VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

2007 School-assessed Task Report

Systems Engineering GA 2

BACKGROUND INFORMATION

The School-assessed Task is commenced in Unit 3 and completed in Unit 4. Components of the task relate to Unit 3 Outcome 2 and Unit 4 Outcome 2.

Unit 3 Systems engineering and energy
Outcome 2

Design, plan, construct and document an integrated system to be completed in Unit 4 Outcome 2, and effectively use diagnostic procedures for the system.

Nature of task

A record of design, planning and production and Production work

Unit 4: Integrated and controlled systems engineering
Outcome 2

Select components for, construct, diagnose, adjust, modify and repair an integrated technological system and its control devices commenced in Unit 3 Outcome 2, and provide an evaluation report of the system, its performance and the management of the project.

Nature of task

Production work accompanied by a record of progress and modifications (pictorial and text material)

and

A report of diagnostic testing and performance data

and

An evaluation report.

Scope of task

The record of design, planning and production should include:

- a design brief (student or teacher generated).
- criteria for evaluating the integrated, controlled system
- research (background information to produce ideas for the design options such as safety, relevant Australian Standards, conventions, components, materials, processes, component assembly methods, suitability of tools, equipment and machines). Students must accurately cite all sources of information they use.
- design alternatives and options. Where relevant, alternative options should be provided and the preferred option should be clearly indicated with justification for its selection.
- a design plan (drawings, sketches, annotations, diagrams, block diagrams, flow charts) for the configuration, assembly, integration and resourcing of manufactured systems, subsystems and components intended to produce an operational device with a **control device**.
- components and materials list, including sources and cost.
- a production work plan (including processes, proposed methods of diagnostic testing and a timeline for the manufacture of the integrated system).
- a record of progress that may include photographic evidence of production work (e.g. logbook) including decisions made and notes of modifications with justifications.

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Where appropriate, students should use information and communications technology (ICT) in the production of the record of design, planning and production and documenting diagnostic testing and the evaluation report. Where ICT is used, hard copy printouts must be provided.

One product only is to be completed over Units 3 and 4. By the end of Unit 3 the production work should be partially constructed. By the end of Unit 4, the production work will result in an operational device in the form of an integrated system with a control device, i.e. a system which is a functional integration of a mechanical subsystem (includes pneumatic, hydraulic) and an electrotechnology (electrical/electronic) subsystem (includes microelectronic). All products must be compliant with safety standards and Australian Standards. Risk assessment and risk management must be addressed throughout the design, construction, testing and operation of the product, which must adhere to safety standards, laws and regulations.

In Unit 4, the evaluation report should be based on the previously developed criteria. The report will include references to the results of at least one diagnostic test carried out to assess the functioning and performance of the integrated system with a control device.

When undertaking diagnostic procedures students need to document (using appropriate technical language):

- the purpose of the test
- procedural steps to perform the test including the equipment used
- expected results
- actual results of the test in quantified (numerical) form
- explanation of the results.

Students are also required to evaluate their management of the project and their work practices.

Teachers must sight and monitor the development and documentation of the student's work on a regular basis. The Authentication Record for School-assessed Tasks should be used for monitoring student's work in progress for authentication purposes. This sheet must be available if requested by the VCAA. The Additional Teacher Comment sheet should be used to document skills and competencies; particularly those relating to the safe use of tools, equipment and machines and construction methods that may not be clearly demonstrated in the student's final presentation.

GENERAL COMMENTS

Advice on management and organisation

Conditions which are conducive to student achievement in the School-assessed Task include well-managed, organised classrooms/work areas and provision of relevant technical resource materials. Teachers need to provide guidelines on the selection of appropriate tasks, timelines, due dates and the requirements of the task. Regular monitoring of progress is also important in supporting and encouraging students through their tasks. Discussion and ongoing feedback assists students in remaining focused on their work throughout the duration of the task. Structuring the task through the various stages of its development is useful and timelines should be set to assist students.

Teachers should document skills and competencies related to Criteria 3, 4, 5 and 6 that may not be clearly demonstrated in the students' final presentation on the Additional Teacher Comment sheet. This is available at: www.vcaa.vic.edu.au/correspondence/bulletins/2008/february/additional-teacher-comment.pdf

Features of successful folio and production work

A wide range of topics was explored in the School-assessed Task. Most students negotiated production topics with their teacher. They organised work plans, work processes and set goals for completion and evaluation.

