Product Ideas:

The Feasibility Methodology

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Abstract: Great inventors focus on creating great concepts, start-ups focus on cool prototypes, a bigger company wants to get into mass production. This paper carries a methodology required to achieve idea conceptualisation, prototype realisation, and product manufacturing.

1. Introduction

Inventors always have an idea in mind. Sadly, most of these ideas go to waste. Even more, an intensive feeling of regret surrounds the inventor when the same idea is developed and implemented elsewhere. An idea is an opportunity, if not acted upon regret only follows, unless a feasibility study revealed the idea is unfeasible or is already registered by someone else.

Converting an idea into success can be achieved through direct investment or pre-sales after a market test, both of which needs to be preceded by one object. That is a physical practical version of the product. Several people might find it helpful to have a clear process on how to move forward, including innovators with great ideas, start-ups new to prototyping, and companies new to product design.

There are two main routes that lead to having an idea. These are intuition and research. Intuition uses a top down approach and is helpful for start-ups having cool ideas and searching for a need for those ideas. More sophisticated companies use a bottom-up approach. They start with research to identify the challenge (the need) and then generate ideas (solutions) to solve identified challenges.

1 **Scope**	2 **Challenges**	3 **Solutions**	4 **Validation**
5 **Concept**	6 **Design**	7 **Prototype**	8 **Manufacture**

Figure 1 Process Table

2. Scope definition

In order to succeed, focus is needed, and priorities should be stated ahead. Complex problems tend to drag the process into many different avenues and all related problems cannot be solved in one go. Challenge to be solved must be chosen wisely based on target goals (e.g. target KPIs), not every seemingly important problem is important.

Next step is to write down all what is known about the problem, based on research and observations. State everything in a systematic manner, so it can be used for reference. This knowledge should be divided into subcategories.

The most fatal direction a project could take is to target additional features, not defined initially in the scope. This is known as scope creeping [1]. This can easily be avoided by having an accurate description of project goals in advance. Any features or preliminary ideas that comes along during the project should be documented and scheduled for other future development projects.

3. Challenge identification

According to the scope, focus should be only given to a specific area. The main challenge within that area to be identified, accordingly. Also choose a challenge that can be feasibly solved. Between changing the height of a short chair and that of a tall person, it is often clear which challenges can be feasibly solved.

The popular and simple Fishbone diagram, also known as Cause-Effect diagram, can be used to connect the causes to its effects. This is especially effective if you have one main root effect. However, the problem is complex you can use a more detailed root cause analysis to highlight root causes and identify the solution direction.

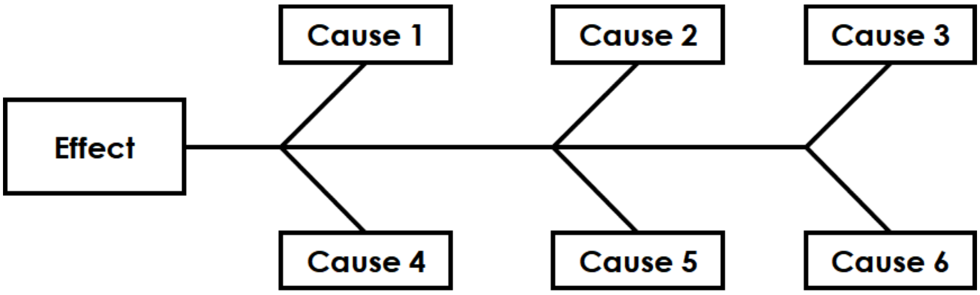

Figure 2 Cause-Effect Diagram

4. Solutions generation

Based on the root cause analysis, the best solution within the project scope. Depending on the complexity, a simple group brainstorming or a more advanced method such as TRIZ 40 principles could be used to generate solutions [2].

There are many other solution generation methods, some of which are very effective such as SCAMPER and "Reverse Thinking" [3]. SCAMPER is similar to TRIZ, but only based on 7 steps that make up the same acronym. These are Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, and Reverse.

Reverse Thinking on the other hand focuses only on the reverse thinking as the name implies. It can find a solution based on the effect instead of the cause. This is especially helpful when the cause cannot be controlled or modified.

5. Solutions validation

An idea can seem great, but it might not be feasible. That is why it is important to gauge the idea feasibility early on before any capital investment is made. The analysis should take into consideration: measuring the level to which the idea implementation will solve the problem; it was initially created to fix. This could be done against a set of requirements identified when the idea was conceived, and it has to fit the project scope.

Prior art is any evidence that the idea is already known. It does not need to exist physically or be available in the market, being documented previously can be enough. However, where prior art exist does not always constitutes a barrier against the use. Sometimes the idea has already been deployed without legal backing like a patent, in such case it is sometimes feasible to use the same idea with little to no modifications.

Although, it might be wise to make sure the idea was not well protected for a good reason, e.g. being ahead of time compared to market need. It also pays to conduct prior art research to make sure you do not infringe on other rights, but also to get inspiration from previous works instead of reinventing the wheel. This is especially helpful for bigger companies who can afford royalties to use innovative developed ideas.

6. Conceptual development

A concept is the implementation plan of the idea. It is as important, if not more important than the idea itself. Usually it takes significant time to develop a good concept and the process must go through several concepts before finalizing one or two concepts. Chosen solutions to be validated against set goals and more importantly relevant intellectual property and prior art. Ideally this can be done in parallel with the solution generation efforts.

