PRACTICAL AND LIGHT EQUIPMENT FOR THE CURIOUS EXPLORER

BY

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF FINE ARTS IN DESIGN
COLLEGE OF DESIGN

GRADUATE SCHOOL, RANGSIT UNIVERSITY
ACADEMIC YEAR 2023

Thesis entitled

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was submitted in partial fulfillment of the requirements

for the degree of Master of Fine Arts in Design

Rangsit University

Academic Year 2023

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August 31, 2023

Acknowledgements

First, I would like to thank my advisor professor, Mr. Sridhar Ryalie, who always encourages me and strengthens me. In terms of writing and wording of papers, he always strictly requires me to "professional standards". Starting from topic selection and topic determination, he has inspired me to rethink, including the paper and myself.

I also wish to thank Mr.Teeranop Wangsillapakun and Mr.David Marc Schafer who are very helpful in the improvement of my research. There are also MFA classmates, their cases gave me reference value, and the classmates are very enthusiastic and helpful, I am very grateful for their help, and it is very meaningful for peer-to-peer learning. And thanks to the MFA faculty. Finally, I would like to thank my family for their support.

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6407036 : Shizhen Tang
Thesis Title : Practical and Light Equipment for the Curious Explorer
Program : Master of Fine Arts in Design
Thesis Advisor : Assoc. Prof. Pakorn Prohmvitak

Abstract

Our backpacks are often on our backs, and when we need to access items, we often take them off and put them on our chest to access them. This paper discusses the practical possibilities of high-elasticity straps for backpacks to reduce the stress on the user. Non-traditional backpacks would allow the curious explorer to access items faster while traveling or hiking, and if this approach is successful, it could be adapted to the majority of backpacks on the market and to a wider range of people. This article explores the possibilities of a range of non-traditional backpacks that could provide a faster and more comfortable experience for people on the go. In the wake of the Covid 19, Thailand has seen a gradual influx of travelers and backpackers. The research methodology for this paper is to survey this target group to identify the main problems of backpacking and various secondary problems; then, compare and contrast several different samples of backpacks, as well as refer to the literature on backpacking, and incorporate these answers to design a new backpack. This paper examines and designs a range of backpacks designed to make it easier for the user to access their belongings, exploring their possibilities and the problems they will encounter. For example, the elasticated shoulder straps cannot be used permanently, and there is a problem of swaying when the backpack is cut in two. Further research will be needed to practise and improve these designs in the future.

(Total 35 Pages)

Keywords: Backpacks, Curious Explorers, Elastic Straps, Convenient, Lightweight

Student’s Signature …... Thesis Advisor’s Signature ....

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Chapter 1

Introduction

1.1 Background and Significance of the Problem

After the Covid-19 pandemic, Thailand experienced a gradual increase in travelers and backpackers. These individuals often rely on backpacks for their journeys. Traditionally, backpacks are worn on the back; when access to items is needed, they are removed and placed in front. Non-traditional backpack designs have the potential to allow curious explorers to access their items more conveniently during their travels or hikes. If this approach proves successful, it could be applied to a broader range of backpacks in the market, benefiting a wider audience. This paper explores the possibilities of various non-traditional backpack designs that can offer a faster and more comfortable experience for people on the move. After extended periods of walking and carrying backpacks, individuals often feel the burden on their shoulders increasing. In Asia, soft bamboo poles are frequently used to carry heavy loads, with the poles' elasticity helping distribute the weight. This paper examines the practicality of incorporating high-elasticity straps in backpack design to reduce user stress.

1.2 Research Objectives

Backpack

1.2.1 Literature Review: Gather relevant literature and extract design principles and knowledge. Develop design solutions based on the literature and innovative ideas. Design Practical and light equipment for the curious explorer, for a pleasant journey.

1.2.2 Design Lightweight and Practical Equipment: Create practical and lightweight equipment for curious explorers to enhance their travel experience.

