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07

REQUIREMENTS CAPTURE AND MANAGEMENT

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PRODUCT DESIGN SCOTLAND

ABOUT US

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

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

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

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

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TOPIC INTRODUCTION

REQUIREMENTS CAPTURE AND MANAGEMENT

The unfortunate truth when thinking about, gathering and writing requirements is that it's a pretty boring task. Most innovators like to focus on the big picture; very few actively want to think about and identify the exact details of what a system or product should be or what it should do. However, as much as it may feel like a tedious task, requirements gathering, capture and ongoing management, are vital processes that must be undertaken by someone involved in the project to ensure that a design is successful. In fact, the requirements define what the thresholds or metrics for "success" or "failure" mean for a project.

So, what are requirements? They are a statement or list of the functions that a design needs to be successful. They help to form a common understanding (between all parties involved) of the vision of the product or system. They also form part of a contractual agreement where, if the requirements are demonstrated to have been met, the outcome will be that to which all parties agreed.

WHAT IS A REQUIREMENT?

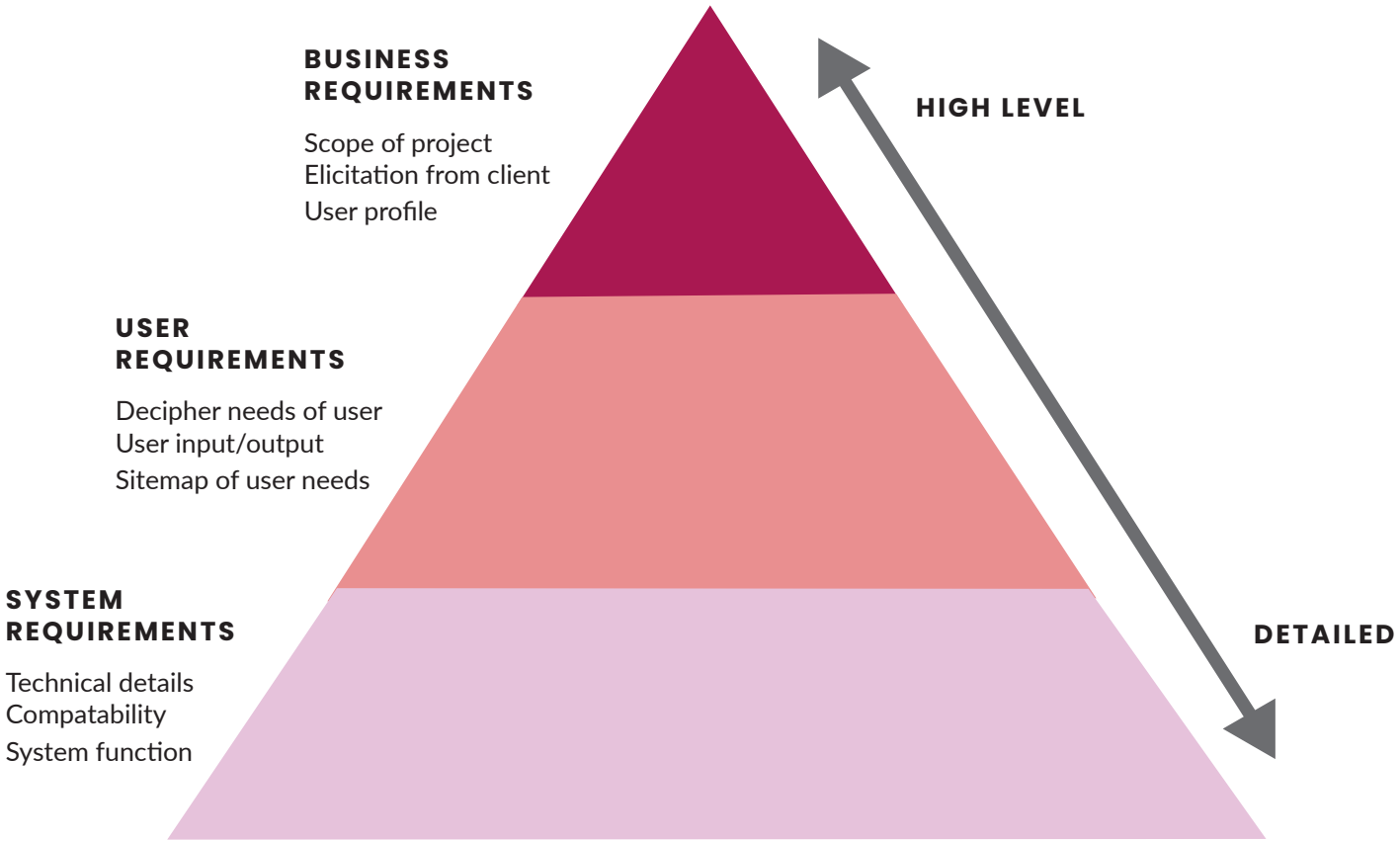
> A requirement is a definition of a physical or functional need of a design or system.

