UPPER EXTREMITY PROSTHETICS: DESIGNING A LIFE WITHOUT LIMITS

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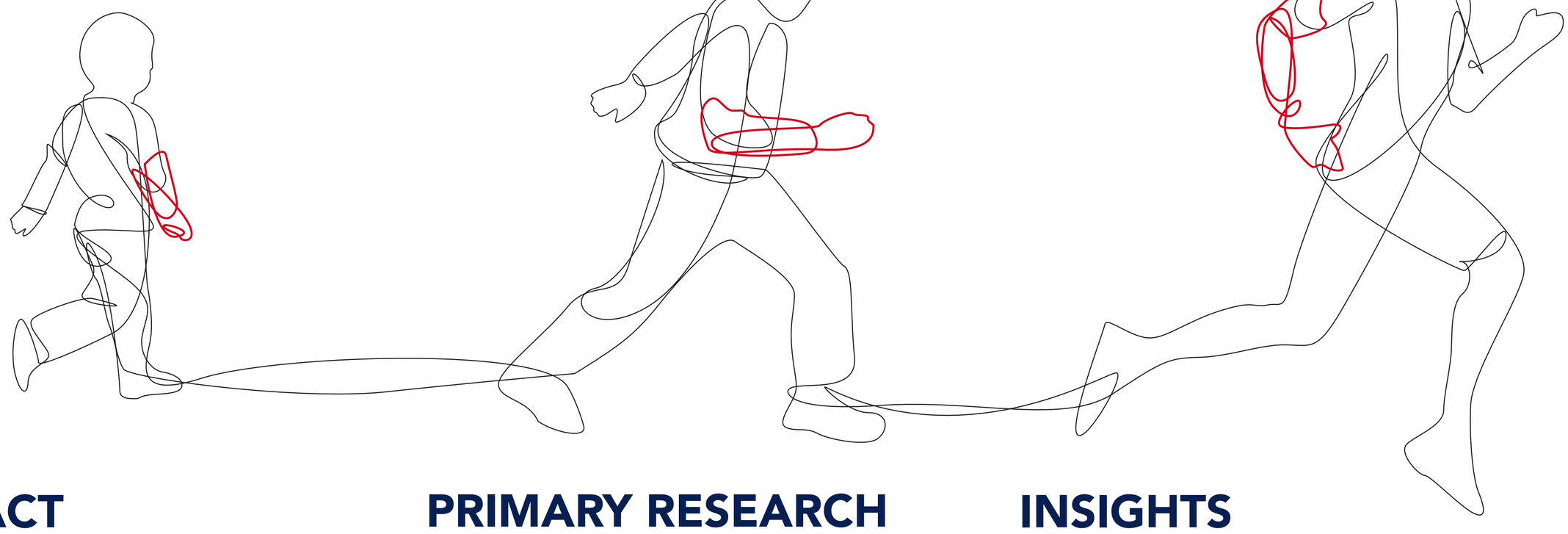
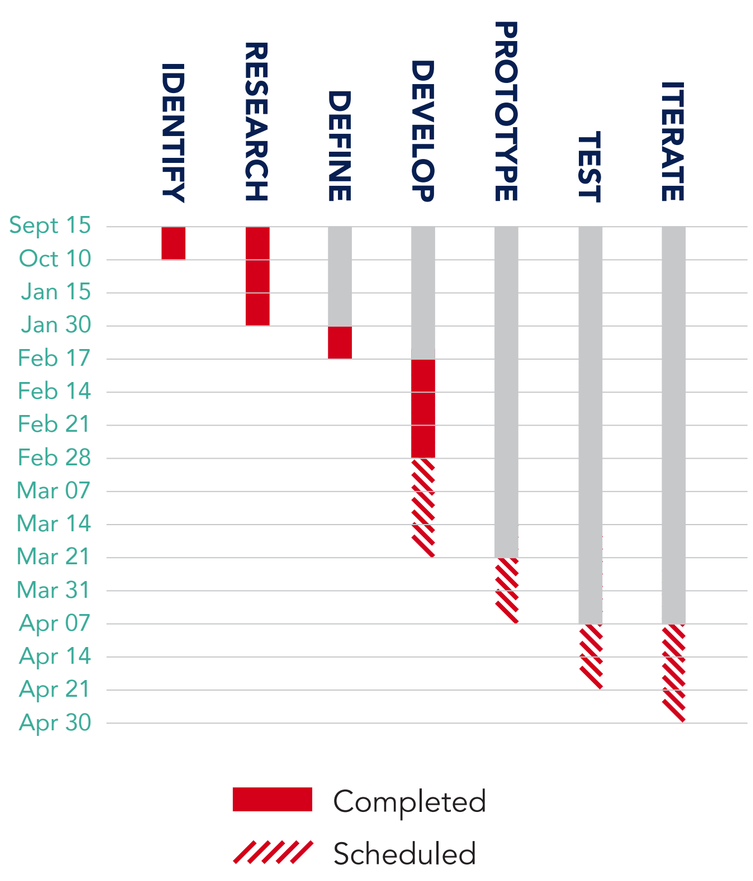


