# TECHNOLOGY INDICATORS OF PROGRESSION

The Indicators of Progression provide support for teachers to interpret the Achievement Objectives (AOs) for each strand of the technology curriculum within *The New Zealand Curriculum* (NZC) (2007). There are three matrices, each focused on one of the three strands of the technology curriculum, describing the eight levels of the NZC. Each matrix:

- restates the Achievement Objectives for each level
- provides guidance to teachers on what they could do to support student learning at each level
- provides indicators of what students should know or be able to do at each level.

The *Teacher Guidance* highlights the importance of the teacher's role in supporting student learning. It also acknowledges how the nature of teaching needs to change to ensure students are able to take more responsibility for their learning as they progress from levels 1-8 of the NZC. This has been emphasised by using the following terms to denote this shift in responsibilities from teacher to student.

- **Provide** is used when the teacher takes full responsibility for introducing and explicitly teaching new knowledge/skill or practices.
- **Guide** is used when the teacher assumes students will have some level of understanding/competency to draw from but continues to take the majority of the responsibility for developing these understandings further.
- **Support** is used when the balance shifts towards the student taking more responsibility for their learning, drawing from their past learning to consolidate and extend their understandings. In this case the teacher plays a more supportive role through questioning and challenging students to support them in their learning.

The *Teacher Guidance* also uses the term **ensure** to denote when the teacher plays a monitoring role to check that conditions critical for learning are present. For example, in 'planning for practice' and 'outcome development and evaluation' the teacher must ensure an appropriate brief is available to guide student work.

The *Indicators* describe generic understandings and capabilities that students should be able demonstrate consistently if they are to be considered to have met the related achievement objective. The indicators for each level should be viewed 'collectively' as indicating the AO at that level. Partial and/or inconsistent student demonstration of the indicators shows that additional and/or further consolidation learning experiences need to be provided to the student. This will ensure that future learning provides the opportunities necessary for the student to demonstrate the achievement described by all of the indicators at that level. It is expected that teachers will contextualise the indicators by re-phrasing them into appropriate language for the unit being studied, and the students they are teaching. By doing this the indicators can be used as targeted learning goals and assessment tools inside the classroom to plan for, guide, and acknowledge student learning.

The *Teacher Guidance* and *Indicators* have been developed through classroom research and refined through subsequent trialling. They are provided to guide formative and summative assessment practices, planning decisions and the development of effective and efficient reporting mechanisms for multiple audiences, including the students, their caregivers, and future teachers both within and across schools.

All three matrices will be periodically reviewed as implementation of the three strands proceeds and further development work in technology is undertaken.

# Components of Technological Practice

The Indicators of Progress within the Technological Practice section are divided into three components:

## Brief Development

Brief development is a *dynamic* process that reflects the complex interactions within ongoing technological practice. A brief is developed to clearly describe a desired outcome that would meet a need or realise an opportunity, and takes into account the physical and social environment. It is comprised of a conceptual statement that communicates *what* is to be done and *why* it should be done.

It also includes specifications that define the requirements of a technological outcome in terms of its *physical* and *functional* nature. The specifications provide guidance for ongoing evaluation during the development of an outcome, as well as serving as an evaluative tool against which the final outcome can be justified as fit for purpose. Brief Development can be thought of as the defining practices of technological practice.

## Planning for Practice

Effective planning techniques are critical for informed and responsive technological practice. Planning tools must be fit for purpose if they are to ensure the successful development of outcomes. Planning allows understandings from past and current experiences, as well as those that may be reliably forecast, to be taken into account in a systematic and managed way. Efficient resource management and accessing of stakeholder feedback relies on forward planning. Planning for practice incorporates *ongoing* critical evaluation and *efficient* and *appropriate* documentation. Planning for Practice can be thought of as the organising practice of technological practice.

## Outcome Development & Evaluation

The development of a *technological outcome (product or system)* involves the creative generation of design ideas leading to the testing and refinement of these into a conceptual design for a potential outcome, and the production and evaluation of an outcome prior to it's acceptance for use in-situ. This is achieved through such things as research, experimentation, functional modelling, and prototyping.

Outcome development and evaluation relies on the use and/or development of constructive skills and knowledge - including those associated with communicating design concepts and working with materials. Analysis of evaluative data gained from functional modelling and prototyping, and the use of this to make informed and justifiable decisions for a potential and/or realised outcome is critical to ensure the final outcome when produced is fit for purpose as defined by the brief. Outcome Development and Evaluation can be thought of as the production and evaluation practices of technological practice.

More information on each of these components can be found in the Technological Practice Explanatory Papers.

NOTE: The Indicators of Progression for the components of Technological Practice can be used to guide and support formative and summative assessment, and provide a basis for reporting purposes. These are based on the work of Dr Vicki Compton and Cliff Harwood. For details of the research underpinning the components please refer to Compton, V.J. and Harwood, C.D. (2005) 'Progression in Technology Education in New Zealand: Components of practice as a way forward.' *International Journal of Design and Technology Education*. Vol 15, #3, 253-287.

## COMPONENTS OF TECHNOLOGICAL PRACTICE: INDICATORS OF PROGRESSION — LEVEL ONE

Teachers should establish if students hold any misconceptions or partial understandings that would inhibit students meeting the level one achievement objectives for the technological practice, and plan learning experiences to challenge and/or progress these as guided by the level one Indicators below.

| Brief Development | Planning for Practice | Outcome Development & Evaluation |
|---|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Describe the outcome they are developing and identify the attributes it should have, taking account of the need or opportunity and the resources available. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Outline a general plan to support the development of an outcome, identifying appropriate steps and resources. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Investigate a context to communicate potential outcomes. Evaluate these against attributes; select and develop an outcome in keeping with the identified attributes. |
| **TEACHER GUIDANCE**<br>To support students to undertake brief development at level one teachers could:<br>• provide the need or opportunity and develop the conceptual statement in negotiation with the students<br>• provide a range of attributes for discussion<br>• guide students to identify the attributes an appropriate outcome should have. | **TEACHER GUIDANCE**<br>To support students to undertake planning for practice at level one teachers could:<br>• ensure that there is a brief against which planning to develop an outcome can occur<br>• provide students with a detailed plan of what they will be doing during their technological practice. This could be presented and explained as a design process the teacher has developed, with key stages that need to happen clearly identified within it<br>• provide a range of appropriate resources for students to select those suitable for their use. Teachers should ensure all resources provided are appropriate for use and students should only be responsible for selecting particular materials components, and/or software from these resources. | **TEACHER GUIDANCE**<br>To support students to undertake outcome development and evaluation at level one teachers could:<br>• ensure that there is a brief with attributes against which a developed outcome can be evaluated<br>• establish an environment that encourages and supports student innovation when generating design ideas<br>• provide opportunities to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and using manipulative media such as plasticine, wire, card etc<br>• provide opportunities to develop skills required to produce their outcome. |
| **INDICATORS**<br>Students can:<br>• communicate the outcome to be produced<br>• identify attributes for an outcome. | **INDICATORS**<br>Students can:<br>• identify what they will do next<br>• identify the particular materials, components and/or software they might use. | **INDICATORS**<br>Students can:<br>• describe potential outcomes, through drawing, models and/or verbally.<br>• identify potential outcomes that are in keeping with the **attributes,** and selects one to produce<br>• produce an outcome in keeping with identified attributes. |

## COMPONENTS OF TECHNOLOGICAL PRACTICE: INDICATORS OF PROGRESSION LEVEL TWO

Teachers should establish if students have developed robust level one competencies and are ready to begin working towards level two achievement objectives for the technological practice components, and plan learning experiences to progress these as guided by the level two Indicators below.

| Brief Development | Planning for Practice | Outcome Development & Evaluation |
|---|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Explain the outcome they are developing and describe the attributes it should have, taking account of the need or opportunity and the resources available. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Develop a plan that identifies the key stages and the resources available. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Investigate a context to develop potential outcomes. Evaluate these against identified attributes; select and develop an outcome. Evaluate the outcome in terms of the need/opportunity. |
| **TEACHER GUIDANCE**<br>To support students to undertake brief development at level two teachers could:<br>• provide the need or opportunity and develop the conceptual statement in negotiation with the students<br>• guide students to discuss the implications of the need or opportunity and the conceptual statements and support them to establish a list of attributes an appropriate outcome could have<br>• provide students with an overview of the resources available and guide them to take this into account when identifying the attributes for the outcome | **TEACHER GUIDANCE**<br>To support students to undertake planning for practice at level two teachers could:<br>• ensure that there is a brief against which planning to develop an outcome can occur<br>• provide students with an overview of the stages they will be working through during their technological practice. This could be presented and explained as a design process the teacher has developed, and it could be used to support students to identify what the key stages are<br>• provide a range of appropriate resources and guide students to decide which particular materials components, and/or software will be required for each key stage Teachers should ensure all resources provided are appropriate for use. | **TEACHER GUIDANCE**<br>To support students to undertake outcome development and evaluation at level two teachers could:<br>• ensure that there is a brief with attributes against which a developed outcome can be evaluated<br>• establish an environment that encourages and supports student innovation when generating design ideas<br>• provide opportunities to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and using manipulative media such as plasticine, wire, card etc<br>• provide opportunities to develop skills required to produce their outcome<br>• guide students to evaluate their outcome against the brief. |
| **INDICATORS**<br>Students can:<br>• explain the outcome to be produced<br>• describe the attributes for an outcome that take account of the need or opportunity being addressed and the resources available. | **INDICATORS**<br>Students can:<br>• identify key stages required to produce an outcome<br>• identify the particular materials, components and/or software required for each key stage. | **INDICATORS**<br>Students can:<br>• describe potential outcomes, through drawing, models and/or verbally<br>• evaluate potential outcomes in terms of identified attributes to select the outcome to produce<br>• produce an outcome in keeping with the brief<br>• evaluate the final outcome in terms of how successfully it addresses the brief. |

## COMPONENTS OF TECHNOLOGICAL PRACTICE: INDICATORS OF PROGRESSION LEVEL THREE

Teachers should establish if students have developed robust level two competencies and are ready to begin working towards level three achievement objectives for the technological practice components, and plan learning experiences to progress these as guided by the level three Indicators below

| Brief Development | Planning for Practice | Outcome Development & Evaluation |
|---|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Describe the nature of an intended outcome, explaining how it addresses the need or opportunity. Describe the key attributes that enable development and evaluation of an outcome. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Undertake planning to identify the key stages and resources required to develop an outcome. Revisit planning to include reviews of progress and identify implications for subsequent decision making. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Investigate a context to develop ideas for potential outcomes. Trial and evaluate these against key attributes to select and develop an outcome to address the need or opportunity. Evaluate this outcome against the key attributes and how it addresses the need or opportunity. |
| **TEACHER GUIDANCE**<br>To support students to undertake brief development at level three teachers could:<br>• provide the need or opportunity and develop the conceptual statement in negotiation with the students<br>• guide students to describe the physical and functional nature of an outcome (e.g. what it looks like and what it can do) taking into account the need or opportunity, conceptual statements and resources available<br>• guide students to identify the key attributes an appropriate outcome should have. Key attributes reflect those that are deemed essential for the successful function of the outcome. | **TEACHER GUIDANCE**<br>To support students to undertake planning for practice at level three teachers could:<br>• ensure that there is a brief against which planning to develop an outcome can occur<br>• provide students with an overview of what they will need to do during their technological practice and guide students to identify key stages and place these on a timeline of some sort<br>• provide resources including a range of appropriate materials, components, software, hardware, equipment, and/or tools for students to select from and guide students to select those that will be suitable for their outcome<br>• guide students to reflect on progress to make informed decisions regarding next steps. | **TEACHER GUIDANCE**<br>To support students to undertake outcome development and evaluation at level three teachers could:<br>• ensure that there is a brief with attributes against which a developed outcome can be evaluated<br>• establish an environment that encourages and supports student innovation when generating design ideas<br>• provide opportunities to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and using manipulative media such as plasticine, wire, card etc<br>• provide opportunity to develop knowledge and skills related to the performance properties of the materials/components students could use<br>• support students to evaluate their outcome against the brief. |
| **INDICATORS**<br>Students can:<br>• describe the physical and functional nature of the outcome they are going to produce and explain how the outcome will have the ability to address the need or opportunity<br>• describe attributes for the outcome and identify those which are key for the development and evaluation of an outcome. | **INDICATORS**<br>Students can:<br>• identify key stages, and resources required, and record when each stage will need to be completed to make sure an outcome is completed<br>• explain progress to date in terms of meeting key stages and use of resources, and discuss implications for what they need to do next. | **INDICATORS**<br>Students can:<br>• describe design ideas (either through drawing, models and/or verbally) for potential outcomes<br>• evaluate design ideas in terms of key attributes to develop a conceptual design for the outcome<br>• select materials/components, based on their performance properties, for use in the production of the outcome<br>• produce an outcome that addresses the brief<br>• evaluate the final outcome against the key attributes to determine how well it met the need or opportunity. |

