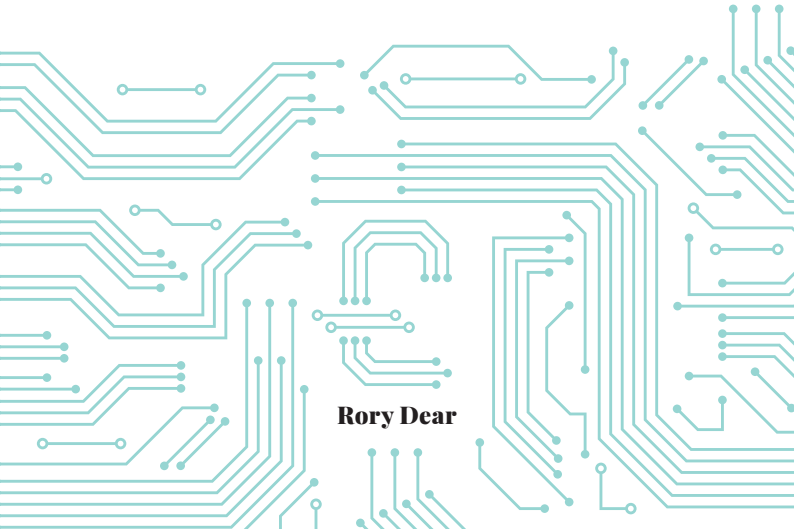
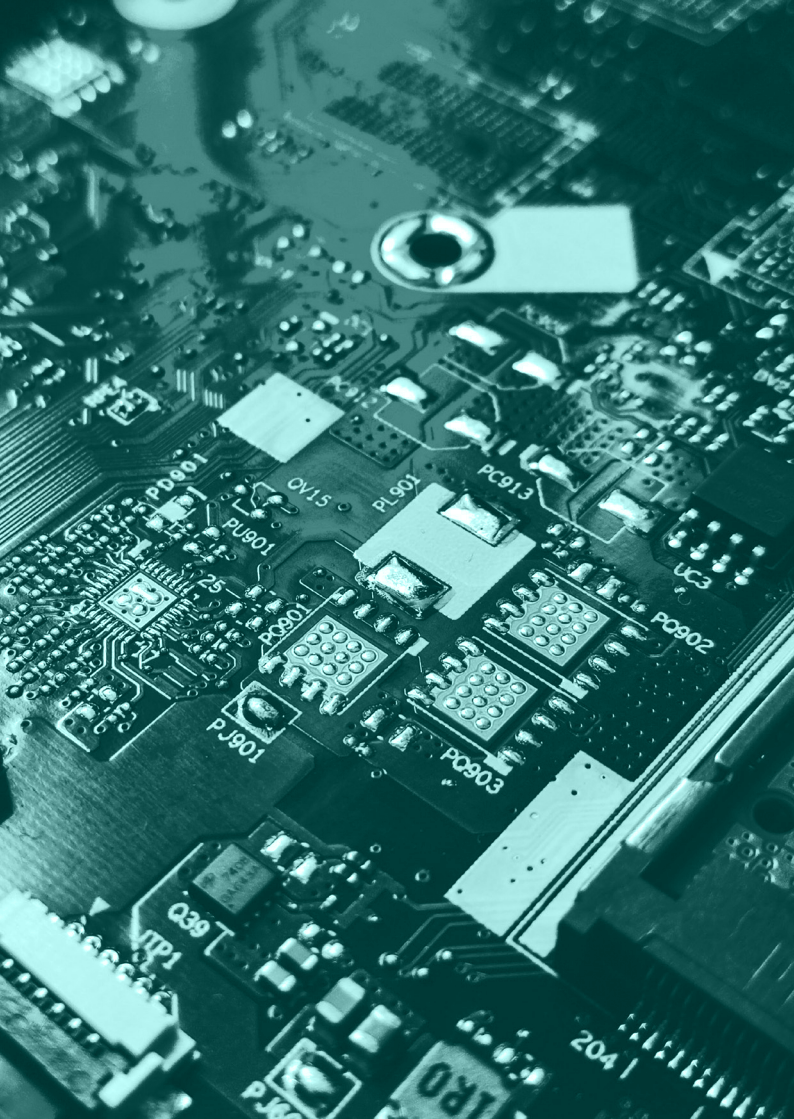
Buyer's guide to electronic product development

Best practices for your exciting journey



Rory Dear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About the Author

Rory Dear is the proprietor of Datasound Laboratories (DSL), embedded/industrial computing and electronic design experts.

