks are being used and suitable participation by all group members is happening.
- Questioning to gauge understanding.

15 mins Discussions and findings.

- Each group to report on their results from their two workstations.
- Results and observations to be roughly tabled on the whiteboard.
- General discussion to be held about speed versus torque, etc.

10 mins Introduce primary task.

- Use OHTs of handout. Do not provide handouts immediately as students' attention is to be kept on OHTs and verbal explanation.
- The age of the students suggest it may be wise for groups to be selected by chance to break down some friendship and gender groups. Names are drawn from a hat.
- General discussion and questions.

Close.

Assessment:

- General observation of students during the activity and random checking of workbooks.

Workstation	Day 1 Group	Day 2 Group
# 1 1:13.9	A	D
# 2 1:16.7	B	E
# 3 1:100	C	A
# 4 1:125	D	B
# 5 1:150	E	C

LESSON PLAN – WEEK 3, LESSON 10

Year level / subject: Year 8 Industrial Technology & Design Education

Work unit / project: Industrial Systems and Control - Mechanisms

Date: **Period:** **Duration:** 40 mins

Topic: Research task presentations.
Manufacture.

Objectives:

- Students will be able to demonstrate their knowledge of levers through oral presentations about their research tasks.
- Students will be able to demonstrate their knowledge and use of materials in the workshop. They should be able to demonstrate confidence in their choices and actions attained from the research, development, experimentation and design stage.

Resources:

- Workshop facility.
- Materials made available for the manufacture of the primary task.

Preparation:
Ensure workshop is clean and tidy after last class and that stock of the basic materials are assembled on the front desk in the class basket.

Procedure:

20 mins Oral presentations of research reports.

- Continuation from the previous lesson.
- Students are to present in 2 minutes their research assignment, explaining their findings and referring to their drawings.
- Teacher to mark presentations.

15 mins Manufacturing and material allocation.

- Students are to begin manufacture of their projects and complete assembly of their simple vehicle kits.
- Teacher to ensure students are on task and question groups to ensure there is a fair distribution of labour and activity.

5 mins Clean up and storage of projects.

Close.

Assessment:

- Students to be marked on content of presentation and delivery technique.

LESSON PLAN – WEEK 4, LESSON 15

Year level / subject: Year 8 Industrial Technology & Design Education

Work unit / project: Industrial Systems and Control - Mechanisms

Date: **Period:** **Duration:** 40 mins

Topic: Written test task.
Testing and evaluation of primary task.

Objectives:

- Students will be able to demonstrate their knowledge and understanding of material covered in the course during the test.
- Students will be able to demonstrate their ability to test their mechanisms, measure results, calculate a performance index and record results.

Resources:

- Copies of test papers and spare pens.
- Stop watches, spring balances, buckets of sand, weight buckets.
- 2 “test beds” constructed from 12 mm plywood to suit the task specification. (Students must be able to clamp their work to the test bed.)

Preparation:
Ensure workshop is clean and that testing equipment is in the workshop.

Procedure:

20 mins Written test.

- Teacher to seat students and hand out test face down.
- Students are given 20 minutes to complete the test.
- Teacher to collect all tests and lock them in the cupboard.

15 mins Testing and evaluation.

- Testing to be carried out at two different places in the classroom or workshop, two groups testing concurrently.
- Other groups to observe and help record data.
- Teacher to circulate to ensure testing is being done correctly and efficiently and that the observers are focussed.
- Teacher to record load capabilities, times and performance index data on the groups’ folio and sign the entry.

5 mins Clean up and storage of projects and equipment.

Close.

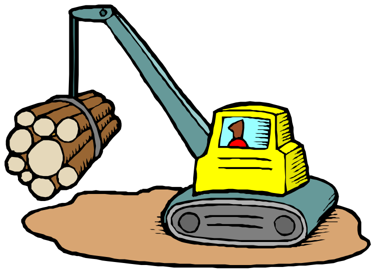
Assessment: Group data to be recorded.

APPENDIX B – Research Task handout

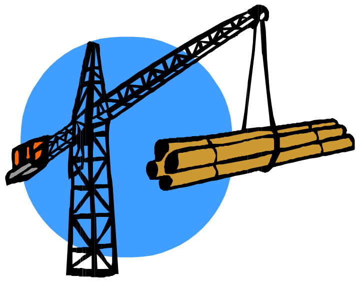
(To be handed out in Week 1, Lesson 2)

INDUSTRIAL TECHNOLOGY & DESIGN EDUCATION

YEAR 8 - INDUSTRIAL SYSTEMS & CONTROL



Lifting Mechanisms



RESEARCH TASK

Background

"Systems are an integral part of the infrastructure of society. They are needed to create or improve methods for solving specific problems. A system is **a method of converting energy for a specific purpose.**" (Systems Technology for Schools, 1998)

A simple system can be illustrated in the use of a spanner to undo a nut (converting our energy to complete work), a pulley to lift a weight, or an electrical circuit in a torch (converting electrical energy to light). A system can be broken down into 3 basic stages – an **input**, a **process** and an **output**. The relationship between the input and the output can be identified as efficiency. To achieve a complex objective, individual systems may be combined together. For example, a car uses many systems e.g. mechanical, electrical, hydraulic, pneumatic, etc. Each system may be a sub-system (brakes or engine) for a system (car).