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Successful student work exhibited the following features:

- the production tasks were completed using a diverse range of work processes requiring a high degree of skill and knowledge
- design plans were thorough, detailed in depth and content with a range of design proposals or options; justifications were made for selection of appropriate options and developed solutions
- diagnostic tests were planned with expected and actual outcomes identified; a sound analysis of the test data was made and explained
- evaluation reports were thorough and discussed the production activities as well as the practical outcomes of the task
- production activities involved working on an integrated system, its subsystems, parts and components; appropriate steps were taken to control the system, its inputs, processes and outputs
- completed systems were operational and produced to a very high standard of assembly and finish
- work required a high degree of effort and time to achieve completed and operational status
- folio work was of high standard in content and detail; a range of communication techniques was used to present information and design work.

Types of products

Examples of successful production activities selected for the School-assessed Task were:

- electromechanical toys and games
- hydraulic lifting, moving and locking devices
- controlled robot arms and vehicles
- controlled model houses, model hoists and bridges
- model watercraft and aircraft
- electromechanical alarm and warning devices for the home
- controlled light and sound systems

Areas of strength and weakness

Many production tasks were of a high standard which reflected the emphasis on quality practical work. With few exceptions the products were integrated systems characterised by 'input–process–output and control' of integrated electrical, electronic and mechanical subsystems.

Teachers and students should note:

- Most projects incorporated control of integrated systems; successful student production activities involved work on integrated systems with processes such as manufacture, repair, modification and assembly of elements and subsystems within controlled operating systems.
- High level evaluation responses involved students commenting on and evaluating their production outcomes by comparing the production plan with the actual outcomes of the production work plans, processes, modifications and difficulties encountered.
- Technical data (obtained from the diagnostic test and essential relevant texts) was used to prove how well the system was performing.
- Design and planning work should be thorough and reflect requirements of the assessment criteria. Students should consider a range of possible ideas or options then select from these for further development. Justifications should be made for selecting what should be the most appropriate option. Students who produced both design and production plans with limited detail were disadvantaged as they had little documentation to refer to when assessing and evaluating their work and related planning activities.
- Some tasks did not involve the 'control of a system' as required for this task. Production work should involve developing an 'operational integrated and controlled system'.

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- Using commercially produced kits and working with simple or basic projects can disadvantage students as this limits the scope of designing, planning and production activities; less complex kits are often suitable only as a subsystem of a larger integrated system.
- Some systems were not integrated; these systems were generally very simple to make and did not use a sufficient range of processes and skill level to achieve high grades. These tasks did not fully satisfy the task criteria for the product to be an 'integrated system' as they did not comprise mechanical and electrical or electronic subsystems.
- Some projects incorporated the use of 240 volt DC power supply which contravenes current school regulations; a number of these products also displayed wiring faults such as bare connections or shortened earth wires; teachers should refer to advice on electrical power supply and related safety issues published in the *VCE Systems Engineering Study Design* (page 9).
- A number of schools used commercially produced workbooks and/or pro formas. Materials of this kind can seriously limit students in developing a relevant and thorough folio consisting of detailed plans, tests and evaluations. For example, some only allowed a few lines for students to justify options or to complete an evaluation. Others only provide one page for each option and two or three pages for development work. Teachers are encouraged to develop their own project task guidelines. They could choose to base these on a combination of the relevant outcomes/ key knowledge and key skills in the study design and the task criteria and use headings linked to each criterion and related sub-criterion points.
- Some teachers allowed students or class groups to produce the same or similar projects. Many of these activities were too basic for this level of study (e.g. servicing a lawn mower or assembling a basic alarm kit). When this approach is used, students' design and development work is often limited in scope due to the confinements of the set task. This is reflected in assessment where high grades are unlikely to be achieved. Students should propose and develop individual products of their own choice.

Further information

Teachers should refer to:

VCAA website
www.vcaa.vic.edu.au/vce/studies/systemseng/systemsengindex.html

VCE Systems Engineering Study Design 2007–2010
www.vcaa.vic.edu.au/vce/studies/systemseng/Systems-Eng-SD-2007.pdf

Study design amendment, November2006
www.vcaa.vic.edu.au/vce/studies/systemseng/syseng-sdchanges.html

2008 Advice for School Assessment
www.vcaa.vic.edu.au/correspondence/bulletins/2008/february/2008FEBSUP1.pdf

VCE Assessment Handbook Systems Engineering
www.vcaa.vic.edu.au/vce/studies/systemseng/SystemsEngHB.doc

Top Designs
www.vcaa.vic.edu.au/excellenceawards/seasonofexcellence/generalinfo/seasonbrochure.html#H3N101F9

Professional development and other support are available through the *Design and Technology Teachers Association Victoria (DATTA Vic – formerly TEAV)* <www.datta.vic.edu.au>.

Diagnostic practice

Teachers should note that testing can be performed at any relevant stage of production, with final testing on completion of the system. Diagnostic testing directly relates to the production activity. It involves using test or measuring equipment to assess the performance of a system and its parts in terms of input–process–output and effective control.