## COMPONENTS OF TECHNOLOGICAL PRACTICE: INDICATORS OF PROGRESSION LEVEL FOUR

Teachers should establish if students have developed robust level three competencies and are ready to begin working towards level four achievement objectives for the technological practice components, and plan learning experiences to progress these as guided by the level four Indicators below.

| Brief Development | Planning for Practice | Outcome Development & Evaluation |
|---|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Justify the nature of an intended outcome in relation to the need or opportunity. Describe the key attributes identified in stakeholder feedback, which will inform the development of an outcome and its evaluation. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Undertake planning that includes reviewing the effectiveness of past actions and resourcing, exploring implications for future actions and accessing of resources, and consideration of stakeholder feedback, to enable the development of an outcome. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Investigate a context to develop ideas for feasible outcomes. Undertake functional modelling that takes account of stakeholder feedback, in order to select and develop the outcome that best addresses the key attributes. Incorporating stakeholder feedback, evaluate the outcome's fitness for purpose in terms of how well it addresses the need or opportunity. |
| **TEACHER GUIDANCE**<br>To support students to undertake brief development at level four teachers could:<br>• provide an appropriate context and issue that allows students to access resources (including key stakeholders)<br>• guide students to identify a need or opportunity and develop a conceptual statement<br>• support students to understand the physical and functional nature required of their outcome, and how the key attributes relate to this<br>• guide students to consider the key stakeholders and the environment where the outcome will be located. | **TEACHER GUIDANCE**<br>To support students to undertake planning for practice at level four teachers could:<br>• ensure that there is a brief against which planning to develop an outcome can occur<br>• provide resources including a range of appropriate stakeholders, materials, components, software, hardware, equipment, and/or tools for students to select from and support students to select those that will be suitable for their outcome<br>• provide planning tools and support students to use these to record key stages and resources needed, including when they will need to access stakeholder feedback, and to (Please note; records only need to capture what students plan to do and what they need to do it to guide their practice and allow them to review this regularly)<br>• support students to identify regular review points and to review their progress at these points<br>• guide students to manage time and organise their selected resources .based on regular reviews of progress | **TEACHER GUIDANCE**<br>To support students to undertake outcome development and evaluation at level four teachers could:<br>• ensure that there is a brief with attributes against which a developed outcome can be evaluated<br>• establish an environment that encourages and supports student innovation when generating design ideas<br>• provide opportunities to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and increasing the range and complexity of functional modelling<br>• provide a range of materials/components and support students to develop the necessary knowledge and skills to test and use them<br>• guide students to evaluate outcomes in situ against key attributes. |
| **INDICATORS**<br>Students can:<br>• identify a need or opportunity from the given context and issue<br>• establish a conceptual statement that communicates the nature of the outcome and why such an outcome should be developed<br>• establish the key attributes for an outcome informed by stakeholder considerations<br>• communicate key attributes that allow an outcome to be evaluated as fit for purpose. | **INDICATORS**<br>Students can:<br>• use planning tools to manage time, identify and record key stages, associated resources, and actions to be undertaken, with progress review points clearly indicated<br>• review progress at set review points, and revise time management as appropriate to ensure completion of an outcome. | **INDICATORS**<br>Students can:<br>• describe design ideas (either through drawing, models and/or verbally) or potential outcomes<br>• undertake functional modelling to develop design ideas into a conceptual design that addresses the key attributes<br>• test the key performance properties of materials/components to select those appropriate for use in the production of a feasible outcome<br>• produce and trial a prototype of the outcome<br>• evaluate the fitness for purpose of the final outcome against the key attributes. |

## COMPONENTS OF TECHNOLOGICAL PRACTICE: INDICATORS OF PROGRESSION — LEVEL FIVE

Teachers should establish if students have developed robust level four competencies and are ready to begin working towards level five achievement objectives for the technological practice components, and plan learning experiences to these as guided by the level five Indicators below.

| Brief Development | Planning for Practice | Outcome Development & Evaluation |
|---|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Justify the nature of an intended outcome in relation to the need or opportunity. Describe specifications that reflect key stakeholder feedback and that will inform the development of an outcome and its evaluation. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Analyse their own and others' planning practices to inform the selection and use of planning tools. Use these to support and justify planning decisions (including those relating to the management of resources) that will see the development of an outcome through to completion. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Analyse their own and others' outcomes to inform the development of ideas for feasible outcomes. Undertake ongoing functional modelling and evaluation that takes account of key stakeholder feedback and trialling in the physical and social environments. Use the information gained to select and develop the outcome that best addresses the specifications. Evaluate the final outcome's fitness for purpose against the brief. |
| **TEACHER GUIDANCE**<br>To support students to undertake brief development at level five teachers could:<br>• provide an appropriate context and issue that allows students to access resources (including key stakeholders)<br>• support students to identify a need or opportunity and develop a conceptual statement<br>• support students understand the physical and functional nature required of their outcome<br>• guide students to develop key attributes into specifications. | **TEACHER GUIDANCE**<br>To support students to undertake planning for practice at level five teachers could:<br>• ensure that there is a brief against which planning to develop an outcome can occur<br>• provide a range of planning tools and support students to analyse these to inform selection of the tools they will use to manage and efficiently record their planning<br>• support students to review and evaluate progress to inform their ongoing planning decisions<br>• guide students to ensure appropriate resources are available (stakeholder/s, materials, components, software, equipment, tools and/or hardware) suitable for their outcome<br>• support students to manage time and resources, including stakeholders interactions. | **TEACHER GUIDANCE**<br>To support students to undertake outcome development and evaluation at level five teachers could:<br>• ensure that there is a brief with clear specifications against which a developed outcome can be evaluated<br>• establish an environment that supports student innovation and encourages analysis of existing outcomes<br>• provide opportunities to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and increasing the range and complexity of functional modelling<br>• provide a range of materials/components and support students to develop the necessary knowledge and skills to evaluate and use them<br>• guide students to evaluate outcomes in situ against brief specifications. |
| **INDICATORS**<br>Students can:<br>• identify a need or opportunity from the given context and issue<br>• establish a conceptual statement that justifies the nature of the outcome and why such an outcome should be developed<br>• establish the specifications for an outcome based on the nature of the outcome required to address the need or opportunity, and informed by key stakeholder considerations<br>• communicate specifications that allow an outcome to be evaluated as fit for purpose. | **INDICATORS**<br>Students can:<br>• analyse own and others use of planning tools to inform the selection of tools best suited for their use to plan and monitor progress and record key decisions<br>• use planning tools to identify and record key stages, and manage time and resources (including stakeholder interactions) to ensure completion of an outcome<br>• use planning tools to record key planning decisions regarding the management of time, resources and stakeholder interactions. | **INDICATORS**<br>Students can:<br>• generate design ideas that are informed by research and analysis of existing outcomes<br>• undertake functional modelling to develop design ideas into a conceptual design that addresses the specifications<br>• evaluate suitability of materials/components, based on their performance properties, to select those appropriate for use in the production of a feasible outcome<br>• produce and trial a prototype of the outcome<br>• evaluate the fitness for purpose of the final outcome against the specifications. |

## COMPONENTS OF TECHNOLOGICAL PRACTICE: INDICATORS OF PROGRESSION — LEVEL SIX

Teachers should establish if students have developed robust level five competencies and are ready to begin working towards level six achievement objectives for the technological practice components, and plan learning experiences to progress these as guided by the level six Indicators below.

| Brief Development | Planning for Practice | Outcome Development & Evaluation |
|---|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Justify the nature of an intended outcome in relation to the need or opportunity and justify specifications in terms of key stakeholder feedback and wider community considerations. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Critically analyse their own and others' past and current planning practices in order to make informed selection and effective use of planning tools. Use these to support and justify ongoing planning that will see the development of an outcome through to completion. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Critically analyse their own and others' outcomes to inform the development of ideas for feasible outcomes. Undertake ongoing experimentation and functional modelling, taking account of stakeholder feedback and trialling in the physical and social environments. Use the information gained to select, justify, and develop a final outcome. Evaluate this outcome's fitness for purpose against the brief and justify the evaluation using feedback from stakeholders. |
| **TEACHER GUIDANCE**<br>To support students to undertake brief development at level six teachers could:<br>• provide an appropriate context and issue that allows students to access resources (including key stakeholders) and guide them to take into account wider community considerations<br>• support students to identify a need or opportunity relevant to the given issue and context<br>• support students to understand the physical and functional nature required of their outcome<br>• support students to develop specifications and justify them based on key and wider community stakeholder considerations. | **TEACHER GUIDANCE**<br>To support students to undertake planning for practice at level six teachers could:<br>• ensure that there is a brief against which planning to develop an outcome can occur<br>• support students to critically analyse a range of planning tools that have been used in past practice<br>• support students to select planning tools that will provide appropriate support for their practice and efficient recording of why key planning decisions were made<br>• support students to ensure appropriate resources are available (stakeholder/s, materials, components, software, equipment, tools and/or hardware) suitable for their outcome<br>• support students to use selected tools to manage resources to ensure completion of an outcome. | **TEACHER GUIDANCE**<br>To support students to undertake outcome development and evaluation at level six teachers could:<br>• ensure that there is a brief with clear specifications against which a developed outcome can be evaluated<br>• establish an environment that supports student innovation and encourages critical analysis of existing outcomes<br>• support students to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and increasing the range and complexity of functional modelling<br>• support students to explore a range of materials/components and to develop the necessary knowledge and skills to evaluate and use them<br>• support students to undertake prototyping to evaluate the outcome's fitness for purpose and identify any further development requirements<br>• support students to gain targeted stakeholder feedback. |
| **INDICATORS**<br>Students can:<br>• identify a need or opportunity from the given context and issue<br>• establish a conceptual statement that justifies the nature of the outcome and why such an outcome should be developed<br>• establish the specifications for an outcome as based on the nature of the outcome required to address the need or opportunity, consideration of the environment in which the outcome will be situated and resources available<br>• communicate specifications that allow an outcome to be evaluated as fit for purpose.<br>• justify the specifications in terms of key and wider community stakeholder considerations. | **INDICATORS**<br>Students can:<br>• critically analyse own and others use of planning tools to inform the selection of planning tools best suited for their use to plan and monitor progress and record reasons for planning decisions<br>• use planning tools to establish and review key stages, identify and manage all resources, and to determine and guide actions to ensure completion of an outcome<br>• use planning tools to record initial plans and ongoing revisions in ways which provide reasons for planning decisions made. | **INDICATORS**<br>Students can:<br>• generate design ideas that are informed by research and the critical analysis of existing outcomes<br>• undertake functional modelling to refine design ideas and enhance their ability to address the specifications<br>• evaluate design ideas in terms of their ability to support the development of a conceptual design for a feasible outcome<br>• evaluate the conceptual design against the specifications to determine the proposed outcomes potential fitness for purpose<br>• evaluate suitability of materials/components, based on their performance properties, to select those appropriate for use in the production of a feasible outcome<br>• produce and trial a prototype of the outcome to evaluate its fitness for purpose and identify any changes that would enhance the outcome<br>• use stakeholder feedback to support and justify key design decisions and evaluations of fitness for purpose. |

## COMPONENTS OF TECHNOLOGICAL PRACTICE: INDICATORS OF PROGRESSION — LEVEL SEVEN

Teachers should establish if students have developed robust level six competencies and are ready to begin working towards level seven achievement objectives for the technological practice components, and plan learning experiences to progress these as guided by the level seven Indicators of Achievement below.

