

PRODUCT DESIGN SCOTLAND TOOLKIT



01

DESIGN PROCESS

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ABOUT US

With a long tradition of innovation, entrepreneurship and commercialisation, the product design sector is one of Scotland's key industries. Through advances in technology, designers are providing innovative products across a number of global markets, including healthcare, energy, communications and mobility. Integration of these technologies into viable, efficient and commercially attractive products is key, and the partnership between technology and product design is becoming ever more important.

Product Design Scotland, managed by Technology Scotland, the representative body for Scotland's Enabling Technologies Sector, has been established to support the product and industrial design sector in Scotland. The network aims to be the focal point for the community, raising awareness of the critical importance of design to future growth and competitiveness and creating a thriving, collaborative network to drive innovation.

By working with companies and organisations across Scotland, we support the sector through:

- Promoting the value of strategic design to government and industry
- Raising the profile of Scotland's product/ industrial design sector
- Increasing visibility of those operating within relevant supply chains
- Improving competitiveness through collaboration and knowledge exchange
- Creating new networks to shape the future of design in Scotland.

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TOPIC INTRODUCTION

DESIGN PROCESS

There is much more to developing an idea that can actually solve a problem or take advantage of a market opportunity than you might think. Many organisations have tried to illustrate it as a simple product design process, but in reality it is more of a complex journey.

No diagram sums up this journey better than the Design Squiggle by Damien Newman, as it is rarely a series of steps from A to B. Often you find yourself going backwards, covering old ground to move forward.



As representative as the above is, the freedom to explore must somehow be controlled if you are to meet deadlines, costs and market expectations, so for this we need to understand and employ Technology Readiness Levels or TRLs.

In this toolkit we will look at best practises and how the design process and TRLs can be combined to manage new product development.



KEY STEPS IN THE DESIGN PROCESS

QUALIFYING THE DESIGN BRIEF

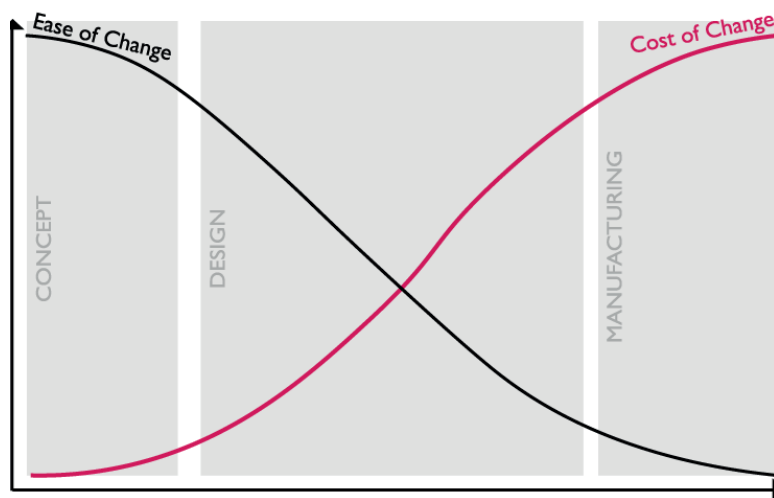
A large part of the process is engagement with the many people involved in the research and development (R&D) process of developing new products. These people are potential customers, designers, investors, manufacturers, distributors and marketeers to name a few, and are collectively known as 'stakeholders'. Every one of them has an interest in your journey.

It is important to understand:

- a. What do stakeholders want from me?
- b. What do I want from them?

These questions should be revisited regularly throughout the design process to ensure the reason why you are developing a particular product is clear. It will always be easier (and cheaper) to make changes at the beginning of the project to reflect your research than it will later once you have committed to manufacturing.

If no one wants it, it will be a very expensive mistake.

