Prototyping

Chapter 3

section 1

Prototyping

"Prototyping" is the technique and process of making a trial version of a product or service before the actual implementation, in a way that closely simulates the final version. Finding a defect or malfunction during mass-production, or after the product had already been delivered to the consumers, can result in a major loss for both businesses and consumers. In waterfall models of product creation, the creative process follows the sequence of planning-design-production. Here, prototyping has been used as a preventive measure to check for design flaws, and to review the manufacturing process before entering the actual production phase. By cycling through the process of trial-test-improvement as quickly and as many times as possible, prototyping enables us to enhance the quality and minimize risk.

From a User's Perspective

As products and services become more complex, prototyping is starting to be used not only as a means to test and improve from purely an engineering perspective, but as a procedure to refine usability, quality of experience, and other aspects that are difficult to quantify.

While key terms like "user-centric design" and "usability" are now widely recognized, when looking at the entire society, there are products and services that seem to have been released without undergoing the basic prototyping process, and to be staging an ambitious user-testing over the entire market.

As Jakob Nielsen [*] pointed out, prototyping and user-testing are not about exhausting the budget and spending extra time to collect statistical data and direct user feedback. The importance is in reading the signs to discover new ways for improvement, a task that requires only a few target users to accomplish. Reading through massive amounts of statistical data and reports will not lead one to gaining these insights. Instead, those directly involved in the processes of planning, design, and production should actively participate in user-testing, and make use of their own specialized perspectives to carefully observe the users for their seemingly trivial, unconscious actions.

In fact, prototyping enables each of the project members to become the first user of the product. For example, in a meeting concerning the project's immediate problems, participants often tend to speak from a particular standpoint within the project team. As professionals responsible for a specific field, they voice their opinions to say things like: "the schedule doesn't allow for any more changes in the product specs," "the plan is technically too difficult to achieve," and "that's just too much trouble to carry out." However, a tangible prototype forces each member to see through a user's standpoint. This leads to comments like "so that's how it turned out," "it's not too bad," and "this part is indeed awkward, how can we make it better?" Members are then able to engage through their unique specialties, to resolve the newly recognized tasks and insights gained through coming into contact with the actual, physical thing. Such is the power of experience through prototyping.

The repetitive prototyping process allows us to view the project from a user's standpoint, to nip the bud of critical problems, and ultimately enhance the quality of the final product.

[*] Jacob Nielsen,
Why You Only Need to Test with 5 Users, 2000.
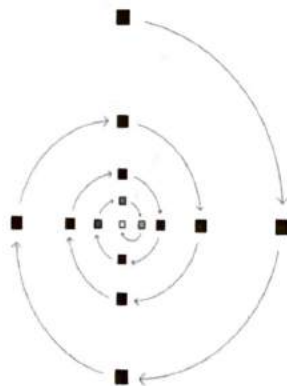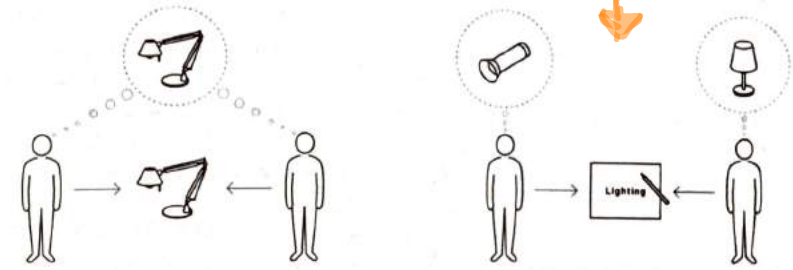
Prototyping Cycle

Aspect of a Communication Tool

Communicating the Value of Experience

Prototyping can also be considered as a tool to communicate the value of experience. Unproductive meetings and presentations occur when the discussion itself is based on abstract ideas and concepts. When the discussion proceeds over such grounds, participants often tend to speak within the limitations of their own personal stories and imaginations. Especially those with ample experience, and confidence based on his own successes (or failures), tend to be unaware of his conceit. When such a person is given the authority to make the final call, the entire direction of the project is at the mercy of his decision.

The more groundbreaking and unprecedented the product or service is, the harder it is to accurately evaluate the product based on prior experience. By presenting abstract ideas and concepts visually instead of verbally, in tangible forms instead of graphic representations as early in the process as possible, we can share and communicate the product's value and appeal not only to the project members, but managers, clients, investors and stakeholders as well. A picture is worth a thousand words, and an experience is worth a thousand pictures.

Facing Problems That Have No Answers

The traditional prototyping method was a means to inspect and review the concrete and physical aspects of a project, such as pre-production and production assessment. This method was adopted based on an assumption that "abstract can be transcribed into concrete," and that the entire process flows in sequence from planning to design, then design to production. By repeating the cycle of prototyping and testing, we can steadily accumulate improvement, and gain confidence by effectively minimizing the risks.

