Navigating the Design to Manufacture Journey

A Guidebook.

This guide will help your business prepare for the journey from Design to Manufacture.

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Contents

First of all, thanks for picking up this guide...

Technology market analysis by CB Insights (2019) found that 97% of start-up companies developing innovative 'hardware' fail (i.e. those developing physical products that require manufacturing). This compares with just 70% of tech start-ups fail (those without a physical product).

Clearly, innovation is tough. There are some specific characteristics of navigating the Design to Manufacture journey that make it more challenging than other kinds of innovation.

- Firstly, a diverse range of skills and experience is required
- Secondly, there is increased dependency on third party relationships
- Thirdly, significant investment is required up front
- Finally, energy and material implications are more acute

The critical need to balance conserving resource and decarbonisation with improving quality of life places a weight of responsibility on innovators. This responsibility brings with it opportunity. Businesses who seek sustainable solutions have the best chances of future success at the end.

Every year we turn 100 billion tons of raw materials into products with less than 10% of this cycled back into the economy (National Geographic, March 2000). Physical products require energy and material to manufacture, often consume additional resource throughout their life and, at some point, will probably no longer be needed by the people who initially bought them. Never has it been so important to think about how we use resources and energy and, to consider the environmental and societal impacts of manufacturing products. Doing so, as early in the development process as possible,is paramount.

As with any adventure, a realistic view of what you are taking on and a system for navigating is fundamental.

We've pulled the very best ideas and thinking from across our network to create this guide to help you on the journey. Although it won't guarantee success, it should help you plan.

I hope you find it useful and enjoy the journey
We'd love to hear about how you get on!

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Introduction

In this guide we aim to help you navigate the Design to Manufacture journey by:

01 Proposing a Systems Thinking mindset that will help you plan and prepare the challenge.

02 Highlighting some of the things you'll need to consider if you are to navigate the journey well. Based on the model presented in the mindset section, considerations are organised into seven closely coupled categories. Much of this is framed as questions to prompt your thinking.

03 Raising awareness of the broader skills needed. Specifically communicating your ideas, networking and collaborating.

04 Signposting you to a set of resources to empower you to explore the economic, environmental and social implications of your innovation further.

Whilst the guide has been developed with physical product innovators in mind, many of the principles are transferable to other innovation areas.

KTN Support

This guide provides you with a framework and some prompts to help you navigate the Design to Manufacture Journey.

At KTN we are creating a network of innovators so powerful, its ideas can change the world. We want to be part of your journey. Across our teams we have unique depth and breath of technical and sector expertise. We are here to help you develop stronger innovations and to connect you for positive change.

Connections are key to innovation, especially when developing physical products – diversity of opinions, ideas, skills and perspectives will make or break your innovation. KTN can help by making powerful connections and help you build your network.

We talk to companies of any size, at any stage in the journey: big or small; sophisticated or basic; early stage or already producing. With limited resource, we focus our effort on supporting and connecting those who have done their homework (e.g. have read and considered the feedback in this guide), who have potential to make the most impact and, who are aligned with our strategy for positive change.

The more clearly you can articulate your challenge, the easier it will be for us to assist you. Some advice on this is available towards the end of the guide.

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The Required Mindset

One of the challenges we most frequently observe is a lack of awareness of the complexity of the Design to Manufacture journey.

Whilst focus and enthusiasm are important factors for success, a realism about the complexity of innovation, the cash-flow requirements and, the breadth of knowledge required is absolutely essential.

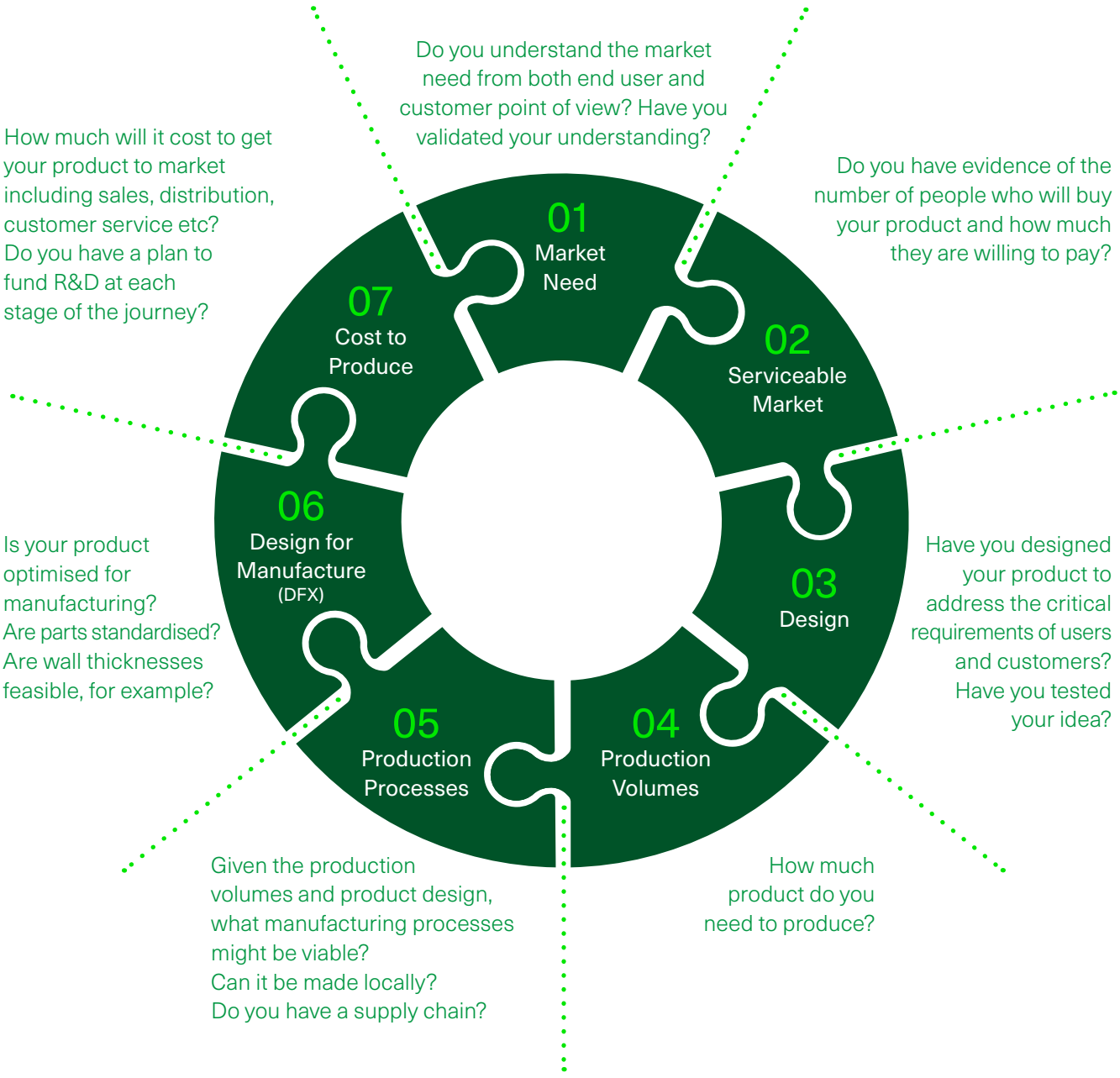
Frequently progress is frustrated because one or more essential elements are overlooked.