1.2.3 Feasibility and Improvement: Validate the feasibility of the design solutions and continually enhance them.

1.3 Research Questions

As a foreign traveler in Thailand, my first steps involve identifying places I want to visit, often seeking recommendations from friends or consulting online resources and guidebooks. Once my destinations are chosen, I need to plan my route and pack essential items into my backpack. The backpack has become my essential tool for outdoor exploration and travel. Given the surge in foreign tourists in Thailand following the COVID-19 pandemic, it's clear that backpacks play a crucial role in their journeys. Thus, this research centers on the backpack as its subject. Figure 1.3 provides a visual representation of this thought process.

Figure 1.1 The Thought Process Behind Selecting Backpacks as the Research Subject

Source: Researcher

1.4 Research Framework

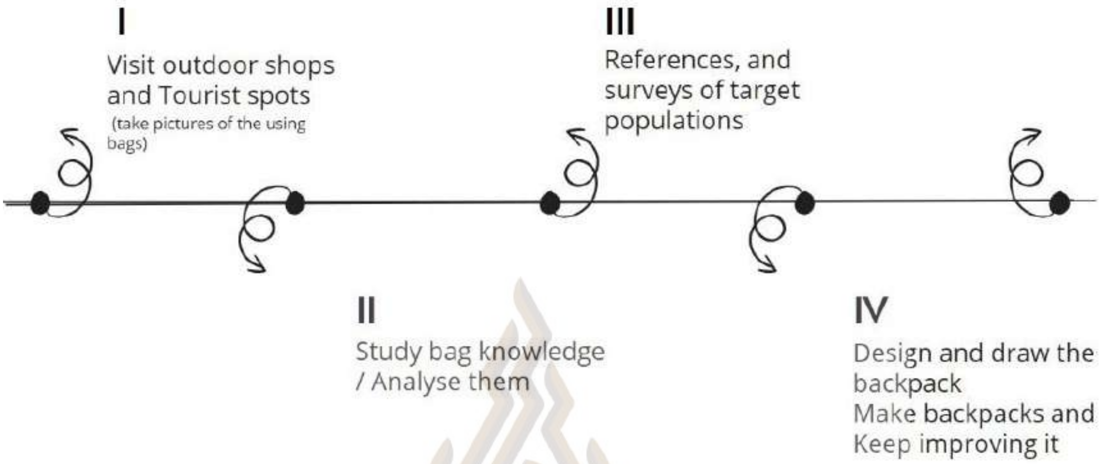

Figure 1.2 Conceptual Framework

Source: Researcher

1.5 Definition of Terms

Curious Explorer: In the context of this thesis, a curious explorer refers to individuals who engage in outdoor and urban travel in Thailand.

Non-Tradition Backpack: This term distinguishes backpack designs that deviate from common market offerings.

Chapter 2

Literature Review

2.1 Load Reduction Systems of the Backpack

2.1.1 Effects of Loading on the Human Body

Research has demonstrated that changes occur in body muscles over time when bearing additional weight. Subjects participated in four walking trials on an instrumented treadmill, each lasting five minutes while carrying no load or an additional 10%, 20%, or 30% of their body weight. As the load increased, so did the net metabolic cost, the stance phase duration, peak stance phase hip, knee, and ankle flexion angles, and all peak joint extension moments (Silder, 2013). Therefore, the weight of the equipment poses a significant issue to be addressed in this context. Mäkelä (2006) highlighted that carrying a heavy backpack exerts compression on the shoulders, with the potential to cause brachial plexopathy (Mäkelä, Ramstad, Mattila, & Pihlajamäki, 2006). Improper backpack use, such as unilateral or excessive posterior loading, has been linked to alignment issues like forward head posture (FHP), rounded shoulders, kyphosis, low back pain, and an asymmetrical axial skeleton (Abrahams, 2001).

2.1.2 Lightweight Standard:

Ultralight backpacking, a subset of lightweight backpacking, prioritizes carrying the lightest and minimal gear (Cole, Jordan, & Dixon, 2006). While no specific technical standards exist, some U.S. hikers consider "ultralight" to mean an initial base weight of less than 4.5kg (10 pounds) (Clelland, 2011).

