Compendium of Blogs

Client Perspective

Design Reference

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Contents

Specification

6 important background pointers for your specification:

- Investigate your market (size, accessibility and route to market)
- Know your user type(s)
- Have an idea of your intended sales volume
- Consider budget in the light of payback (Return on Investment)
- What are competitors doing?
- How many steps from first design to market (e.g. is there a Proof of Concept or investor stage)?

Specification is a great start to a project…. Or at least it can be. It shows planning and organisation; there are two types of approach:

Historic approach

- Make an enquiry or two
- Ponder on all the implications
- Create a detailed list of all features (display/lights/switches/communications)
- Create an even more detailed list of what the features do
- Possibly try to specify some of the key elements in the system

Total number of pages: 3–30+

Agile approach

- Make an enquiry or two to assess overall scale
- Talk to the designers about how the end user will employ the device
- Outline the possible types of user (e.g. end-user, service, installation)
- Indicate areas of success or failure in older or competing products

Total number of pages: 1–2

	Historic	Agile
Focus	Product centred	User centred
Management	Micro-management	Clear division of knowledge market vs. design
Speed	Slow planning/commercial implications at each step	Quicker to start and easier to direct to end goal
Base cost	Defined but inflexible	Defined
Variation cost	Proportional to change	Often none
End result	Depends on ability to predict all outcomes	Depends on ability to understand the user

Choosing a technical design team

5 insights

1) Do not be put off or think of your own position being “inferior” because the technology that you might need is ahead of you. Technology is a tool. If you saw a man using an axe, the understanding of the axe (tool) would not phase you. You might be surprised at the man’s speed and accuracy which he has acquired through skill and practise. Technology based design is an educated skill. However, education is only a foundation; experience and practise are critical elements.

   How you feel and approach the project and its team will greatly affect the overall outcome.

2) You are bound to have some sort of dialogue with the potential design team but it is the nature of the dialogue that holds the greatest key. The primary function of the communication is often perceived to be the outline of your needs or the specification. In reality the most valuable part of the communication is how you feel…

   Are you put at ease? Are your questions handled with an educational/informative tone or an air of superiority? Can you work with this person/team?

3) A good design outfit will have a commercial view of your product or project and be able to advise accordingly. Unless your project is solely related to research type activity, it is likely that you are looking to sell the ultimate creation as a product in a market. The viability of the design is not just in avoiding manufacturing pitfalls – it requires a commercial insight too. You should gain a sense that the potential design team has this.

4) Electronic Product Design is an example of where several disciplines are involved. It is important to bring all members of the team together early in the project. These days it does not matter if the Industrial Design team is in London and the Electronic Design team is in Cornwall. Collective communication can be readily set up and have all parties to share in the origination. This is not to create a design by committee – it is to ensure that there are no major (costly) problems created by choosing one path in ignorance of the implications elsewhere.

   Commercial design teams will often say “yes” to the project to win it – that’s natural. You are very likely to be able to sense whether the person/team is genuinely able to present a coherent picture of experience with other disciplines.

5) Good design should conclude in such a way that you have the product that you need and the freedom to use it as you see fit. Right at the start, find out how your potential team deal with Intellectual Property Rights and the transfer of all rights and data to you.

   You should be given all rights on conclusion in normal design contract but this is not always the case. These rights should also be backed up with an openness that is free of technicalities or terminologies aimed at creating a smokescreen. Again, your early dialogue should soon give a perception of how open and fair minded the design team is.

Proposal and Quotation

4 steps to controlling your design project costs

LUCK = Labour Under Correct Knowledge

"How much is it going to cost?"

