# Technological Modelling

Technological modelling is the testing of design ideas to see if they can contribute to a fit-for-purpose technological outcome. There are two types of technological modelling:

* Functional modelling is the ongoing testing of design concepts
* Prototyping is the realisation of a fully functioning model

Taken together, the two types of modelling provide evidence of factors that may impact on, and consequences that may result from, the development of a technological outcome

Technological modelling involves two kinds of reasoning:

* Functional reasoning – how to make it happen, how it is happening
* Practical reasoning – should we make it happen? should it be happening?

## Indicators of progression

Level 1

**Achievement objective**

Students will:

Understand that functional models are used to represent reality and test design concepts and that prototypes are used to test technological outcomes.

**Teacher guidance**

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

* 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.
* 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.)
* 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
* provide students with the opportunity to interact with a variety of functional models and guide them to identity 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
* guide students to identity that prototypes are the first versions of fully completed technological outcomes
* provide students with a range of prototyping examples and guide them to identify that the purpose of prototyping is to test the outcome.
* examples should include the modelling practices of technologists.

**Indicators**

Students can:

* describe what a functional model is
* identify the purpose of functional modelling
* describe what a prototype is
* identify the purpose of prototyping.

Level 2

**Achievement objective**

Students will:

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.

**Teacher guidance**

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

* 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
* provide students with the opportunity to explore a variety of functional models and identify the specific design concept/s being tested
* guide students to discuss the sorts of things that could be explored and tested using functional modelling
* provide students with a range of prototyping examples and guide them to identify the specifications that were used to evaluate the prototype
* provide students with the opportunity to discuss how specifications provide a way of measuring the fitness for purpose of the prototype

Examples should include the modelling practices of technologists.

**Indicators**

Students can:

* describe the sorts of things that functional modelling can be used for in technology
* identify the design concept being tested in particular functional models
* identify why prototyping is important in technology
* identify the specifications used to evaluate particular prototypes.

Level 3

**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.

Level 4

**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.

Level 5

**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.

Level 6

**Achievement objective**

Students will:

Understand the role and nature of evidence and reasoning when managing risk through technological modelling.

**Teacher guidance**

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

* 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.

* 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.
* 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
* support students to analyse examples of technological modelling to understand how risk is explored and identified within particular technological developments.

Examples should include the modelling practices of technologists and should include instances where modelling was undertaken to explore and identify risk.

**Indicators**

Students can:

* describe practical and functional reasoning and discuss how they work together to enhance decision making during technological modelling
* explain the role of technological modelling in the exploration and identification of possible risk/s
* discuss examples to illustrate how evidence and reasoning is used during functional modelling to identify risk and make informed and justifiable design decisions
* discuss examples to illustrate how prototyping provides information to determine maintenance requirements to ensure minimal risk and optimal performance over time.

Level 7

**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.

Level 8

**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.