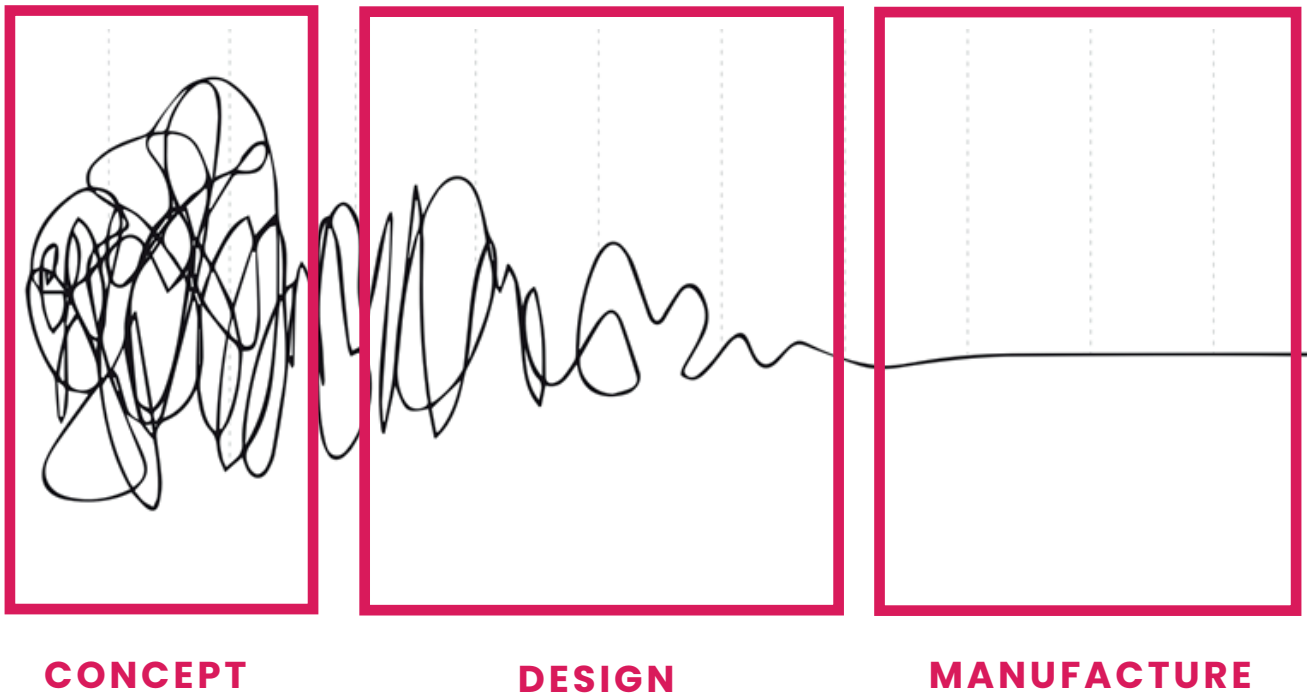


At the beginning of a project, change is easy and relatively low cost.

Making changes later in the project can be difficult and very expensive.

A DESIGN JOURNEY

As the design process is a mixture of research, investigation, human factors and prototyping, it naturally feels quite overwhelming, but as you untangle the process it becomes clearer and more constrained, as illustrated below.



DESIGN PROCESS AND TECHNOLOGY READINESS LEVELS

Engagement with stakeholders will help build a design brief, but the design process needs to be measured against a series of steps called Technology Readiness Levels, or TRLs. These levels enable the process to be continually 'sense checked', providing structure and ensuring the design is ultimately fit for purpose.

TRLs were developed at NASA during the 1970s, following on from the original Apollo Space Program. It has subsequently provided the backbone for many engineering projects - both large and small - around the world.