He also spent 5 years as the European Editor for Embedded Computing Design, reporting on trends and tribulations across the industry and continent.

His involvement across multiple design engineering disciplines and a vast range of customer driven projects has given him a broad experience in what those outsourcing electronic design activities want and most importantly, need.

He appreciates tasking a 3rd party to realise an electronic design idea is fraught with risk, so wrote this book to assist those undertaking this journey to make it a successful one, first time.

Contents

1

Understanding your market

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Introduction

For seasoned individuals or companies, you may wish to skip this section; but for those entirely new to the game, you absolutely must start here.

So many arguably good product ideas fail by neglecting this key phase. Who can forget Google Glass!? In 2012, Google believed it would revolutionise how we interact with the world but failed to consider or predict consumer's privacy concerns, the impact of bugs on consumer confidence, poor battery life, bans from public spaces, and frankly an inability to live up to the hype - all stymied public adoption of the technology and in 2015 it was discontinued.

It is of course impossible to anticipate every possible angle that would determine a product idea's success or failure but applying maximum due diligence at the outset is the best risk mitigator available.

Target audience

Understanding your demographics is key in determining the likely success or failure, of your product idea.

If you intend to sell directly to a consumer, marketeers typically suggest you consider your customer profile in terms of age, gender, marital status, income, location, education, and occupation – though there may be more to consider.

If you intend to sell your product to companies, you should consider industry, products/services offered and their target markets alongside their size, maturity, number of employees, revenue etc.

Critically, regardless of who you are selling to you need to understand what want or need would your product fulfil, what pain would it solve – and what currently do they perceive is the best solution?

Competition

The problem with good product ideas is invariably someone else has gotten there first. Completely unique, world-changing ideas are hard to come by but often success comes from building on what is already there and simply making it better, whatever that may mean for its market.

Apple did not invent the smart phone, but they revolutionised the market, differentiating by focusing on user experience rather than joining the hardware arms race of the time – even with a much higher price point, look where it got them.

Start by identifying all likely competing products, tabularising every relevant feature to compare and align to pricing - then think outside of those boxes.

- *What shortfalls do these products have?*
- *How can I differentiate my product?*
- *What price point do I need to achieve?*

2

Defining your requirement

Defining your requirement

Introduction

Before anyone can start designing anything, we need define exactly what we want to end up with.

I have seen ‘requirements definition’ documents range anywhere between a 100-page comprehensive specification right down to a pencil sketch on an old scrap of paper.

Those newer to product development often capture the headline functionality but can neglect to consider wider elements of the specification, such as environmental or certification needs.

Ideally, there should be no areas left undefined at the point of design commencement, important design decisions need to be made based on the specification as a whole and leaving elements open can leave you exposed to a rocky development phase or an imperfect final product.

Scope

Defining the scope is the critical first step in defining your overall requirement, as it lays out which elements themselves need defining and provides the necessary clarity for any external partner to be able to provide a quotation against.

If you wish to develop your own software and enclosure but wish to outsource everything else. A scope definition may look like the example below.

Electronic Product X

- Development **(mix)**
  - PCB **(external partner)**
  - Software/Firmware **(in-house)**
  - Enclosure **(in-house)**
- Certification/Approvals **(external partner)**
- Manufacture **(external partner)**

When you later come to identifying your external partner, it is important to ensure their scope aligns with your own.

Functional

Defining your functional needs can be as simple as a long bullet point list of features, such as below.