New approaches to prototyping that are being practiced at takram, however, work beyond the concrete aspects of the project. By actively oscillating between concrete and abstract, our prototyping method helps to raise the levels of the abstract side as well.

When viewed from the side of businesses, which have familiarized themselves with the traditional prototyping methods, our way of prototyping might cause some uneasiness and friction. Because this new method contains possibilities of challenging the originary concept and the proposed problem itself, preventive actions taken to minimize risks may falsely appear as factors that aggravate uncertainty, and conversely raise the amount of risks involved.

However, we are no longer living in an age where success can be achieved merely by fulfilling the tangible needs and solving obvious problems. We frequently find ourselves confronting "insoluble problems," and this is true for both businesses and individuals alike. We must recognize the inherent risks in presuming that the once-established problems and projects are irreversible, and to blindly advance the project through a waterfall sequence.
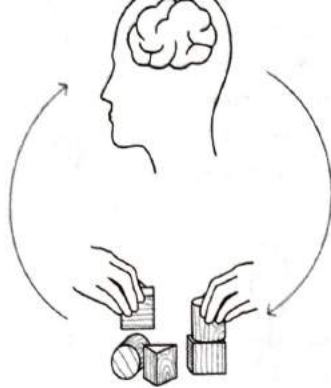
Interplay of Abstract and Concrete

Prototyping for Creative Process

"Design thinking" is a technique used to solve difficult problems, and is widely recognized by both businesses and individuals. Although the term "design thinking" connotes a sort of brainstorming or an ideation technique involving Post-its, its essence lies in prototyping, and to rapidly translate the idea into physical manifestations.

Creative innovation does not originate in a linear process. Rather, it emerges from the complex interactivity between abstract and concrete. Methods like prototyping and brainstorming are catalysts to promote this interactivity, and one should not mistake prototyping as merely a way to translate an idea into physical form. It is important to regard the prototype as a trigger for ideation, to think beyond the initial hypothesis, and to flexibly accept the need to redefine the problem and its challenges.

When prototyping for a creative process, one shouldn't be too concerned if the initial hypothesis turns out to be misguided or incorrect. Prototyping is like throwing a ball in the darkness: where the ball makes a splashing sound, we might discover a puddle; where we hear a distinct echo, we might find a glass floor. By constantly testing the hypothesis, prototyping acts like a sonar to help us gradually recognize the surrounding context as tangible and real.

aha!

Concept Sketch and Dirty Prototyping

Sketching can be considered as a method of prototyping; a highly repetitive innovation tool allowing one to constantly shift between abstract and concrete. With basic training, anybody can draw consistent and accurate sketches. Of course, for those who are able to draw freely, sketches function not only as a thought process, but also as a modeling process as well. For the purpose of prototyping, however, perfectly beautiful sketches are not necessarily essential.

As evident in terms "paper prototyping" and "dirty prototyping," the essence of sketching lies in the act of immediately manifesting the idea, even if roughly at first, and to continue refining it using pieces of paper, cardboards, styrofoam, stationary, and whatever material available at hand.
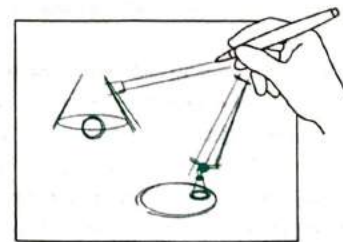
Design Engineering and Prototyping

As products and services continue to become modern and complex, it is also becoming more difficult to solve problems through traditional approaches like sketching and dirty prototyping.

takram's advantage lies in our ability to employ expertise across many fields, without having to differentiate between software/hardware, and design/engineering. Our diverse skills and knowledge allow us to efficiently create prototypes through various techniques and methods.

In prototyping, it is important to manifest the degree of experience that is as close to the desired level as possible. Achieving this requires a special skill. Engineers are often too serious about what they are making, and designers lack the ability to create tangible prototypes that demonstrate the actual experience, even if they may "look" like the real product. To prototype efficiently and in high quality, one must be able to shift freely between these two conundrums. Needless to say, it is important for one to be always resourceful, by being in touch with the latest technologies and tools, and reserving the time for technical research and development. There are also situations that require a person to be flexible and clever, and be open to using "magical" techniques based on simple principles. These include the "Wizard of Oz," a trick used to stage a seemingly automatic program that is manually controlled from behind the curtains, and the "80-20 rule," which forces one to focus on refining the critical 20% of the entire program.