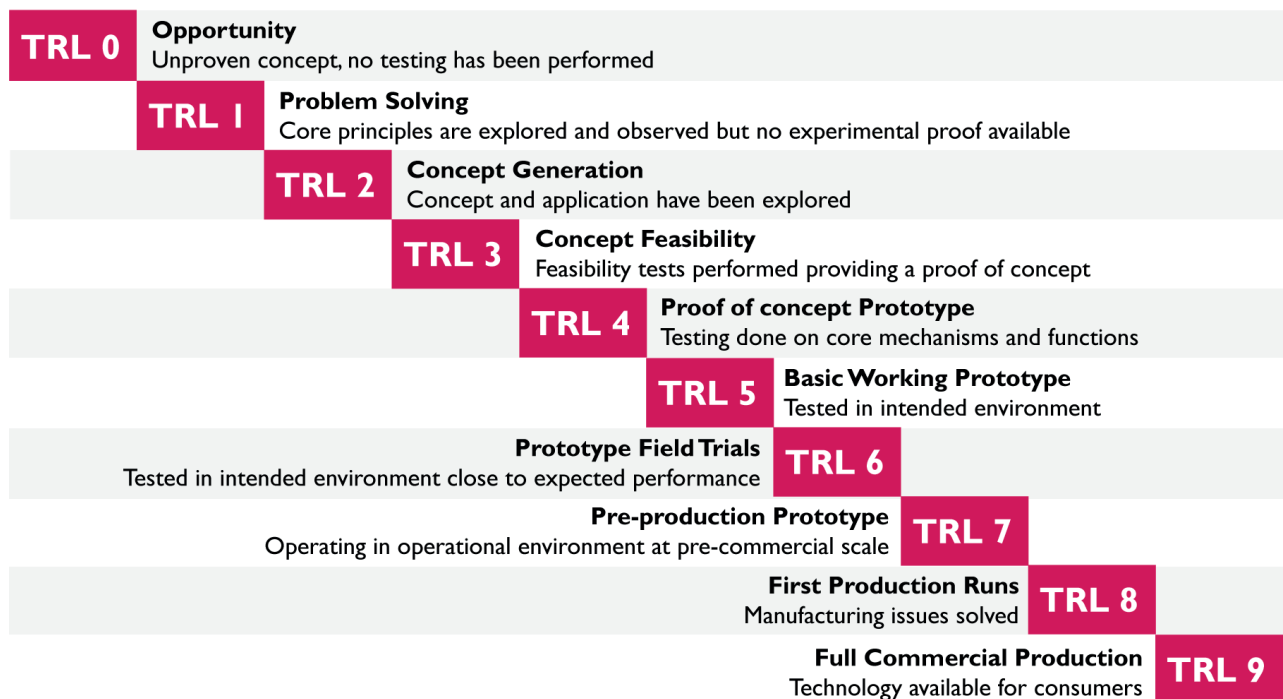
UNDERSTANDING TRLs

TRLs run from 0 to 9. TRL 0 is best described as an opportunity. No concept, only a desire or need. This is where we ask - what are we designing? TRL 9 is where the final product is in the customers hands at a price they are prepared to pay.

The levels between these two points break the journey up into recommended milestones, which can be used to manage product testing, funding rounds, manufacturing suitability and customer engagement.

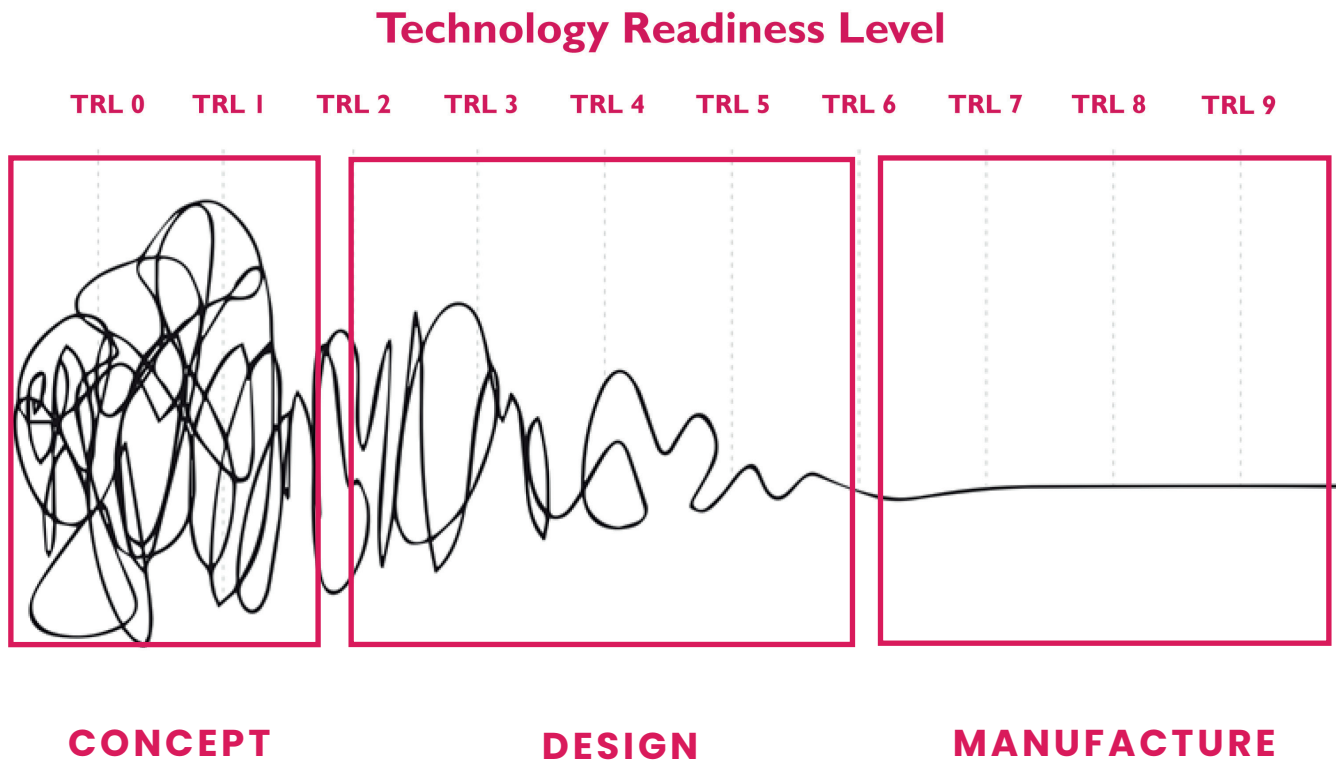
The complete TRLs are shown below:

Technology Readiness Level



BRINGING IT ALL TOGETHER

Combining the soft skills of the design process and the hard deliverables of the TRLs means the measurements being made are based on stakeholder feedback and engineering quality.



By working on the product design and engineering concurrently, the process becomes more efficient and ultimately more cost effective.

By considering both, the design journey should be flexible when it needs to be, firming up as you get closer to manufacturing the product. The investment will be proportional to the return, but until you start selling the money only goes one way.

Key Takeaways

- An idea comes after the opportunity has been identified and explored.
- Understand the opportunity as fully as you can by identifying your stakeholders and their role in your journey.
- Break a project down into steps using the TRLs as a guide, as this can help manage finances and maintain agility throughout the project.
- Make sure the amount invested is proportional to the return. How you measure that is up to you.
- As a starting point, successful companies invest around 10% in R&D.



CASE STUDY

DEVELOPMENT OF A HUMANE LAMB TAIL DOCKING AND CASTRATION DEVICE

OVERVIEW

Lamb tail docking and castration is a sore subject for animal welfare groups and ethical consumers, but are often necessary husbandry procedures. Traditionally, pliers are used to apply a rubber ring around the appendage, and often without any pain relief.

An initial study carried out in the 90s identified that a precise dosage of local anaesthetic around key nerves would dramatically speed up a lamb's recovery following the procedure. However, a commercially viable solution had not been realised. Until now.

In 2019 Numnuts® was launched in Australia as the world's first humane sheep 'marking' (castration and tail docking) device.

EXPLORING THE OPPORTUNITY

The opportunity has been identified (TRL 0), and so must be explored. A feasibility study is the first step in looking into the market to uncover consumer trends for meat and wool produce. Engaging with stakeholders and users early on to gain insight into the industry allows input to be included at an early stage. Key stakeholders at this point include farmers, vets, anaesthetists and needle experts, along with scientific and engineering bodies to help guide the ideas process.



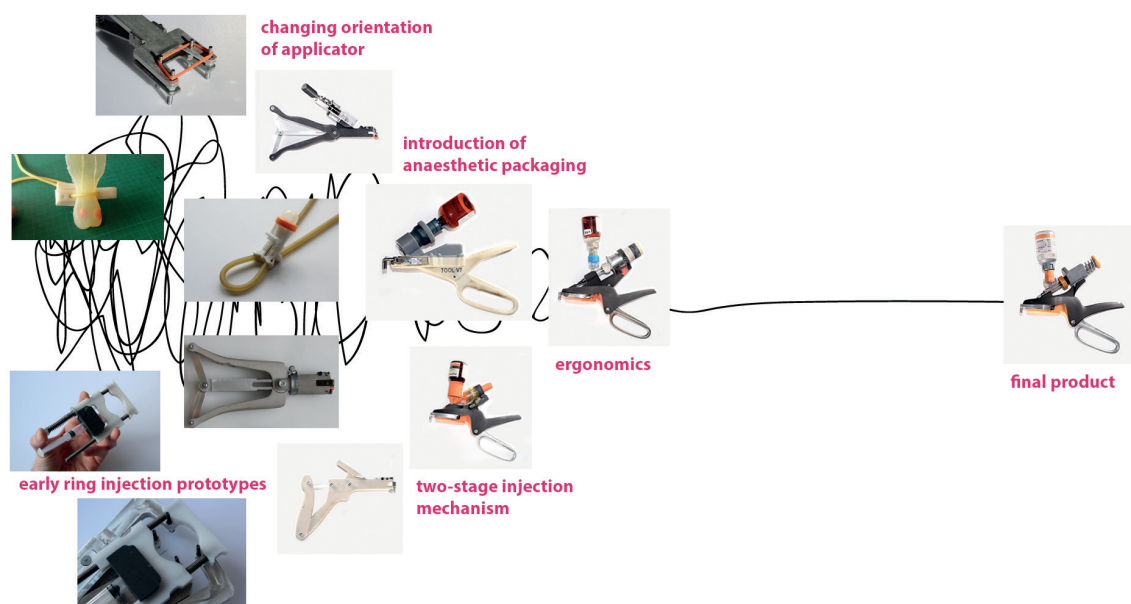
Early engagement carried out during numerous clinical trials allows for a clear understanding around dosage and location of injection, and working with farmers helps to direct design choices around fluid handling and dispensing of local anaesthetic (TRL 1). The requirements identified at this stage help to create the design brief:

INITIAL DESIGN BRIEF (THE OPPORTUNITY)

- Ability to create target(s) to administer local anaesthetic to key areas
 - Ability to deliver precise dose of local anaesthetic (this volume was discovered during the design process)
 - User safety around needles and anaesthetic
 - Reliable application of a constricting device
 - Replaceable consumable business model to be commercially viable
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DEVELOPING THE IDEA

With a clear brief in mind, work begins around concept generation. Prototyping and testing is key to gain feedback from stakeholders and enable testing. This project saw us develop 15 different versions of the prototype as we progressed methodically through TRL 2-6, with each prototype undergoing successive rounds of rigorous product testing, user feedback, refinement and ergonomic improvements. This iterative prototyping and testing helps to raise any significant design changes that need to happen, decreasing the risk of having to make these later in the process, where the cost of change is much higher.



Being on-site in commercial farming environments during product testing and trials, and involved first-hand in the treatment of lambs, allows us to get into the mindset of the user and gain invaluable insight into the usability of the system both from the operator's perspective as well as that of the animal.

At this stage we can confirm three key pieces of intellectual property:

- A multi-stage injection mechanism to control location of needle and dosage.
- An anti-tamper, quick to change packaging solution for the anaesthetic.
- An applicator which combines both and can be used by all levels of skill.



MOVING TO MANUFACTURE

With a design tested in field trials (TRL 6), the product then moves to a pre-production stage (TRL 7). Changes to the design can occur after tooling has been created (TRL 8-9), and these can be costly and often be inevitable, but keeping the scale of these changes small is key – something achieved by ensuring rigorous feedback and testing taking place early in the process.

Throughout the development of the device the business case was reviewed several times. With every review it became clearer the business would need to be launched in Australia. The biggest market.

THE RESULT

Eight years in development, Numnuts® is a journey that began from an initial call for innovation in the meat and wool industries following demand from consumers and supply chains. Using a novel injection mechanism and packaging of a local anaesthetic, Numnuts® de-skills the administering of this local anaesthetic by providing pain relief to the nerves that are worst affected by the procedure during that first hour.

Since launching in Australia mid-2019, over two million lambs have benefited from the Numnuts® treatment. Now well established as a mainstream means of alleviating pain during the necessary animal husbandry process of lamb marking, Numnuts® has been very well received by key stakeholders. This ranges from anaesthetic manufacturers that are benefitting from a new product line through to farmers themselves who have been able to increase their margins by adopting ethical welfare practices.



4C PROFILE

We understand the risks of innovation, so our capabilities start at the top level with strategy. Our 'fresh eyes', skills and experience help our clients achieve growth and find efficiencies through new innovations.

Along with over 20 years of consulting in design and innovation, the launch of Numnuts in 2019 has provided another level of experience in bringing a product to market.

It led to sourcing and securing major investment, international stake-holder management, research & development, management of Intellectual Property, business development, manufacturing, supply and marketing.

This experience has given us a unique perspective of spotting opportunities and developing for commercial gain which has been put to practice for our clients.

Projects range from short-term assistance with strategic decisions to long-term collaboration through the whole product development cycle - from concept to manufacture, including product verification testing and regulatory compliance support.

To further de-risk this journey, our multidisciplinary team deliver creative engineering and:

- Innovation strategy and facilitation
- Design thinking
- User-centred research
- Industrial and process design
- Product design engineering
- Mechanical and mechatronic engineering
- Electronic and electrical engineering
- Model making and prototyping
- Design for manufacture
- Production and integration management



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