2.1.3 The Lightening Effect of Elastic Shoulder Straps:

The mechanism of Anti Gravity System (AGS) backpack lies in the use of highly elastic shoulder straps to create a bouncing motion when the user walks, thus the user doesn't feel the constant load of the bag, which is similar to a bamboo pole (Figure 4.8). Theoretically speaking, under the same load, this results in a feeling of reduced exertion to users as compared to ordinary backpacks. a comparative study was made to test the effect of AGS backpacks on relieving perceived exertion to users. It was concluded that given the condition of appropriate weight-bearing and walking speed, the backpack with AGS design could give users a labor-saving feeling and more regular growth of subjective fatigue compared with an ordinary backpack. (Yang, 2020)

2.2 A Nontraditional Backpack

Kimberly (2016) employed a traditional backpack (U.S. Polo Assn Sport Backpack, Colfax, LA, USA) and a BackTpack (BackTpack LLC, Salem, OR, USA) to manipulate load carriage (Dahl, 2016). The load was added to the backpacks in increments of 1, 5, and 10 pounds to represent 15% and 25% of the wearer's body weight, covering loads both below and above recommendations in the literature (Al-Khabbaz, 2008) (Hong, 2003) (Kistner, 2012). The load distribution was even in the backpacks, with the heaviest weight closest to the spine for the traditional backpack (BP) and balanced weights between the two pockets for the BackTpack (BTP) shown in Figure 2.1, promoting a more upright posture and potentially reducing poor posture characteristics and low back pain associated with load carriage.

Figure 2.1 Traditional Backpack (left) and Nontraditional Backpack (BTP) (right)

Source: Dahl et al., 2016

Chapter 3

Research Methodology

3.1 Population and Samples

Figure 3.1 illustrates the classification of the target users. Foreign travelers in Thailand can be categorized based on their destinations, including outdoor and city travelers. Further classification is possible by the duration of travel, such as one-day trips or short-distance travel lasting 2-3 days. Longer trips require larger backpacks, accommodating items like clothing and toiletries. Outdoor hikers often explore jungles, some of which remain uncharted, or Thailand's national forest parks. They must carry an adequate supply of drinking water, and today, water bags with long straws are available on the market for easy refilling (Figure 3.2). Additionally, travelers often need quick access to items such as tissues, sunglasses, compasses, mobile phones, pocket knives, cameras, and more.

