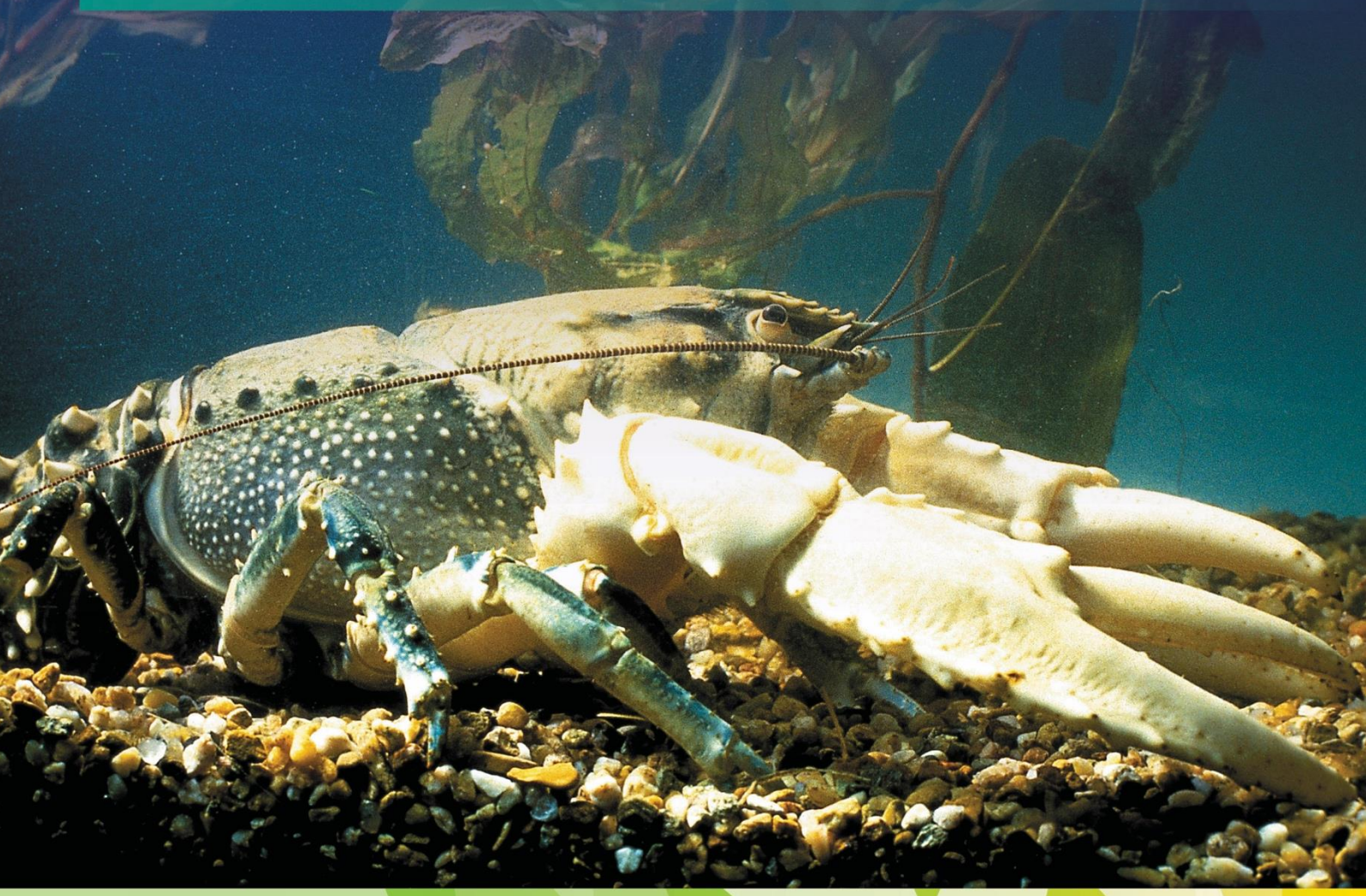
Department of Primary Industries

The Yabby Unit - Design Project 2

Design and build an Aquaponics system

Technology Mandatory

Area of Study - Agriculture and Food Technologies and Engineered Systems



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DPI in SCHOOLS

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Cover image Murray crayfish, Source NSW DPI.