KEY STEPS IN REQUIREMENTS CAPTURE AND MANAGEMENT

REQUIREMENTS CAPTURE AND FORMATION

HOW REQUIREMENTS ARE MADE

Requirements are usually captured and formed from discussions with the client. The client may already have a fully fleshed out set of requirements that they've gathered based on use cases, brainstorming, end customer questionnaires and interviews. If this is the case, the conversation around this should be fairly straightforward and mainly focus on clarification of points. However, there may be a more skeletal list, or even just an idea on paper, or in mind. The less well defined the requirements are, the more work and discussions are required before design work starts: it's essential to fully understand the functional needs of the project and to get them written down at a detailed level (IE at the system level).



From the system-level, derived requirements are formed by the designers to fill out any missing points in the picture. Further, any project-specific safety or industry standards that are required to be met by law will also be considered by designers and added at this stage.

GETTING REQUIREMENTS RIGHT

It is vital to think about the full scope of what the system should be able to do – as well as what isn't necessary (or is "out of scope"). Poorly defined, conflicting or overly tight requirements most often lead to a product that doesn't meet a user's needs or expectations: they can also lead to lengthy design or even redesign stages. Requirements should be broken down into fully defined, unambiguous and verifiable functions.

Examples of basic requirements:

REQUIREMENT NUMBER	NAME	REQUIREMENT	COMMENT
1.	Normal operating ambient temperatures.	Normal operating ambient temperatures for this system shall be considered as 0°C to 45°. All requirements shall be met across this temperature range.	As this unit is designed for indoor use, there are no known use cases where the system will be required to operate outside of this temperature range.
2.	IP rating.	IP rating for the system enclosure shall be IP53.	Protection against damage from dust ingress is required. Low levels of water ingress protection required (spray from a cleaning bottle is the only known use case).

REQUIREMENTS MANAGEMENT: CAN REQUIREMENTS BE CHANGED ONCE THEY'RE AGREED?

Requirements' documentation shouldn't be considered fluid or dynamic – as much work as possible should be done upfront to get them right first time. This allows the lowest project cost and minimal delay to be achieved.

However, as the project develops, the client may demand changes to requirements (for a number of emergent reasons). The effect of each requirement change on the project will need to be analysed. For example, if a change is requested half-way through a design project, this may cause significantly more rework than if it is requested a few days after the initial agreement. It is important to explain the reason for the change so that the full picture can be understood and implications considered.

REQUIREMENTS AND DESIGN STAGES

Depending on the complexity of the design, it often makes sense to split the requirements and the design cycle into multiple stages. Each stage builds on the previous one in terms of proof-of concept; proof of correct technology choice; and increases in complexity and rigidity. Design flows vary according to the project but often follow a process similar to the stages outlined below:

1 - PROTOTYPE DESIGN

This is a more rapid design cycle using off-the-shelf or pre-assembled parts wherever possible. This will allow the client to get the basic functions or outline of their product as fast as possible to prove their concept will work and sell. It may not look anything like the final intended version but would be designed to prove the basic function, or it may look like the intended version but have no or rudimentary functionality. The goal of the prototype will depend on the client's needs (e.g. a mock up demo to show to investors, a proof of concept to receive initial end customer feedback etc.). Requirements for this stage will be very simple and the most open to interpretation or alteration of all design stages.

2 - MINIMUM VIABLE PRODUCT (MVP) DESIGN

Once the basic idea has been proven by a prototype and any requirement changes found from the prototype stage have been made and agreed, the MVP design can begin. At this stage, the design will probably utilise more bespoke design elements. This version will have the minimum viable feature set implemented to start testing functionality and then progress to verifying the design with the client's potential customers as quickly as possible. Requirements will be more rigid and clear at this stage than the prototype stage but there may be some wiggle room allowed for designers in order to get the job done quickly.

3 - PRODUCTION CANDIDATE (PC) DESIGN

Once the MVP has been user tested and there is enough feedback from the outside word, this information can be fed back into forming Product Candidate 1 (PC1). PC1 should have the full requirements set implemented but will still need to undergo end user testing to ensure it meets the client's own customers' needs. All requirements should aim to be met at this stage.