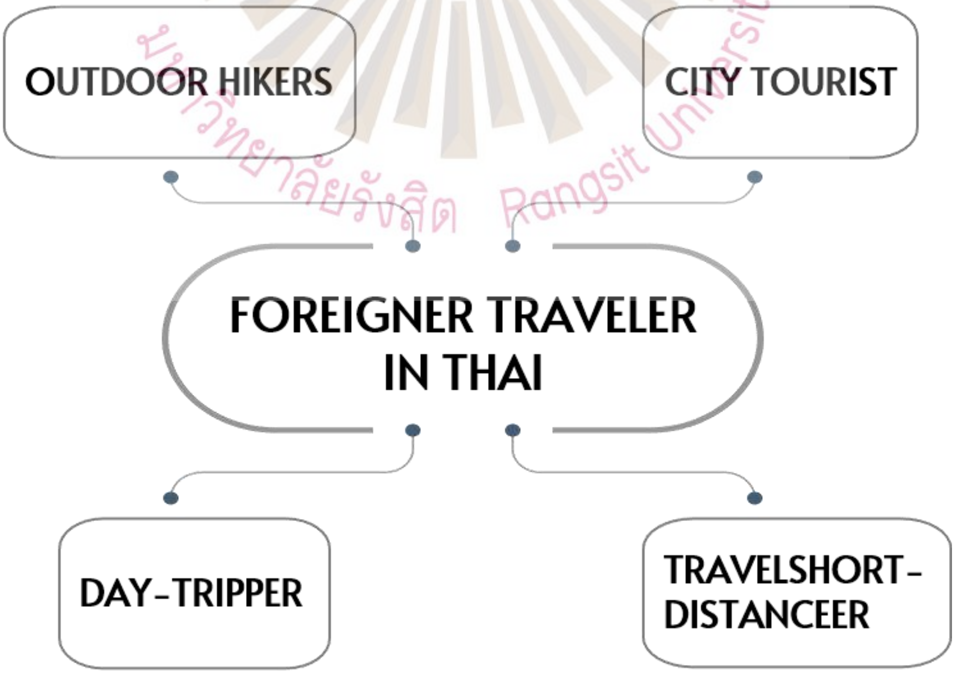

Figure 3.1 The Classification of Target Users

Source: Researcher

Figure 3.2 The Water Bag for Convenient Access to Drinking Water

Source: Abegg, 2023

3.2 Research Instruments

3.2.1 Surveys and Questionnaires

To gather insights and engage potential users in the design process, additional surveys and questionnaires were conducted. This included online questionnaires targeting users residing in Thailand and statistical comparisons of various backpacks.

3.2.2 Literature

Access relevant literature, Search for relevant information and compare products, extract principles from their designs, and use them to make your designs.

3.3 Data Collection

3.3.1 Online Questionnaire for Target Users

A week-long online questionnaire about backpacking was posted on social platforms used by foreigners in Thailand, as outlined in Table 3.1. However, web-based questionnaires may not always yield precise responses, as online attitudes may differ from real-world experiences. To address this, in-person interviews were conducted at tourist attractions in Thailand, drawing from personal travel experiences. Figures 3.3 and 3.4 depict some issues encountered by target users during their travels, and Figure 3.5 illustrates a selection of questions related to backpacks.

The issues identified include:

1) Thin shoulder straps causing uneven weight distribution.
2) Lack of waterproofing.
3) Limited one-handed operation due to the need to hold the bag down.
4) Poor control, instability, and low positioning.
5) Small capacity, necessitating an additional bag.
6) Difficulty accessing contents depending on the backpack's design.
7) Uneven weight distribution.
8) When the pack is overloaded or improperly packed
9) Knotting of straps.
10) Security concerns.
11) Sweating on the back during extended use.

Table 3.1 Online Questionnaire for Target Users Living in Thailand.

gender	1. Do you think your day travel backpack or short-distance backpack has any shortcomings?	2. Your suggestions for your backpack (what features or improvements do you want it to have)
Male	1) Backpacks are inconvenient 2) Being too tired to carry weights when you are older	1) There is a load-bearing frame 2) Collapsible shrinkage 3) There are air cushions
Female	Backpack heavy	Lighten up
Male	No, it depends on the distance and content	There are comfortable backpacks shoes and other equipment
Female	Things can't be packed too much, a lot is needed outside	It can hold a lot of things, unique enough
Female	It's too small, and it's bulky if it's big	I think it is a storage bag that can hold a lot of things, umbrellas, water cups, cosmetics, etc., and it is easy to find when looking for it
Female	1) The appearance is not very good 2) The shoulder straps are slightly narrow, which may be less comfortable when carrying heavy objects	1) Better looking including color and shape 2) The shoulder straps are designed to be stronger/more good-looking to cope with the need to carry heavy loads.
Female	Smaller capacity	Beautiful increased capacity and light material

Figure 3.3 Problems Encountered by Target Users of Backpacks at Sites in Thailand

Source: Researcher

Figure 3.4 Problems Encountered by Target Users of Backpacks at Sites in Thailand