- 7” touchscreen display
- 4 x USB 2.0 ports
- 2 x Digital Inputs
- etc.

For those less experienced in electronics, it is equally acceptable to define your functional requirement in terms of what the user needs it to do and utilise an external partner’s expertise to convert those usage needs into a specification.

This second approach is also usually a better way to define software, especially when considering the alternative of individually defining what buttons do what on every screen!

You also need to consider any other electronics you plan to interface to, with how they interface.

Mechanical

Defining the mechanical elements of your product can be one of the easiest or most complex aspects of your requirements definition.

If you've an existing enclosure, this can be as simple as defining a PCB's footprint, mounting points and where external I/O needs to align with the outside world.

If part of your scope is developing a new enclosure, defining its mechanical characteristics, and marrying those to the internal electronics can require some in-depth thinking.

Enclosures for industrial applications often have installation space constraints – but aesthetics are generally not so important.

Enclosures for consumer applications generally lack those space constraints but aesthetics are everything, which can result in complex curves that the internal electronics must cope with.

Environmental

Properly considering where and how your product will be used is critical. If it is designed for usage in the Antarctic but has a minimum operational temperature of 0°c – you have a real problem.

Think carefully about the full range of locations your product could end up, not just its ideal location. Key aspects to consider are –

Ambient temperature, humidity, altitude

What is the minimum and maximum it must operate within?

Weather

Will it be exposed to the elements, what must it cope with?

Pollutants and contaminants

Will it be exposed to dust, water, any other type of ingress?

Electrical

What power sources are available? Are they regulated? Are there risks of power outages or surges?

Commercial

The key commercial requirement to define is unit pricing. What do you need to be able to produce each unit for, to enable you to make sufficient profit ,at a competitive sell price, to be commercially viable?

You will also want to take a step back and forecast how many units you expect to sell and in what period, to determine what quantities you can realistically build per production batch.

Production batch size has a significant impact on unit pricing, as unit pricing drops significantly with higher quantities and can get expensive for small numbers.

I recommend considering the largest quantity you could realistically fund in total and seek an external partner who will allow you to split that build into smaller, more manageable batch deliveries.

Documentation and Approvals

These fall into two categories.

You will likely require approval certification to legally be able to place your product on the market. Both those relevant to any electronic product (i.e. CE) and those specifically relating to your target application, industry and geography. If you are unsure, it is likely an external partner can advise you on what is required.

You are also likely to want supporting documentation for your design, whether this is a functional specification, product manual, quick start guide or whatever is appropriate.

It is important to consider and record what you require to ensure that any potential partner takes responsibility for achieving, or at very least designs your product to adhere to the relevant regulations.