Each stage may need to be repeated multiple times before moving on to the next stage, with requirements documents being updated each iteration with any applicable changes.

REQUIREMENT PITFALLS

OVER-AMBITIOUS REQUIREMENTS

Often, entrepreneurs or inventors will want their idea to 'be made the best it can be - everything should be as accurate and efficient as possible'. While this is understandable, finding out the necessary levels of sensor accuracy, system efficiency, environmental ruggedness etc., will be far more cost-effective when it comes to the design cycle and also to unit production.

If there are only ever going to be a handful of units produced, the cost of each unit is less relevant and therefore expensive sensors, components, a bespoke enclosure etc. can be used to speed up the design cycle. However, as soon as the units start flying out the door in larger volumes, the cost of this over-engineered product with unnecessary levels of accuracy will really start to hurt profitability.

It is notable that the design could "fail" because it doesn't meet an unnecessarily ambitious requirement. So, the best path is to start off with achievable requirements and modify as the product cycle continues.

SCOPE CREEP

Changes or clarifications to requirements are often necessary. Some may seem trivial on the face of it. These are often made during a call or email conversation, and may be presented as so minor as to be unnecessary to change the official documentation.

This becomes difficult to manage, since part of the product's requirements description is now no longer in a single document. The change may have a detrimental impact that, if unmanaged, emerges later on in the project. If clarifications or modifications are needed, it's best to give designers time to consider the implications so they can respond with consequences to the project timescale or cost, if any. This will allow the client to make an informed decision and update their requirements documentation if necessary. Otherwise, unplanned scope creep will likely cause detrimental effects later on in the project, all of which could have been avoided.

REQUIREMENT FAQ'S

WILL ALL REQUIREMENTS ALWAYS BE MET?

Designers will always strive to meet all requirements set out by their client. For simpler designs, these can generally be met without major issues. However, as the complexity of a design grows, the chances of one or more of the requirements being unachievable in some form, grows. If this hurdle is met, there will be discussions with the client to find a resolution. An example is it could be removed for the first version to be reinstated in a later design cycle.

WHAT IF I DON'T WANT TO CREATE A SET OF REQUIREMENTS?

Without requirements, designers are unlikely to understand what a client is looking for beyond a fuzzy picture. The client also needs to gather requirements so that they know who their target customers are and what they want.

Sometimes, potential clients don't see the value in making requirements at all and wish that designers would 'just get on with the job' based on only on preliminary discussions and emails. This can mean a difference in vision between the various parties involved which can lead to misunderstandings with project timelines also affected. The design company (or companies) can pro-actively work with the client to come up with the requirements list; it isn't usually up to the creator to come up with this document on their own.

CAN'T YOU JUST START DESIGNING THE THING ALREADY WHILE WE COME UP WITH THIS LIST?

The risks of starting off in the wrong direction without an agreed set of requirements are significant. Projects which start before this point often run for as long, if not longer, than they would have done due to the confusion caused by the fuzzy starting picture and ever-changing sea of drip-fed requirements. It may not feel like it but the fastest route to success is to figure out exactly what is required with the design partners: only then should designers start working in a commonly agreed direction toward a well-defined and desired outcome.

MAGE
CONTROL SYSTEMS

PROFILE

Serving as one of Scotland's largest product design houses, Mage Control Systems is the one-stop shop for bringing innovative ideas to fruition.

The company's core capabilities in complex embedded control systems design, advanced algorithm development, power electronics, IoT & sensing solutions and safety-critical software development is what sets Mage apart from the rest. Simply put – we understand how electronics, software and mechanical modelling work together to meet complex challenges that demand embedded control system solutions.

Mage has a strong history that includes extensive experience within its leadership team stemming from the aerospace & defence sector. The company's capabilities uniquely develop and enhance designs across a wide range of industry sectors, harnessing the reliable and robust practices utilised in the aerospace & defence sector.

Working across a range of industry sectors, Mage Control Systems Ltd.'s expertise and technologies have been developed and honed to sharpen core skills and know-how around:

- products that require to operate in unpredictable and harsh environments (e.g., deep sea, extreme high and low temperatures, at altitude, under shock and vibration).

- highly effective cost engineering coupled with high power density solution designs – value and performance is optimised whilst reducing size and weight.

- successful development of products that not only drive and control precise, complex movement but can also enable essential feedback by utilising intelligent sensing technology.

- consistent performance in meeting stringent requirements for safety-critical designs and needs for military and defence standards etc.

- development of safe, end-user human-interface controlled equipment and sensing/monitoring technology.

- development of complex BUS architectures including RS422, CAN BUS, Ethernet, Ethercat and wireless technologies.

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