| Brief Development | Planning for Practice | Outcome Development & Evaluation |
|---|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will: Justify the nature of an intended outcome in relation to the issue to be resolved and justify specifications in terms of key stakeholder feedback and wider community considerations. | **ACHIEVEMENT OBJECTIVE**<br>Students will: Critically analyse their own and others' past and current planning and management practices in order to develop and employ project management practices that will ensure the effective development of an outcome to completion. | **ACHIEVEMENT OBJECTIVE**<br>Students will: Critically analyse their own and others' outcomes and evaluative practices to inform the development of ideas for feasible outcomes. Undertake a critical evaluation that is informed by ongoing experimentation and functional modelling, stakeholder feedback, and trialling in the physical and social environments. Use the information gained to select, justify, and develop an outcome. Evaluate this outcome's fitness for purpose against the brief. Justify the evaluation using feedback from stakeholders and demonstrating a critical understanding of the issue. |
| **TEACHER GUIDANCE**<br>To support students to undertake brief development at level seven teachers could:<br>• provide a context that offers a range of issues for students to explore<br>• guide students to select an authentic issue within the context. An authentic issue is one which is connected to the context, and allows students to develop a brief for a need or opportunity that can be managed within the boundaries of their available resources.<br>• support students to identify a need or opportunity relevant to the issue<br>• support students to understand the physical and functional nature required of their outcome<br>• support students to justify the nature of their outcome in terms of the issue it is addressing<br>• support students to develop specifications and provide justifications for them drawing from stakeholder feedback, and wider community considerations such as the resources available to develop the outcome, ongoing maintenance of the outcome once implemented, sustainability of resources used to develop the outcome and the outcome itself, disposal of the developed outcome when past its use by date. | **TEACHER GUIDANCE**<br>To support students to undertake planning for practice at level seven teachers could:<br>• ensure that there is a brief against which planning to develop an outcome can occur<br>• support students to critically analyse a range of planning tools and project management practices that have been used in past technological practice<br>• support students to select and use planning tools to make effective planning decisions and establish and manage all resources (including time, money, stakeholder/s, materials, components, software, equipment, tools and/or hardware etc). Effective planning decisions enable the outcome produced to successfully meet the brief.<br>• support students to select and use planning tools which will allow for the efficient recording of justifications for key planning decisions made.<br>• support students to ensure appropriate resources are available (stakeholder/s, materials, components, software, equipment, tools and/or hardware) suitable for their outcome. | **TEACHER GUIDANCE**<br>To support students to undertake outcome development and evaluation at level seven teachers could:<br>• ensure that there is a brief with clear specifications against which a developed outcome can be evaluated<br>• establish an environment that supports student innovation and encourages critical analysis of existing outcomes<br>• support students to critically analyse evaluative practices used within functional modelling<br>• support students to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and increasing the range and complexity of functional modelling<br>• support students to explore a range of materials/components, and to develop the necessary knowledge and skills to evaluate and make effective use of them<br>• support students to undertake prototyping to gain evidence that enables clear judgments regarding the outcome's fitness for purpose and determine the need for any changes to enhance the outcome<br>• support students to gain targeted stakeholder feedback and understand the implications of the physical and social environment in which the outcome is to be located. |
| **INDICATORS**<br>Students can:<br>• explore the context to select an issue<br>• identify a need or opportunity relevant to their selected issue<br>• establish a conceptual statement that justifies the nature of the outcome and why such an outcome should be developed with reference to the issue it is addressing<br>• establish the specifications for an outcome using stakeholder feedback, and based on the nature of the outcome required to address the need or opportunity, consideration of the environment in which the outcome will be situated, and resources available<br>• communicate specifications that allow an outcome to be evaluated as fit for purpose<br>• justify the specifications in terms of stakeholder feedback, and the nature of the outcome required to address the need or opportunity, consideration of the environment in which the outcome will be situated, and resources available. | **INDICATORS**<br>Students can:<br>• critically analyse existing planning tools and project management practices to inform the selection of planning tools appropriate for the technological practice to be undertaken, and for recording evidence to support any revisions to planning<br>• use planning tools to set achievable goals, manage all resources, plan critical review points, and revise goal and resources as necessary to ensure the effective completion of an outcome<br>• use planning tools to provide evidence for any revisions made at critical review points and justifies the appropriateness of planning tools used. | **INDICATORS**<br>Students can:<br>• generate design ideas that are informed by research and critical analysis of existing outcomes<br>• develop design ideas for outcomes that are justified as feasible with evidence gained through functional modelling<br>• critically analyse evaluative practices used when functional modelling to inform own functional modelling<br>• undertake functional modelling to evaluate design ideas and develop and test a conceptual design to provide evidence of the proposed outcome's ability to be fit for purpose<br>• evaluate suitability of materials/components, based on their performance properties, to select those appropriate for use in the production of a feasible outcome<br>• undertake prototyping to gain specific evidence of an outcome's fitness for purpose and use this to justify any decisions to refine, modify and/or accept the outcome as final<br>• use stakeholder feedback and an understanding of the physical and social requirements of where the outcome will be situated to support and justify key design decisions and evaluations of fitness for purpose. |

## COMPONENTS OF TECHNOLOGICAL PRACTICE: INDICATORS OF PROGRESSION — LEVEL EIGHT

Teachers should establish if students have developed robust level seven competencies and are ready to begin working towards level eight achievement objectives for the technological practice components, and plan learning experiences to progress these as guided by the level eight Indicators below.

### Brief Development

**ACHIEVEMENT OBJECTIVE**

Students will: Justify the nature of an intended outcome in relation to the context and the issue to be resolved. Justify specifications in terms of key stakeholder feedback and wider community considerations.

**TEACHER GUIDANCE**

To support students to undertake brief development at level eight teachers could:

- support students to identify a context that offers a range of issues for them to explore. Context refers to the wider social and physical environment in which technological development occurs. Contexts may include but are not limited to: storage, afterschool snacks, outdoor living, sustainable energy, sport, educational software, streetwear, portability, furniture.
- support students to identify considerations that will need to be taken into account when making judgments of fitness for purpose in its broadest sense. Fitness for purpose in its broadest sense refers to judgments of the fitness of the outcome itself as well as the practices used to develop the outcome. Such judgments may include but are not limited to considerations of the outcome's technical and social acceptability, sustainability of resources used, ethical nature of testing practices, cultural appropriateness of trialling procedures, determination of life cycle, maintenance, ultimate disposal, health and safety.
- support students to select an authentic issue within their selected context
- support students to identify a need or opportunity relevant to the issue and context
- support students to understand the physical and functional nature required of their outcome
- support students to justify the nature of their outcome in terms of the issue and context
- support students to develop and justify specifications that will allow the evaluation of the outcome and its development to be judged as fit for purpose in the broadest sense.

**INDICATORS**

Students can:

- identify and evaluate a range of contexts to select an authentic issue
- explore context to identify considerations related to fitness for purpose in its broadest sense
- identify a need or opportunity relevant to their selected issue
- establish a conceptual statement that justifies the nature of the outcome and why such an outcome should be developed with reference to the issue being addressed and the wider context
- establish the specifications for an outcome and its development using stakeholder feedback and based on the nature of the outcome required to address the need or opportunity, consideration of the environment in which the outcome will be situated, and resources available
- communicate specifications that allow an outcome to be evaluated as fit for purpose in the broadest sense.
- justify the specifications as based on stakeholder feedback and the nature of the outcome required to address the need or opportunity, consideration of the environment in which the outcome will be situated, and resources available.

### Planning for Practice

**ACHIEVEMENT OBJECTIVE**

Students will: Critically analyse their own and others' past and current planning and management practices in order to develop and employ project management practices that will ensure the efficient development of an outcome to completion.

**TEACHER GUIDANCE**

To support students to undertake planning for practice at level eight teachers could:

- ensure that there is a brief against which planning to develop an outcome can occur
- support students to critically analyse a range of project management practices and explore how project scheduling is used to manage technological practice
- support students to establish and implement a coherent project schedule that allows for the coordination and management of the: regular review of goals, planning tools, all resources required (time, money, stakeholder/s, materials, components, software, equipment, tools and/or hardware etc) and review points
- support students to provide evidence of effective and efficient planning decisions. Effective and efficient planning decisions ensures that the use of resources is optimised during the development and production of an outcome produced to successfully meet the brief.

**INDICATORS**

Students can:

- establish a coherent project schedule suitable for the physical and social environment where the outcome is to be developed and implemented, informed by critical analysis of existing project management
- implement project schedule, undertaking reflection at critical review points to revise or confirm schedule to ensure the effective and efficient completion of an outcome
- manage the project to provide evidence of the coordination of goals, planning tools, resources and progress review points and justify planning decisions.

### Outcome Development & Evaluation

**ACHIEVEMENT OBJECTIVE**

Students will: Critically analyse their own and others' outcomes and their determination of fitness for purpose in order to inform the development of ideas for feasible outcomes. Undertake a critical evaluation that is informed by ongoing experimentation and functional modelling, stakeholder feedback, trialling in the physical and social environments, and an understanding of the issue as it relates to the wider context. Use the information gained to select, justify, and develop an outcome. Evaluate this outcome's fitness for purpose against the brief. Justify the evaluation using feedback from stakeholders and demonstrating a critical understanding of the issue that takes account of all contextual dimensions.

**TEACHER GUIDANCE**

To support students to undertake outcome development and evaluation at level eight teachers could:

- ensure that there is a brief with clear specifications against which a developed outcome can be evaluated
- establish an environment that supports student innovation and encourages critical analysis of existing outcomes and knowledge of material innovations
- support students to critically analyse the ways in which the fitness for purpose of existing outcomes have been determined, and how appropriate development practices were established
- support students to develop drawing and modelling skills to communicate and explore design ideas. Emphasis should be on progressing 2D and 3D drawing skills and increasing the range and complexity of functional modelling
- support students to explore a range of materials/components and to develop the necessary knowledge and skills to evaluate and make effective use of them.
- support students to establish which materials/components would be optimal for use when taking into account all contextual dimensions
- support students to undertake prototyping to gain evidence that enables clear judgments regarding the outcome's fitness for purpose and determine the need for any changes to enhance the outcome
- support students to gain targeted stakeholder feedback and understand the implications of the physical and social environment in which the outcome is to be located.

**INDICATORS**

Students can:

- generate design ideas that are informed by research and critical analysis of existing outcomes and knowledge of material innovations
- develop design ideas for feasible outcomes that are justified with evidence gained through functional modelling that serves to gather evidence from multiple stakeholders and test designs ideas from a range of perspectives
- undertake evaluation of design ideas informed by critical analysis of evaluative practices to support the development of a conceptual design for an outcome that optimises resources and takes into account maintenance and disposal implications
- undertake functional modelling of the conceptual design to provide evidence that the proposed outcome has the potential to be fit for purpose
- evaluate suitability of materials/components, based on their performance properties, to select those appropriate for use in the production of a feasible outcome that optimises resources and takes into account maintenance and disposal implications
- undertake prototyping to gain specific evidence of an outcome's fitness for purpose and use this to justify any decisions to refine, modify and/ or accept the outcome as final
- use stakeholder feedback and an understanding of the physical and social requirements of where the outcome will be situated to support and justify an evaluation of the outcome and development practices as fit for purpose.

# Components of Nature of Technology

The Indicators of Progress within the Nature of Technology section are divided into two components:

## Characteristics of Technology

Technology is defined as purposeful intervention-by-design. It is a human activity, known as technological practice that results in technological outcomes that have impact in the world. Technological outcomes can enhance the capability of people and expand human possibilities. Technological outcomes change the made world, and may result in both positive and negative impacts on the social and natural world. Technology uses and produces technological knowledge. Technological knowledge is aligned to function and validation of this knowledge occurs within technological communities when it is shown to support the successful development of a technological outcome. Technology is historically positioned and inseparable from social and cultural influences and impacts. Contemporary Technological Practices increasingly rely on collaboration between people within the technology community and with people across other disciplines.

## Characteristics of Technological Outcomes

Technological outcomes are products and systems developed through technological practice for a specific purpose. A technological outcome is evaluated in terms of its fitness for purpose. Technological outcomes can be described by their physical and functional nature. A technological outcome can only be interpreted when the social and historical context of its development and use are known. The term proper function is used to describe the function that the technologist intended the technological outcome to have and/or its socially accepted common use. If a technological outcome does not carry out its 'proper' function successfully it is described as a malfunction. Alternative functions are successful functions that have been evolved by end-users. Technological outcomes work together with non-technological entities and systems in the development of socio-technological environments.

More information on each of these components can be found in the Nature of Technology Explanatory Papers.

NOTE: The Indicators of Progression for the components of the Nature of Technology can be used to guide and support formative and summative assessment, and provide a basis for reporting purposes. These were originally based on the work of Compton and France. For details of the research underpinning these components please refer to Compton V.J and France B.J. in *Curriculum Matters 2007*. The teacher guidance and indictors have been revised and further developed by Dr V Compton and A Compton as a part of the Ministry of Education funded research project: *Technological Knowledge and Nature of Technology: Implications for teaching and learning*.