Source: Researcher

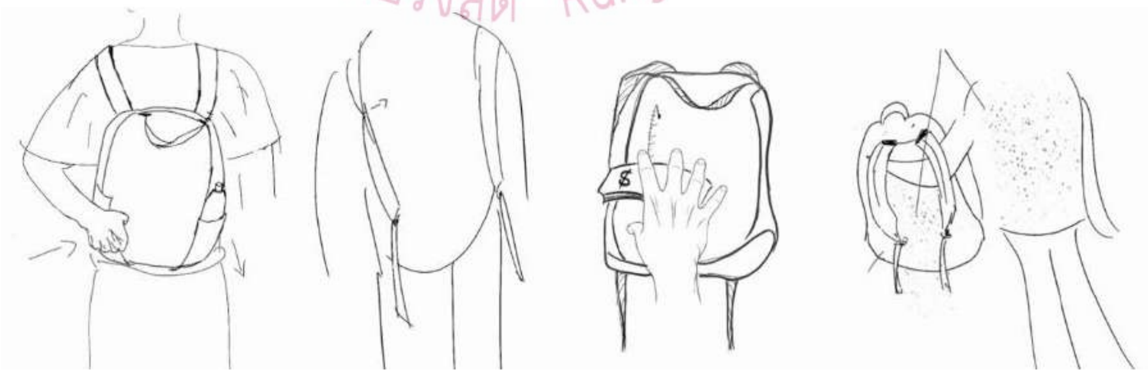

Figure 3.5 Issues Faced by Backpack Users (Complementary Part). From left to right: inconvenient access to items from inside the backpack, knots in the shoulder straps, safety concerns, and lack of breathability on the back.

Source: Researcher

3.3.2 Statistics on Backpacks

Statistics were conducted on several backpack brands commonly used for daily activities, as presented in Figure 3.6. Five different backpacks were chosen for detailed analysis, as indicated in Table 3.2.

Figure 3.6 Statistics on Some of the Different Brands of Backpacks for Daily Use

Source: Researcher

Table 3.2 Functions and Statistics of Five Common Backpacks on the Market
Notes: G10L: G4Free 10L Small Foldable Backpack Hiking Lightweight Backpack for Women Men Outdoor Hiking Camping Travel Climbing; O: Osprey Ultralight Stuff Pack Review; P14L: Patagonia Backpack, Noble Grey, Altvia Pack 14L; N18L: The North Face Unisex's Basin 18 Backpacks, One Size; N27L: The North Face Kaban 2.0 Backpack 27;

Brand	price(£)	Put water (ice)	Bag charging port	Earphone port	easy access to things	Light weight	Stability	Size(Inch)
G10L	23.99	√	×	×	×	250g	√	15.5*9*3.5
O	42.18	√	×	×	×	136g	√	17*8
P14L	70	×	×	×	×	477g	√	18*9.25*8.5
N18L	102.75	√	×	×	×	600g	√	11*5.9*19.2
N27L	125	√	×	×	×	1270g	√	17.9*5.9*13

Brand	Breathability	Fold	Dirt-proof	Zippep quality	Size(Inch)	Weatherproof	rain guard	Bag bottom guard
G 10L	√	√	×	×	15.5*9*3.5	√	×	×
O	√	√	√	×	17*8	×	×	×
P14L	√	×	√	×	18*9.25*8.5	√	√	×
N18L	√	×	√	×	11*5.9*19.2	√	√	×
N27L	√	×	√	×	17.9*5.9*13.7	√	×	×

3.4 Data Analysis

Combining data from questionnaires and statistics, it is evident that backpacks face numerous usability issues. These issues include the need for quicker access to items within the backpack and a focus on reducing weight to accommodate a larger volume of items for target users.

Chapter 4

Research Results

4.1 Convenient Backpack Design

4.1.1 Design of Backpack Solutions

In Figure 4.1, a sketch of the design thinking process reveals the concept of a backpack that can be transformed. By using two single-shoulder bags or cutting a traditional backpack down the middle and connecting them with buckles (Figure 4.2), a versatile and changeable backpack can be created. A three-dimensional representation of this changeable backpack is shown in Figure 4.3.