Contents

Information for teachers

Syllabus context

The Yabby unit of work is mapped to outcomes from *Agriculture and Food Technologies* context and *Engineered systems* of the NSW Technology Mandatory (2017) syllabus. It integrates content from agriculture technologies, digital technologies and engineered systems to enable delivery considering the school context and available resources.

Agriculture technologies (food and fibre production) focus on the investigation of managed environments, such as farms and plantations. Students learn about the processes of food and fibre production and investigate the innovation and sustainable supply of agriculturally produced raw materials. Students develop deep knowledge and understanding about managed systems that produce food and fibre through designing and producing solutions.

The *Digital technologies* context encourages students to develop an empowered attitude towards digital technologies, use abstractions to represent and deconstruct real-world problems, and implement and evaluate digital solutions. Students have the opportunity to become innovative creators of digital technologies in addition to effective users of digital systems and critical consumers of the information they convey.

The *Engineered systems* context focuses on how force, motion and energy can be used in systems, machines and structures. Students are provided with opportunities to experiment and develop prototypes to test their solutions. They understand how forces and the properties of materials affect the behaviour and performance of engineered systems, machines and structures. Knowledge of these principles and systems enables the design and production of sustainable, engineered solutions.

Source: NESA, 2017. Technology Mandatory Syllabus.

Learning outcomes

This unit of work provides students with the opportunity to investigate Australian freshwater crayfish production in Australia and the importance of aquaculture production to our society.

Resource description

This document is a design and production folio, allowing students to record and work through the design and production process which has been scaffolded into activities.

This design folio focuses on students designing and building an aquaponics system to house crayfish.

Obviously, the logistics of each student building an individual project may be impractical so teachers should adapt the resource. Modifications could include students voting on the best design to produce as a class or students breaking into groups to design and build specific aspects of the project.

This workbook should be used after completing the "Yabby Unit" document. These resources are designed to be used together, however, teachers should alter the resources to suit learners, school facilities and individual skills.

Animal welfare considerations

Ensure that you consult your school animal welfare officer and the NSW Animals in Schools website for more information about welfare, animal requirements and legislation for keeping crayfish in schools for scientific purposes.

Glossary

Term	Definition
Aesthetic	Aesthetic judgement is concerned with the visual impact or appeal of a *product* or *environment* and is influenced by social, emotional and demographic factors.
Criteria for success	A descriptive list of essential features against which success can be measured.
Design brief	A concise statement clarifying a project task and defining a need or opportunity to be resolved after some analysis, investigation and research. It usually identifies users, criteria for success, constraints, available resources and timeframe for a project and may include possible consequences and impacts.
Design process	A process that typically involves investigating and defining; generating and designing; producing and implementing; evaluating; and management to create a designed solution.
Design solution	A product, service or environment that has been created for a specific purpose as a result of design thinking, design processes and production processes.
Designing	A process that typically involves investigating and defining; generating; producing and implementing; evaluating; and collaborating and managing to create a designed solution.
Evaluating	Measuring performance against established criteria. Estimating nature, quality, ability, extent or significance to make a judgement determining a value.
Functionality	Design of products, services or environments to ensure they are fit for purpose and meet the intended need and identified criteria for success. Criteria for success in relation to functionality are likely to include such things as operation, performance, safety, reliability and quality. That is, does the product, service or environment do what it was meant to do, or provide what it was meant to provide? (For example, does the torch provide light, is it easy to hold, and is it safe to use?)
Material	A substance from which a thing is or can be made. Natural (e.g. animals, food, fibre, timber, mineral) and fabricated (e.g. metal alloys, plastics, textiles, composites) materials. Materials are used to create products or environments and their structure can be manipulated by applying knowledge of their origins, structure, *characteristics*, *properties* and uses.
Paddock to plate	All steps in the growing, processing and preparation of food.
Product	Products are the end results of natural, human, mechanical, manufacturing, electronic or digital processes to meet a need or want.
Resources	In Design and Technologies, this includes technologies, energy, time, finance and human input.
Risk management	A practice of identifying potential risks in advance, analysing them and taking precautionary steps to reduce the risk. Risk management involves risk identification, analysis, response planning, monitoring, controlling and reporting.
Technologies	Materials, data, systems, components, tools and equipment used to create solutions for identified needs and opportunities, and the knowledge, understanding and skills used by people involved in the selection and use of these.