More than anything else, through prototyping, one must be able to receive an experience that is close to, or as real as, the experience of the final product or service. The trajectory is slightly different from the ability to create technically sound prototypes, and instead lies in the amount of ideas, skills and know-hows in rendering an experience. The following are methods of prototyping according to various purposes and situations throughout the product creation process.
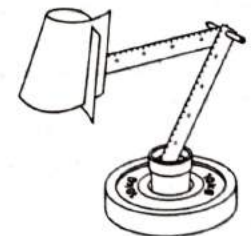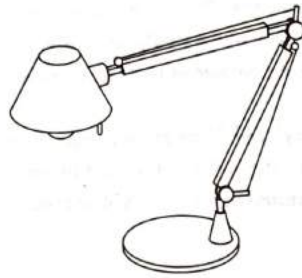
to render an experience

Concept Sketch   Dirty Prototype

Cold Mock-Up

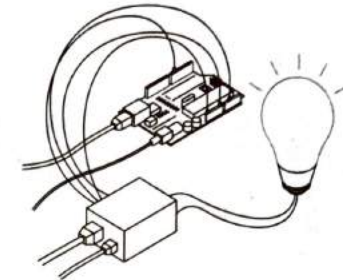Technical Prototype

Cold Mock-Up

A cold mock-up is a prototype made for the purpose of checking the shape, size, color, and feel of the final product. While cold mock-ups are not functional, they are finished with the same visual quality as the final product.

These mock-ups can also be used for something more than visual proofing; by reproducing the actual tangible experience of operating or handling the product, cold mock-ups enable us to study usability and the kind of impression it leaves to its users.

In the recent years, this design method is being applied not only to product development but in artistic fields of critical design and speculative design as well, where the goal is not to solve a problem, but to raise questions. Cold mock-ups enable us to imagine and provoke discussions, by manifesting futuristic technologies into realistic forms. takram's prototypes for artificial organs called *Shenu*, which was released in 2012 dOCUMENTA (13), is a good example of a successful and well-received speculative design that illustrated a compelling view of a futuristic context where the product might actually exist.

Technical Prototype

Technical prototype is a kind of prototyping for investigating technically realistic ways to implement an idea, and is sometimes called "Proof of Concept." Ways to realize an idea is never limited to one. The purpose of technical prototyping is to determine, through trial and error, the most effective and efficient way to combine hardware and software in order to achieve the final goal. For example, when creating a prototype that reacts to body motion, one needs to select the most suitable technology for achieving this purpose. In this case, one must first find the hardware, and decide whether to use a special sensor or a camera, and if the camera should be a webcam, 3D camera or a special infrared camera used in motion captures films. On the software side, one must determine if a general library is sufficient or to write a custom image recognition algorithm.

Furthermore, in cases where the hardware deals with physical phenomena, one must make sure if the idea physically holds during the early stages of the process. Although the quality of the finish is not the primary focus in technical prototypes, these prototypes are also different from dirty prototypes in that their component technology and physical mechanisms actually function. In the example of *Ibuki* released in 2014 Light+Building, where we floated a thin Konica Minolta OLED panel into air with a fan, the project would surely have forestalled had we sat around the desk, debating over the rationality of floating a panel. All details aside, prototyping starts from running to the nearby DIY store to purchase acrylic pipes and USB-powered fans, and making a technical prototype to test whether wind power is enough to float a panel into the air.

Working Prototype (Hot Mock-Up)

A working prototype (hot mock-up) is a close visual replica of the final model, with fully built-in functionalities that simulate the actual experience of the product, a compatible synthesis of a technical prototype and a cold mock-up.

One example of a working prototype is the car navigation system takram partook in the design and development for Toyota's concept car, *NS4*, that was presented at the 2012 Detroit Motor Show. This prototype was tailored, down to its details, in a quality that closely resembled the final mass-production model. It was modeled so that users could actually sit in the driver's seat, and participate in the new operating experience of using two panels placed by the handle and the front window.

Even if not as elaborate as the concept-car, a prototype can be made to replicate the final version both in design and functionality, by focusing on the critical part of the experience that one is trying to achieve. In any event, the most important part of a working prototype is not about adjusting the design for mass-production, but to closely recreate the final, ideal experience. For example, to make a prototype for a car navigation system, it is not necessary to use the slim and sturdy built-in control system designed specifically for automobile installation. Rather, one should select the most suitable device from a wide range of choices, and in this case, should consider using a high-spec computer for system control. By doing so, we can rapidly cycle through many prototypes and translate various new ideas into concrete forms, without spending too much cost on fine-tuning the performance.
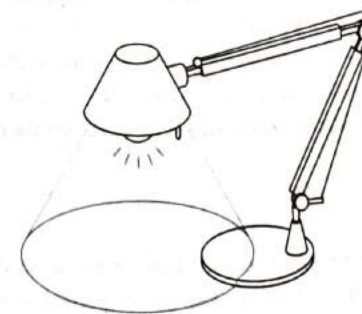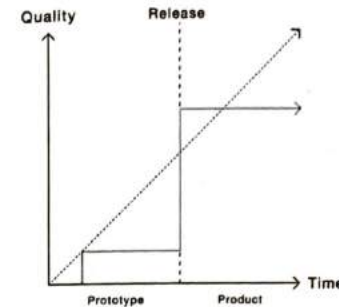