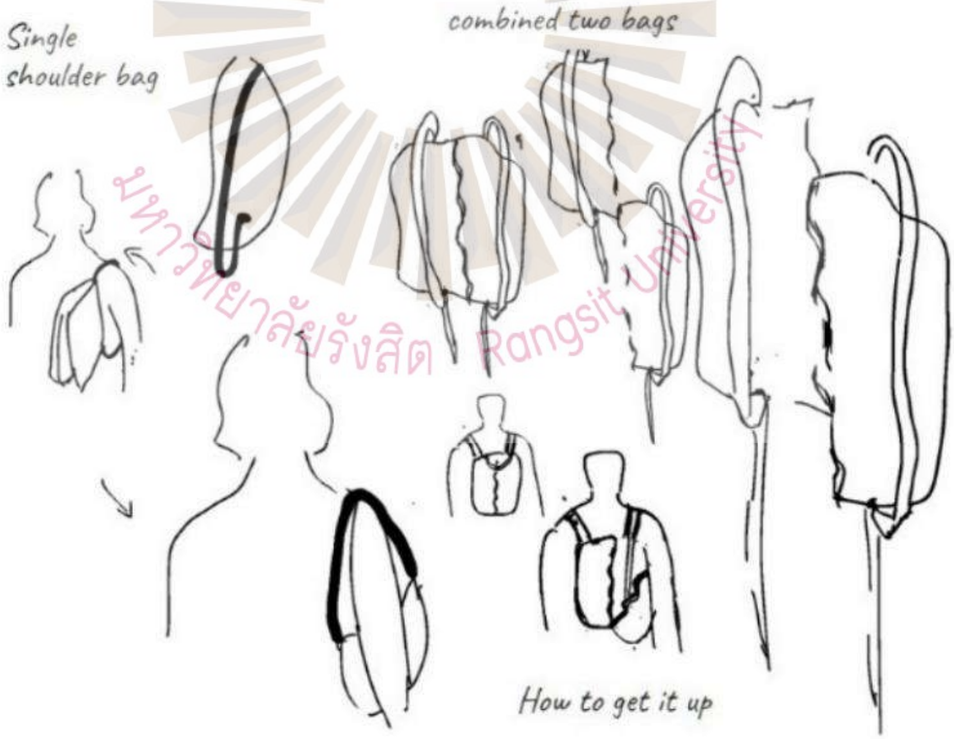

Figure 4.1 Sketch of the Design Thinking Process

Source: Researcher

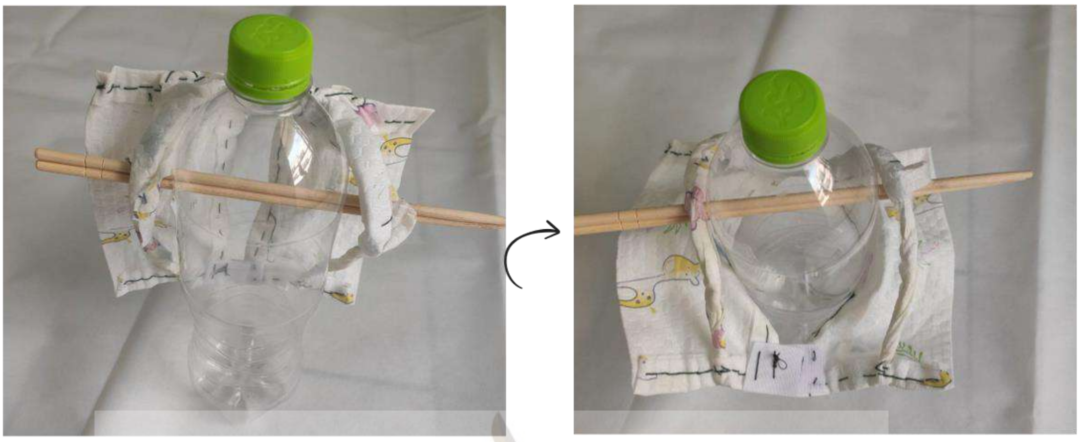

Figure 4.2 Conceptual Prototype for the Backpack Design

Source: Researcher

Figure 4.3 Three-Dimensional Display of the Changeable Backpack

Source: Researcher

4.1.2 Execution of My Design Prototype

The final product is depicted in Figure 4.4, In order from left to right: showing the backpack in its normal walking state, with the buckle undone and fastened around the waist, and in a zipped and in-use configuration.