## COMPONENTS OF NATURE OF TECHNOLOGY: INDICATORS OF PROGRESSION — LEVEL ONE

Teachers should establish if students hold any misconceptions or partial understandings that would inhibit students meeting the level one achievement objectives for the nature of technology and plan learning experiences to challenge and/or progress these as guided by the level one Indicators below.

### Characteristics of Technology

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand that technology is purposeful intervention through design

**TEACHER GUIDANCE**

To support students to develop understanding of **characteristics of technology** at level 1, teachers could:

- provide opportunities for students to discuss what is meant by the made, natural, and social world and guide them to identify technological outcomes as making up a significant part of the made world
- provide students with examples of technologists and guide them to identify the sort of things they do as part of their technological practice. Technological practice involves the defining practices underpinning the development of a brief, the organising practices underpinning planning, and the production and evaluation practices involved in the development of an outcome that is fit for purpose as defined by the brief
- guide students to identify that the aim of technology is to design and make outcomes for an identified purpose.

**INDICATORS**

Students can:

- identify that technology helps to create the made world
- identify that technology involves people designing and making technological outcomes for an identified purpose
- identify that technological practice involves knowing what you are making and why, planning what to do and what resources are needed, and making and evaluating an outcome.

### Characteristics of Technological Outcomes

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand that technological outcomes are products or systems developed by people and have a physical nature and a functional nature.

**TEACHER GUIDANCE**

To support students to develop understanding of **characteristics of technologi**cal outcomes at level 1, teachers could:

- provide students with a range of contemporary and historical technological products and systems and encourage them to explore these through such things as: using, 'playing', dismantling and rebuilding as appropriate
- guide students to recognise the products and systems explored as technological outcomes developed by people to be suitable for particular users
- guide students to identify technological outcomes when presented with a collection of technological and non-technological objects and systems
- guide students to identify the physical nature of technological outcomes. The physical nature of technological outcomes refers to its physical attributes. For example; size, shape, colour, smell, texture, componentsguide students to identify the functional nature of technological outcomes. The functional nature of technological outcomes refers to its functional attributes. That is, what the outcome or part of the outcome does. For example; provides grip, transports mass, stores, joins surfaces.

**INDICATORS**

Students can:

- identify technological outcomes in a group of technological and non-technological objects and systems
- identify who might use particular technological outcomes
- identify the physical attributes of technological outcomes
- identify the functional attributes of technological outcomes.

## COMPONENTS OF NATURE OF TECHNOLOGY: INDICATORS OF PROGRESSION — LEVEL TWO

Teachers should establish if students have developed robust level one understandings and are ready to begin working towards level two achievement objectives for the nature of technology and plan learning experiences to progress these as guided by the level two Indicators below.

### Characteristics of Technology

**ACHIEVEMENT OBJECTIVE**

Students will:
Understand that technology both reflects and changes society and the environment and increases people's capability.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technology at level 2, teachers could:

- provide opportunities for students to discuss the made, natural, and social world and guide them to explore how technology relates to each of these
- provide students with examples of different technologist's practice and guide them to identify any social and/or environmental issues that might have influenced their practice and the nature of the outcomes they produce. For example; social attitudes to the environment has resulted in some technologists choosing to only use renewable materials, cold and windy environmental considerations requiring clothing outcomes that have insulating and close-fitting attributes
- provide students with examples of technological outcomes and guide them to explore how these have changed over time and identify any changes that have resulted in terms of people's capability to do things. Examples should allow students to recognize that increasing capability to do things may result in both positive and negative impacts on the person, society and/or the environment
- provide students with the opportunity to explore a range of technologies and guide them to identify examples of positive and negative impacts on people, society and/or the environment.

**INDICATORS**

Students can:

- describe the relationship between technology and the made, natural and social world
- identify social and/or environmental issues that may have influenced particular technological practices and/or the attributes of outcomes produced
- describe how particular technological outcomes have changed over time and identify if this resulted in changing how people do things
- describe examples to illustrate when technology has had a positive impact on society and/or the environment
- describe examples to illustrate when technology has had a negative impact on society and/or the environment.

### Characteristics of Technological Outcomes

**ACHIEVEMENT OBJECTIVE**

Students will:
Understand that technological outcomes are developed through technological practice and have related physical and functional natures.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technological outcomes at level 2, teachers could:

- provide students with a range of technological outcomes and non-technological objects and guide them to identify which of these could be described as technological outcomes and explain why. Technological outcomes are defined as fully realised products and systems, created by people for an identified purpose through technological practice. Once the technological outcome is placed in situ, no further design input is required for the outcome to function. Taking this definition into account, technological outcomes can be distinguished from natural objects (such as trees and rocks etc), and works of art, and other outcomes of human activity (such as language, knowledge, social structures, organisational systems etc)
- provide students with a range of contemporary and historical technological outcomes and encourage them to explore these through such things as: using, 'playing', dismantling and rebuilding as appropriate
- guide students to identify the technological outcomes explored as products and/or systems. Identifying an outcome as a product or system will influence the description of its physical nature. For example, if a technological outcome is identified as a product, the focus for describing its physical nature will be on the physical attributes afforded by the shaping, cutting, finishing etc of the materials it is made from. If a technological outcome is identified as a system, the focus for describing its physical nature will be on the physical attributes afforded by the components within it and how they are connected
- guide students to identify the relationship between physical and functional attributes in technological outcomes. For example the flat bottom of a cup (physical attribute) allows it to be stable on a flat surface (functional attribute)
- guide students to recognise that physical and functional attributes can give clues as to who might use the technological outcome for its intended purpose.

**INDICATORS**

Students can:

- describe what technological outcomes are and explain how they are different to natural objects and other things created by people
- identify a technological product and describe relationships between the physical and functional attributes
- identify a technological system and describe relationships between the physical and functional attributes
- describe the physical and/or functional attributes of a technological outcome that provide clues as to who might use it .

## COMPONENTS OF NATURE OF TECHNOLOGY: INDICATORS OF PROGRESSION LEVEL THREE

Teachers should establish if students have developed robust level two understandings and are ready to begin working towards level three achievement objectives for the nature of technology and plan learning experiences to progress these as guided by the level three Indicators below.

| Characteristics of Technology | Characteristics of Technological Outcomes |
|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand how society and environments impact on and are influenced by technology in historical and contemporary contexts and that technological knowledge is validated by successful function. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand that technological outcomes are recognisable as fit for purpose by the relationship between their physical and functional natures. |
| **TEACHER GUIDANCE**<br>To support students to develop understanding of characteristics of technology at level 3, teachers could:<br>• provide students with examples of different technologist's practice and guide them to identify how social and environmental issues could have influenced their decision making about; what should be made and why, how planning should be done and what resources should be used, how materials could be manipulated and tested, how outcomes should be evaluated, and manufacturing considerations<br>• provide students with the opportunity to explore a range of technologies and guide them to determine why they have changed over time. Reasons for changes include such things as changing needs, fashions, attitudes, ethical and environmental stances etc., or the development of new materials, skills and knowledge<br>• guide students to determine the impacts different technologies have had on society and/or the environment over time<br>• provide students with opportunities to discuss technological knowledge as knowledge that technologists agree is important for the development of a successful outcome and that if this knowledge is useful for a number of situations it can be codified for quick reference. For example; material tolerances, ratios, dosage. | **TEACHER GUIDANCE**<br>To support students to develop understanding of characteristics of technological outcomes at level 3, teachers could:<br>• provide students with a range of technological outcomes with unknown functions to explore and guide them to make informed suggestions regarding who might use them and the possible function they could perform, as based on an exploration and analysis of their physical nature<br>• provide students with the opportunity to explore a range of technological outcomes that are similar in their functional nature but have differences in their physical natures and vice versa<br>• support students to understand that the intended use and users, socio-cultural and physical locations all combine to determine how the physical and functional attributes can be best matched for optimum fitness for purpose. For example; a selection of brooms could be described as having similar functional attributes (clean an area by sweeping unwanted material to another location, able to be used while standing) but whether they are for a young child to sweep dust of the kitchen floor or for an adult to sweep water off driveways will mean quite different physical attributes will be decided upon to ensure the broom is fit for its purpose. Alternatively, a selection of brushes could be described as having similar physical natures (all have flexible bristles) but the way in which they are used will determine their functional nature as to whether they function to clean, act as a reservoir to spread a substance, or to separate something<br>• guide students to understand the relationship between the physical and functional nature in a technological outcome. That is, the functional nature requirements set boundaries around the suitability of proposed physical nature options (for example a chair for a child will constrain the dimensions of the chair) and the physical nature options will set boundaries around what functional nature is feasible for a technological outcome at any time (for example heavy cast iron pots will not be suitable for everyday use by the elderly)<br>• guide students to understand that the judgment of a technological outcome as a 'good' or 'bad' is related to the match between its physical and functional nature, its intended user/s and the context they would normally use it in. |
| **INDICATORS**<br>Students can:<br>• describe how societal and/or environmental issues can influence what people decided to make, how they would undertake planning, the selection of resources, and how they would make and test an outcome<br>• explain why particular technological outcomes have changed over time<br>• describe examples of how technology has impacted on the social world over time<br>• describe examples of how technology has impacted on the natural world over time<br>• identify that technological knowledge is knowledge that technologists agree is useful in ensuring a successful outcome. | **INDICATORS**<br>Students can:<br>• describe possible users and functions of a technological outcome based on clues provided by its physical attributes<br>• describe examples of technological outcomes with different physical natures that have similar functional natures<br>• describe examples of technological outcomes with different functional natures that have similar physical natures<br>• explain why a technological outcome could be called a 'good' or 'bad' design.. |

## COMPONENTS OF NATURE OF TECHNOLOGY: INDICATORS OF PROGRESSION — LEVEL FOUR

Teachers should establish if students have developed robust level three understandings and are ready to begin working towards level three achievement objectives for the nature of technology and plan learning experiences to progress these as guided by the level three Indicators below.

### Characteristics of Technology

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand how technological development expands human possibilities and how technology draws on knowledge from a wide range of disciplines.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technology at level 4, teachers could:

- provide students with opportunities to examine a range of technologies that have and/or could expand human possibilities by changing people's sensory perception and/or physical abilities. Examination of technologies should allow students to gain insight into how decisions are based on both what *could* and what *should* happen
- guide students to understand that 'expanding human possibilities' can result in positive and negative impacts on societies and natural environments and may be experienced differently by particular groups of people
- provide students with opportunities to examine and debate examples of innovative technologies that resulted in new possibilities. Examples should draw from the past and present and allow students to identify the creative and critical thinking that underpinned the developments.
- provide students opportunity to explore the wide range of knowledge and skills from diverse disciplines that support technology
- provide students opportunity to explore differences between technological knowledge and knowledge from other disciplines
- guide students to analyse a range of examples of technological practices and to identify the knowledge and skills that informed initial design decisions and ongoing manufacturing decisions. Examples should be drawn from within their own and others' technological practice and allow students to gain insight into how technological knowledge and skills, and knowledge and skills from other disciplines, can support technology.

**INDICATORS**

Students can:

- identify examples where technology has changed people's sensory perception and/or physical abilities and discuss the potential short and long term impacts of these
- identify examples of creative and critical thinking in technological practice
- identify and categorise knowledge and skills from technology and other disciplines that have informed decisions in technological development and manufacture

### Characteristics of Technological Outcomes

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand that technological outcomes can be interpreted in terms of how they might be used and by whom and that each has a proper function as well as possible alternative functions.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technological outcomes at level 4, teachers could:

- provide students with the opportunity to explore examples of technological outcomes and guide them to identify their proper function. Proper function can be determined from an analysis of both the design intent that drove the outcome's development as well as how it is most commonly used
- provide students with examples of technological outcomes where the proper function of a technological outcome has changed over time because an alternative use was successful and then became socially accepted as the norm
- provide students with examples of technological outcomes that have been used unsuccessfully for other purposes and/or in different environments and support them to identify the negative impacts. Impacts may be in terms of expected action not resulting, damage to the outcome, injury to the user, the damage to the social or physical environment – or any combination of these
- provide students with a description of an identified purpose (e.g. a stated need or opportunity) and other relevant details. These details should include such things as intended users and the environment in which it is to be situated. Support students to generate potential designs for a technological outcome and describe the physical and functional attributes it would require if it could be justified as a good design leading to an outcome that was fit for purpose.

**INDICATORS**

Students can:

- explain the proper function of existing technological outcomes
- explain how technological outcomes have been successfully used by end-users for purposes other than what they were originally designed for
- explain how technological outcomes have been unsuccessfully used by end-users for purposes other than what they were originally designed and discuss the impacts of this
- explain possible physical and functional attributes for a technological outcome when provided with intended user/s, a purpose, and relevant social, cultural and environmental details to work within.