Working Prototype
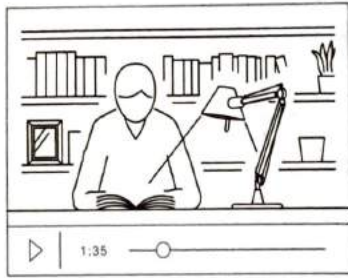
Movie Prototype

Final Product

Planning Process for Software

Planning Process for Hardware

Movie Prototype

In fields where complex and advanced planning and manufacturing process is required to turn new idea into a product, some projects bear the responsibility of anticipating one to two, or in some cases, five to ten years into the future of technological progress.

Of course, the more distant the presumed future is, the more technically difficult it is to make the working prototype. For example, even if one might anticipate that the prototype's sensor device will become smaller and more efficient within a few years, since it doesn't yet exist, the current sensors might undermine the technical expectations in size and performance. While it is important to share the experience through a working prototype, the separation between the prototype and the final product forces each person to separately envision the product in a futuristic context. Consequently, it becomes more difficult to share the same experience and sensibility across the entire team.

In these situations, movie prototypes are highly effective. Movie prototypes illustrate the scenes of how the product or service will be used through moving imagery and story. In a movie prototype, one can use computer graphics to illustrate the parts that are technically unattainable, and draw out scenarios of the future that one is trying to realize.

While the movie lacks credibility if used alone, it can be reinforced as a compelling story by supplementing it with a working prototype or a technical prototype as physical evidence.

Additionally, movie prototypes can also act as vehicles to efficiently communicate aspects of the project that are difficult to share with those who haven't yet experienced the prototype, to people outside the team and the company.

In a UI (user interface) prototype that we actually proposed to a client, we combined a working prototype with a movie prototype. Although the project had assumed five years into the future, our prototype gained support within the company, and a part of its functionalities was actually implemented into the product after two years from our proposal.

Feasibility Limits Ideation

What ultimately differentiates prototyping from ideation is that a prototype, in whatever shape or form, must be able to provide the actual experience of that idea. During an ideation phase, one should be careful not to yield to a psychological bias of unconsciously avoiding ideas that cannot be made into a prototype. By being too concerned with feasibility, one unknowingly puts on the brakes to his own ideas.

The easiest way to break away from "not being able to conceive unattainable ideas," is to maximize the amount of ideas that are attainable and that can be made. But the boundaries of ideation can be broadened just by having an awareness on whether the idea is being confined to feasibility. By employing various techniques and methods we have mentioned here, and sometimes mixing fiction to explore new ways of prototyping, seemingly unrealistic ideas can guide us to innovations and breakthroughs for products that don't yet exist today.

When Prototypes Become the Actual Product

In the field of software, where there are no physical limitations, a scalable process of releasing the prototype to the public is becoming a reality. As evident in terms like agile and lean (development methods focused "agility" and "getting rid of excess" respectively), once the prototyping cycle hits a certain level, the prototype itself is being released to the public as the final product.

In the domains of hardware, there is yet a long distance between the trial model and the mass-produced object. However, this is beginning to fade with the emergence of new manufacturing technologies like digital fabrication.

In software, not only can we use the prototype as a finished product, but we can also update it after it has already been released. For example, in the field of wearable devices, released products are now becoming updatable. This is made possible by transferring most of the computer-processed functionalities and the UI to the smartphone (except for the parts that can only be realized through hardware).

With the evolution of the CPU processing speed known as the Moore's Law, we can easily envision the future possibilities of using smartphones to accomplish what we have previously achieved through high-spec computers.

It is the beginning of a time when both the prototype and the final product are actualized through same technology, where a prototype is the final product. The evolution of technology is not limited unto itself. Changes in the society's systems that promote the product creation process, as represented by crowd-funding services, will also accelerate our progress.

Prototyping for the Future

As mentioned before, we are living in an age when we must confront the intertwined, complex problems that cannot be broken down to smaller sub-problems. The challenges faced by both individuals and businesses are intimately related to the challenges of the entire society we live in today. In this sense, we should understand that prototypes are not only models of a business's product or service, but are trial renderings of our society's future. Nothing in the future is fixed.

Prototyping is not about hinting at one's own predictions of the future, but about envisioning and guiding ourselves to the approaching possibilities that we want to make happen.

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