Source: Adapted from Australian Curriculum (ACARA) Glossary

Design and build an aquaponics system

Design situation

Aquaponics is a system of agriculture which involves growing aquatic animals and hydroponic plants (plants grown without soil), in a combined or integrated system. In an aquaponic system, the aquatic animal waste supplies the plants nutrients for growth and the plants filter and maintain water quality for the aquatic animals.

Aquaponics farming systems are sustainable and environmentally-friendly alternatives to conventional agriculture. It is an intensive farming system, with the ability to grow animals and plants at high stocking rates and densities in a small amount of area.

Aquaponics systems have many advantages including:

- They provide year round fresh produce
- They recycle water
- The system can be set up anywhere, as long as electricity and good quality water is available
- They reduce fertiliser usage
- They reduce food miles and pollution associated with production, processing, packaging and transport of purchased food
- They are easy to set up and maintain

Follow this link to watch 'Murray Hallam on Gardening Australia' investigate aquaponics.

***Think about* - How you can design and produce an aquaponics system that will produce year round fresh produce at your school.**

Design brief

Design and build a freshwater crayfish aquaponics system for your school.

Constraints

When designing and producing your aquaponics system consider and plan for the following limitations:

- A grow-out area for crayfish with good light, temperature control of extremes heat and cold, crayfish shelter and space specific to the species you will grow
- An aeration system to oxygenate the water for the crayfish
- A filtration system to maintain water quality for crayfish
- A plant area separate from crayfish for plants to grow. When designing this area consider the types of plants you will grow and their requirements for light and space
- Consider the water source you will use for your system. Consider how you will drain and refill it and how any waste water will be recycled.
- Your system must prevent crayfish escaping and prevent any predation of crayfish from birds and other fauna
- Consider the area that you will house the aquaponics systems to identify size and area limitations and environmental limitations such as temperature and rainfall for electrical equipment
- Build your aquaponics system using recycled materials where possible.

Design folio production

Your design folio is an important communication tool for design projects. It should show the journey of your design projects development, from recording your first rough ideas on paper, to the final evaluation of your design brief solution.

The design and production process

Throughout this unit, you will explore and learn about design process and how to apply it in your design project. The folio will assist you to work through the design process.

The design and production process:

- Involves a sequence of organised steps which provide a solution to design needs and opportunities
- May take a few seconds or minutes, or years depending on the complexity of the task
- May involve one person or many people
- May be simple or complex, depending on the task
- Involves the designer questioning (or evaluating) throughout the process (Department of Education, 2018)