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The data obtained as a result of the diagnostic testing is used to gain a greater understanding of the system, rectify problems or to measure its performance compared with prescribed recognised standards.

Tests were usually performed:

- at the beginning of the task, in order to determine faults
- during the production task, as a means of testing a sub-system
- in most cases, at the end of the production activity to determine the outcome and operational effectiveness of the system.

COMMENTS FOR EACH CRITERION

Assessment criteria

The extent to which the **record of design, planning and production** demonstrate:

Criterion 1: Skill in developing a design plan for an integrated system.

- Use of a design brief to outline a project that is an integrated system with a control device.
- Use of a range of presentation methods for communicating ideas and design plans for the proposed system.
- Use of research in developing options.
- Development of a range of options and justification for the preferred option.
- Development of a range of criteria suitable for evaluating the product.

To score a **Very High** for this criterion there must be very effective use of a range of presentation methods for communicating ideas and options. A student must make extensive use of highly relevant research to develop an appropriate range of options for meeting the requirements of the design brief and provides a comprehensive justification for the preferred option. A wide range of criteria that are suitable for evaluating the product should be provided.

The biggest change to this criterion has been in the use of a design brief to outline the project. The design brief is focussed more on a problem to be solved rather than in terms of the needs of a client or end user. The design brief directs the rationale behind the of research, planning and construction phases.

Better examples of the use of presentation methods include the use of thumbnail sketches, photographs, scale drawings, circuit diagrams, flow charts and programs. Good communication of ideas does not necessarily require the use of CAD programs or other ICT based design packages.

The research undertaken by students has always been the strength of the School-assessed Task. Teachers should encourage their students to include only information that is relevant to the project. Annotations can explain the relevance of the research or establish the credentials of the resource. Students documenting their research processes regularly describe the reasons for the research, the credentials of the interviewee or resource, and the information gathered through the research.

There were two approaches to the development of options for the project. Students either described three or four systems that would satisfy the requirements of the design brief, or otherwise described options that were to be considered for many of the subsystems or components of the project.

The preferred design option was often decided using a selection chart, grading each of the options with reference to a variety of well explained considerations.

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Criterion 2: Skill in preparing the production plan

- Sequence of steps needed to complete the product in the available time.
- Knowledge of relevant Australian Standards, the components, tools, equipment, machines, materials and processes required to make the integrated system.
- Ability to prepare a materials and components list (including their sources and costs) required to produce the system.
- Ability to assess and document safety risks associated with the production task.

To score a **Very High** for this criterion, a student must provide a clear and realistic plan of how the product is to be completed in the time available. The plan details the sequence of steps and a very comprehensive materials/components list and demonstrates sound knowledge of relevant Australian Standards, the components, tools, equipment, machines, materials and processes (including proposed diagnostic testing) to be used. A comprehensive and relevant risk assessment is presented.

High-quality work involved the production of a thorough design and planning folio. Good design work included consideration of a range of ideas with justifications made for selection of appropriate solutions. Students used a range of methods to communicate their ideas and plans including text, graphs, CAD, illustrations, CD-ROM and posters.

Successful plans outlined in detail the stages intended to be used in production work. This was achieved by listing the sequence of steps of either the entire production or for each subsystem. Establishing the time required for each step in production gives students a point of reference when reviewing how well they met time constraints.

Australian Standards have been incorporated to improve students' awareness of the existence and role of the standards. In cases where it was difficult to find and access standards that apply to production models, reference was made to standards that apply to components, machines, tools or procedures associated with the production process.

Lists of machines, tools and materials were often compiled incorporating photographs, safety considerations and the method of use.

Risk assessment has been only recently introduced into the requirements of the production. Tables outlining the degree of risk, appropriate precautions to be followed and the responses and treatment associated with the risk were included.

The extent to which the **production work and accompanying documentation including the record of progress and modifications** demonstrate:

Criterion 3: Skill in the application of processes in producing an integrated system.

- Range of processes used.
- Degree of difficulty in the processes used.
- Ability to record progress and modifications.
- Efficient use of time during production

To score a **Very High** for this criterion, a student should demonstrate a very high level of skill in the safe application of a wide range of processes, including several with a high degree of difficulty. Advanced understanding of the relationship between the production sequence, processes and time lines is evident. Clear, concise and regular recording of progress/modifications and deviations from the production plan is evident.

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Production activities which received very high ratings exhibited a wide range of processes (usually five or more) and these were of suitable diversity and complexity. Students presenting simple projects containing limited production processes cannot rate highly. Increasingly photo-journals were used to describe the range of tasks and the finish of the production processes. Photographs also assisted in establishing authenticity.