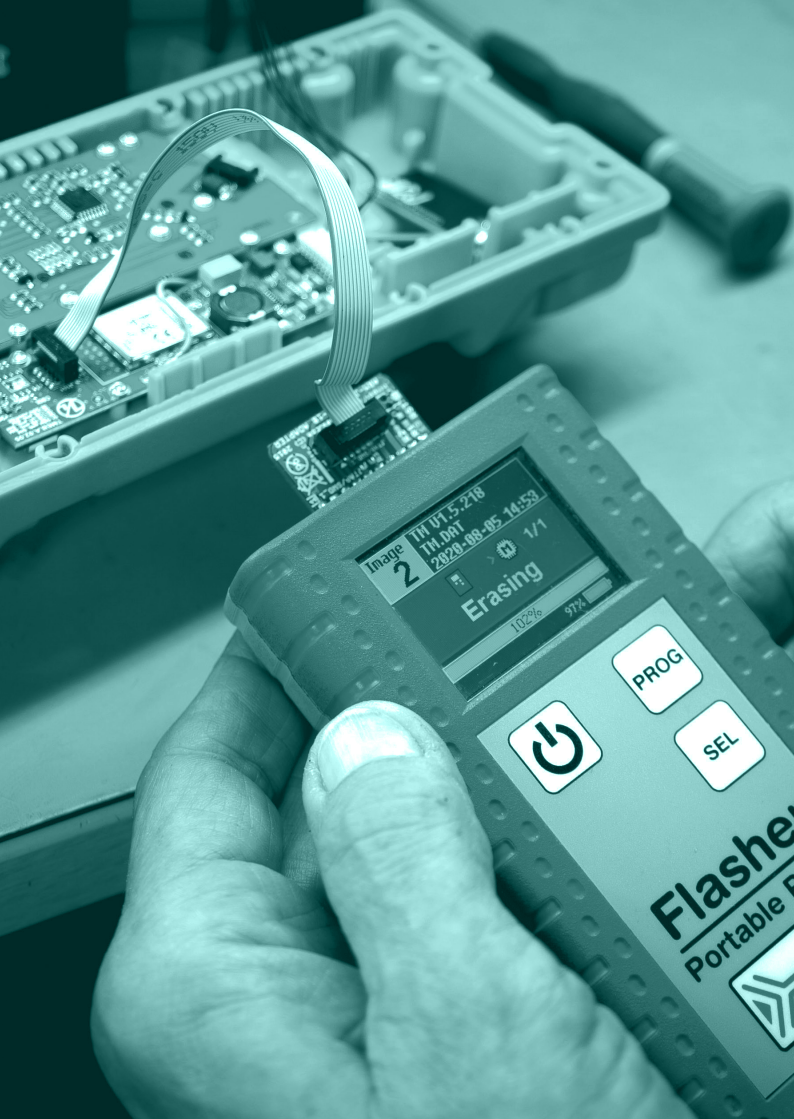
Required and Desired – the trade off

Often it is not as simple as having a bullet point list of features in isolation. You will invariably have a list of critical functionalities but also be considering some ‘nice to haves’ where their inclusion or exclusion relies upon external factors.

Typically, that external factor is cost and how much additional is involved in implementing a desired feature. In a world where every product has a competing product, aligning the price point to the feature set is an important consideration.

These considerations are not always around ‘in or out’ features either, sometimes they are upgrades to what is already a critical function (i.e. the type of power input connector) or they could unknowingly conflict with critical functions at a technical level.

I recommend documenting these ‘required’ and ‘desired’ elements then talking them through with your external partner to settle the specification.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3

Understanding the process

Understanding the process

Introduction

Exactly how a professional individual or team undertakes an electronic design project is likely honed over decades of experience in a continued drive to reduce cost, risk and timescales.

However, the top-level process is universal and thus it is that which I shall be talking you through.

The initial, often collaborative stages, centre around defining exactly what it is that will be designed, before moving onto the development effort itself.

Once the design work and all simulated testing possible is complete, physical prototypes must be built to test the design in the real world.

Those testing phases span functional, environmental and approval type testing to validate its suitability and integrity as a product.

Finally, we must migrate past the design phase to the manufacturing phase and beyond to success.

Specification

Before any design can occur, it is vital that exactly what is being designed is rigidly and comprehensively defined. Poorly defined specifications risk project delays and cost overruns, but even more importantly risk the overall success of your product.

Even if you have a clear idea in your head of what you are looking to produce, it is possible there remain elements you have not yet considered as detailed in the 'Defining your requirement'.

The output of this phase of careful deliberation should be a comprehensive document (usually labelled a 'Design Specification') that defines exactly what you wish to end up with and the key component selection to achieve that.

This document should later be able to be held up against a physical prototype and every line ticked as being fully satisfied and compliant.

Schematics

Now the specification and key component selection is defined, this phase concentrates on how those key components (a processor, memory, storage, USB hubs etc.) connect to one another and the outside world.

This sounds relatively simple but often these devices have hundreds of pins to which each specific pin must connect to a specific pin on another device, not forgetting the typically hundreds of passive components (capacitors, resistors etc.) that must be employed in between to achieve an electrically valid and robust circuit.

It is critical the schematics are thoroughly checked as even one pin going where it should not, can lead to short or open circuits, which may be in a middle PCB layer that is completely inaccessible to rectify.