Innovators tend to spend a disproportionate amount of time focusing on the technical challenge when relationships, finance and understanding the market and business model are at least as important.

A product won't be manufacturable, commercially viable or an attractive investment unless aspects over and above the basic functionality and form are considered.
Simultaneously and incrementally maturing information across all the aspects highlighted in Figure 1 is critical to managing risk and developing products that investors, customers and support agencies are likely to be enthusiastic about.

This approach to defining the problem and gradually maturing information combined with a focus on the interdependencies between considerations is known as "Systems Thinking".

It is good practice to set a risk level, and a back out point. If you end up self-funding past your comfortable risk level without seeing a return then seriously consider taking the exit. Relentless pursuit of an idea on the basis of sunk cost doesn't make good business sense and can be detrimental to health. Likewise, upfront set a clear exit plan and process. Be clear with yourself about whether you are building a business, or building an idea to sell on.



Although applying systems thinking increases the likelihood of success, it doesn't offer any guarantees. Openness to failure, a willingness to seek and appreciate alternative perspectives and an enthusiasm for learning from mistakes are critical. Think of Thomas Edison who said: **'I have not failed. I've just found 10,000 ways that won't work.'** Success rarely comes easily.

That's not to say, 'never give up'. Entrepreneurs are sometimes overly optimistic and ignore the signs that customers are just not interested. If you're going to fail, fail fast by proactively looking for weaknesses in your own ideas and exposing your thinking to critical friends. A great read to get into this mindset of failing fast is *The Lean Start-up* by Eric Ries.

Uncertainty is inherent in innovation.

Chances are, you're not embarking on a well-trodden path. The guidance here is not a step-by-step instruction on making your way from Design to Manufacture. Rather, we provide a description of the main features you'll need to negotiate.

All the features will be part of your journey. Some may be so easy that you resolve them without even recognising, whilst others might be a long hard slog with lots of careful planning, skill and thought required.

In our experience, innovation is not a linear process. Although we present the landmarks in sequence, we do not suggest a sequential flow for addressing them.

It is important that you adopt a holistic mindset in approaching the landmarks. Navigating this journey involves unlocking clues from each area, with each informing the other and cumulatively building a complete map. It is this complete map that will provide confidence to investors or funders who are key to scaling up your manufacturing.

Through years of work supporting innovators across a wide range sectors, we believe the key landmarks in Navigating the Design to Manufacture journey are:

01 Market need

02 Serviceable market

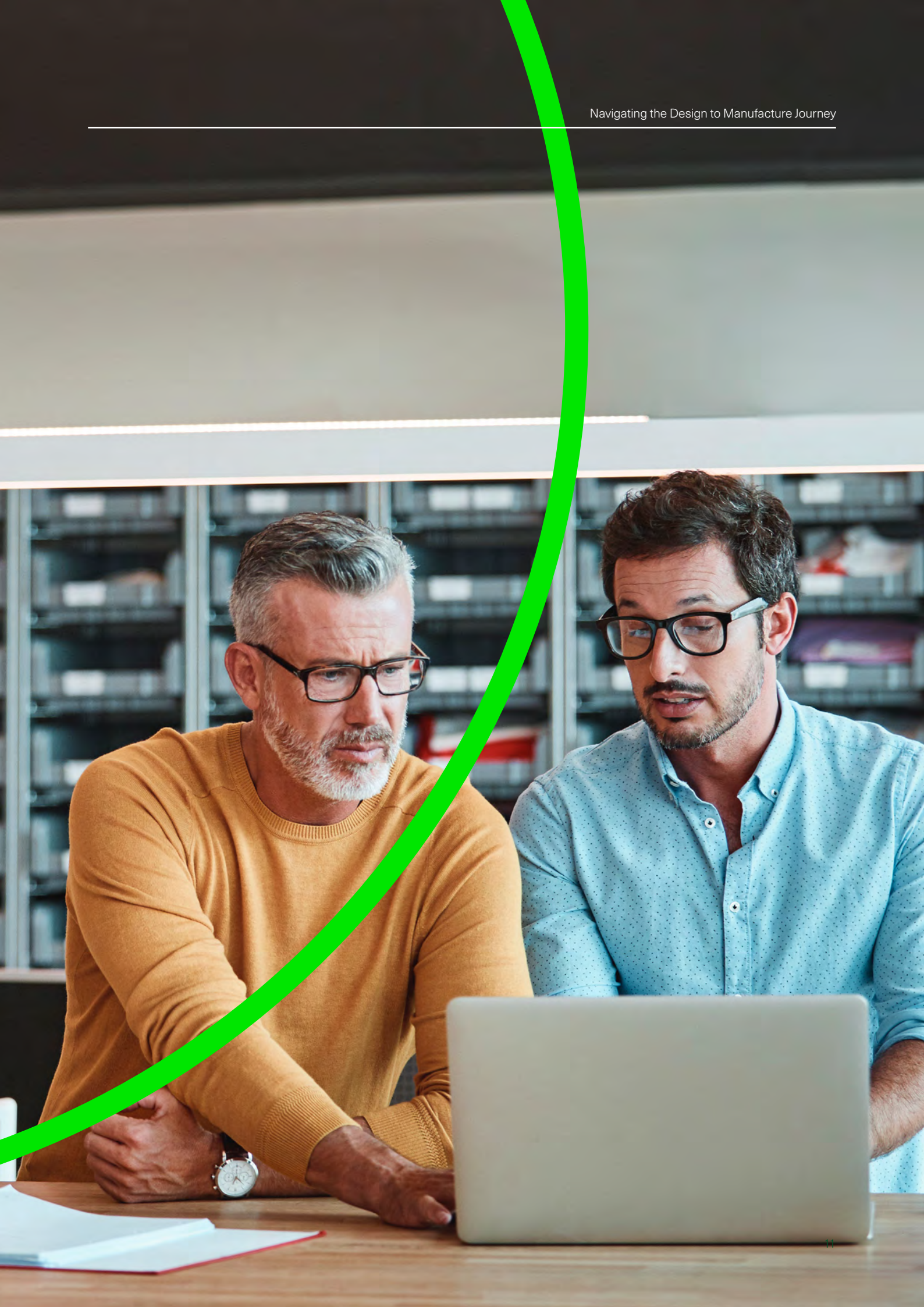
03 Design

04 Production volumes

05 Manufacturing processes

06 Design for manufacture

07 Cost to produce



01 Market Need

Understanding market need is essential for good product design. 'If you build it, they will come' rarely works these days.

More than identifying a gap in the market, real insights into what drives the need or opportunity will ensure better design and can help you develop an appropriate revenue model.

- Are you aligning what you are doing with broader social and environmental trends and challenges?
- Why would your product be chosen over another?
- How would your product be used?
- How much would people be willing to pay and for what functionality?
- Will your product be integrated with a service?
- Do people expect a warranty beyond minimum regulations?
- What do you, your customers and end users' value?

As well as understanding who your end user is, you also need to understand customers and other stakeholders. Rather than assuming, have conversations and sense check your understanding. If you are developing a component that is part of a larger system, it's important that you speak with the supply chain and the Original Equipment Manufacturer to understand their needs, testing requirements and existing systems.

- How does your product fit with other systems?
- Is it a component in a wider system?
- How will it fit into production systems?
- How does it fit with delivery systems, logistics systems, retail systems?
- Is it easy to package and transport?
- How will you handle product returns and customer support when the time comes?
- What testing requirements and regulations do manufacturers and distributors expect your product to fulfil?

Being able to evidence market need will be an important aspect of securing investment.

The resource at the end of the guide contains a raft of tools that can help you develop and validate understanding of end users. It can be useful to focus on delivering the simplest possible solution or for testing with a small group of customers before finalising design and ramping up production.

Sector specific safety standards and regulations are effectively mandatory to place your product on the market and need to be identified early on for all the regions in which you are considering selling. Make sure you have identified all the safety standards that apply to the product you are developing and, that you consider the requirements and costs for certification.

Be sure to consider the factors shaping your market: the broad environmental and societal trends and, new innovations in both technical and commercial areas. Be careful that you don't become too enamoured with a particular solution as you may find you are leapfrogged by a new approach or technology.

"It helps to start with a real problem. All opportunities are born out of problems. A designer's key skill is not design, it is observation. It's seeing the problem. Data matters but data is a measure of what has already happened. The challenge is to innovate for what will happen"

— Mark Shayler, This is Ape

02 Serviceable Market

Understanding your market size will help you establish production volumes.

You can get an approximate estimate of the market size by using publicly available data from the Office of National Statistics (ONS), Market research reports, contacting trade or membership associations or determining the number of sales of similar products on the market. If you are developing a component for part of a larger system, it's important that you speak with the OEM.

It is worth considering how quickly you will be able to scale production, distribution and customer support and how you will finance scaling.

Establishing market size is an important aspect of securing investment and can factor in valuing your early stage business. The stronger the evidence you have, the better.

The potential market size and the size of the market you are able to access are two different things. Depending on which strategy you adopt, the size of the market you are able to reach, and the rate at which you are able to reach the market will vary.

How much of the market can your realistically reach?

- Different geographical markets (e.g., UK, EU, US, Canada, China, Japan, etc.) have different regulatory requirements. There is a cost to have your product tested to prove that it complies with each set of requirements and to maintain compliance throughout the product lifecycle.

- Retail channels and sales model capacity and customer sales cycles: How will you access customers? How will you secure and process sales? How often will customers replace your product / be in the market for a product like yours?

- Manufacturing capacity: How many units is it possible to make and over what period of time? How much lead time do you need? Will you hold stock? How will you manage stock levels?

- Logistics capacity: How many units can you deliver to customers?

- Customer service: How can you service products once they are in use? What will you do about returns, complaints and queries? What is your capacity for this? Have you accounted for the associated costs?

Market size will help you model costs and cash flow. Consider what is realistic and the relationships you will need to build to reach your market. You might want to consider fulfilment partners and local distribution hubs. The carbon impact, responsiveness and cost or various shipping options are also worth bearing in mind. Make sure you have understood the needs of those who will help you reach your market. Who is key? Will you work with an Original Equipment Manufacturer, a contract manufacturer or a distributor? Will you licence your technology or do you wish to sell to customers directly?

03 Design

Design can be viewed as the process of incrementally reducing the risk of further investment in product development. It is the plan that establishes the basis for making a product or system.

Product design requires diverse skills and experience. Good Design can add value to your product, and we'd recommend engaging with the practice early – whether that's through professional service or through your own efforts. Rather than being the exercise of producing product renders and engineering drawings, the real value of design is in developing well considered solutions that embody Systems Thinking practices suggested in this guide.

Whether you work with a professional designer or go it alone, it can be useful to have a good grasp of design skills to enable you to develop a robust product solution. There is no substitute for experience. Building skills takes time and effort, but the following practices applied consistently will set you on the right path:

" £20 at the hobby store and an evening at the dining table can save months and millions. A low fidelity prototype using readily available craft materials can quickly isolate and resolve problems."