## COMPONENTS OF NATURE OF TECHNOLOGY: INDICATORS OF PROGRESSION — LEVEL FIVE

Teachers should establish if students have developed robust level four understandings and are ready to begin working towards level five achievement objectives for the nature of technology and plan learning experiences to progress these as guided by the level five below.

### Characteristics of Technology

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand how people's perceptions and acceptance of technology impact on technological developments and how and why technological knowledge becomes codified.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technology at level 5, teachers could:

- provide students with opportunities to examine and debate examples of innovative technological developments. Examples should draw from the past and present and allow students to explore how creative and critical thinking impacts on developments and how what could happen and what should happen were considered
- guide students to analyse a range of examples of technologies to examine how people's perceptions and/or level of acceptance has influenced the practices and decisions underpinning their development and implementation. Examples should be drawn from the past and present to allow students to gain insight into the influence past experiences have on the perception and acceptance of existing and future technological practice and outcomes
- guide students to analyse a range of examples of technological practices to identify codified technological knowledge that was used to inform design and manufacturing decisions. Technological knowledge becomes codified when technological experts consider it is useful for a number of situations. Codified technological knowledge refers to such things as codes of standards, material tolerances, and codes of practice including codes of ethics, intellectual property codes, etc. Examples should be drawn from within their own and others' technological practice
- provide students with opportunities to discuss the role of codified knowledge in technology and understand why and how particular knowledge becomes codified. Codified knowledge provides others with access to established knowledge and procedures that have been shown to support successful technological developments in the past and can serve to remind technologists of their responsibilities. In this way codified knowledge can be used to provide constructional, ethical and/or legal compliance constraints on contemporary technological practice
- provide students with opportunities to discuss how established codified knowledge can be challenged and that ongoing revision is important due to the changing made, social and natural world. For example, the development of new materials, tools, and/or techniques, shifting social, political and environmental needs and understandings, and technological outcome malfunction, can all serve to challenge existing codified knowledge.

**INDICATORS**

Students can:

- discuss examples of creative and critical thinking that have supported technological innovation
- explain how people's past experiences of technology (both in terms of the nature of practices undertaken and the initial development and ongoing manufacturing of outcomes) influences their perception of technology
- explain how people's perception of technology influences their acceptance of technology
- explain how people's perception of technology impacts on future technological development
- explain how and why technological knowledge becomes codified
- explain the role codified knowledge plays in technological practice.

### Characteristics of Technological Outcomes

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand that technological outcomes are fit for purpose in terms of time and context. Understand the concept of malfunction and how "failure" can inform future outcomes.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technological outcomes at level 5, teachers could:

- guide students to analyse a range of examples of how technological outcomes have been evaluated as fit for purpose according to its appropriateness to the time and context of its development. Examples should be drawn from within students own and others' technological practice and allow students to examine the criteria used to make the judgment
- guide students to explore a range of examples of technological outcome failure and support them identify those that are examples of malfunction. Malfunction refers to a single event failure of a technological outcome as opposed to failure due to 'wear' or reaching the end of the outcome's designed lifespan
- guide students to analyse examples of technological outcome malfunction to gain insight into how such events can inform decisions about the future of the outcome. Decisions may be made to withdraw or modify the technological outcome or retain the outcome with modified operational parameters. Operational parameters refer to the boundaries and/or conditions within which the outcome has been designed to function.

**INDICATORS**

Students can:

- explain why time and context are important criteria for judging the fitness for purpose of technological outcomes
- evaluate past technological outcomes in the light of experiences subsequent to their development and/or contemporary understandings
- explain what is meant by the malfunction of technological outcomes
- explain the cause/s of particular technological outcome malfunction.

## COMPONENTS OF NATURE OF TECHNOLOGY: INDICATORS OF PROGRESSION — LEVEL SIX

Teachers should establish if students have developed robust level five understandings and are ready to begin working towards level six achievement objectives for the nature of technology and plan learning experiences to progress these as guided by the level six Indicators below.

### Characteristics of Technology

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand the interdisciplinary nature of technology and the implications of this for maximising possibilities through collaborative practice.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technology at level 6, teachers could:

- support students to analyse a range of examples of technological development and explain how different disciplines have impacted on the nature of the technological practice undertaken and how this in turn has influenced understandings of the contributing disciplines. Examples should include those from the students own work and others' technological practice and allow students to gain insight into the interdisciplinary nature of technological practice
- support students to explore examples of where collaborative work between technologists and/or other people has led to new possibilities for technological practice and/or outcome design. Examples should include those from the students own work and others' technological practice and allow students to gain insight into the way idea generation and exploration can be enhanced through collaboration
- support students to understand that interdisciplinary collaboration provides exciting opportunities to 'work at the boundaries' of established fields and appreciate that this may lead to situations where no codified technological knowledge exists to guide practice, tensions between people may arise, and a greater number of unknown consequences may result
- provide students with opportunities to discuss how the interdisciplinary nature of technology and the need for collaboration can influence how technology is understood and accepted by different groups in both positive and negative ways.

**INDICATORS**

Students can:

- explain how different disciplines have impacted on technological practice
- explain why collaboration is important in technological developments that involve interdisciplinary work
- explain how interdisciplinary collaboration in technology can enhance and/or inhibit technological development and implementation
- describe examples of interdisciplinary collaboration in technology that has influenced, or could influence public understanding and acceptance of technology.

### Characteristics of Technological Outcomes

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand that some technological outcomes can be perceived as both product and system. Understand how these outcomes impact on other outcomes and practices and on people's views of themselves and possible futures.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technological outcomes at level 6, teachers could:

- support students to discuss particular technological outcomes as a product and a system and support them to understand that the categorization of product or system is not an inherent property of the outcome, but rather how it is perceived by people in order to describe, and/or analyse it
- guide students to explore examples of socio-technological environments to explain how technological outcomes (products and systems) and non-technological entities and systems (people, natural environments, political systems etc.) interact together . Examples should be drawn from past, present and possible future socio-technological environments. Socio-technological environments include such things as communication networks, hospitals, transport systems, waste disposal, recreational parks, factories, power plant etc.
- support students to understand that interactions in socio-technological environments are complex and result in dynamic relationships between technological outcomes, entities and systems. Guide students to explore the influences and impact of these relationships on the way technological outcomes are developed and manufactured.

**INDICATORS**

Students can:

- explain why some technological outcomes can be described as both a product and a system
- describe socio-technological environments and the relationships of technological outcomes involved
- discuss the interactions between technological outcomes, people, and social and physical environments within particular socio-technological environments
- explain why understanding socio-technological environments allow technological outcomes to be better understood.

## COMPONENTS OF NATURE OF TECHNOLOGY: INDICATORS OF PROGRESSION — LEVEL SEVEN

Teachers should establish if students have developed robust level six understandings and are ready to begin working towards level seven achievement objectives for the nature of technology and plan learning experiences to progress these as guided by the level seven Indicators below.

### Characteristics of Technology

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand the implications of ongoing contestation and competing priorities for complex and innovative decision making in technological development.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technology at level 7, teachers could:

- provide students with opportunities to discuss the inseparable nature of technology and society and guide them to explore examples to analyse instances of the complex intertwining of society and technology. Contexts for exploration could be selected from areas such as; communication practices and communication technologies, life experiences and medical technologies, sporting endeavours and equipment/enhancement technologies
- provide students with opportunities to discuss technology as a field of on-going contestation and competing priorities that require resolution through complex decision making and guide students to recognise the role of functional and practical reasoning in such decision making
- guide students to critically analyse examples of technological practice to gain insight into how technologists identify and deal with contestable issues by understanding socio-cultural influences. Socio-cultural influences include such things as: social; cultural; political; environmental; and economic influences. This can be done through understanding the socio-cultural influences on fundamental aspects of technology in a particularly defined setting. Aspects of technology include such things as: problem identification and refinement to establish needs and opportunities; the development of designs and technological outcomes; resource selection and justification; post development manufacturing; implementation and ongoing in situ evaluation; maintenance and disposal; and ethical, social and moral responsibilities
- guide students to critically analyse examples of technological practice to gain insight into how technologists take competing priorities into account during decision making. Competing priorities include such things as: innovation versus acceptance/continuation; time versus quality; majority acceptance versus acceptable to all; social versus environmental benefit; ethical versus legal compliance etc.
- guide students to critically analyse examples of innovative technological developments. Examples should draw from the past and present and allow students to gain insight into how informed creativity, critical evaluation and the pushing of boundaries can support innovative decision making and outcomes. Opportunity should also be provided to critique innovative developments in terms their impact on how technology is understood and accepted by different groups in both positive and negative ways.

**INDICATORS**

Students can:

- discuss examples to illustrate how socio-cultural factors influence technology and in turn technology influences socio-cultural factors in complex and ongoing ways
- explain technology as a field of on-going contestation and why competing priorities arise
- explain how influences and priorities have been managed in technological decisions of the past
- explain how critical evaluation, informed creativity and boundary pushing impacts on technological development and public views of technology.

### Characteristics of Technological Outcomes

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand that technological outcomes are a resolution of form and function priorities and that malfunction affects how people view and accept outcomes.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technological outcomes at level 7, teachers could:

- provide students with opportunities to discuss how malfunction can impact on the design or manufacturing of similar and related technological outcomes
- provide students with opportunities to identify that form refers to the physical nature of a technological outcome and function refers to the functional nature of the outcome. Design elements related to an outcome's physical nature include such things as: colour; movement; pattern; proportion; harmony; taste etc. Design elements related to an outcome's functional nature include such things as strength; durability; stability; efficiency; nutritional value etc. Design elements are prioritised in different ways as determined by such things as a designer's intent for the outcome, understandings of materials, the socio-cultural location the outcome is to be situated, professional and personal beliefs etc.
- support students to critically analyse the physical and functional nature of technological outcomes to identify how design elements appear to have been prioritised and to explain how such a priotisation could be justified
- support students to analyse the prioritisation of design elements in particular technological outcomes with respect to the intended purpose of the technological outcome, intended users and specific context, the wider socio-technological environment it was a part of, and the era of its development and to make informed judgments as to the outcome's fitness for purpose.

**INDICATORS**

Students can:

- explain how malfunction can impact on the design and/or manufacture of similar and related technological outcomes
- justify how the design elements appear to have been prioritised in technological outcomes
- justify the fitness for purpose of technological outcomes in terms of their physical and functional nature and socio-technological environment/s they are used within.

## COMPONENTS OF NATURE OF TECHNOLOGY: INDICATORS OF PROGRESSION LEVEL EIGHT

Teachers should establish if students have developed robust level seven understandings and are ready to begin working towards level eight achievement objectives for the nature of technology and plan learning experiences to progress these as guided by the level eight Indicators below.

### Characteristics of Technology

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand the implications of technology as intervention by design and how interventions have consequences, known and unknown, intended and unintended.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technology at level 8, teachers could:

- support students to critically analyse examples of technological developments and their consequences, known and unknown and intended and unintended, to gain insight into the social responsibility technologists have due to the interventionist nature of technology. Examples should allow students to gain insight into how technology has real and long term impacts for the made, natural and social world. Students should be supported to discuss the implications this has for technologists' collective responsibility
- support students to understand that technology can challenge people's views of what it is to be 'human'. Contexts for exploration could include contemporary developments in the area of communication technologies, artificial intelligence, human-robotic interfaces, second-life gaming, genetic engineering, nanotechnology etc.
- support students to explore and critique the role of technology in the creation of sustainable environments. This would include discussion of such things as the ethics of designing for limited technological outcome lifespan, designing to comply with minimal engineering ideals, utilizing and developing sustainable materials, reducing energy consumption and waste, developing and managing socio-technological environments, etc.

**INDICATORS**

Students can:

- discuss technology as intervention by design and explain the impacts and implications of this
- discuss why technology can challenge people's views of what it is to be 'human'
- critique the role of technology in the development of sustainable environments
- discuss future scenarios where technology plays out different roles and justify projected impacts.

### Characteristics of Technological Outcomes

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand how technological outcomes can be interpreted and justified as fit for purpose in their historical, cultural, social, and geographical locations.