PCB Layout

Laying out the PCB itself starts with the outline, this may be flexible or incredibly rigid depending upon the application and the intended enclosure.

Key component placement occurs for parts that need to be in a specific place (i.e. externally accessible connectors such as USB must align with the opening on your enclosure) on the PCB. Similarly, some components will need to specifically not be in a particular place, such as too close to tracks that could cause interference.

The remainder of required components are then place and tracks created between them to replicate the connectivity defined within the schematic phase.

Finally, a thorough review of the PCB layout must take place to ensure accuracy and compliance with PCB standards and to ensure best practice has been followed throughout.

Enclosure Development

Industrial product developers sometimes elect to utilise an off-the-shelf enclosure to avoid the need to pay for enclosure development or costly tooling, as they are often hidden from sight.

Retail product developers and those industrial applications where aesthetics are important will elect to design a custom enclosure specifically for their product.

If you are designing a custom enclosure, it makes a lot of sense to either use the same external partner who is designing the electronics, or ensure they are directly connected as significant collaboration will be required to ensure both marry together perfectly.

There are various materials and methods of manufacture available, all with different pros and cons across up front cost versus unit pricing, so the quantities you intend to produce are often an important factor in enclosure design direction.

Prototyping

Building a physical prototype is often the most exciting part of the process, the first time we get to see our design in the flesh and fully test it.

It is important to remember that your first prototypes are unlikely to be perfect, consider them a physical testing platform to interrogate every aspect of the design that cannot be tested by cross-checking or simulation – a platform to hone and tweak to then achieve the perfect design.

Typically, changes made between a first prototype and production include improvements on yield, reliability, and EMC behaviour.

There is usually a sweet spot of how many prototypes to produce depending upon the complexity and size of the PCB, typically quantities of between 5 and 10 are elected.

Certification and Approvals

At a minimum, your design is likely to fall under the certification requirements of the Low Voltage Directive (LVD), Machinery Directive and Electromagnetic Compatibility (EMC) Directive.

This means to put your electronic product on the market you need to have tested and be certified to have passed within the limits of that legislation.

Outside of that common requirement for all electronic devices, products intended for certain applications and industries often have their own approvals requirements, those for medical, automotive and aerospace are most stringent.

Finally, the geographies you intend to sell your product within will likely have their own approval requirements, which may be different to your primary market. If you are unclear what will be required to place your product on the market, an external partner will likely be able to assist.