— Dr Andy Bell, Design Strategy, AMRC

01 Think from other points of view - One of the main skills of a designer is empathy: understanding how others experience the world and imagining how they think. Striving to get into the head of an end user or customer will help you see the product from their point of view and can help you develop a more robust solution. Tools like 'Personas', 'Scenarios' or 'Empathic modelling' can aid you in this process. Consider how your product will fit with the wider system.

02 Critique your own ideas - look for flaws rather than confirmation. By asking "why wouldn't this work?" you'll uncover opportunities to improve the design and further reduce the risk of investment.

03 Build awareness of design principles and design methods - Explore some of our suggested resources to develop a toolbox of practical ways of thinking and time-honoured rules. Before detailing a design, be sure to consider the viability of realising your design in practice (see Design for Manufacture).

04 Prototype and test your ideas - Modelling or prototyping can range from sketches to sophisticated scale models. Expressing the idea on paper or with cardboard cut-outs can help expose flaws and can help build thinking. Consider the cheapest and easiest way to get the feedback you need. Only use expensive, high-fidelity prototypes when essential. Validate requirements and solutions by discussing models and prototypes with stakeholders. If you are contracted to deliver a product or component, consider how you will demonstrate you have met all the agreed requirements.

05 Make use of relevant design standards for good practice. BS 8887, BS 7000, PAS 440, BS 8888 etc.

06 Make sure you are intimately familiar with sector specific safety standards and regulations that apply to your product. These must be carefully integrated into design decision making. Missing these is setting up the project to fail.

04 Production Volumes

If your product is part of the supply chain for a larger system, volumes will likely be dictated by an OEM.

Otherwise, production volume is closely linked to market size and closely coupled to production processes.

Getting production volume right is a balancing act.

It is important that you are able to meet demand as it emerges, but you don't want to have an excess of product inventory. It is worth considering how you will ramp-up volume over time by considering a range of different demand scenarios. Changing the method of manufacturing to switch-up volume will be costly.

As you refine thinking about: your market and costs, and decide on processes, production volumes are something you should re-evaluate. Do your assumptions hold as other decisions change? Is the strategy you have adopted still valid?

Here are three strategic approaches you might consider:

Start small and manage risk
To help demonstrate market demand, to test and develop the route to market and logistics models and to build confidence for larger investment, it can be useful to start with low volumes. Low initial production volumes are not without risk. If you demonstrate viability but don't have the ability to scale quickly, you can leave yourself open to someone else replicating or improving on your ideas and taking your market share.

Go big or go home
Economies of scale can make larger volumes appealing. Generally speaking, investment required for larger production volumes is likely to be higher than for small volumes. Tooling can be one of the largest costs and is something that is often overlooked by novice innovators. Rapid tooling and soft tooling (aluminum or non-heat-treated steel) options exist for lower cost entry and can be relatively easy to ramp up with hard tooling.

Be careful to consider the costs of custom manufacturing infrastructure (as well as the tooling cost). Large volumes often require automation for high-throughput product testing and assembly. With large volumes there is also the cost of inventory to consider and a higher risk of being left with excess stock.

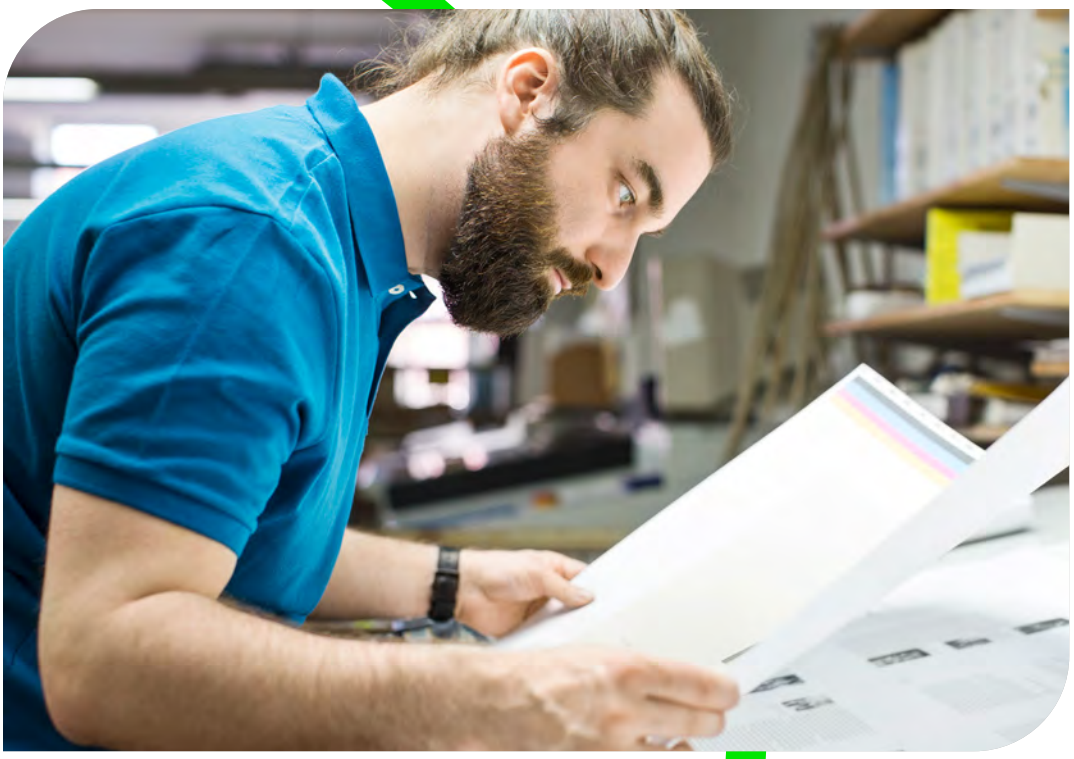
Design for adaptability
If you are in a fast-moving technology sector it is also worth considering the possibility of your component stock or functionality becoming obsolete. Modular design (being able to easily switch out components or collections of components that deliver a functionality) and working with specialists to understand component supply are just two approaches that can help mitigate some of this risk.

The scale-up strategy that is appropriate for you needs to be carefully considered. As the other considerations: market need, market size, design, manufacturing processes etc. become clearer, you might adjust your approach to production volumes and scale up which may, in turn, impact the design and manufacturing processes or invalidated certification.