After solutions are vetted, one or two solutions should have high conformity to set goals, and are also very feasible to implement. The winning solution must be optimized to match implementation methodology. For example: if the solution is a mass-produced product, it would require design for manufacturing optimization.

Proof of concept or heuristic models should assist the decision during this phase. This validation level ensures that at the basic level a selected solution is able to achieve all goals set initially.

Mock-ups are usually made to communicate the idea without consuming valuable development time at the beginning of the process. A simple mockup prepared from e.g. cardboard, to represent the idea, or an off-the-shelf product modified to add the value expected from the new idea.

7. Design development

The theoretical implementation of the idea starts by a preliminary design based on selected concept(s). This step outlines most of product features and identifies the general shape and size. Product aesthetics are usually defined and frozen within this step. The detailed design then goes on to identify all specifications of the product, especially those directly related to product ease of manufacturing and assembly. One of most important factors identified in this step is product strength and durability.

The design is then presented using 3D drawings, usually in STEP file format. However, higher standards require the 3D drawing to be paired with 2D technical drawings identifying specific tolerances and finish required for each feature of the product parts. This is particularly important; all interfacing parts are to match together in the assembly.

8. Prototype preparation

Prototypes are important to the movement of the design from the digital to the physical existence. This is very helpful to assist visual and functional aspects. It also helps get feedback from various stakeholders, especially the end user. Prototypes range from basic ones usually now done using FDM 3D printers to sophisticated ones done using final manufacturing processes, e.g. CNC milling, Injection moulding.

Prototypes are different from mock-ups, where mock-ups can be started, as early as, in the concept development stage to provide an understanding of ideas. Prototypes are usually used to validate ideas usability at a closer level to the actual end-product.

Prototypes are transformation of ideas from a theoretical phase into a practical one. Prototypes allow functionality test and refinement, help decide on materials, showcase and discuss ideas clearly with all stakeholders. A prototype demonstrates the idea as a viable solution, before any implementation takes place. Prototypes can demonstrate the required functionality, usability, durability, aesthetics, or all of these combined. The extend of prototype coverage depends on the budget and the level of new innovation introduced. Most ideas are building upon one or more previously demonstrated ideas, so a functional prototype might be enough [4].

Prototypes can be built using a variety of easy to shape materials, where mock-ups can be made using clay-like material such as Sugru for flexible prototypes [5], most prototypes nowadays are made using 3D printing. The use of 3D printing doesn't have to be expensive and a local 3D printing shop can be usually found. However, if exceptional quality is required, powder based 3D printers might be the most suitable option.

Services such as Shapeways [6], provide fast turnaround time for quality 3D printed parts. Sometimes prototypes need to have a specific strength, such as those of metal product, for which CNC machining blocks of a suitable metal is the best option. This could be done at local CNC workshops or using a standardized service such as Fictiv [7].

Some companies chose to produce a small production run to test their products. Some of them can even do this in house, such as Apple. That way a product can be tested before it is even considered for further development.

9. Manufacturing optimisation

Manufacturing products is an exciting process, but can be challenging without prior manufacturing experience. Product features usually need to be optimized before manufacturing. Steps required are summarised as follows:

1. Design and materials analysis
2. Manufacturing processes comparison against quantity and quality
3. Design optimization for manufacturing processes selected
4. Suitable supplier allocation and design needs communication

The amount of analysis and modifications highly depends on the manufacturing process selected, which in turn is dependable on the production quantity required. Sometimes even all factors could be satisfied with an affordable process, it is better to choose more costly ones to obtain higher quality.

One sample example is producing office wares using acrylic sheet cutting verses producing the same products using plastic injection moulding. The first has almost zero tooling cost, while the second has a considerable investment upfront. The acrylic cost per piece is relatively high, but for small productions it is very affordable. On the other hand, injection moulding costs relatively much higher upfront, but renders larger quantities at a fraction of the cost and with higher quality. In that case, no matter the quantity, if quality is the main goal, injection moulding would be chosen over acrylic blanking.

Companies with excellent design track record achieve the high quality by optimizing products during the manufacturing process itself. Apple reportedly does this, and it takes 4 to 6 weeks for each iteration cycle [8]. It takes them years to produce just one product, so they work ahead on future planned products. They always come late to the market, but with the best in class quality. This might not be suitable for every company. Companies with less resources will need to produce products within short development cycles. In fact, when Apple started they produced their first product, “Apple 1”, as only a barebones motherboard without any of the main input or output essentials [9].

10. Tolerance is key

Quality is mainly guided by the manufacturing tolerance. The lower the tolerance the higher the quality. The end user might not be aware of the tolerance factor, but they can spot a poor-quality product. Poor tolerance (large tolerances) allow a container to leak, a key to get stuck, or a phone to look cheap.

The absence of accurate tolerances the product will look and function poorly. In short, tolerance allowance is how close is the end-product to the planned theoretical design.

11. Conclusion

Challenge identification steps are best suited for innovative businesses, large corporations, or government bodies, where their complex problems cannot be tackled directly based on intuition alone. Solutions should be generated within the defined scope. Effective solutions should be identified early in the process and validated against the project goals.

Project management needs to be clear on what goals need to be accomplished. The best in class product can only be made on multiple iterations. The decision maker needs to know when it is time to stop the iteration process, and which features should be scheduled for the next product iteration, and what is the target product quality.

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