**TEACHER GUIDANCE**

To support students to develop understanding of characteristics of technological outcomes at level 8, teachers could:

- provide students with opportunity to extend their understanding of fitness for purpose. This extended notion is called 'fitness for purpose in its broadest sense' and refers to the 'fitness' of the outcome itself as well as the practices used to develop the outcome (e.g. such things as the sustainability of resources used, ethical nature of testing practices, cultural appropriateness of trialing procedures, determination of lifecycle and ultimate disposal)
- support students to explore the implications of a commitment to developing technological outcomes that are fit for purpose in the broadest sense on the design, development and manufacturing of technological outcomes
- support students to critically analyse a range of technological outcomes to evaluate their fitness for purpose, in its broadest sense. The evaluation will be based on the physical and functional nature of the outcome, the historical, cultural, social, and geographical location of the final outcome as well as its development, and any information available regarding its performance over time
- support students to explore possible benefits and disadvantages of employing the notion of fitness for purpose in its broadest sense in different contexts related to the design and development, manufacture, evaluation and analysis of technological outcomes.

**INDICATORS**

Students can:

- discuss the implications of viewing fitness for purpose in its broadest sense on the design and development of technological outcomes
- discuss the implications of viewing fitness for purpose in its broadest sense on the manufacture of technological outcomes
- justify the fitness for purpose, in its broadest sense, of technological outcomes
- debate the value of employing the notion of 'fitness for purpose in its broadest sense' as related to: the design and development, manufacture, evaluation and analysis of technological outcomes.

# Components of Technological Knowledge

The Indicators of Progress within the Technological Knowledge section are divided into three components:

## Technological Modelling

*Technological modelling* refers to modelling practices used to enhance technological developments and includes functional modelling and prototyping. *Functional modelling* allows for the ongoing testing of design concepts for yet-to-be-realised technological outcomes. *Prototyping* allows for the evaluation of the fitness for purpose of the technological outcome itself.

Through technological modelling, evidence is gathered to justify decision making within technological practice. Such modelling is crucial for the exploration of influences on the development, and for the informed prediction of the possible and probable consequences of the proposed outcome. Technological modelling is underpinned by both *functional and practical reasoning*. Functional reasoning focusses on 'how to make it happen' and 'how it is happening'. Practical reasoning focusses on 'should we make it happen?' and 'should it be happening?'

Decisions as a result of technological modelling may include the: termination of the development in the short or long term, continuation of the development as planned, changing/refining the design concept and/or the nature of the technological outcome before proceeding, or to proceed as planned and/or accept the prototype as fit for purpose.

## Technological Products

Technological products are material in nature and exist in the world as a result of human design. Understanding the relationship between the composition of materials and their related performance properties is essential for understanding and developing technological products. Technological knowledge within this component includes the means of evaluating materials to determine appropriate use to enhance the fitness for purpose of technological products. It includes understandings of how materials can be modified and material innovation. Understanding the impact of material selection and development on the design, development, maintenance and disposal of technological products is also included.

Technological Systems

Technological systems are a set of interconnected components that serve to transform, store, transport or control materials, energy and/or information. These systems exist in the world as the result of human design and function without further human design input. Understanding how these parts work together is as important as understanding the nature of each individual part.

Technological system knowledge includes an understanding of input, output, transformation processes, and control, and an understanding the notion of the 'black box' particularly in terms of sub-system design. Understanding redundancy and reliability within system design and performance, and an understanding of the operational parameters of systems are also included. Specialised languages provide important representation and communication tools and are therefore included to support developing ideas of system design, development, maintenance and troubleshooting.

More information on each of these components can be found in the Technological Knowledge Explanatory Papers.

NOTE: The Indicators of Progression for the components of Technological Knowledge can be used to guide and support formative and summative assessment, and provide a basis for reporting purposes. These were originally based on the work of Compton and France. For details of the research underpinning these components please refer to Compton V.J and France B.J. (2007). Towards a New Technological Literacy: Curriculum Development with a Difference. In *Curriculum Matters 3*: 2007158-175.Wellington: NZCER. The teacher guidance and indictors have been revised and further developed by Dr V Compton and A Compton as a part of the Ministry of Education funded research project: *Technological Knowledge and Nature of Technology: Implications for teaching and learning*.

## COMPONENTS OF TECHNOLOGICAL KNOWLEDGE: INDICATORS OF PROGRESSION LEVEL ONE

Teachers should establish if students hold any misconceptions or partial understandings that would inhibit them meeting the level one achievement objectives for technological knowledge and plan learning experiences to challenge and/or progress these as guided by the level one Indicators below.

| Technological Modelling | Technological Products | Technological Systems |
|---|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand that functional models are used to represent reality and test design concepts and that prototypes are used to test technological outcomes. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand that technological products are made from materials that have performance properties. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand that technological systems have inputs, controlled transformations, and outputs. |
| **TEACHER GUIDANCE**<br>To support students to develop understanding of technological modelling at level 1, teachers could:<br>• provide students with the opportunity to discuss why technological modelling is important to the development of technological outcomes and that it involves both functional modelling and prototyping.<br>• guide students to identify that functional models are representations of potential technological outcomes and that they exist in many forms (e.g. thinking, talking, drawing, physical mock-ups, computer aided simulations etc)<br>• provide students with the opportunity to discuss that design concepts includes design ideas for parts of an outcome, as well as the conceptual design for the outcome as a whole<br>• provide students with the opportunity to interact with a variety of functional models and guide them to identify that the purpose of functional modelling is to test design concepts to see if they are suitable for use in the development of an outcome<br>• guide students to identify that prototypes are the first versions of fully completed technological outcomes<br>• provide students with a range of prototyping examples and guide them to identify that the purpose of prototyping is to test the outcome.<br>• examples should include the modelling practices of technologists. | **TEACHER GUIDANCE**<br>To support students to develop understanding of technological products at level 1, teachers could:<br>• provide students with a range of technological products and encourage them to explore these through such things as: using, 'playing', dismantling and rebuilding as appropriate<br>• guide students to identify the materials that the products explored are made from<br>• provide opportunity for students to discuss that performance properties of materials refer to such things as thermal and electrical conductivity, water resistance, texture, flexibility, colour etc.<br>• provide students with the opportunity to explore common materials and guide them to identify their performance properties<br>• provide students with a range of technological products to explore and guide them to identify ways in which materials have been manipulated to make the product. For example, in a wooden toy the wood has been shaped, sanded and painted; In a sandwich, the bread dough has been shaped, cooked and sliced; in a cushion the fabric has been cut and sewn together. | **TEACHER GUIDANCE**<br>To support students to develop understanding of technological systems at level 1, teachers could:<br>• provide students with a range of technological systems and encourage them to explore these through such things as: using, 'playing', dismantling and rebuilding as appropriate<br>• guide students to identify the components and how they are connected in the systems explored<br>• guide students to identify the inputs and outputs of technological systems and provide opportunity for them to recognise that a controlled transformation has occurred. |
| **INDICATORS**<br>Students can:<br>• describe what a functional model is<br>• identify the purpose of functional modelling<br>• describe what a prototype is<br>• identify the purpose of prototyping. | **INDICATORS**<br>Students can:<br>• identify materials that technological products are made from<br>• identify performance properties of common materials<br>• identify how the materials have been manipulated to make the product. | **INDICATORS**<br>Students can:<br>• identify the components of a technological system and how they are connected<br>• identify the input/s and output/s of particular technological systems<br>• Identify that a system transforms an input to an output. |

## COMPONENTS OF TECHNOLOGICAL KNOWLEDGE: INDICATORS OF PROGRESSION LEVEL TWO

Teachers should establish if students have developed robust level one understandings and are ready to begin working towards level two achievement objectives for technological knowledge and plan learning experiences to progress these as guided by the level two Indicators below.

| Technological Modelling | Technological Products | Technological Systems |
|---|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand that functional models are used to explore, test, and evaluate design concepts for potential outcomes and that prototyping is used to test a technological outcome for fitness of purpose. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand that there is a relationship between a material used and its performance properties in a technological product. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand that there are relationships between the inputs, controlled transformations, and outputs occurring within simple technological systems. |
| **TEACHER GUIDANCE**<br>To support students to develop understanding of technological modelling at level 2, teachers could:<br>• guide students to understand that design concepts refers to design ideas for parts of an outcome, as well as the conceptual design for the outcome as a whole<br>• provide students with the opportunity to explore a variety of functional models and identify the specific design concept/s being tested<br>• guide students to discuss the sorts of things that could be explored and tested using functional modelling<br>• provide students with a range of prototyping examples and guide them to identify the specifications that were used to evaluate the prototype<br>• provide students with the opportunity to discuss how specifications provide a way of measuring the fitness for purpose of the prototype<br>• examples should include the modelling practices of technologists. | **TEACHER GUIDANCE**<br>To support students to develop understanding of technological products at level 2, teachers could:<br>• guide students to understand that performance properties of materials refer to such things as thermal and electrical conductivity, water resistance, texture, flexibility, colour etc.<br>• provide students with the opportunity to research and experiment with a range of materials and guide them to describe how their performance properties relates to how they could be useful. For example, a material that was water and UV resistant, durable, and easily cleaned could be useful for outdoor furnishings<br>• provide students with the opportunity to research and experiment with a range of materials and guide them to describe how particular materials can be manipulated.<br>• provide students with a variety of technological products to explore and encourage them to explore these through such things as: using, 'playing', dismantling and rebuilding as appropriate<br>• guide student to describe the relationship between the materials selected and their performance properties. For example, a school lunch box is made of plastic because plastic can be molded into different shapes, and is hard, durable, lightweight and easily cleaned. | **TEACHER GUIDANCE**<br>To support students to develop understanding of technological systems at level 2, teachers could:<br>• provide students with the opportunity to identify that simple technological systems are systems that have been designed to change inputs to outputs through a single transformation process<br>• provide students with a range of simple technological systems and encourage them to explore these through such things as: using, 'playing', dismantling and rebuilding as appropriate<br>• guide student to understand the role of each component and to identify the changes that are occurring in the transformation process<br>• guide students to understand that sometimes transformation processes may be difficult to determine or understand and these can be represented as a 'black box'. That is, a black box is described as a way of depicting a part of a system where the inputs and outputs are known but the transformation process is not known. |
| **INDICATORS**<br>Students can:<br>• describe the sorts of things that functional modeling can be used for in technology<br>• identify the design concept being tested in particular functional models<br>• identify why prototyping is important in technology<br>• identify the specifications used to evaluate particular prototypes. | **INDICATORS**<br>Students can:<br>• describe the performance properties of a range of materials and use these to suggest things the materials could be used for<br>• describe feasible ways of manipulating a range of materials<br>• suggest why the materials used in particular technological products were selected. | **INDICATORS**<br>Students can:<br>• describe the change that has occurred to the input to produce the output in simple technological systems<br>• identify the role each component has in allowing the inputs to be transformed into outputs within simple technological systems. |

## COMPONENTS OF TECHNOLOGICAL KNOWLEDGE: INDICATORS OF PROGRESSION — LEVEL THREE

Teachers should establish if students have developed robust level two understandings and are ready to begin working towards level three achievement objectives for technological knowledge and plan learning experiences to progress these as guided by the level three Indicators below.

### Technological Modelling

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand that different forms of functional modelling are used to inform decision making in the development of technological possibilities and that prototypes can be used to evaluate the fitness of technological outcomes for further development.

**TEACHER GUIDANCE**

To support students to develop understanding of technological modelling at level 3, teachers could:

- provide students with the opportunity to explore different forms of functional modelling and guide students to gain insight into the different types of information that have been gathered
- provide students with the opportunity to discuss how functional modelling informs decision making and guide them to identify the benefits and limitations of functional modelling in examples provided
- provide students with the opportunity to understand that benefits include such things as reducing the risk of wasting time, money and materials and limitations arise due to the representational nature of modelling. That is, what is being tested is necessarily partial and therefore prototyping is required to fully test the outcome
- provide students with the opportunity to discuss that specifications include both acceptability and feasibility considerations related to the outcome's fitness for purpose
- provide students with the opportunity to explore a range of examples of prototyping and guide them to gain insight into how appropriate information can be gained to evaluate a technological outcome's fitness for purpose against the specifications
- provide students with the opportunity to discuss the role of functional modelling and prototyping to develop an understanding of the importance of both in technological development.
- examples should include the modelling practices of technologists and should provide students with the opportunity to explore both successful prototypes and those that did not meet specifications.

**INDICATORS**

Students can:

- discuss examples to identify the different forms of functional models that were used to gather specific information about the suitability of design concepts
- identify the benefits and limitations of functional modelling undertaken in particular examples
- describe examples of particular prototypes that did not meet specifications.
- explain why functional modelling and prototyping are both needed to support decision making when developing an outcome.

### Technological Products

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand the relationship between the materials used and their performance properties in technological products.