Most systems utilise an **energy source** and a **control mechanism**. The energy source (human strength, electricity, etc.) is the input. The control mechanism (block and tackle, engine, etc.) is the process. What is the output?

Task

Levers are one of the simplest methods of performing a task by utilising **mechanical advantage**. Mechanical advantage allows users to perform a task safely or easier. Using a crowbar to move a boulder along the ground or opening a Milo tin with the handle end of a spoon are examples of levers.

1. Students are asked to identify some item that uses a lever to perform some task, or demonstrates the principle of leverage when it is used. The mechanism (or system) could be quite simple like a pair of scissors,

or it could be part of a complex mechanism (a sub-system) such as the gear stick in a car.

2. Access and print off the information found at www.scicentrer.com about the three classes of lever. Determine which class of lever your system or sub-system represents.

3. Write 300 words describing how your lever works and what are the input, process and output. What is the energy source? Discuss the effectiveness of the lever and whether you think it is a good solution for the purpose. Could it be improved?

4. Draw your lever system or sub-system. This can be a pictorial drawing (isometric or similar), orthographic views (at least two), a diagram, or a combination. Label the parts of the system (input, output, process, input energy, output energy, etc.

In Lessons 9 and 10 of this unit of work, you will be required to give a short presentation to the class of your findings (1 to 2 minutes).

Assessment

	% of Research Task Mark
Written research	40%
Graphical Communication	40%
Oral Presentation	20%

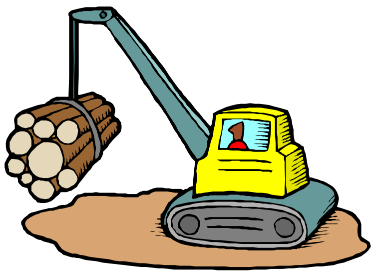
Value of Research Task in the Unit of Work **20%**

Due Date:

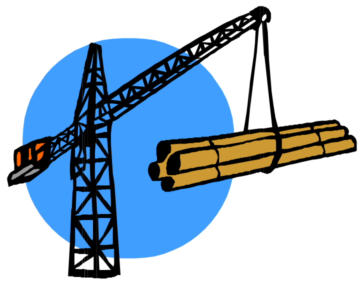
APPENDIX C – Primary Task handout

(To be handed out in Week 1, Lesson 4)

YEAR 8 - INDUSTRIAL SYSTEMS & CONTROL



Lifting Mechanisms



PRIMARY TASK

Background

> "Systems are an integral part of the infrastructure of society. They are needed to create or improve methods for solving specific problems. A system is **a method of converting energy for a specific purpose.**" (Systems Technology for Schools, 1998)

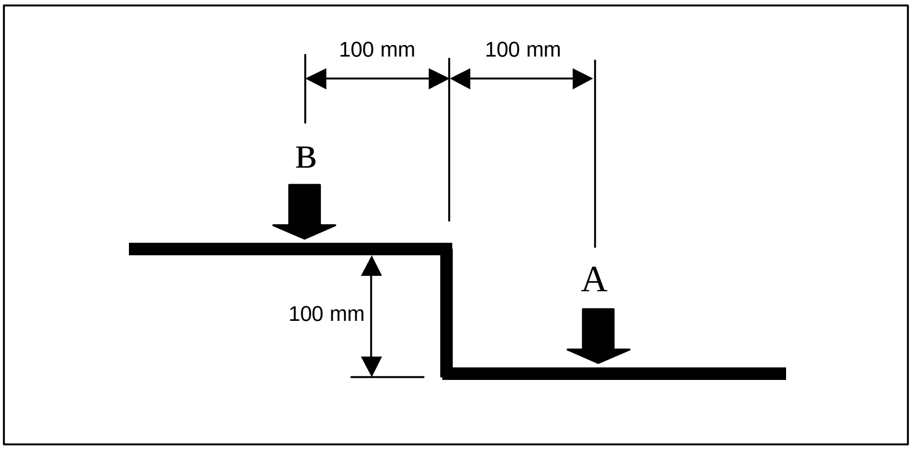
A simple system can be illustrated in the use of a spanner to undo a nut (converting our energy to complete work), a pulley to lift a weight, or an electrical circuit in a torch (converting electrical energy to light). A system can be broken down into 3 basic stages – an **input**, a **process** and an **output**. The relationship between the input and the output can be identified as efficiency. To achieve a complex objective, individual systems may be combined together. For example, a car uses many systems e.g. mechanical, electrical, hydraulic, pneumatic, etc. Each system may be a sub-system (brakes or engine) for a system (car).