05 Manufacturing Processes

The appropriate Manufacturing processes for your product will depend upon the required functionality, the material you wish to use, the finish of your product and the volumes needed. Rather than manufacturing being an afterthought, it is important to consider the process that might be used as you develop your product concept.

Certain functionalities might have to be traded off against cost of manufacturing processes or materials. Understanding of the benefits and weaknesses of various manufacturing processes and materials can help inspire better performing product solutions. Conversations with your manufacturer can you help you optimise your design, supply chain and costs. Here are six things you might want to consider:



- Unit cost and cost for tooling: the break-even point - Many processes are associated with significant upfront tooling costs and are only economical for large volumes (e.g., casting or injection moulding) whilst others are inexpensive to set up but difficult to scale (e.g., machining or additive manufacture). As you build up capital, demonstrate the market for your product and secure investment for a larger run, you might choose to use slightly different processes for initial batches. Be careful, however! If you are in a highly regulated market, switching manufacturing processes can require re-certification at great expense. Re-investing in tooling as you scale can be expensive.

- Impact on functionality, finish and sustainability - Consider how the manufacturing process will impact functionality, finish and sustainability aspects of your product. It is especially important to think about these things from a customer point of view and to think about your values as a brand and a business. Resources such as 30 ideas for the circular economy and Life Cycle Analysis can help you think this through.

- Appropriate manufacturing test procedures – consider which features are critical to test and how your product works. How critical is it to identify faulty products before they reach the market? (e.g., safety risk vs. reputational risk). Make sure you have quality assurance checks in your process, as appropriate.

- Tolerances - Tolerances specify how precisely something has to be made. Tight manufacturing tolerances are expensive. Carefully evaluate whether or not they are actually required or find alternative ways to achieve them (i.e., different processes or design features).

- Relationships with manufacturing partners - Good relationships with manufacturing partners are of the utmost importance. Trust is crucial. Contract manufacturers have commitments to other big orders and working with a start-up can be a risk for them. Having a manufacturing partner who is invested in your idea and has values similar to your own can help mitigate some of this risk. How to they approach looking after the environment and their workers for example? Good manufactures are likely to add value and even IP to your design – treat them as a partner and build relationships early. You might even want to tailor your design and product offering around the capabilities of a good manufacturer. As you enter into a relationship with your manufacturer, having clear contractual agreements is critical.

- If you need to go abroad to find a manufacturer we'd suggest that you seek recommendations. As well as the quoted price for manufacture it is worth factoring in cost of travel, cost of quality and the potential stress of a remote relationship across time zones with cultural and language barriers.

06 Design for Manufacture

70-80% of product cost is determined through design decisions. Making the right choices early on can save time and expense later. Poor decisions will lead to inefficient production or low product quality and can be very difficult to resolve once the investment in manufacturing has been made.

- **Understand the manufacturing process –** it is imperative that you understand the limitations and strengths of the manufacturing process that you are using and design with this in mind. Certain geometries may be easy with some methods and impossible with others. The properties of the material you wish to use will also have a bearing on the suitability of the method.

- **Minimise the number of parts –** Generally speaking, the more individual components, the more complex and expensive your design. Every feature should have a function and, where possible, design parts to perform two or more functions. For example, a brace might conduct current and provide structural strength. There are exceptions to this. For example, one big part can be less attractive from a maintenance point of view.

- **Use standardised parts within your product or across a range –** Try and keep fixings the same size and type, for example. Use international standards where possible (e.g., SIO 4762 cap screws or DIN137 spring washers). As well as being more aesthetically and ergonomically coherent, this will make procurement, manufacturing and maintenance easier.

- **Consider the process of Assembly –** Think about how your product will be assembled. One direction assembly (i.e. parts that stack) will simplify the production process and can have a significant impact on product cost. Parts that are difficult to assemble or require the product to be re-orientated will add in time and cost. The effect will be magnified at high volumes. Aim to make assembly intuitive and eliminate the possibility for mistakes where possible. Think about what happens if the product doesn't work after it has been assembled. How easy is it to debug and repair?

- **Modularisation –** If your product is to have a long life in service (i.e. would benefit from being updatable, be easily maintained or customisable). Having a modular design can have significant cost benefits as well as adding value to the consumer. If you are designing a complex system, decoupling certain components and functionalities from the rest of the system can also have benefits within the design process (i.e. can reduce rework).

- **Electronics –** With electronic products, specific Design for Manufacture and test guidelines exist and are worth understanding. The IPC specifications tree helps identify which ones to focus on. For IoT products the IoTSF provides best practice guidance. In addition to Designing for

Manufacturing (DfM), there are likely to be other systems level requirements that can make or break a product's success.

- **Design for Excellence (DFX) –** Design for Manufacture itself is one of many characteristics which fall into the DFX category. You should consider the need to apply DFX best practices or methods as appropriate to your design. These may include categories such as Design for Assembly, Design for Cost, Design for Testing, Design for Maintainability, Design for Robustness, Design for Supply Chain, Design for Safety, Design or Sustainability etc. By considering such requirements as early as possible in the design development you can enhance your design and mitigate disruption and failures later in the project and product lifecycles.

- **Design for Full Lifecycle –** The design development might be considered part of a project lifecycle which then crosses into a product lifecycle. The design itself results in parts being procured and manufactured, assembly, test, transport, handling, installation, commissioning, operation, servicing, repair, overhaul and ultimately decommissioning. Each of these phases of the product lifecycle should be considered during the design phase and any key requirements or considerations should be captured in the design requirements for example a 25 year service life, or accessibility for maintenance using standard tools, or for 95% of parts to be re-usable. Although these needs may feel superfluous when you're focused on making the design work they can set your design apart from competitors enabling a more attractive, more sustainable proposition, and could potentially even influence your business model e.g. a lease model as opposed to a sales model.

07 Product Cost

Although this is the last of the seven considerations, it is central to the purpose of the journey and has to be the focus at every stage. If the cost to produce cannot be covered and offer a return on investment then the product will not be commercially viable.

Does this match with what people are willing to pay? If not, you might want to explore adapting some of the factors before reaching a final design solution.

- Production volumes
- Manufacturing methods
- Design (can you add more value or reduce costs)
- Strategy for reaching the market (can you reach a larger market, increase volumes and reduce costs?)