This is potentially the single most important question at the outset of a project. Unfortunately, the answer is not just a figure. You should expect your design team to show the details so that you are able to clearly see:

a) Costs
   i) Fixed price elements – often design labour
   ii) Variable price elements – prototype materials
   iii)
b) Specification – very project/product dependent (not all may apply)
   i) User types (engineer/installer/security/maintenance/end user)
   ii) Size/profile/casework
   iii) Define uses rather than features
   iv) Define behaviours rather than 100 lines of "if this happens /do that"
   v) Battery life/power consumption/standby or sleep modes
   vi) Performance characteristics (distortion levels, accuracy, power etc.)
   vii) Relevant standards (CE/EU Harmonised, industry specific criteria)

c) Scope of work – does it provide:
   i) Proof of Concept
   ii) Prototype
   iii) Demonstration standard – often used for attraction of investment
   iv) Pre-production
   v) Fully developed production device including revisions after pilot manufacture

d) Who is involved/know your supplier(s)
   i) All work conducted by direct employees of the contracting organisation
   ii) Specialist activities are contracted out on the basis of long term association
   iii) Responsibility for the delivered result is with the prime contractor

e) Level of test and whose responsibility
   i) Basic bench test
   ii) Parametric tests with some measured results
   iii) Field testing (often the client influences or controls this)
   iv) Beta testing of product with known end-customers (very much client led)

f) End point
  i) Who owns the Intellectual Property Rights?
  ii) Do you have access or control of all relevant design files (original CAD files/drawings, Gerber files, source code etc.)?
  iii) What kind of follow on support is offered?

Proposal to Quotation

Commonly, the expectation is that a quote should be obtained. Even in tightly regulated quotation processes, the offerings in different quotations are frequently diverse. This means that a direct price comparison is not possible.

A fixed figure in a quotation can only be for a specific scope of work to one specification.

The concept of a proposal and quotation is an offering based on proposed route to the end goal. This allows the proposal element to be discussed and amended to suit the revised requirements. Once all parties agree to the structure then it is a quotation based on a known set of parameters and outcomes.

Commercial Awareness

Your design team should be commercially aware and consider the business case. The whole exercise of any project from Proof of Concept to total product design is a means to generating new revenue or added value. The design team should appreciate that the project is more than an indulgence of the design process – it is a necessary step towards a commercial goal.

Design teams with experience and commercial awareness are likely to have useful insights into risks and pitfalls as well as potential savings. This experience will combine many years of hands on with the observation of countless projects. Ignoring these insights begs the opportunity to rediscovers known commercial pitfalls. Engage your design team in dialogue and seek their opinion in this area – you do not have to agree with it or follow any recommendation. Being aware of risks and savings will help you to manage the process.

Manageable sizes

Most projects have a series of steps. These should be of manageable proportions, preferably with defined outcomes. There may be instances where a single step is many weeks of work. Wherever possible it is better to break them into monthly “chunks”. It is far easier to make many small corrections to direction rather than end up with a project that is hugely deviant from its intended path.

Money, cost, cash-flow are very able to surface as an issue in a project. Design projects do not work well if these issues keep surfacing. If the proposal/quotation was set up correctly, then there should be fair and timely payments for the work done. This means that the design team should be delivering identifiable value for the payment stages.

A good proposal/quotation will offer the project with the work stages already separated into manageable sizes with definable outcomes or identifiable value.

It all sounds very simple and on the whole it is.
However, we have helped to recover many projects that have "gone off the rails" elsewhere. The usual story revolves around not doing some apparently simple things – simple things matter.

Simulation

How to save 20–30% or more in a design project

Measure twice, cut once

The old adage "measure twice, cut once" is thought to come from the world of wood work. Assuming the first measurement is correctly taken and marked can result in a large loss. The problem is that a "single" error in the process may be a total loss of the piece of wood.

A similar scenario is also present in the electronics design world. The first stages of a design may create schematics and a circuit board. Once this board is populated with parts, it can look like the whole process has been fast tracked and is "nearly done". If the gamble pays off then it might work. However, if the gamble does not pay off, then the time taken to make it work will cost dearly in parts and time.