**TEACHER GUIDANCE**

To support students to develop understanding of technological products at level 3, teachers could:

- provide students with the opportunity to discuss that performance properties of materials can be measured objectively and subjectively. Subjective measurement is reliant on people's perception (tasty, evokes a sense of natural beauty, warm and inviting etc) where as objective measurement is not (conductivity, UV resistance etc). The fitness for purpose of a product relies on the material providing appropriate performance properties to ensure the product is technically feasible and acceptable (safe, ethical, environmentally friendly, economically viable, etc -as appropriate to particular products)
- provide students with a variety of technological products to explore and guide them to identify the performance properties of all the materials used, and to explain if these could be measured objectively or subjectively
- provide students with a variety of technological products and guide them to explain how properties combine to make the product both technically feasible and socially acceptable.

**INDICATORS**

Students can:

- describe the properties of materials used in particular products that can be measured objectively
- describe the properties of materials used in particular products that can be measured subjectively
- describe how the properties combine to ensure the materials allow the product to be technically feasible and socially acceptable.

### Technological Systems

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand that technological systems are represented by symbolic language tools and understand the role played by the "black box" in technological systems.

**TEACHER GUIDANCE**

To support students to develop understanding of technological systems at level 3, teachers could:

- provide students with the opportunity to investigate a range of technological systems and guide them to understand that technological systems do not require further human design decision making during the transformation process for the inputs to be transformed to outputs. That is, a technological system will produce particular outputs in an automated fashion once the inputs have initiated the transformation process
- guide students to understand that a 'black box' is a term used to describe a part of a system where the inputs and outputs are known but the transformation process is not known
- provide examples of technological systems that contain unknown transformation processes (black boxes) and guide them to understand the role these play in terms of the advantages and/or disadvantages for developers and users
- provide opportunity for students to discuss that the fitness for purpose of a technological system relies on the selection of components, and how they are connected to ensure the system is technically feasible and acceptable (safe, ethical, environmentally friendly, economically viable, etc -as appropriate to particular systems)
- provide students with examples of how technological systems can be represented and guide students to interpret the specialised language and symbol conventions used
- provide students with opportunity to use specialised language and symbol conventions to represent technological systems to others.

**INDICATORS**

Students can:

- describe what 'black box' refers to within a technological system and the role of particular black boxes within technological systems
- identify possible advantages and disadvantages of having black boxed transformations within particular technological systems
- describe how the components, and how they are connected, allow particular systems to be technical feasible and socially acceptable
- describe particular technological systems using specialised language and symbol conventions.

## COMPONENTS OF TECHNOLOGICAL KNOWLEDGE: INDICATORS OF PROGRESSION — LEVEL FOUR

Teachers should establish if students have developed robust level three understandings and are ready to begin working towards level four achievement objectives for technological knowledge and plan learning experiences to progress these as guided by the level four Indicators below.

### Technological Modelling

**ACHIEVEMENT OBJECTIVE**

Students will: Understand how different forms of functional modelling are used to explore possibilities and to justify decision making and how prototyping can be used to justify refinement of technological outcomes.

**TEACHER GUIDANCE**

To support students to develop understanding of technological modelling at level 4, teachers could:

- provide students with the opportunity to explore how using different media influences the type of information that can be gathered
- provide students with the opportunity to discuss how different possibilities can be explored through functional modelling of design concepts and prototyping in order to make socially acceptable as well technically feasible decisions
- guide students to examine examples of functional modelling practices to identify how these were used to explore possibilities and gather different types of information to justify design decisions
- guide students to examine examples of prototyping and identify how information from these were used to justify the fitness for purpose of technological outcomes or to identify the need for further development
- examples should include the modelling practices of technologists and should include instances where refinements to the prototype were required to meet specifications.

**INDICATORS**

Students can:

- explain how functional modelling and prototyping allows for consideration of both what 'can' be done and what 'should' be done when making decisions
- discuss examples to illustrate how particular functional models were used to gather specific information about the suitability of design concepts
- identify information that has been gathered from functional models about the suitability of design concepts and describe how this information was used
- describe examples to illustrate how prototypes were tested to evaluate a technological outcome's fitness for purpose
- identify information that has been gathered from prototyping and describe how this information was used.

### Technological Products

**ACHIEVEMENT OBJECTIVE**

Students will: Understand that materials can be formed, manipulated, and/or transformed to enhance the fitness for purpose of a technological product.

**TEACHER GUIDANCE**

To support students to develop understanding of technological products at level 4, teachers could:

- provide students with the opportunity to discuss what is meant by materials being formed, manipulated and transformed. Forming refers to bringing two or more materials together to formulate a new material resulting in a different overall composition and structure to that of the original materials. This results in different performance properties. For example: mixing flour, water and salt to make dough; mixing wood fibres, resin and wax to make MDF; glass fibre and a polymer resin combined to form fiberglass or fibre reinforced polymer (FRP). Manipulating materials refers to 'working' existing materials in ways that do not change their properties as their composition and structure is not altered. For example: cutting; molding; bending; jointing; gluing; painting. Transforming refers to changing the structure of an existing material to change some of its properties, but in terms of its composition, it remains the same material. For example: felting; beating an egg white; steaming timber to soften its fibres and allow it to be manipulated (bent)
- guide students to understand that for materials to be selected for use in a technological product, their performance properties must align with the desired specifications of the product.
- guide students to recognise that during development of a product, specifications are established that will require the manipulation, and in some cases, transformation and formation, of materials.
- provide students with a variety of technological products to explore and guide students to identify examples of when materials needed to be manipulated, transformed and/or formed to enable material linked specifications of the product to be met and contribute to the product's fitness for purpose.
- provide students with a scenario outlining technical and acceptability specifications for a product and support them to explore and research materials to determine what material would be suitable and how they could be manipulated and/or transformed to meet product specifications
- support students to communicate material related details effectively. Material related details include such things as what materials would be feasible and how they would need to be formulated, manipulated and/or transformed. Effective communication uses specialised language and symbols.

**INDICATORS**

Students can:

- describe examples to illustrate how the manipulation of materials contributed to a product's fitness for purpose
- describe examples to illustrate how the transformation of materials contributed to a product's fitness for purpose
- describe examples to illustrate how the formulation of new materials contributed to a product's fitness for purpose
- communicate, using specialised language and drawings, material related details that would allow others to create a product that meets both technical and acceptability specifications.

### Technological Systems

**ACHIEVEMENT OBJECTIVE**

Students will: Understand how technological systems employ control to allow for the transformation of inputs to outputs.

**TEACHER GUIDANCE**

To support students to develop understanding of technological systems at level 4, teachers could:

- provide students with the opportunity to investigate a range of technological systems and guide them to identify how transformation processes are controlled
- support students to understand that control mechanisms can function to enhance the fitness for purpose of technological systems by maximising the desired outputs and minimising the undesirable outputs
- provide students with a scenario outlining technical and acceptability specifications for a system and support them to explore and research components and connectivity factors to determine what components would be suitable and how they could be connected to meet system specifications
- support students to communicate system related details effectively. System related details include such things as what components would be feasible, layout requirements, and how they would need to be connected. Effective communication uses specialised language and symbols.

**INDICATORS**

Students can:

- explain how transformation processes within a system are controlled
- describe examples to illustrate how the fitness for purpose of technological systems can be enhanced by the use of control mechanisms
- communicate, using specialised language and drawings, system related details that would allow others to create a system that meets both technical and acceptability specifications.

## COMPONENTS OF TECHNOLOGICAL KNOWLEDGE: INDICATORS OF PROGRESSION — LEVEL FIVE

Teachers should establish if students have developed robust level four understandings and are ready to begin working towards level five achievement objectives for technological knowledge and plan learning experiences to progress these as guided by the level five Indicators below.

### Technological Modelling

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand how evidence, reasoning, and decision making in functional modelling contribute to the development of design concepts and how prototyping can be used to justify ongoing refinement of technological outcomes.

**TEACHER GUIDANCE**

To support students to develop understanding of technological modelling at level 5, teachers could:

- provide opportunity for students to identify practical and functional reasoning underpinning technological modelling. *Functional reasoning* provides a basis for exploring the technical feasibility of the design concept and the realised outcome. That is, 'how to make it happen' in the functional modelling phase, and the reasoning behind 'how it is happening' in prototyping. *Practical reasoning* provides a basis for exploring acceptability (including socio-cultural and environmental dimensions) surrounding the design concept and realised outcome. That is, the reasoning around decisions as to 'should it happen?' in functional modelling and 'should it be happening?' in prototyping.
- provide opportunity for students to explore how informed and justifiable design decision making relies on both functional and practical reasoning and draws from evidence provided from modelling
- guide students to analyse examples of functional modelling practices to explain how these were used to gain evidence to justify design decisions with regards to both technical feasibility and acceptability. Such justifications will rely on the synthesis of evidence gained from modelling that sought feedback from different stakeholders.
- guide students to analyse examples of prototyping to explain how results were to used justify an outcome as fit for purpose or requiring refinement.
- provide opportunity for students to understand that maintenance requirements can be identified through prototyping and guide them to identify that maintaining an outcome can involve controlling environmental influences and/or undertaking ongoing refinements of the technological outcome
- support students to gain insight from prototyping examples into how testing procedures can provide information regarding maintenance requirements of a technological outcome
- examples should include the modelling practices of technologists and should include instances where refinements to the prototype were required to meet specifications.

**INDICATORS**

Students can:

- identify examples of functional and practical reasoning within design decision making
- explain how evidence gained from functional modelling was used to justify design decisions
- identify examples of functional and practical reasoning underpinning prototype evaluations and the establishment of maintenance requirements
- explain how evidence gained from prototyping was used to justify outcome evaluation as fit for purpose or in need of further development.

### Technological Products

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand how materials are selected, based on desired performance criteria.

**TEACHER GUIDANCE**

To support students to develop understanding of technological products at level 5, teachers could:

- guide students to understand that the composition of materials determines what performance properties it exhibits. Composition relates to such things as the type and arrangement of particles that make up the material.
- support students to analyse examples of how materials have been selected to gain insight into how this selection relies on understanding the composition of the materials available and using this knowledge to help decide which materials in combination would provide the best 'fit' with the product specifications
- examples should include the material selection practices of technologists.

**INDICATORS**

Students can:

- discuss examples to illustrate how the composition of materials determines performance properties
- explain the link between specifications of a product and the selection of suitable materials for its construction
- discuss examples to illustrate how decisions about material selection take into account the composition of the material and the specifications of the product.

### Technological Systems

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand the properties of subsystems within technological systems.

**TEACHER GUIDANCE**

To support students to develop understanding of technological systems at level 5, teachers could:

- guide students to understand that the properties of a subsystem relate to its transformation performance and its level of connective compatibility and that additional interface components may be required to ensure a subsystem can be effectively integrated into a system
- provide students with the opportunity to analyse a range of examples of complex technological systems that contain at least one subsystem. Complex technological systems are those designed to change inputs to outputs through more than one transformation process
- guide students to identify subsystems within technological systems and explain them in terms of their properties
- support students to use examples to gain insight into how the selection and interfacing of subsystems relies on understanding the transformation and connective properties of subsystems to ensure the best 'fit' with the required system specifications
- examples should include the subsystem selection and interfacing practices of technologists.

**INDICATORS**

Students can:

- identify subsystems within technological systems and explain their transformation and connective properties
- discuss how transformation and connection properties of subsystems impact on system layout and component selection
- discuss examples to illustrate how interfaces take into account the connective compatibility between subsystems and other system components.