Most systems utilise an **energy source** and a **control mechanism**. The energy source (human strength, electricity, etc.) is the input. The control mechanism (block and tackle, engine, etc.) is the process. What is the output?

Task

Students are to work in small groups (2 or 3) to design, manufacture and test a mechanism for lifting and moving a weight. Each group is to be provided with a simple vehicle kit. It is possible to assemble the kits with different gear ratios to more **power** (torque) or more **speed**. The assembled kits can be used as stationary power sources to enable lifting and/or moving of the weight. But . . . only two kits can be used. The third is for spare parts or to be substituted in the final design if a different gear ratio is needed to improve efficiency of the mechanism.

The load will be an ice-cream bucket or similar that can be filled with sand. The weight to be lifted is to be specified by each group. This can be decided experimentally during testing of the rigs, sand added or removed as required. The container can be weighed after successful lifts.



The load is to be raised vertically 100 mm and moved horizontally 200 mm from A to B (see above).

Students are to design a crane, gantry or other mechanism to perform the task. Apart from the simple vehicle kits they can use any of the materials available for the project – *Foamcore* cardboard, *Bainbridge* board, balsa wood, pine (DAR and dowel), sheet metal, metal rod (steel and aluminium), string, wire, glue, fittings, etc. Concepts to consider include reducing friction (pulleys, bearings) and possibly increasing friction (gears on shafts to stop slip).

The mechanism's **efficiency** is measured by calculating a **performance index**. This is:

Mass lifted, M (grams) ÷ Time taken A to B, T (seconds)

Hint: Is it better to move a smaller load quicker or a larger load slower?

Assessment

	% of Primary Task Mark
Folio of development drawings and sketches*	20%
Half-way progress mark*	10%
Mechanism drawing	20%
Workmanship of completed mechanism*	20%
Workability and efficiency of completed mechanism*	30%

* same mark given to each group member

Value of Primary Task in the Unit of Work **40%**

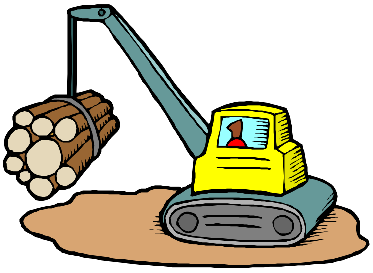
Testing Date:

APPENDIX D – Graphical Communication Task handout

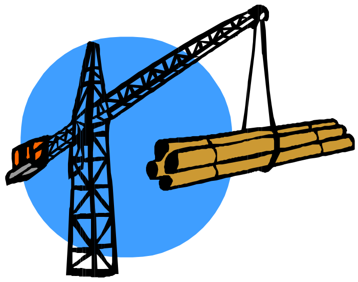
(To be handed out in Week 4, Lesson 13)

INDUSTRIAL TECHNOLOGY & DESIGN EDUCATION

YEAR 8 - INDUSTRIAL SYSTEMS & CONTROL



Lifting Mechanisms



GRAPHICAL COMMUNICATION TASK

Background

You and your group members have been busily researching, designing and manufacturing a mechanism that will lift and move mass. You are now required as individuals to produce drawings to graphically communicate your finished design.

Task

Produce two A3 drawings to graphically communicate your finished design. The drawings need to have enough information (notes, details, dimensions, etc.) to allow someone else to interpret your drawings and be able to build a replica of your mechanism.

The drawings are a **communication tool** and can be freehand or technically drawn, accurately representative or diagrammatic. You must decide what will best communicate the necessary information – pictorial views (isometric, etc.), orthographic (top view, side view, etc.), details, colour or black and white.