The "cut once world"

Measuring twice looks like taking twice as long to do the job. In reality the measuring side is a small proportion of the whole process. In a situation where there is a problem in the "cut once world", consider the circumstances. The material price has doubled, the measurement time is now repeated and the whole cutting exercise is also duplicated.

Lean and agile systems tend towards minimised levels of operation and design with test in mind. Hawkshead has long operated such methodology and is pleased to find wider support for the lean/agile world. The difficulties of reconciling electronic design with agile software approaches has left many design entities in the "cut once world".

A rigorous approach

There is an alternative. It is called measuring twice. There are several ways in which this can be done; simulation is perhaps the easiest of these to portray.

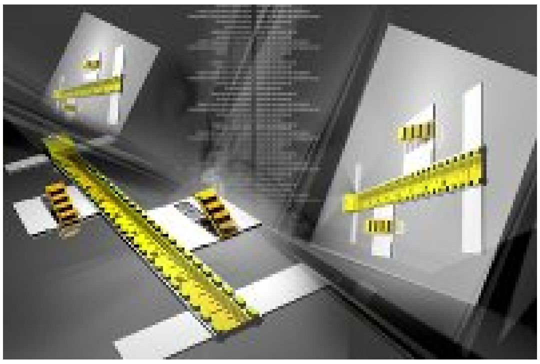
Simulation is an opportunity to work in a virtual environment. Like many such processes the concept of “garbage in, garbage out” very much applies. Calculations and spread sheets are probably in supporting roles too so that the input is not garbage. Usefully constructed simulations offer multiple benefits. A (not exhaustive) list of benefits includes:

- component values are optimised and system tolerant
- temperature or component variance is managed
- verification of circuit topologies
- correct closure of closed loop systems
- ability to continue tests into realms where real components may fail

An important outcome of the simulation process is the measured result or graph. It refines and perhaps defines the understanding that is required for a successful project conclusion.

Cost savings

When the prototype board is ready for test, both the designer and the client can share in a degree of confidence. The circuit values assigned will already be in the right range for first tests. The results of practical measurement can be readily compared with the original, virtual predictions and graphs.



If there is a problem or divergence, a return to the simulations will often highlight the relevant issues in minimal time. This avoids a vast amount of hunting in the proverbial dark. Where there are questions of power control or heat build-up, the simulation approach often saves the cost and time of replacing burned out power devices.

The steps from first concept through prototype and then to production and marketing are increasingly expensive. By the time the prototype is considered to exist it is likely that plans are well in hand to market the product. Delays into the market and worse still problems with the product in the market make the “twice measurement” a pocket change cost. It comes as some surprise that a more informed approach is not far more widespread.

The choice is simple:

- Take the fastest approach to cutting your wood and hope for the best
- Measure twice, avoid the gamble and reach the market perfectly sized

Design process – schematics and PCB design

Diagnose your designer

This part of the design process relates to schematics and PCB design. It can be viewed as the core of electronic design. It is ultimately YOUR design and you should feel able to look at and question it. However, this is an area where considerable differences emerge between designers and their audience.

Accessibility

This is the most important aspect of all. Good design is a specialist skill acquired by education and experience over many years. In spite of that, it is practised by "ordinary" people. You should be able to understand any part of the design either through necessity or pure curiosity.

The process of design, even at the core, should be a process that is informative and perhaps educational. Above all it should make sense or follow a logical path that you can follow with ease.

Cranky words

The technical world is full of strange words and acronyms. Some of these are necessary and a good designer will use these terms but explain them. Wherever possible more commonly used words and descriptions are employed.

Excessive technical terms or proliferations of pompous expression are not useful. The aim of language is to convey meaning and assist understanding. Good designers stay away from sounding technical even if it makes their job sound simple.

Schematic pictures

Schematics are like simplified maps. They show how the elements of a circuit are connected. The symbols used are strange to the casual observer but they are understood as a world-wide "common language". Reading schematics is like trying to read a book in a foreign language – useless unless you know the language.

