# 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?

## Key ideas

### Representations

All “models” are by definition representations of reality. In technological practice:

* functional models play a crucial role in identifying an outcome’s potential and its probable impact on the world before it is fully realised as a technological outcome and implemented *in situ*
* prototypes enable technologists to explore factors that may have a bearing on the future development/manufacture of a technological outcome, in this way supporting them to justify the outcome as fit (or not fit) for purpose.

Technological modelling is an important tool in every technological domain but the knowledge and skills involved in creating and interpreting models are domain-specific.

The media and procedures used in technological modelling will vary depending on the stage of development and the preferences, needs, and capabilities of the technologist. Another consideration is the requirements of those who will provide input and feedback.

In the early stages of a development, functional modelling may simply consist of the technologist thinking through their design ideas and discussing them with other technologists and/or stakeholders to test their suitability. As the development progresses, selected designs may become drawings on paper or computer, then more formal written explanations and annotated diagrams. The next step may be three-dimensional mock-ups made from easily worked materials such as clay, cardboard, or polystyrene foam, or virtual CAD/3D models, which enable design ideas to be tested and evaluated to determine their technical feasibility and social acceptability. Increasingly, the materials used approximate those that will be used in the fully realised technological outcome. The final prototype will attempt to use these exclusively.

#### Note to teachers

At levels 1–4 students can learn much about functional modelling within the context of their own practice. But by the time they get to level 5 they need to be learning from the experience of a broad range of technologists so that their understanding is not limited to what they can personally do or by the opportunities available in their school setting.

Also, most school projects are one-offs, so students will gain very little experience of *prototyping* from their own practice. This means that their conceptual understanding of technological modelling needs to be developed through exposure to prototyping in a broad range of technological endeavour.

The location of the technological modelling component within the technological knowledge strand signals that students are expected to learn about the relevant concepts primarily from multiple real-life examples rather than their own (necessarily limited) practice.

### Functional modelling

*Functional modelling* goes under different names; for example, “test” or “predictive modelling” in biotechnology, “animatics” in film making, a “toile” in garment making, and “mock-ups” or “mocks” in architecture and structural engineering. In each case the modelling involves testing design concepts to see if the outcome under development (or some part of it) meets the appropriate physical and functional requirements.

Functional modelling enables technologists to evaluate design concepts from different perspectives and assess their likely impact. They can then make justifiable decisions about the technical feasibility and social acceptability of proposed technological outcomes, taking into account specifications, materials and techniques, historical and sociocultural considerations, etc., any of which, if ignored, could potentially have negative consequences.

Functional modelling in the early stages of a development may result in the decision (i) not to proceed any further, (ii) to revise the original concept, (iii) to proceed to the next stage, or (iv) to revise the brief to better describe what is required of a fit-for-purpose outcome.

The time to establish whether a design concept has worth in its broadest sense and to be asking the “what if” questions is earlier rather than later, so extensive functional modelling in the early stages of technological practice is strongly recommended. Early-stage functional modelling typically involves “guesstimation” based on other, similar technological developments and/or related situations, problems or issues, and on stakeholder feedback on design ideas.

Functional modelling can reduce the waste of resources that is inevitable when a technologist rushes into the realisation phase relying on a build-and-fix approach to carry them through. This makes functional modelling an important tool for enabling environmentally sensitive and sustainable developments.

The better the functional modelling, the more confident a technologist can be that an outcome will be fit for purpose and have minimal unexpected and/or undesirable impacts.

It is important however to keep in mind that functional models can ever only represent or simulate reality and for this reason they have their limitations.

### Prototyping

*Prototyping* (literally, “creating the first of a kind”)is the realisation of a functioning, material model of a technological outcome prior to its implementation in its destined location. With the creation of a prototype the outcome now exists in a material form,soit has an increased impact on the world.

The purpose of prototyping is to enable evaluation of a technological outcome’s fitness for purpose against the brief, and to determine whether it meets acceptability criteria or needs further development. Prototyping allows for in-depth exploration of the impacts (intended and unintended) that the outcome will have on people and/or the physical and social environment.

As with functional modelling, prototyping can result in (i) a “no-go” decision, (ii) modest refinements, or (iii) major changes to the design concept – in which case there was probably some major deficiency in the earlier stages of the project.

Given the high cost of producing a prototype (time, labour, materials, money, client confidence, etc.), abandoning a project or making major modifications at this late stage will have serious implications for the technologist. Indeed, such occurrences may quickly undermine the viability of a project or business.

Sometimes prototyping leads to the decision to implement a technological outcome as is but most often it results in small-scale modifications that will enhance the outcome’s performance and/or suitability*.*

So prototyping serves two functions: (i) optimising the fitness for purpose of a technological outcome and (ii) providing evidence that a technological outcome is ready for implementation. In industry, prototyping is also used to test scale-up opportunities, providing information that feeds into decisions regarding ongoing or multi-unit production and marketing.

Different communities of technological practice have their own methods of prototyping. If a technologist wants to use other methods they need to be seen to have equal or greater utility than those currently accepted.

### Control over a development

The figure below shows that, at first, technologists have a lot of control over how a design is progressed. Then, as the design concept enters the transition phase where it is realised in material form, this level of control is much reduced. At the same time, the potential impacts (for example, environmental, social, economic or political) of the outcome on the world, both beneficial and harmful, are much increased.



The transition/realisation phase is a critical point in any technological development because once past, the outcome exists for better or worse (the genie is out of the bottle), though further developmental work can usually be halted or substantially revised.

### Modelling and risk management

By identifying possible risk factors in a development, technological modelling can inform risk management decisions. Assessing risk involves establishing the likelihood that a particular circumstance will actually happen, and how severe its impact would be. Once this has been done a considered decision can be made to avoid, mitigate, transfer, or retain the risk.

### Types of reasoning

Technological modelling makes use of both *functional* and *practical* reasoning to provide a holistic evaluation of a technological outcome’s potential and its likely “impact on the world”:

* *Functional reasoning* explores the technical feasibility of the design concept and outcome: “how to make it happen” (functional modelling) and “how it is happening” (prototyping);
* *Practical reasoning* explores the acceptability (moral, ethical, social, political, economic, environmental, etc.) of the design concept and outcome testing: “should it happen” (functional modelling) and “should it be happening” (prototyping).