Figure 4.4 Execution of My Design Prototype

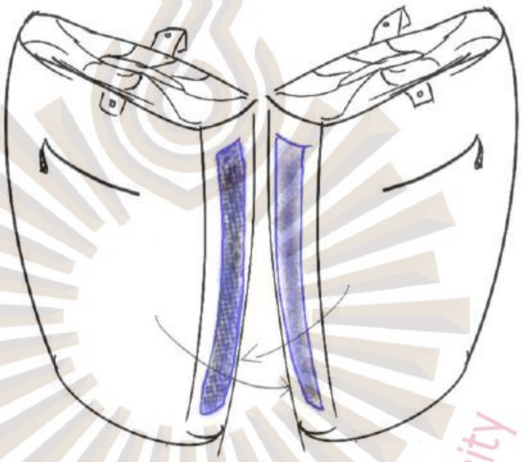

Figure 4.5 Use of Velcro to Enhance Stability

The backpack can be cut into two bags and placed separately on the front of the chest for easy access to items in the backpack (Figure 4.4)The backpack's easy access design works, but because the pack is broken down into two bags, they sway against each other when placed behind the back and the user is walking. Could we then make a frame or strap to hold the two bags on the surface so that they don't shake from side to side? The easier solution is to place Velcro in the blue labeled areas Figure 4.5 to act as to maintain the stability of the backpack.

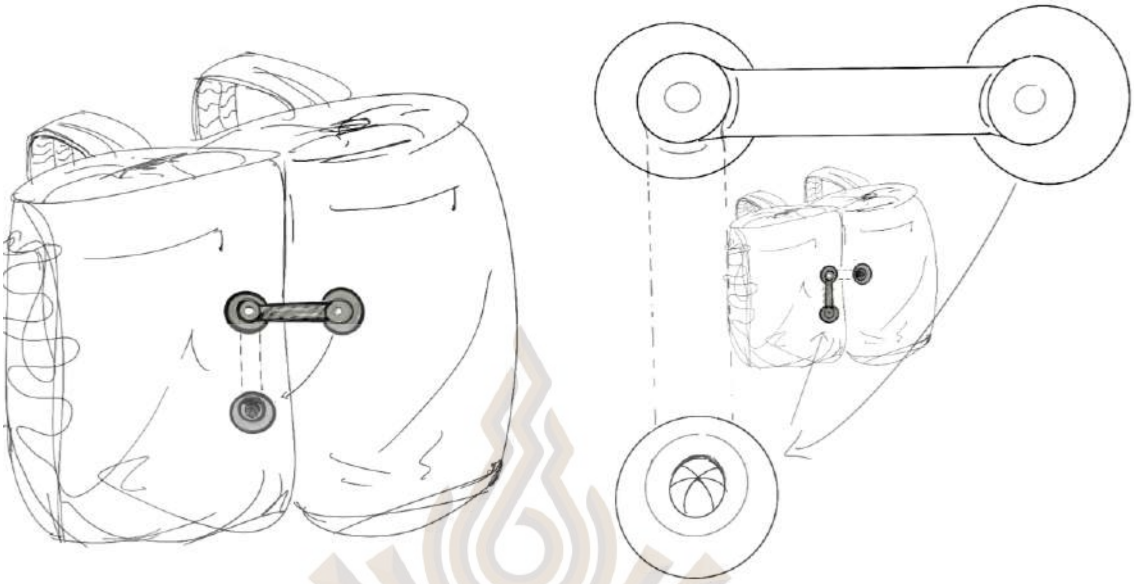

Figure 4.6 Movable stabilizer

To prevent swaying when the backpack is separated into two bags and placed behind the back, a movable stabilizer was introduced (Figure 4.6). The stabilizer adjusts its position horizontally on the back and vertically on the waist, functioning similarly to a magnet's alignment.