In spite of their necessary, specialist, approach there are some things you can tell purely from the schematics. They should have structure. This means that you can see or sense a "flow" from the way that it is presented on the page.

Some circuits take up many pages, so there should be a header page that shows how the various pages are linked. Labels on the header page will also give a view as to the core functions of the circuit groups that follow. The header page will have a logical presentation, usually in a left to right flow of data or signal(s).

Whether a single page is the entire circuit or just a subset of it, there should be a visible organisation to the page. The left/right flow will tend to apply. Some circuits are drawn as blocks and there may be several blocks on a page. These blocks should align top and bottom so that visually there are “sentences” of blocks.

A slave like approach is not required, so that the odd exception is permitted where space or visual clarity is a greater priority. A schematic that has no clear separation between blocks and has “sentences” that have no imaginary ruled lines are indications of less considered design.

Once again the presentation of the schematic(s) should be plain and straight forward even if the symbols are alien.

Printed Circuit Board

The Printed Circuit Board (PCB) is very likely to be the single most expensive part of the assembled circuit. More than that, it is a customised process to deliver you a bespoke end solution. Once created and sent for manufacture it cannot be changed. Once deigned on the computer, your designer should be checking with you to ensure that you are happy for the design to proceed to the next step.

Unlike the simplified map of a schematic, the PCB has to operate in the real physical and electrical world. Mounting holes, control locations and other physical constraints may force the circuit to be laid out in a prescribed manner. In spite of this there should be ordered groups of components. Where there are multiples of similar circuit blocks, they should like similar instances.

Some circuits are too dense to allow the components to have legends beside them. Other circuits are more dense still and appear to have all components “jostled” up tight to one another. Don't be afraid to ask your designer to talk you thought the circuit.

Whether the process you need is visual or a verbal walk through, you should be able to discern the level of care and consideration given. Very dense circuits may not be as simple to view from a component perspective but there is a common trait to all boards. The connecting tracks should display an order and tidiness. The tracks should all meet pads (component connections) and “holes” squarely to their centre.

The overriding visual appearance of a well-designed board is that the track (copper) layers should appear to be “obvious” and not at all complicated. If it looks simple when viewed as a whole, then the chances are a great board is before you.

	Bad Design	Good design
Language	Technical/baffling	Straight forward, terms explained
Approach	Superior	Educational or “down to earth”
Schematics	Unwieldy, hard to follow any sense	Organised, neat, sense of flow
PCB	A web of intrigue and chaos	Ordered and apparently simple
In charge	The designer	You

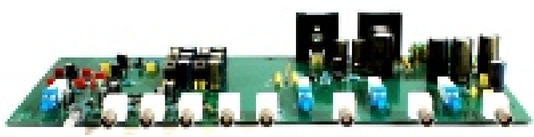
Prototype

A behind the scenes view

Virtual meets reality

The prototype of any circuit is the first time that all the theory and calculation meets the real world. You hope that the circuit works first time but this is an optimistic stance and fraught with supposition. There are a myriad of small details that make up a circuit, connections and component values being only a part of the whole.

Parasitic components are an example. A parasitic component is not a physical component but one that can exist due to placement of parts, proximity to another circuit or simply due to the length of wire. Leakage (high value resistance), capacitance and inductance can all exist. In most cases these are predicted but the final outcome requires careful determination – it is not just function that is tested but also how well it performs.



Staged behaviour

With some circuits you do not just “throw the switch” and hope for the best. It is quite common to power up the circuit in stages. It may appear to take longer but it saves time and money to proceed in a cautious manner. If there is any kind of fault (miscalculated part, faulty device) there is a very real possibility that large chunks of the entire circuit could be destroyed.