Criterion 4: Skill in the use of tools, equipment and machines.

- Range of tools, equipment and machines used.
- Competence/technical skill in the use of tools, equipment and machines.
- Appearance and finish of the product.

To score a **Very High** for this criterion
Demonstrates a very high level of technical skill in the correct and safe use of a wide range of tools, equipment and machines. A very high standard (evident in the appearance and operational status of the system) is achieved through the correct and effective use of all tools, equipment and machines.

Projects that demonstrated a high degree of proficiency gained high ratings for this criterion. The quality of soldering, drilling, machining, material preparation and assembly are examples where the competent use of tools, equipment and machines is demonstrated. Highly rated work exhibited components assembled to correct codes of practice or standards.

Criterion 5: Skill in realising the plan

- Performance and quality of the completed technological system with comparison to the plan and recorded modifications.
- Suitability of the selection and use of appropriate materials, components, methods of assembly and conventions to meet the design plan.

In assessing this criterion, the teacher should consider the student's project management skills and production outcomes in terms of:

- intended function or purpose
- steps or sequence required to produce the product as
- outlined in the production plan
- intended range of processes used
- intended range of tools, equipment and machines used
- major components/elements and materials used
- degree of accuracy and precision
- operational status of the product
- method/s of testing the system
- method of 'finishing' or presenting the product.

To score a **Very High** for this criterion
The product accurately reflects the design and production work plan and documented modifications in all aspects. All decision making has been documented and where relevant, valid and detailed reasons have been provided to justify all modifications.

Projects should demonstrate similarities to the actual project proposal, design plan and any recorded modifications. The system should be complete and operational as planned.

The extent to which **the diagnostic testing, documentation and performance data** demonstrate:

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Criterion 6: Understanding of appropriate diagnostic test procedures

- Planning of the tests.
- Skill in carrying out the tests.
- Accessing and using related technical information.

To score a **Very High** for this criterion
Provides accurate, relevant and detailed descriptions of the purpose and procedural steps for the tests and refers to relevant technical information. The tests are implemented with a high level of skill. Highly rated work identified the purpose and description of the test using appropriate terminology. Expected test outcomes were stated and supported by relevant technical data. Quality responses provided detailed and logical procedural steps for the test as well as identifying tools and equipment used. Possible sources of errors and methods of reduction during the test were stated. Low-scoring responses often did not identify potential errors or alternative test methods.

Criterion 7: Analysis of data gained from diagnostic testing

- Specification of test data in quantified (numerical) form.
- Explanation of the actual results versus the expected results.
- Accurate use of technical information and appropriate technical language to explain results.

To score a **Very High** for this criterion
Accurate, relevant and quantified test data is presented. Using relevant technical information the test data is interpreted accurately and used to thoroughly explain the actual results using appropriate technical language (including errors).

Students are required to present the data collected from the diagnostic test in a clear, identifiable, technically correct form using SI units where applicable. Most students presented the data using appropriate tables or charts. Images of CRO screens were often presented to describe the information gathered in tests. The source of the technical information was also identified. Very good responses presented an explanation of the actual result versus the expected result and identified the effect of errors.

The extent to which the **evaluation report** demonstrates:

Criterion 8: Evaluation of the processes, work practices and the product

- Effectiveness of the production work plan.
- Difficulties encountered and how these were addressed.
- Suitability of the product with reference to the previously established criteria.
- Description of how the system could be improved.

To score a **Very High** for this criterion
Provides a comprehensive review of the design and production activities, including a thorough review of the efficiency of the production work plan, logbook and recorded modifications. A very thorough discussion of the difficulties encountered and how these were addressed. Makes valid judgments about the suitability of the product and the extent to which it matches the design and production plan and in reference to the previously established criteria for evaluation. Provides a thorough explanation of areas for improvement of the system.

The evaluation requires students to state the intended outcome and the actual outcome of the completed system and to make a reasonable analysis of these. Discussion should support judgments made about the production task such as the results from the planned diagnostic test and operation or performance of the final product. Students were also required to evaluate the sequence of operations

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of their production activities, comment on the nature of changes and identify safety concerns. Good work displayed a sound knowledge of all the above aspects.

Most students made good use of the evaluation criteria established in the criteria 1 design plan to make judgments about their finished product and their production processes. Students generally were able to provide an honest judgment of how the completed system and the production process worked; and how improvements could be made.

A note on marking

It is very important that teachers mark the work of all students appropriately and only according to the criteria. Cross marking within a school or within a teacher network is vital to a school's quality assurance and should not be compromised. Teachers are advised to attend professional development and collaborate with colleagues to assist in marking student work.

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