ABSTRACT

When you're a kid you don't think very much about how your body grows, it just does. Sometimes you may get a little taller or stronger but you never think very far beyond that point - unless you have to wear a prosthetic.

The question of how children that wear prosthetic limbs keep up with their ever-changing bodies as they grow into adulthood is what sparked our curiosity and led us to research the multifaceted prosthetics industry for this thesis project. We wanted to see if there was a socially, fiscally, and environmentally responsible solution to this problem and if not, what we could do to help.

PROCESS



The Design Management process is a complex but very structured approach with defined phases for generating and evolving ideas that will enable a design challenge to become a functioning solution.

SECONDARY RESEARCH

Having very little knowledge of the prosthetics industry, we began our exploration process the same way a new amputee may have, if they were trying to learn everything they could about their recent condition. We found the people that provide continuous care to prosthetic patients such as, CPO's (Certified Prosthetics & Orthotics), Orthopedic Surgeons, and Physical therapists. We looked at the FAQ pages on the websites of these various people, which gave us more insight into the patient's perspective and helped us to develop our interview questions. Once we felt that we had searched high and low and were not able to find answers to our questions through secondary research methods, we turned our attention to interviewing the end users.

PRIMARY RESEARCH

PEOPLE

Developing an understanding the human element and its complexities was critical to the foundation of our research. We needed to understand how amputees that wear prosthetics felt about their condition, what they love and hate about their prosthetic, when they use it, how they take care of it. Their pain points are what guided our process.

> *"Washing the dishes is the hardest thing. Typing on the keyboard is just impossible."* (Amputee)

We garnered insights about amputees physical and psychological struggles of adapting to what is known as their "new normal." We learned how leg amputees have to wear a prosthetic in order to perform any action while - in contrast - arm amputees often find no relevant use for it. The same differences can affect equally the psychological aspects, creating a wide and diverse spectrum of behaviors and tendencies among the patients.

> *"The ratio of lower to upper extremity amputees is 11:1 across the country"* (Ryan Pane, CPO)

The bottom line is that each amputee lives a different life with different battles. What is common among all of them is primarily the awareness of having the potential to perform almost any action, and being able to achieve almost any dream. However, many will never be able to afford the kind of prosthetics that allow them to pursue their goals because the cost is too high. Very few patients have health care plans that cover them fully; everybody else is destined to endure an ongoing series of compromises.

> *"A child's prosthesis may have to be updated several times a year depending on their age and growth rate."* (Dr. Johnson, Orthopedic Surgeon)

The most affected are children and their families, as children need to change their prosthetic multiple times a year. Fathers and mothers would sacrifice everything to guarantee a healthy and comfortable life for their children, but often they have to bear the acceptance of lower standards.