Assessment

	% of Primary Task Mark
Content	60%
Neatness and Presentation	40%

Value of Graphical Communication Task in the Unit of Work	**20%**

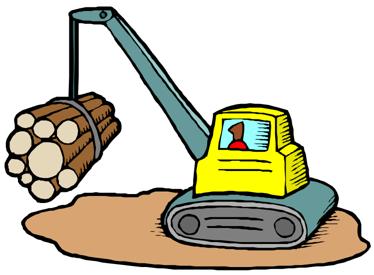
Due Date:

APPENDIX E – Written test

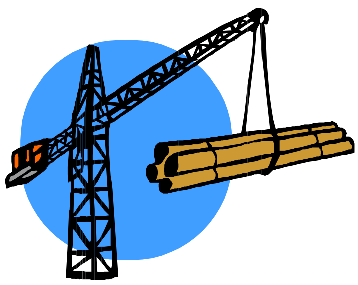
(To be handed out in Week 1, Lesson 4)

INDUSTRIAL TECHNOLOGY & DESIGN EDUCATION

YEAR 8 - INDUSTRIAL SYSTEMS & CONTROL



Lifting Mechanisms



WRITTEN TEST

1. A car is a **system**. Name 3 **sub-systems** that are part of a car and help it to perform.

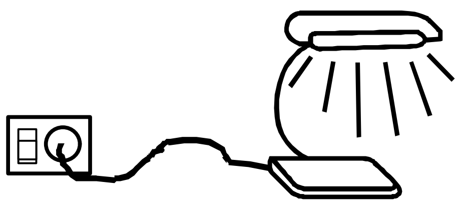
   ……………………………………………………………………………

   ……………………………………………………………………………

   ……………………………………………………………………………

2 marks

2. Below is a picture of a lamp. Indicate the input and energy used, the process, and the output and what energy or work is produced.



3 marks

3. The handbrake on a bicycle is:

   a. A crank mechanism.
   b. A gear mechanism.
   c. A lever mechanism.
   d. A pulley mechanism.

(circle correct answer)

1 mark

4. The bicycle handbrake applies the braking by means of:

    a. Hydraulic control.
    b. Cable control.
    c. A linkage mechanism.
    d. Pneumatic control.

1 mark

5. If a 4WD car had to climb a steep hill, would a gear ratio be selected to produce high torque and low speed, or low torque?

    ………………………………………………………………………………………

2 marks

6. Name two machines used in industry that can be used for lifting and moving heavy loads.

    ………………………………………………………………………………………..

    ………………………………………………………………………………………..

2 marks

7. Draw an orthographic side view of a wheelbarrow. Draw with an arrow to show the location and direction of effort (be sure to label the arrow as "effort"). Draw with an arrow to show the location and direction of load and label the arrow. Use a triangle on your drawing to indicate the fulcrum and label it.

3 marks

8. What class of lever is a wheelbarrow?

    ………………………………………………………………………………

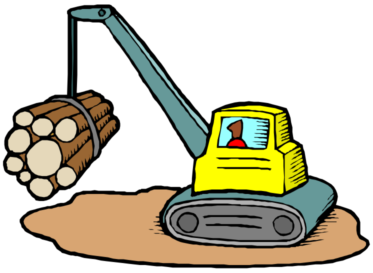
1 mark

Value of Written Test Task in the Unit of Work 20%

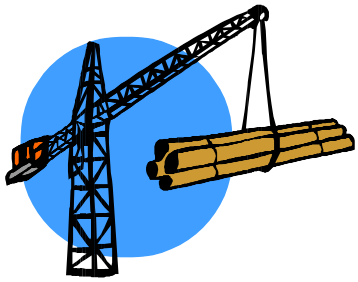
APPENDIX F – Supplementary Task

INDUSTRIAL TECHNOLOGY & DESIGN EDUCATION

YEAR 8 - INDUSTRIAL SYSTEMS & CONTROL



Lifting
Mechanisms



SUPPLEMENTARY TASK

There are many different energy sources available to make systems function. For the list of systems below, write 50 – 100 words for each to explain:

- What is the energy source (input) for the system?
- How is the energy source used (process)?
- What is the result, work done or energy produced (output)?
- Name some other ways to use the energy source.

There are reference books available for your investigation or possibly use www.google.com to search for information.

Include pictures and diagrams, if possible.

System 1 – A water wheel used to grind grain.

System 2 – A hot glue gun.

System 3 – A solar hot water system on the roof of a house.

System 4 – A windmill used to pump out underground water.

System 5 – A lawn mower.

Construct a simple working model using the relevant energy source of one of the following:

- System 1
- System 2
- System 3

APPENDIX G – Scorpio Technology – Parts

The information in this appendix comprised downloads from the Scorpio Technology website:

http://scorpiotechnology.com.au

APPENDIX H – Scorpio Technology – Simple vehicle information

The information in this appendix comprised copies of the comprehensive information sheets and teacher notes that are supplied with simple vehicle kits purchased from Scorpio Technology.

APPENDIX I – Sample OHT source material

The information in this appendix comprised copies of illustrations from *Design and Technology* (Caborn, Mould & Cave, 1989). These excellent illustrations were used to support the teaching of the subject matter, and no breach of copyright was intended.

Illustrations were taken from Chapter 8 (Technology for design: Mechanisms and control).

APPENDIX J – Safety resource

Material originally used in this section is not available for use or publication.