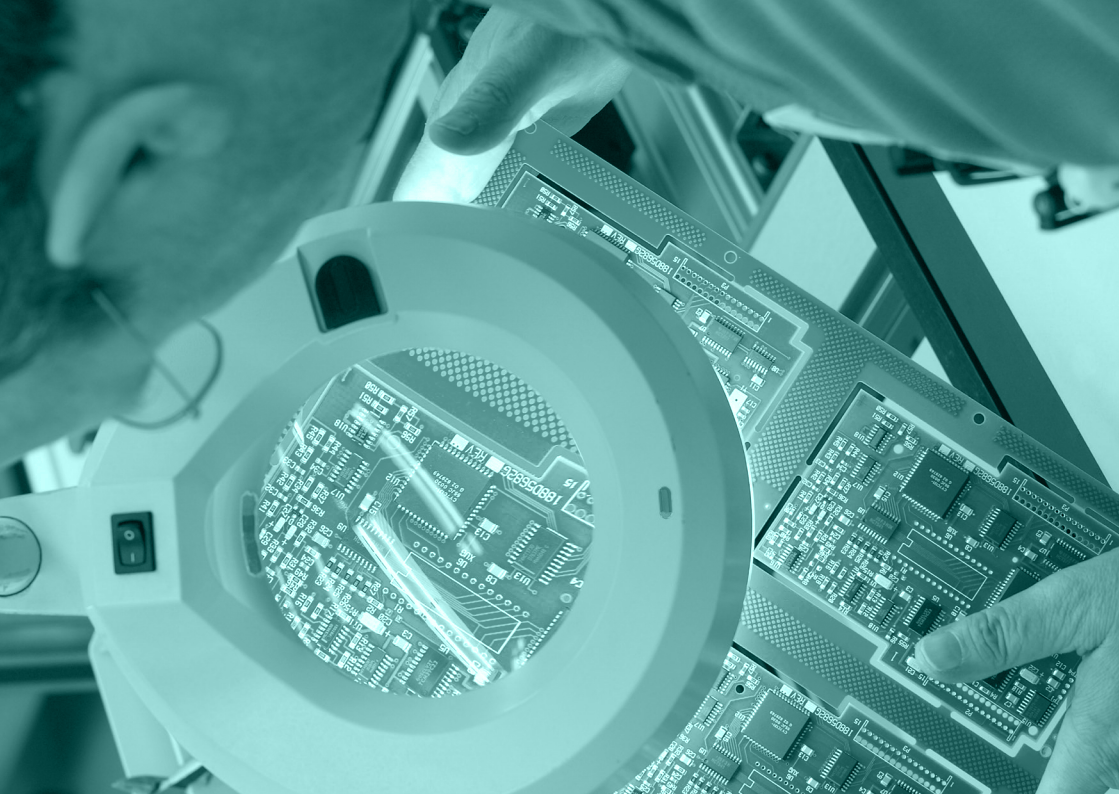
Handling change

Whilst every effort should be made to avoid mid-design change by comprehensively considering and defining the specification beforehand, sometimes due to external factors it is unavoidable.

Maybe you have only now realised a strong demand for a specification tweak from the marketplace or identified some brand-new feature you would really like to crowbar in that would really help to make the design more successful – what can you do?

Thankfully, most external design partners are set up for such mid-design change and whilst not ideal, have robust ways of managing this that reduce the cost and time-scale impact of doing so.

Often these are managed as an 'Engineering Change Request' or similar that presents the cost and time-scale impact on the design phase and the unit pricing for you to be able to make an informed decision whether to make that change.



4

Finding the right partner

Finding the right partner

What is important to me?

There is no universal 'right partner' for everybody, they will vary in skill, size, longevity, experience, scope, and cost to name but a few examples.

The first port of call in identifying what is important to you can often start with **why** you are looking to use an external partner in the first place – the prospective partner must at a minimum be able to tick all those boxes.

Beyond that bare minimum, you as an individual or company will likely have desires around the type of partner you want to work with, perhaps moulded from past experiences, good or bad.

The following chapter will help you to define exactly what is important to you when considering an external design partner to work with, making the right choice of partner can be the difference between a successful product design and a costly nightmare!

Evaluating a potential partner

When evaluating a potential partner, most will start at a company's website. These have value as a top-level review to determine if they likely have the right experience or qualifications to warrant the investment of time in having initial conversations, but they tell you very little about the people you would likely be working with and are designed to create that perfect perception, which may not marry to the real-world company.

There are likely elements you will note as being important to you as you progress through this chapter, that can only be determined once you start engaging with a prospective partner.

Some will be simply questions you must ask as the answer is not readily available on their website. Others, particularly those less black and white around responsiveness, culture, integrity, working styles etc. do not lend well to direct questioning and are to be observed in those interactions.

Who are they?

Understanding the top-level characteristics of a potential external design partner is by and large the same process you would follow for investigating any new supplier.

You are likely interested in how long they have been in business and their financial stability, to give you confidence in at very least them being operational for the duration of your project.

Unlike a supplier you are looking to make a one-off purchase from, or one who stocks generic widgets you can alternatively buy from anywhere, it is likely you are looking for a longer-term relationship so can you have confidence they will be around for the duration.

It is highly likely you will at some point have component obsolescence issues you will need to resolve or will want to make improvements to your design at some point – so focus on stability.

What are they?

Having defined exactly what you need and the scope of that support, we need to hold any potential partner up against that list.