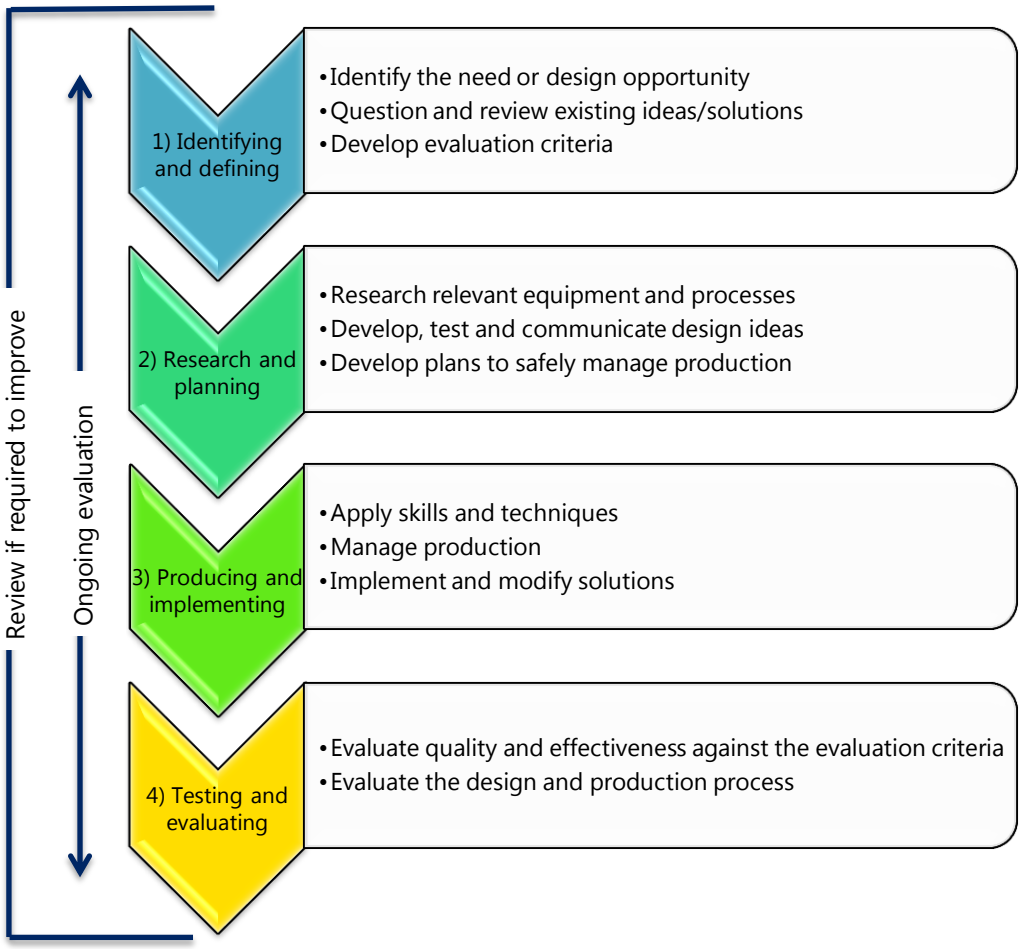

Figure 1 the design and production process. Source [Department of Education, 2018, Crack the Code]

Design activities

1 Identifying and defining

Thinking about the design brief

Underline circle or highlight words in the design brief that give you specific information of instructions.

Design and build a freshwater crayfish aquaponics system for your school.

Criteria for success

In order to complete this project, what will you need to do? Make a list of the things you believe will make your project a success. Add more lines if required.

☑ _____

☑ _____

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Prior knowledge

What knowledge and skills do you already have that you could use to solve the problem or make the product?

- **I know** _____
- **I can** _____

Probe

What are the gaps in your knowledge? What else do you need to find out about the problem before you start?

_____

_____

_____

Personal goals

What new skills and or information will you need to learn to complete this project?

_____

_____

_____

_____

Question and review existing ideas and solutions- group activity

1. **Follow these links to watch and investigate design ideas and construction methods to create aquaponics systems**
    - Build a large aquaponics system farm crayfish and vegetables
    - Aquaponics System- How we easily build aquaponics garden
    - How to assemble a small aquaponics system
    - Small scale aquaponics system for hobbyists/beginners
2. **In your group brainstorm 'yabby aquaponics systems'. Ideas to think about include: freshwater crayfish species, types of systems, plants to grow, growing medium, environmental constraints, where the system will be housed, cost of materials, materials available, tools needed, expertise needed, and aesthetics.**
3. **Make a list of five possible solutions from your group.**
4. **For each idea identify and discuss materials needed or available.**
5. **In your group pick your favourite idea and pitch it to your class.**

Use this space to include pictures of aquaponics systems which have inspired you and your group.

2 Research and planning

Learning activity – which yabby species?

You have learnt about different species of freshwater crayfish farmed in Australia. Choose a species you would like to grow in your aquaponics system. For this species answer the following.

Yabby species_____

Identify the species natural distribution.
How much space does the species need (stocking rate)?
What will you feed the yabby species?
How often will you feed the yabby species (winter vs. summer)?
What temperature range does the species require?
If you have juveniles and adult yabbies present in your aquaponics system, how will you provide shelter for both, to prevent cannibalism?
Is the species appropriate? Why? Or why not?

Learning activity – what to grow in the plant grow bed?

In conjunction with the major design project you will need to grow plants in your hydroponic grow out area.

Find a list of plants that you can grow which suit your local climatic conditions. Investigate the Australian Bureau of Meteorology to investigate your local climate.

For each plant, you will also need to know:

- Spacing between plants and rows
- How to care for your plants (fertiliser, water, sunlight and other management requirements)
- Suitable for aquaponics?

Investigate the seed packets page on the Yates website, to complete the following table.

