# Technological Systems

Technological systems are sets of interconnected components that transform, store, transport, or control materials, energy, and/or information for particular purposes. In any system, how the parts work together is as important as their individual characteristics.

Important technological systems concepts include:

* input, output, transformation, and control
* "black box”
* redundancy and reliability
* operational parameters.

System design, development, maintenance, and troubleshooting require the use of specialised language and representations.

## Indicators of progression

Level 1

**Achievement objective**

Students will:

Understand that technological systems have inputs, controlled transformations, and outputs.

**Teacher guidance**

To support students to develop understanding of technological systems at level 1, teachers could:

* 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
* guide students to identify the components and how they are connected in the systems explored
* 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**

Students can:

* identify the components of a technological system and how they are connected
* identify the input/s and output/s of particular technological systems
* Identify that a system transforms an input to an output.

Level 2

**Achievement objective**

Students will:

Understand that there are relationships between the inputs, controlled transformations, and outputs occurring within simple technological systems.

**Teacher guidance**

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

* 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
* 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
* guide student to understand the role of each component and to identify the changes that are occurring in the transformation process
* 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**

Students can:

* describe the change that has occurred to the input to produce the output in simple technological systems
* identify the role each component has in allowing the inputs to be transformed into outputs within simple technological systems.

Level 3

**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.

Level 4

**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.

Level 5

**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.

Level 6

**Achievement objective**

Students will:

Understand the implications of subsystems for the design, development, and maintenance of technological systems.

**Teacher guidance**

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

* 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.
* support students to identify why subsystems may be ‘black boxed’ for development and1 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).
* 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
* support students to analyse examples of how subsystems have been selected and used in particular complex technological systems.
* support students to use examples to gain insight into how the use of subsystems can impact on system design, development and maintenance

Examples should include system design, development and maintenance practices of technologists.

**Indicators**

Students can:

* explain the variety of roles played by subsystems in complex technological systems
* explain the implications of using subsystems during the design, development and maintenance of complex technological systems
* describe examples to explain how control and feedback requirements impact on subsystem use.
* discuss examples to illustrate the advantages and disadvantages of subsystems employed in particular technological systems.

Level 7

**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.

Level 8

**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.