Philosophies and Techniques in Product Development

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Introduction

People interact with many products every day, and behind every successful product is a product development team who really understands the needs of their users. Product development unites engineering, design, marketing, and business with the goal of delivering value. A solid understanding of product development fundamentals helps engineering teams, whether it is a student project team or a group of entrepreneurs, deliver a better, more relevant, and more valuable result.

Throughout the process, it is critical for engineers to think like designers. Merholtz (2008) describes design as the process of generating solutions for humans (Merholz, 2008, What Do We Mean by Design? section, para 2). The human centered design professor and author Don Norman states: "Engineers and businesspeople are trained to solve problems. Designers are trained to discover the real problems." (Norman, 2013, p. 218).

The design process can be generally described as a five step process: analysis of the problem, synthesis of the findings into actionable design choices, design of a solution, validating the design for the desired result, and reaching a working prototype. Every team and company will approach the design process differently, and this tech note seeks to introduce some philosophies and techniques that may be applied during the design process.

Analysis Stage:

Designers are focused on remaining in the problem space: they are committed to gaining a deep understanding of the problems that justify the existence of the product. Here, a *product* is defined as anything that is the result of a design and engineering process, not just final products on a store shelf. All products are justified by some need, whether it is intellectual curiosity of the builder or a market demand, and its success can be measured by how well it meets that need.

Ethnography

In the author's experience, it is often helpful for the designer to focus on who they are designing for and why this product is valuable to them. Ethnographic research has emerged as a popular way to answer those questions in a way that captures more human complexity. Ethnography seeks to understand humans by studying them in their natural environment through interviewing and on-location research (Merholz, 2008, Using Ethnography as a Research Tool section, para. 3). Research can be primary or secondary. Primary research seeks to understand the group of individuals that will make up your user pool by using tools such as surveys, interviews, and focus groups. Secondary research identifies larger trends in the world such as market competition.

Synthesis Stage:

Research is only valuable if it is understood and used by all members of a design team. It is often necessary to condense that information into a more convenient form.

User Personas

Research is commonly transformed into and distributed as user personas: fictional representations of users or customers that are informed by research. Personas have real feeling stories and problems, and

they are an effective tool that convert data and findings into something that designers can empathize with and design for (Merholz, 2008, Create Truly Useful Deliverables and Artifacts section). Personas will vary between teams and organizations, but they will typically have a name, relevant demographics informed by customer research, and an explanation of their problems.

Research should be used to drive design decisions, especially those relating to product specifications. Mital (2014) describes a six step, formalized process to establish requirements, but in practice, research typically contain actionable trends. If personas are detailed and are informed by research, teams may design for their persona by addressing the needs articulated in that persona.

Design Stage:

Development Methodologies:

In the author's experience, product development is typically a structured process with the two most common techniques being waterfall and agile development. Waterfall development is similar to playing a closed world game: there is a set progression of levels and a storyline to follow. Waterfall emphasizes getting the work at each sequential step done right and not returning to the last step. This process is clear and simple, but it neglects the inherent ambiguity in design work resulting in a process that does not respond well to external changes (e.g., changes in the market, in the customer needs, etc.).

Agile development is an umbrella that encompasses many different *frameworks* that all tie back to the agile manifesto, a set of values that agile developers practice ("Principles behind the Agile Manifesto", n.d.). Agile frameworks vary dramatically, but when compared to waterfall, agile frameworks are more similar to playing an open world game. Designers are free to explore and wander at their own pace. This allows for the iteration and the flexibility needed to react to external changes.

Design Strategies:

Design thinking is often employed as a framework in which to approach the design process. One of its core characteristics is its emphasis on human centered design, which Norman (2013) defines as, "The process of ensuring that people's needs are met, that the resulting product is understandable and usable, that it accomplishes the desired tasks, and that the experience of use is positive and enjoyable" (Norman, 2013, p. 219). Human centered design thoroughly tests prototypes to validate that the proposed solution is actually solving the problem identified by customers. This iterative process does not operate in a vacuum; design iteration is done with customers, not just for customers. Designers using design thinking will use methods such as the double diamond method: diverge-problem, converge-problem, diverge-solution, and converge-solution. The double-diamond method encourages designers to explore and understand nuances from within the problem or solution space before converging into a focused output (Norman, 2013, p. 219-221).

Implementation:

In the author's experience, designing using human centered design principles and implementing via an agile framework gives the designer the ability to focus on delivering a valuable product to the end user without penalizing them for pivoting to try new ideas or to respond to changes in user demands. To make sure that development stays on track, it is wise to implement Norman's (2013) advice on using deadlines strategically: "There is nothing like a firm deadline to get creative minds to reach convergence" (Norman, 2013, p. 221).

Prototyping Stage:

Creating physical models is an important way to evaluate whether a design is meeting the customer needs. Computer aided design, or CAD, is frequently used to create physical models to be manufactured. There are many CAD options available for different applications and users. The author recommends Autodesk Fusion 360 for its relative ease of use, feature set, and its cloud services.

3D Printing Simplified:

Filament-based 3D printing (Fused Deposition Modeling [FDM]) is a common way to prototype hardware. FDM is what most people think of as 3D printing and work by stacking layers of melted plastic on top of each other to make a 3D form. In addition to

understanding the constraints of the particular printer and the materials being used, it is important to consider the constraints and best practices for FDM.

When CADing a part with multiple components, it is important to consider assembly. Making a prototype easy to assemble reduces frustration for your team when assembling and disassembling for testing and debugging. Mital (2014) has some suggestions regarding designing for manual assembly including designing components to be self-aligning and self-securing during assembly, reducing the overall number of components, and designing for *pyramidal assembly* ("best to assemble from above") (Mital, 2014, Manual assembly section).

Not everything that can be modeled in CAD can be prototyped by FDM. FDM cannot print over empty space as the molten plastic would just fall through; this is often encountered in overhangs or situations where gaps need to be bridged. To get around this, FDM prints scaffolds called *supports*. This significantly increases print time, material waste, and finishing time, so it is suggested to reduce the amount of support material during the CAD stages and by considering the best orientation for printing in to minimize overhangs. The exception is if the overhang is gradual (45 degrees or less) or if the gap is less than 2 cm, it may be possible to print without supports (Horvath, 2014, Bridging section).

Conclusion

Product development brings together designers, engineers, and customers together to create something valuable. Product development is a difficult and uncertain process that may not lead to successful results, and it is not a process that can be summarized in a multi-page document. Product development can vary dramatically between teams and organizations, and the approaches outlined in this document may not be appropriate for your project. By researching the available design techniques and philosophies, you can design your product development process so that it meets the needs of your users (e.g., engineers, designers, etc.) and the problem that your team is trying to solve.

References

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