Whilst grant funding and savings can cover early stage development, getting to manufactured products requires substantial investment. This ultimate investment hurdle needs to be considered as early as possible in the process so the correct relationships can be built, the important questions can be confidently answered, and the main risks can be mitigated. It can take six months to raise investment – factor this into cash flow projections and invest effort in understanding your funding roadmap – establish what funding is available from a public innovation and private funding perspective.

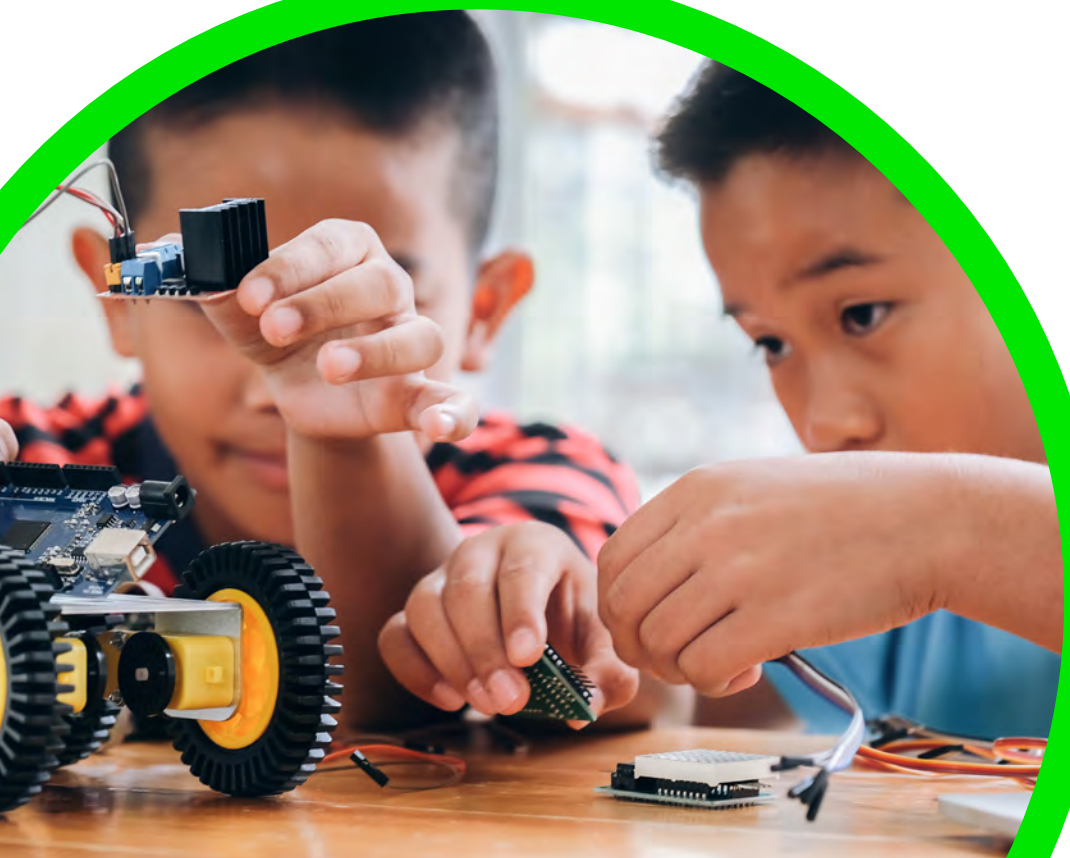
Realism about the level of investment required is a critical consideration and should be at the forefront of your mind as you navigate the Design to Manufacture journey. If you feel it is not a hurdle you want to contend with you can look at partnership models and licencing agreements. Such agreements don't negate the need to think about the considerations laid out in this guide, they just provide a context for your journey.

KTN provides a comprehensive set of resources around funding and finance including how to apply for grant funding and pitching for investment.

Entrepreneurs often want their products to have every conceivable feature. However, these extra features are not without costs.

Do customers care about that extra feature? Just because it is interesting, it doesn't mean they are willing to pay extra for it. Don't assume they want it, ask.

House of Quality is a tool that can help you objectively map out and rate features in order to work out which ones to include and which to leave off. It is especially useful if the cost of including all the features is not feasible.



Intellectual Property

There can be tension between balancing talking about ideas with protecting IP. This needs to be given careful consideration and handled wisely. Seek advice from an IP professional if you are at all unsure.

To develop understanding of the market needs and requirements, it is critical that you talk to customers, users and other stakeholders but you must also be cognisant of disclosing your ideas. This is especially true if you are going to (but haven't yet) filed for a patent or design right.

- If you are designing a new product it is quite likely that you have developed IP. Different types of IP maybe considered. You should identify which ones are most relevant to you at an early stage.

- Patents can be used to protect a specific and innovative aspect of your design. They aren't always the right strategy but if you do intend to go down this route you cannot disclose your idea publicly until it is filed - it will invalidate your application.

- You should be able to discuss your idea in broad terms without giving away the sensitive details. However, if you are intending on registering for a patent or design right you should file your registration before disclosing your idea.

- As a small innovator, you should consider your ability to defend an NDA or patent. Ultimately, relationships are based on trust. Even with an NDA or patent, you should be careful about what you disclose and to whom. Be careful about sending full assembly drawing files when a component drawing file would suffice, for example.

- It is worth considering that the people you are talking to will add to your understanding and ultimately may contribute to better and more valuable IP.

- If you collaborate with other parties, such as an external designer or manufacturer, you should ensure that proper IP ownership assignments are put in place from the start of your collaboration.

- You can obtain valuable information by visiting the UK Intellectual Property Office (IPO) website and via support available from the IPO, the British Library and other public institutions.

- IP ownership can contribute to the value of your business. It is worth understanding this value if you are looking to raise investment.

How to Approach Networking and Collaborating

From capturing requirements to building relationships with suppliers or raising finance, when it comes to getting a product to market, a wide range of skills and expertise is required.

- You cannot go it alone.
- Building relationships is key to success.
- Make use of networking organisations where you can. Attending relevant events can help you get to know the community and you'll absorb knowledge about challenges, opportunities and effective ways of working.