PLANET

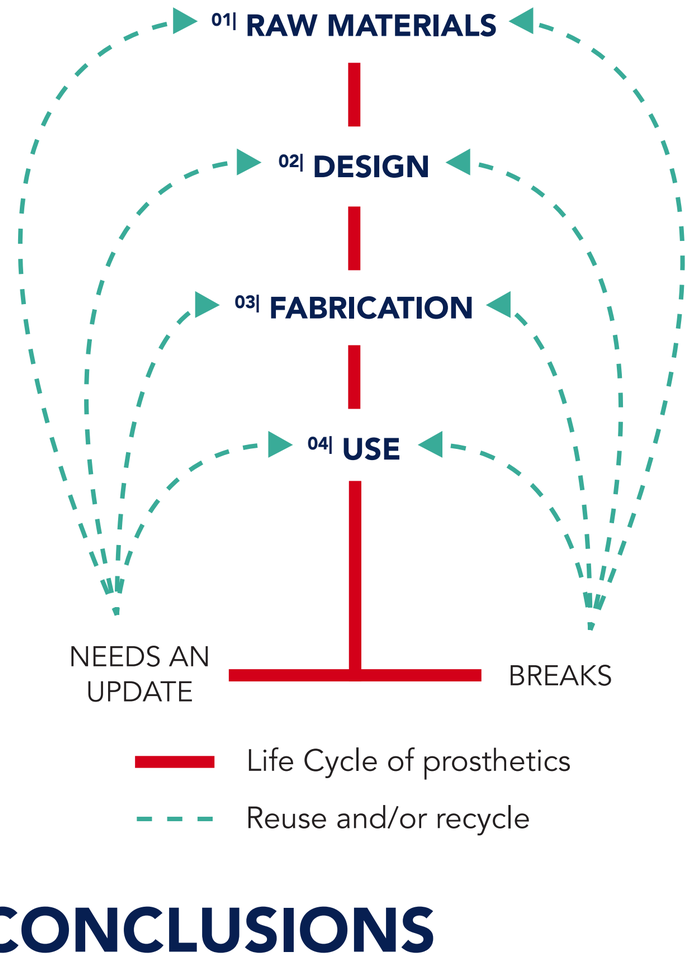
The materials used in the design of prosthetics can be organized into two categories: process materials and finishing materials. Process materials are used mainly during the initial prototyping stages, and are consistently reused and recycled. Finishing materials are the strong and durable materials used to make the prosthetic that a person will use daily until it is time to get updated. These materials cannot be reused or recycled because they are custom fit to each patient.

PROFIT

Once an amputee has been fitted for their prosthetic socket, they will have to make updates to that socket as their residual limb evolves over time. This means that they will have to be fitted for a new socket several times before they are able to wear a permanent socket. As for children, their bodies are constantly growing, so depending on their age and growth rate, they may need to change their socket multiple times a year. This can be a financial burden for individuals and families because most insurance companies will provide $2,500 - $5,000 per year to prosthetic patients. The average cost of a prosthetic, however, is in the range of $5,000 - $50,000 or more.

INSIGHTS

The linear economic model exercised by the prosthetics industry has a significant impact on the environment and the cost structure of prosthetic limbs. This is due to the misuse of certain materials which are used to fabricate prosthetics that patients will inevitably grow out of and have to update. Patients who have stopped growing will also have to change their prosthetic more or less often depending on how active they are. In addition, patients with upper extremity prostheses do not find them to be at all useful. A lot of them do not even wear their prosthetic unless they have to for a certain chore or to go out. Our design objective in this case is to develop an upper extremity prosthetic that will suit the daily needs of the wearer and decrease the average cost and environmental impact of prosthetic limbs. This can be achieved by designing the prosthetic to suit a circular economic model as illustrated below.



CONCLUSIONS

The next phase of the design process was to find solutions for the challenges listed below, and then combine the most feasible, exciting, and innovative aspects of those ideas. The prototypes will then be shared with the people that we are designing for and refined based on their feedback. This process of continuous discovery, iteration, and refinement is how teams of designers produce innovative solutions to some of the world's most wicked problems every day.

I ***How might we design an upper extremity prosthetic that fulfills the daily needs of the wearer?***

II ***How might we design a prosthetic that suits the functional and financial needs of children and their families?***

III ***How might we improve the process of making a socket so that it is financially, socially, and environmentally efficient?***