Their website can be helpful in this respect, often such partners have various case studies or a list of specific experience and expertise you can reference and gain a level of comfort against.

Where you require a partner to have a specific certification (i.e. to design a medical device) eliminating those that do not possess this immediately can save you time later.

The highly varied and specialist nature of electronic product development may mean your potential partner cannot present specific experience with your application or in your industry, so it is always worth exploring the potential partner's level of comfort with your application and the scope of the task.

Where are they?

Is their physical location important to you?

In days gone by having a partner within a manageable 'driving distance' was of critical importance but nowadays with the development of remote working, it is far less so.

If the potential partner is not within easy physical reach, consider any scenarios relevant to your development where you may need to physically visit and explore with them how their remote working technology could mitigate this.

Typically, there is little need for face-to-face interaction during a project's development but many, including myself, still value having first built that personal relationship with people we will be working with – albeit this is achievable to some degree using video conferencing applications.

Why are they?

Many consider any business exists primarily to make money, but I believe it is far deeper than that. Most business owners I know have a wider mission, with a genuine desire to further their industry and really make a tangible difference.

What primarily motivates the business owner trickles down into the culture of everyone working within the business and dictates what your experience will be as a client.

In utilising an external partner for such a critical business function, you are effectively placing your reputation in their hands and thus are unlikely to want a partner motivated purely by profit.

- *Can you trust them?*
- *Do they show integrity?*
- *Are they transparent?*
- *Do they share my values?*

These are all questions that can only be judged on their behaviour, not from a 'values' poster on their wall.

How are they?

How does your potential partner work?

Do they invest in the latest tools and technology to improve their efficiency (thus reducing your costs) and to mitigate risk?

Do they have clearly defined and well-honed proven?

How do their design costs work? Do they charge up front merely for a proposal? What is their day rate?

There are so many questions to ask when learning about a potential partner, but those above, to me, are the fundamentals around the 'how'.

A less tangible consideration is how they will interact with you and what do you want? Do you want to be challenged with alternative ideas to improve the product or profitability – or do you want them to simply do as you dictate blindly?

5

Manufacturing

Manufacturing

Can I get my design manufactured directly?

When considering the scope, many are not sure during those early phases whether manufacturing is in scope for their potential design partner or not – especially if this is their first product design.

In my experience, if your design partner can offer this service, it is well worth exploring.

Having the designer manage the manufacturer can insulate you against all the pesky queries and issues that are par for the course in any kind of manufacturing but can be particularly prudent where there are hundreds or thousands of individual components making up a product.

Each of those components have varying availabilities and many may become obsolete during the lifetime of your product's manufacture. Having the designer manage these issues, such as confirming suitability of alternative component manufacturers or designing out any obsolescence behind the scenes can be invaluable.

Obsolescence Management

Managing obsolescence throughout the manufacturing life-cycle of a product can range from very little effort to requiring complete redesigns, depending upon how critical the obsolete component is and what alternatives are available – if you have little experience yourself in electronic design this process can be daunting.

Due diligence is always applied whilst designing products to not include components nearing the end of their life-cycle, but manufacturers can (and do) make components obsolete without warning, particularly as a result of acquisitions.

The more complex a part, typically the more complex the process to design it out is. There may be a 100% pin compatible alternative, though more complex parts such as a processor is highly unlikely to have such an easy replacement and will often require some engineering effort to successfully migrate.

Managing stock

In striving to obtain the lowest unit cost it can be easy to over commit on the total batch quantity, particularly for the first production run when it is difficult to predict the rate of market uptake.

Falling into this trap can leave you both financially over committed and needing to find somewhere to store the vast quantities of product you committed to taking in a single batch.

Speak to your potential partner about the possibility of scheduled (i.e. 10 batches of 50 pieces) or call off (500 pieces within 12 months) arrangements to both alleviate the financial pressure as you will only be invoiced with each drop and reduce the need to physically store a large quantity of product from day 1.

Working with your manufacturer to understand when you will first start receiving product can help with getting those pre-release orders in!