Understanding what motivates and drives the other party is critical. Whether it is understanding the requirements of a customer or the capacity of a manufacturer, you need to be able to listen to what they are looking for and then figure out if you are willing and able to work with them on helping them achieve that.

Be realistic about your expectations - third parties such as manufacturers are often in demand and have limited capacity for small projects or low production volume. Don't expect endless amounts of free support. Large projects from established companies make up the majority of their orders and sometimes leave little capacity for smaller projects. The big orders pay the salaries and will probably take priority.

If possible, select manufacturers that are excited about your product. Many manufacturers consider small projects with inexperienced innovators a risk as they often result in a financial loss due to unrealistic expectations and moving goalposts. Any manufacturer or design consultancy will need to understand what value or risk you offer them beyond just a cheque. The better prepared you are for the Design to Manufacture Journey and, the more you appreciate and understand the value they offer, the more comfortable they will be working with you.

When working with professional designers, be sure to heed their advice about best use of their time and where they can contribute most to getting your product to market. Insisting they create a prototype or 'final' product renders when they aren't convinced you have a sufficient understanding of the market or the right cost-function balance will create frustration and you'll be missing out on an opportunity to take a useful step forward on your journey.

If you are reluctant to invest your own time and effort (to secure investment, grant funding application development, exploring certification, evidencing the market etc.) then others are less likely to see the value in supporting you through the journey.

Be open to feedback and willing to learn from people in your community. Find out what worked for other people and investigate how they overcame challenges similar to your own. Go to events, ask people questions, be interested in them and build up rapport.

"Collaboration thrives where there is an openness to embrace new practice and thinking. Having a flexible framework with 'rules' for collaboration is important. Think of a football game where you don't know the rules. Someone passes you the ball and they are screaming at you because you don't know what to do. You need to know how the game works if you want to help your team win"

— Danny Kane, Filament

Communicating your ideas

Getting a physical product to market requires breadth of expertise and experience. It's never a solo voyage. Pitching is so much more than just talking to investors.

Clearly communicating your idea and your "ask" matters at every single stage of the process! In a busy landscape, with the odds stacked against you, good communication is essential to getting the support and feedback you need – from customers, investors, manufacturers and others in the supply chain.

In terms of improving your chances of successfully navigating the journey, effective verbal and written communication of your idea is just as important (if not more important!) as technical models and drawings.

"We always get founders to talk to at least 100 people about their idea. Make sure you have a market before you put too much effort into the production process"

— Alan Clayton, HAX

01 A pitch is like a model or prototype

If you are philosophical you might like to think about a model as an abstraction of reality. It might be a mathematical or computational simulation, a cardboard model or a 2D model like a sketch or process diagram. Even a word, sentence, paragraph or evaluator pitch can be conceptualised as a model. A prototype is a model that has the purpose of helping us test our ideas.

Creating a model helps us clarify our own thinking, exercise our ideas and expand our understanding. Also, just like a physical prototype, modelling with words and sentences can help us get feedback. From a practical perspective, be aware that writing and speaking is one of the most effective, easiest, cheapest and most overlooked mechanisms for modelling and testing ideas!

Write down your ideas, craft the structure, refine how you communicate verbally. Test how your idea is interpreted and feedback as a means to improve both your communication and your idea.

02 In a busy landscape you can conceptualise asking for support of any kind as 'pitching'

Whether it's time or finance, resources are scarce, and capacity is limited. Developing a physical product is risky (the data suggests only a small percentage of you will succeed). With grant funding, private investment, innovation support or even paid-for design consultancy services, judgements need to be made about where to best spend time and money.

Supporters and collaborators are looking to invest in whoever is most likely to deliver a return. Making it easy for people to understand what you are doing and why they should help you will open doors. Equally, anything opaque or ambiguous in your message presents a barrier to helping you and attention will likely be grabbed elsewhere.

When requesting support, be as clear and concise as possible. Even if you're not quite ready, it can help to create a pitch deck or complete a draft of a funding application such as an Innovate UK Smart grant. As well as helping to clarify your thinking, this will help you think through the ingredients of innovation from a funders point of view.

03 Have a call to action in your message and embrace challenging questions

Whether it's pitching for investment, asking for support from an organisation like KTN or engaging with a design consultancy, having a clearly constructed 'ask' makes it easier for busy people to respond. It's quite likely they won't commit to your ask straight away. They might challenge your ideas (super helpful!) or refer you on to someone else who can help. Take this in the spirit it is intended.

Questions are not necessarily an invite to restate your views because you weren't understood. They are more likely to be a prompt to help you rethink them. Questions can help:

- Establish a clearer view of the context, in order to work out how best to provide support.
- Develop and clarity your thinking around your proposition
- Test your commitment to putting in effort to progressing the idea. Poorly thought through answers won't reflect well. Successfully taking a hardware product to market requires tenacity and an ability to build relationships.

Resources

We know that innovating is a skill that can be honed and developed through practice but input from others is essential for the journey.

We have compiled a collection of twenty online series, books, Reports and Guides, and Tools that can provide a reference for novice innovator and experienced entrepreneurs alike.

Online Series: recorded webinars and courses on the overall journey

Navigating the Design to Manufacture journey webinars and blogs
To address this very issue, the manufacturing team at KTN and Product Design Scotland have curated some of the most experienced minds to share their thoughts on a range of areas pertinent to navigating the Design to Manufacture series. The series covers a range of topics: from managing costs and creating a business model to building a team and scaling manufacturing. You can watch the whole series, or select topics that suit you best.

HAX fireside chat
We have a bonus episode of the online Navigating the Design to Manufacture Journey series – a fireside chat with HAX run the world's first and largest hardware accelerator programme. Alan Clayton, one of the original HAX team has helped oodles of start-ups on their journey.

Dragon Innovation Design for Manufacture series
A free, comprehensive online course on Design for Manufacture (DfM) aspects of navigating the Design to Manufacture journey from manufacturing experts at Dragon Innovation. The series contains really good info on some specific manufacturing methods combined with some great insights into project management and costing. Dip in and out as you wish.