## COMPONENTS OF TECHNOLOGICAL KNOWLEDGE: INDICATORS OF PROGRESSION — LEVEL SIX

Teachers should establish if students have developed robust level five understandings and are ready to begin working towards level six achievement objectives for technological knowledge and plan learning experiences to progress these as guided by the level six Indicators below.

| Technological Modelling | Technological Products | Technological Systems |
|---|---|---|
| **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand the role and nature of evidence and reasoning when managing risk through technological modelling. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand how materials are formed, manipulated, and transformed in different ways, depending on their properties, and understand the role of material evaluation in determining suitability for use in product development. | **ACHIEVEMENT OBJECTIVE**<br>Students will:<br>Understand the implications of subsystems for the design, development, and maintenance of technological systems. |
| **TEACHER GUIDANCE**<br>To support students to develop understanding of technological modelling at level 6, teachers could:<br>• guide students to explain how practical and functional reasoning underpin technological modelling. *Functional reasoning* provides a basis for exploring the technical feasibility of the design concept and the realised outcome. That is, 'how to make it happen' in the functional modelling phase, and the reasoning behind 'how it is happening' in prototyping. *Practical reasoning* provides a basis for exploring acceptability (including socio-cultural and environmental dimensions) surrounding the design concept and realised outcome. That is, the reasoning around decisions as to 'should it happen?' in functional modelling and 'should it be happening?' in prototyping.<br>• guide students to understand the concept of risk as it relates to reducing instances of malfunctioning of technological outcomes, and/or increasing levels of outcome robustness.<br>• guide students to understand how technological modelling is used to manage risk through exploring and identifying possible risk factors associated with the development of a technological outcome<br>• support students to analyse examples of technological modelling to understand how risk is explored and identified within particular technological developments.<br>• examples should include the modelling practices of technologists and should include instances where modelling was undertaken to explore and identify risk. | **TEACHER GUIDANCE**<br>To support students to develop understanding of technological products at level 6, teachers could:<br>• provide students with the opportunity to research and experiment with a range of materials to develop understandings of how the composition and structure of materials impacts on how they can be manipulated and/or transformed, or combined to formulate a new material.<br>• guide students to understand that material evaluation enables decisions to be made about how a material would support, or not, the fitness for purpose of particular technological products, and decrease the probability of a product malfunction.<br>• support students to analyse examples of how materials have been evaluated to determine their suitability for use in particular technological products<br>• examples should include the material evaluation practices of technologists. | **TEACHER GUIDANCE**<br>To support students to develop understanding of technological systems at level 6, teachers could:<br>• guide students to understand the role subsystems play in the design, development and maintenance of complex technological systems. Complex technological systems are those designed to change inputs to outputs through more than one transformation process.<br>• support students to indentify why subsystems may be 'black boxed' for development and/ or maintenance purposes and guide them to understand how this can result in both advantages (reduced need to understand all aspects of the system, ability to replace faulty subsystem without disrupting the entire system) and disadvantages (trouble shooting can be difficult).<br>• guide students to understand how control and feedback at a system level allow 'back up' or 'shutdown' subsystems to be employed to reduce malfunction and/or component damage<br>• support students to analyse examples of how subsystems have been selected and used in particular complex technological systems.<br>• support students to use examples to gain insight into how the use of subsystems can impact on system design, development and maintenance<br>• examples should include system design, development and maintenance practices of technologists. |
| **INDICATORS**<br>Students can:<br>• describe practical and functional reasoning and discuss how they work together to enhance decision making during technological modelling<br>• explain the role of technological modelling in the exploration and identification of possible risk/s<br>• discuss examples to illustrate how evidence and reasoning is used during functional modelling to identify risk and make informed and justifiable design decisions<br>• discuss examples to illustrate how prototyping provides information to determine maintenance requirements to ensure minimal risk and optimal performance over time. | **INDICATORS**<br>Students can:<br>• explain how the composition and structure of different materials enables them to be manipulated in specific ways<br>• explain how the composition and structure of materials determines the ways they can be transformed<br>• explain how the composition and structure of materials impacts on how they can be combined to formulate a new material<br>• describe the role of material evaluation in determining material suitability for use in a technological product<br>• discuss examples to illustrate how material evaluation informed the selection of materials in particular product development. | **INDICATORS**<br>Students can:<br>• explain the variety of roles played by subsystems in complex technological systems<br>• explain the implications of using subsystems during the design, development and maintenance of complex technological systems<br>• describe examples to explain how control and feedback requirements impact on subsystem use.<br>• discuss examples to illustrate the advantages and disadvantages of subsystems employed in particular technological systems. |

## COMPONENTS OF TECHNOLOGICAL KNOWLEDGE: INDICATORS OF PROGRESSION — LEVEL SEVEN

Teachers should establish if students have developed robust level six understandings and are ready to begin working towards level seven achievement objectives for technological knowledge and plan learning experiences to progress these as guided by the level seven Indicators below.

### Technological Modelling

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand how the "should" and "could" decisions in technological modelling rely on an understanding of how evidence can change in value across contexts and how different tools are used to ascertain and mitigate risk.

**TEACHER GUIDANCE**

To support students to develop understanding of technological modelling at level 7, teachers could:

- support students to explore how context impacts on the perception of the validity of evidence presented. Therefore, shifting from one context to another can change the status of the evidence provided by technological modelling.
- support students to explore how and why different people and communities accept different types of evidence as valid. That is, the status given to evidence is dependent on a range of factors including ethical views and the perceived authority of people involved in the presentation of the evidence
- support students to understand how decisions underpinning technological modelling based on what should and could happen, rely on an understanding of how evidence gained may differ in value across contexts and/or communities
- support students to understand how technological modelling is used to ascertain and mitigate risk. Ascertaining risk involves establishing the probability of identified risks. Mitigation involves taking steps to reduce the probability of the risk being realised and/or severity of the risk should it be realised
- support students to analyse examples of technological modelling to understand how risk is ascertained and mitigated within particular technological developments
- examples should include the modelling practices of technologists and should include instances where modelling was undertaken to mitigate risk.

**INDICATORS**

Students can:

- discuss examples to illustrate why the status of evidence gained from technological modelling might change across contexts
- explain why different people accept different types of evidence as valid and how this impacts on technological modelling
- explain the role of technological modelling in ascertaining and mitigating risk
- describe examples to illustrate the strengths and weaknesses of technological modelling for risk mitigation.

### Technological Products

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand the concepts and processes employed in materials evaluation and the implications of these for design, development, maintenance, and disposal of technological products.

**TEACHER GUIDANCE**

To support students to develop understanding of technological products at level 7, teachers could:

- support students to understand that material evaluation enables decisions to be made about what material would be optimal to ensure the fitness for purpose of particular technological products
- support students to explore a range of subjective and objective evaluative procedures used to identify the suitability of materials for different uses
- support students to describe the underpinning concepts and processes related to subjective and objective evaluative procedures
- support students to understand the selection of appropriate material evaluation procedures relies on understanding the composition and structure of materials, how their properties can be enhanced through manipulation or transformation, the performance criteria required by technological products and an understanding of the physical and social context within which the technological product will be situated
- support students to identify and analyse examples of how materials have been evaluated to allow material selection decisions that maximize the potential fitness for purpose of particular technological products and to gain insight into how material evaluation procedures can be used to identify product maintenance and disposal implications and therefore inform design, development and post production care decisions
- examples should include the material evaluation practices of technologists.

**INDICATORS**

Students can:

- discuss a range of subjective and objective evaluative procedures used to determine the suitability of materials and describe the underpinning concepts and processes involved in particular procedures
- discuss examples of material evaluation procedures undertaken to support material selection decisions and justify the appropriateness of these procedures
- discuss examples to explain how material evaluation impacted on design and development decisions
- discuss examples to explain how material evaluation impacted on maintenance and disposal decisions.

### Technological Systems

**ACHIEVEMENT OBJECTIVE**

Students will:

Understand the concepts of redundancy and reliability and their implications for the design, development, and maintenance of technological systems.

**TEACHER GUIDANCE**

To support students to develop understanding of technological systems at level 7, teachers could:

- support students to understand the concepts of redundancy and reliability in relation to technological systems. *Redundancy* relates to the inclusion of more time, information and/or resources than would strictly be needed for the successful functioning of the technological system. *Reliability* relates to the probability that a system will perform a required function under stated conditions for a stated period of time
- support students to identify and analyse a range of examples of technological systems to gain insight into how redundancy and reliability factors have impacted on system design, development and maintenance decisions
- examples should include system design, development and maintenance practices of technologists.

**INDICATORS**

Students can:

- explain the concept of redundancy in relation to technological systems
- discuss examples of particular technological systems to illustrate how factors related to redundancy impacted on system design, development, and/or maintenance decisions.
- explain the concept of reliability in relation to technological systems
- discuss examples of particular technological systems to illustrate how factors related to reliability impacted on system design, development, and/or maintenance decisions.

## COMPONENTS OF TECHNOLOGICAL KNOWLEDGE: INDICATORS OF PROGRESSION — LEVEL EIGHT

Teachers should establish if students have developed robust level seven understandings and are ready to begin working towards level eight achievement objectives for technological knowledge and plan learning experiences to progress these as guided by the level eight Indicators below.

### Technological Modelling

**ACHIEVEMENT OBJECTIVE**

Students will: Understand the role of technological modelling as a key part of technological development, justifying its importance on moral, ethical, sustainable, cultural, political, economic, and historical grounds.

**TEACHER GUIDANCE**

To support students to develop understanding of technological modelling at level 8, teachers could:

- support students to develop a critical and informed understanding of why technological modelling is an important aspect for ensuring responsible and defensible decisions are made during the design, development and any subsequent manufacturing of technological outcomes.
- support students to critically analyse examples of technological modelling practices that were undertaken to address a range of competing and contestable factors to gain insight into how these factors can be handled. These factors arise from such things as differing moral, ethical, cultural, and/or political views and the way in which people adhere to and understand issues such as sustainability, globalisation, democracy, global warming etc.
- examples should include the modelling practices of technologists and should include instances where modelling was undertaken to deal with competing and contestable factors.

**INDICATORS**

Students can:

- explain the role of technological modelling in making informed, responsive and defensible design and development decisions
- explain the role of technological modelling in making informed, responsive and defensible manufacturing decisions
- discuss examples to illustrate a range of technological modelling practices that have been undertaken in situations with competing and contestable factors
- critique examples of technological modelling practices in terms of how well they address underpinning factors.

### Technological Products

**ACHIEVEMENT OBJECTIVE**

Students will: Understand the concepts and processes employed in materials development and evaluation and the implications of these for design, development, maintenance, and disposal of technological products.

**TEACHER GUIDANCE**

To support students to develop understanding of technological products at level 8, teachers could:

- support students to understand that material evaluation enables decisions to be made about what material would be optimal to ensure the fitness for purpose when taking into account both the technical feasibility and social acceptability of the product.
- support students to critically analyse a range of subjective and objective evaluative procedures used to justify material suitability and to explain the underpinning concepts and processes involved in these procedures
- support students to understand why the selection of appropriate material evaluation procedures relies on understanding the composition and structure of materials, how their properties can be enhanced through manipulation or transformation, the performance criteria required by technological products and an understanding of the physical and social context within which the technological product will be situated.
- support students to understand that the development of new materials relies on understanding: existing materials including their advantages and limitations; new material composition and structure possibilities; formulation procedures; future requirements, needs and desires; and an awareness that new evaluative procedures may need to be developed to determine the suitability of new materials
- support students to identify and analyse examples where new materials have been developed, including past and contemporary examples, to gain insight into how material formulation and subsequent evaluation procedures are used to address performance, maintenance and disposal implications and inform design and development decisions
- examples should include material development (including formulation procedures) and evaluation practices of technologists.

**INDICATORS**

Students can:

- discuss examples of the formulation of new materials and explain the underpinning concepts and processes involved in their development
- discuss examples of evaluation procedures undertaken to determine the suitability of new materials and explain the underpinning concepts and processes involved in particular evaluations
- discuss examples of past material developments and explain how these impacted on product design, development, manufacturing, maintenance and disposal
- discuss examples of contemporary material developments and suggest probable implications for future technological product design, development, manufacturing, maintenance and disposal.

### Technological Systems

**ACHIEVEMENT OBJECTIVE**

Students will: Understand operational parameters and their role in the design, development, and maintenance of technological systems.

**TEACHER GUIDANCE**

To support students to develop understanding of technological systems at level 8, teachers could:

- support students to understand what operational parameters are and the role they play in the design, development and maintenance of technological systems. *Operational parameters* refer to the boundaries and/or conditions within which the system has been designed to function and are influenced by a number of factors associated with the technical feasibility and social acceptability of the system.
- support students to identify and differentiate highly complex systems. Highly complex systems include self-regulatory and intelligent systems. *Self regulatory* systems are those that have been designed to adjust the functioning of transformation processes in response to feedback from any part of the system to produce desirable and known outputs. *Intelligent systems* have been designed to adapt to environmental inputs in ways that change the nature of the system components and/or transformation processes in known and unknown ways to produce desirable but unspecified outputs.
- support students to identify and analyse a range of technological systems including simple, complex and highly complex technological systems
- support students to use examples to gain insight into underpinning operational parameters and how these have impacted on and been influenced by system design, development and maintenance decisions.
- examples should include system design, development and maintenance practices of technologists.

**INDICATORS**

Students can:

- explain what operational parameters are in relation to technological systems
- explain the operational parameters established for particular technological systems and explain the factors that influenced these
- discuss examples of technological systems to illustrate how operational parameters impacted on system design, development and maintenance
- discuss examples of simple, complex and highly complex technological systems to illustrate the demands that increasing complexity in system design requires in terms of establishing operational parameters.