Plant type	Months it can grow?	Fertiliser requirements	Water requirements	Light requirements	Plant spacing	Row distance	Suitable for aquaponics ? (✓/✗)

Learning activity - aquaponics system concepts

1. **Sketch ideas for at least 4 different aquaponics systems you might produce.**
2. **For each design idea, consider and label:**
   - **Materials**
   - **Yabby protection**
   - **Approximate size and dimensions**
   - **Where yabbies are grown**
   - **Where plants are grown**
   - **How you provide yabbies shelter**
   - **Water recycling and aeration**
   - **Provision of light**

Aquaponics system 1

Aquaponics system 2

Aquaponics system 3

Aquaponics system 4

3. **Complete the table on your ideas.**

Aquaponics system	Possible? Practical? (✓/✗)	Potential for success (✓/✗)	Identify the positives and negatives
1			
2			
3			
4			

4. **Ask students in your class their opinion of your concepts. Which aquaponics system is the most popular?** _____
5. **From the table above identify which aquaponics system is the most practical and has the greatest potential for success? This is the design you will put into action. Give your aquaponics system a name.**

   _____

   _____

6. **List all materials you will use or need for your project. For anything you need to buy, include an approximate cost.**

   _____

   _____

   _____

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   _____

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7. **What is the total approximate cost of your aquaponics system?**

8. **List the tools that you will use to complete your project.**

9. **Identify the growing medium you will use for your plants.**

10. **Explain how your water filtration system works.**

11. **Explain how the aeration and filtration systems work.**

12. **Identify how any waste water is recycled.**

13. **Identify how you will provide shelter and protection for the yabbies.**

14. **On this page sketch and describe in detail your final aquaponics system design. You will use this as a blueprint for your aquaponics system. Label:**
    - **Materials**
    - **Yabby protection**
    - **Size and dimensions**
    - **Where yabbies are grown**
    - **Where plants are grown**
    - **Provision of light**

Learning activities – Action plan

Write an action plan for producing your acquaponics system. Your plan should include all key steps that you must carry out to successfully build your acquaponics system. For each step in your plan, consider and answer the following questions in your table. Add more rows if required.

- *What* action must be carried out
- *Who* is responsible for the action?
- *How* will it be achieved?
- *Where* will this step happen?
- *When* is this step due to be finished?

Step	What	Who	How	Where	When	Complete (✓)

3. Producing and implementing

Learning activity - Safe and ethical work practices

Throughout this unit you will have the opportunity to work in a range of environments using tools and equipment to build your aquaponics system.

These areas will have specific equipment, risks and rules which you must follow for your own safety and the safety of others.

Complete the following questions to identify workplace health and safety issues.

1. **Does your design have any risks or safety concerns? (For example electrical equipment near water). List them.**

   _____
   _____
   _____
   _____

2. **How can you minimise or remove these risks?**

   _____
   _____
   _____
   _____

3. **List 5 specific tools or equipment you will use.**

   _____
   _____
   _____
   _____
   _____

4. **Identify 5 risks from using these tools.**

   _____
   _____
   _____
   _____
   _____

5. **Identify 5 ways to minimise these risks.**

   _____
   _____
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   _____
   _____
   _____

Learning activity - Record your progress

Follow your action plan to create your total system. Use this page to attach photos of your progress.

4. Testing and evaluating

1. **List two things about this project that you are most proud of.**

_____
_____
_____
_____

2. **How did your aquaponics system meet the design brief?**

_____
_____
_____
_____
_____
_____

3. **Is your design functional? (Why, why not or what could you change?)**

_____
_____
_____
_____
_____

4. **List any criteria for success that you did not meet.**

_____
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_____
_____
_____
_____

5. **Was time management an issue with your project? Explain.**

_____
_____
_____
_____

6. **When using tools, were there any safety issues or risks you encountered?**

_____
_____
_____
_____

7. **What would you do differently if you were to repeat this project?**

_____
_____
_____
_____

8. **What did other people say about your work?**

_____
_____
_____
_____

9. Overall what do you think were the best parts of your folio and final product?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Figure 2 *Cherax destructor*. Source NSW DPI