Books

The Hardware Start-up: Building Your Product, Business, and Brand
This book provides a road map and best practices to turn your hardware product idea into a business. It takes you from concept to product launch, providing strategies for idea validation, branding, marketing and sales, prototyping, manufacturing, distribution, funding, and legal issues. It is a must-read full of practical advice if you are planning to start a hardware business.

Bringing a Hardware Product to Market: Navigating the Wild Ride
This concise book explores the traditional phases in developing a hardware product that is mass-produced using standard manufacturing techniques, as well as lessons to improve survivability via market research. It provides a practical roadmap so you know what to expect and what you should be planning for while avoiding common pitfalls that hardware start-ups face.

The Lean Start-up
Many start-ups begin with a product that they think people want – which often is not the case. The Lean Start-up is an international best-seller that provides a systematic approach to figuring out what customers want before you commit too many resources, testing your vision continuously, and adapting before it's too late. Although many of the lessons from this book are better suited for software startups, it is a valuable read for any entrepreneur as valuable learning can be gained from prototyping techniques.

MAKING IT: Manufacturing Techniques for Product Design
A beautifully presented and informative book designed to inspire you as you think about how your product might be made. It will help you match appropriate methods to production volumes and materials. We also love that it provides insights into sustainability considerations. From jiggering and jollying to electroforming and blow-moulding, this book covers it all. As well as helping make decisions about manufacturing, the contents of this book can inspire new concepts and will inform better decision making throughout the design process.

Total Design: Integrated Methods for Successful Product Engineering
Stuart Pugh's Total Design Methodology highlight a wide range of considerations pertinent to good product design. Although there are similarities with the approach we suggest in this guide, we recommend incrementally maturing information across all the decision areas rather than a linear, iterative process (which can lead to rework). Pugh's methodology is great for thinking about some of the different aspects that ought to be considered.

The Universal Principles of Design
This little pocketbook (larger version available) offers 150 tools from a variety of design disciplines complete with illustrated examples. Covering concepts such as Abbe, Affordance, Dunning-Kruger effect, Modularity and Ockham's Razor, this book really is a gem and is bound to get you thinking about design in different ways.

The Universal Methods of Design
This little pocketbook (larger version available) offers 100 ways to research complex problems, develop innovative ideas and design effective solutions: Bodystorming, Cognitive mapping, Laddering, Persons and Speed-dating and Word clouds are just a few. Each example is accompanied by an illustrated example and is bound to inspire you. Lots of great examples to encourage you out of your normal frame of reference.

Resources

Tools

The Innovation Canvas
The recipe for success requires aligning your capability, the offer, and the opportunity around your innovation. The design team at KTN have created the Innovation Canvas, a tool set to h elp cover all the relevant factors (beyond just Design to Manufacture) in a concise and holistic template. We have a beautiful card set or an online version. Having someone to walk through this with you (and to ask you challenging questions) can be really helpful – let us know if you'd like some input.

Technology Readiness Levels
Technology Readiness Levels are a NASA concept that has been adapted and is widely used in Innovation and Complex Systems design to articulate the maturity of a technology -i.e. how ready it is for Inservice use. Knowing where you are on the TRL scale can help you decide what sort of funding is most relevant to you. Broadly speaking, in the UK Levels 1-4 are the remit of the Research Councils, Levels 4-8 are funded by Innovate UK and the Catapult Centres whilst Levels 6-9 generally require Private Financing.

Manufacturing Readiness Levels
The Manufacturing Readiness Level scale was developed by the US Department of Defence to measure the maturity of a technology or system from a manufacturing perspective. The levels describe how manufacturing considerations must begin at the earliest stage in a technology or products development and should continue throughout the systems lifecycle.

Arup's Drivers of Change cards
A research-based publication developed by Arup, these cards help innovators explore factors which will affect the world in the future. These include energy, waste, climate change, water, demographics, urbanisation and poverty. Each card contains a fact, an equation and a detailed explanation to stimulate thinking. Cards can be downloaded from the Drivers of Change website.

30 ideas for a circular economy
Developed by KTN and The Agency for Design, the thirty cards are divided into three categories: System, Product and Business Models. This tool presents methods for realising circularity in your business and we find it stimulates great discussion in group settings. With illustrated practical case studies on the back of each card, the examples will spark creative thinking and open up your mind to new possibilities.

ConeX Portal or Reshoring UK
Both Reshoring UK and ConeX are handy websites which can help you find manufacturers (or, in the case of ConeX, other design and innovation partners) who specialise in specific methods or who are in your local area. Drop down menus and map-based functionality are helpful. Although neither portal is definitive they should provide a helpful starting point.

Reports & Guides

Hardware club report
This annual report on all thing's hardware related can help manage your expectations by giving a view of experiences across the globe. Did you know, for example, that it typically takes around 3 months to find a contract manufacturer? On average, shipping is around 15 weeks late; getting to DfM is one of the biggest challenges and 69% of European Hardware Startups have had grant funding. The hardware club website also has a great source of relevant blog content.

KTN's Good application guide
The Good Application Guide is a must read for anyone applying for grant funding.

IoT hardware from prototype to production
This publication by the Digital Catapult provides guidance for start-ups to launch hardware based IoT products and services. It provides guidance to navigate the journey from concept through mass production to the end of product life. The report highlights the important considerations that should be made in each phase of development. Although the guide was designed with hardware based IoT products and services in mind, many of the important considerations highlighted here are transferable to other product categories.

Collaborators

This guide has been produced by KTN as a result of collaborative work with the following organisations:

PRODUCT DESIGN SCOTLAND

Innovation Caucus

UKRI Innovate UK

CATAPULT High Value Manufacturing

bsi.

4c

filament

The University Of Sheffield. AMRC Advanced Manufacturing Research Centre

ELVIS & KRESSE Rescue - Transform - Donate

ASPIRE ENGINEERING

DYNAMIC EMS

Blueprint

ENIGMA PEOPLE SOLUTIONS

eama Engineering and Machinery Alliance

ROYAL ACADEMY OF ENGINEERING

product design

ReshoringUK UK Engineering Marketplace

RS

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gtma Manufacturing Resource Centre

INVENTYA Your success. Our commitment

OXFORD BROOKES BUSINESS SCHOOL

room innovates


rype office


SCINTILLA


HAX


tharsus


THE
Bessemer
SOCIETY


University of
Strathclyde
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