6

Conclusion

Conclusion

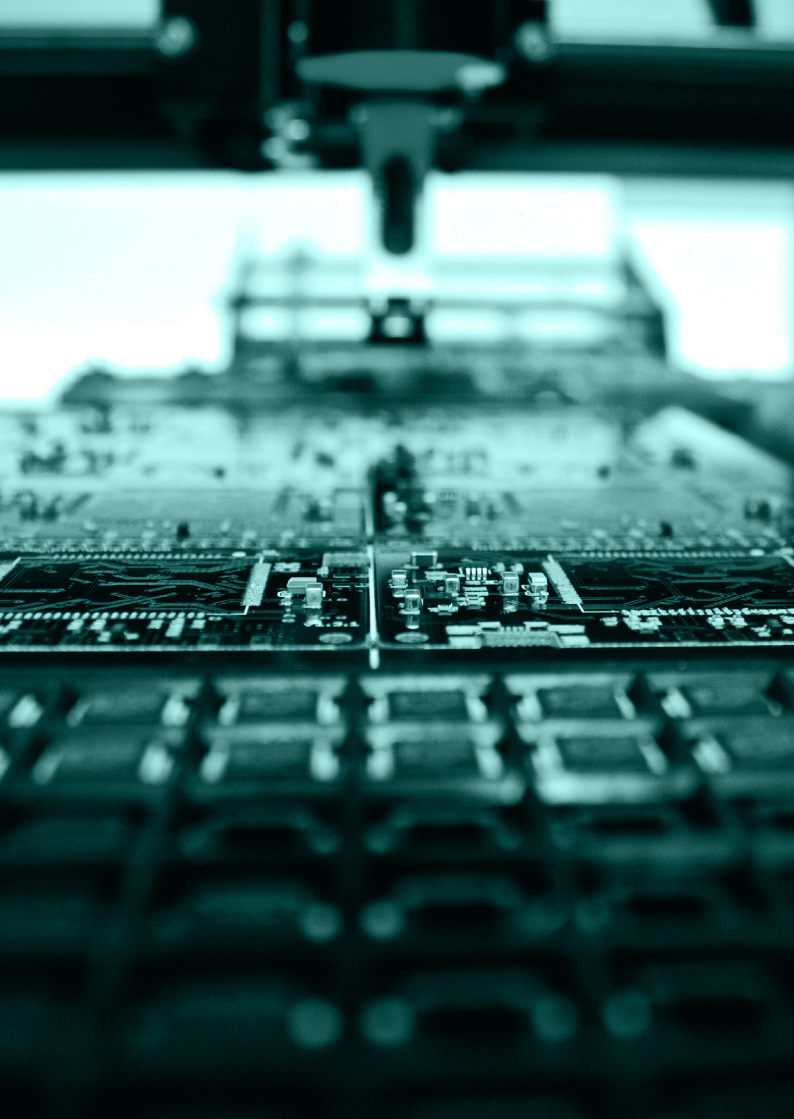
Am I ready to choose my partner?

Hopefully having reached the conclusion of this guide, you feel significantly more comfortable with selecting an external design partner and how the process is likely to work thereafter.

Remember, ask as many questions as you need to make you comfortable - and then ask some more.

I would like to take this opportunity to wish you every success with whatever you are designing and however you choose to undertake it.

I would love to hear from anyone who this guide has helped and any feedback on how it could be made better.



Be prepared

Whether it is your first time bringing a new electronic product to market or you are a seasoned project manager, this guide contains everything you need to know for that journey.

From how to define your requirement, to analysing key phases of the design process and selecting a design partner – we guide you through every stage to help you mitigate risk and ensure a successful product development.

Product development can be a daunting proposition, this guide was instrumental in helping me prepare and undertake that journey successfully.

Alan – Hymn Technology

A valuable guide to navigating the challenging journey of electronic product development, with all the critical best practice, and tips to avoid pitfalls and ensure success.

Andrew – Brightwell Systems Ltd