Thankfully errors are rare and the above approach avoids compounding the original problem. The most usual reason for staged power up is actually to save time. If the entire circuit is forced into life you could find circuit chaos on your bench. How do you know what is causing the issue? Staged power up allows the various blocks of circuitry to be assessed in more detail without the distraction of the other stages. Bit by bit the entire realm of blocks is allowed to function taking the circuit to the desired level of function.

Testing

Testing the prototype means rather more than the odd meter reading or visual inspection with an oscilloscope. These bench tests are important and should be completed. However the testing should also include any integration with case work and its function with any other devices in a system configuration.

There is another side to testing which is often underestimated. In application the circuit will be required to function whenever the user needs it. This might mean 24/7 functionality or it might be just hours at a time. Testing should reflect that. In summary it is vital to make as much use of the prototype as possible in a manner similar to an end user. That way you can be sure that you have done the testing and not left your end customers to be unwilling guinea pigs.

There is another article already on the site regarding the importance of "play" (http://www.hawksheaddesigns.co.uk/index.php/related-topics/play-time-in-a-technical-world).

On the way to production

3 steps to avoid the biggest bear trap

After you have a prototype of your product, the next step in the chain is production. It is a salutary warning that statistically more potential products fail in the step between prototype and production than at any other point in the chain. So what goes on here and what should you expect from your design team?

Test, test, test

There is a feeling amongst many that once the prototype is working then "that's it". Products, whether they are for business, industrial application or consumer use, are used by people. People all have different views on how things are done. The new product is new to them and they will not have grown to know the intricacies of the device through the weeks and months prior to its launch.

The implications of this lack of familiarity are many. It is commonly acknowledged that people only resort to reading the manual as a last resort (if at all). Perhaps more than anything else the "field trials" of some description are the most important aspect. If you cannot let the product out of sight until launch day, then employees or trusted family or friends might be the way to go. You might be surprised to know how valued a customer feels if he is invited to be part of the unpublished program.

"Field trials" are often skipped for reasons of commercial pressure (too costly, not enough time). The bottom line is that the product is going to be tested and trialled one way or another. The trials and tribulations of early product or the first draft of the manual will be assessed. Anything that goes wrong or is awkward or is not intuitive will be the fault of the product or "the idiot that wrote the manual." Users (aka other people) do not blame themselves. You can elect to have this process under close control or have the full force of market opinion deliver their "paid for" verdict.

Pre-production run

Costs related to a product increase at a dramatic rate as you move from the design to manufacture. The ultimate costs are often in the marketing. Whatever the cost structure, the step to production is an important one. There is often a price break where large quantities can be purchased for less unit cost. The temptation to dive straight in with a big order is great; the price is better after all… or is it?

Normally the best approach is to run enough production to satisfy the smallest possible requirement. If anything shows up in batch variation, manufacturability or durability then it is far more cost effective to sort this on a limited run rather than a full run. The alleged cost savings of the higher volume are quickly over shadowed by the added cost of any error – it does not matter whose fault or why, it is just a commercial reality from which there is no hiding.

Design team input

Your design team should have considerable experience in taking designs from the bench to successful large scale manufacture. Preferably this will cover everything from high volume, low budget to small volume high value. You can tap into this experience to assist in the decision making process for your specific needs.

Designers need to be pedantic in the detail as this is the substance of design. However, a practical approach is also required. The buyers of the parts and services required for manufacture will adhere to the designer's information. Good designers will respond as reasonable human beings and invite queries for alternative parts if some are elusive or on long lead times. Practical advice is also highly useful.

The manufacturing team may not be able to interpret everything from a stack of drawings and files. Communication between a helpful designer and “the factory” is a sure fire way to speed up the process and reduce costs. Assembly plants charge for throughput. If they are stuck and need to spend time resolving issues they may well have to charge extra. A quick call can save most, if not all of this cost.

Designers design circuits and products. Other people have to build them. It is the cohesion and communication between these skill sets that sets the tone for the future. Good designers know this and will support both you and the manufacturing team in the transfer to full scale production.