References and further reading

Aquaponics System- How we easily build aquaponics garden

Outdoor Life, 2016, '*Aquaponics System- How we easily build aquaponics garden*' YouTube, https://youtu.be/dAeJ5RwqPFQ, viewed July 24 2018

Build a large Aquaponics system, farm Crayfish and Vegetables

Easy aquaponics, 2017, '*Build a large Aquaponics system, farm Crayfish and Vegetables'*, YouTube, https://www.youtube.com/watch?v=-61r4LU5UGA&feature=youtu.be, viewed July 24 2018

Crack the Code

Department of Education, 2018, '*Crack the Code*', Sate of NSW, Department of Education, NSW Government, Education, Public Schools, https://education.nsw.gov.au/teaching-and-learning/curriculum/key-learning-areas/tas/s4-5/resources/crack-the-code, viewed July 24 2018

How to assemble a small aquaponics system

The Kings Roost, 2014, '*How to assemble a small aquaponics system*', YouTube, https://youtu.be/wmsgpQFruME, viewed July 24 2018

Small scale aquaponics system for hobbyists/beginners

Athey, L, 2014, '*Small scale aquaponics system for hobbyists/beginners*', YouTube, https://youtu.be/IVSEmwY2u0I, viewed July 25 2018

Technology Mandatory Years 7-8 Syllabus

NESA 2017, '*Technology Mandatory Years 7-8 Syllabus'*, NSW Education Standards Authority, NSW Syllabus for the Australian curriculum, http://educationstandards.nsw.edu.au/wps/wcm/connect/84369526-14e2-4fd3-acc0-98062f574a0e/technology-mandatory-7-8-syllabus-2017.pdf?MOD=AJPERES&CVID=, viewed July 24 2018

NSW syllabus outcomes

Technology Mandatory 2017 Stage 4

Outcomes	Content
Agriculture and Food Technologies	
TE4-1DP designs, communicates and evaluates innovative ideas and creative solutions to authentic problems or opportunities **TE4-2DP plans and manages the production of designed solutions** **TE4-3DP selects and safely applies a broad range of tools, materials and processes in the production of quality projects** **TE4-5AG investigates how food and fibre are produced in managed environments** **TE4-6FO explains how the characteristics and properties of food determine preparation techniques for healthy eating** **TE4-10TS explains how people in technology related professions contribute to society now and into the future TE4-10TS**	Identifying and defining • investigate how food and fibre production is managed in environments as a system and how sustainability can be improved, for example: (ACTDEK032) **ST** • develop criteria to evaluate design ideas, processes and solutions, the functionality, aesthetics and a range of constraints, e.g. accessibility, cultural, economic, resources, safety, social, sustainability, technical (ACTDEP038, ACTDIP027, ACTDIP031) **DT ST** Researching and planning • design and plan a product associated with agricultural production (ACTDEP036) **DT ST** • investigate ideal conditions for growth and development of an agricultural plant or animal (ACTDEK032) **ST** Producing and implementing • produce and implement an agricultural project and/or produce nutritious food (ACTDEP039) **DT** • select, justify and use a range of appropriate tools and techniques in an agricultural project and/or food preparation (ACTDEK037) **DT ST** • identify and apply safe and ethical work practices, for example: **DT** – correct use of tools and equipment Testing and evaluating • evaluate the effectiveness and suitability of choices made during the development and production of the solution • assess the solution against the predetermined criteria
Engineered Systems	
TE4-1DP designs, communicates and evaluates innovative ideas and creative solutions to authentic problems or opportunities **TE4-2DP plans and manages the production of designed**	Identifying and defining • investigate needs or opportunities for designing an engineered system and investigate and select from a range of materials, components, tools, equipment and processes (ACTDEP035) **DT ST** Researching and planning • select and use a variety of critical and creative thinking strategies

solutions **TE4-3DP selects and safely applies a broad range of tools, materials and processes in the production of quality projects**	to generate innovative design ideas, for example: DT ST – sketching – experimenting – brainstorming • generate and communicate the development of design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation techniques, for example: (ACTDEP036) CT DT – sketches, drawings and computer-aided drawing (CAD) – models and prototypes – engineering reports – digital presentations Testing and evaluating • evaluate the effectiveness and suitability of choices made during the development and production of the engineered solution • assess the solution against the predetermined criteria