Elastic shoulder straps were employed to reduce the load and enhance comfort. These elastic straps were connected to the backpack, as shown in Figure 4.7, with the elastic fabric facilitating the connection, allowing the backpack to move up and down to counteract pressure, similar to the swinging motion of a soft stretcher (Figure 4.8). Compliant bamboo poles have long been used for load carriage in Asian cultures. Although this custom differs from Western conventions of rigid body attachments (e.g. g. backpack), potential benefits include reduced peak shoulder forces as well as metabolic transport cost savings. (Schroeder, 2018)The practicality of the elastic straps is low and after a period of use, they will fail, meaning they will lose their elasticity and will not work. Can many spare replacement elastic bands be replaced in time when they expire? Like electric toothbrushes, the brush head must be replaced within a certain period.

Figure 4.7 Elastic Straps for Backpack Connections

Figure 4.8 A farm Worker Carries a Bamboo Pole in Northern Vietnam.

Source: Schroeder, 2018

4.2 Improvements Based on Common Backpacks

Figure 4.9 presents enhanced solutions suitable for outdoor hikers based on existing backpack designs. The left side illustrates a typical hiking backpack with wide shoulder straps, often lacking in breathability in the front chest area. My solution is to enlarge the waist section to accommodate items like water bottles, hats, tissues, clothes, and other necessities. This design enables better access and ventilation.

The right side of Figure 4.9 portrays a common shoulder bag that can be rotated around the waist for item access. To address the uneven load distribution on the body, my improvement adds an extra shoulder strap. Users can unbuckle one side of the shoulder strap when needed and then rotate the bag to the waist for convenient access.

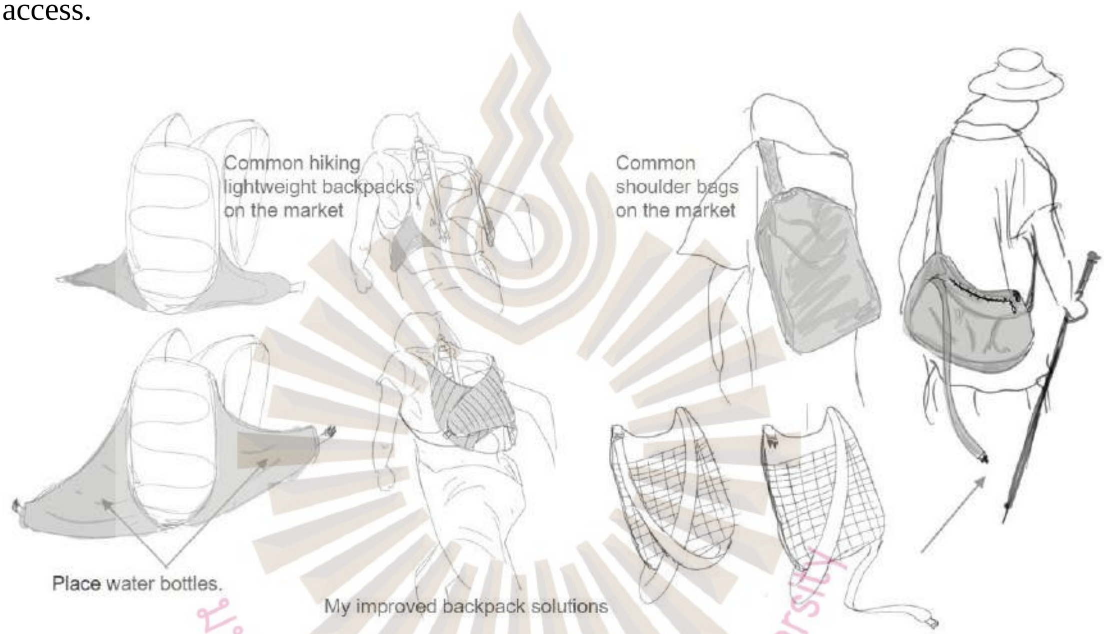

Figure 4.9 Improvements Based on Common Backpacks

4.3 Solutions Designed for Different Populations

4.3.1 Designed for Children

Figure 4.10 presents backpack designs tailored for children aged 6-10 years. Children's backpacks typically have smaller capacities, ranging from 10 to 20 liters. These backpacks are designed to be versatile, allowing children to rotate them to the front chest for easy access. Stabilizing frames with adhesive backs prevent wobbling when worn on the back.

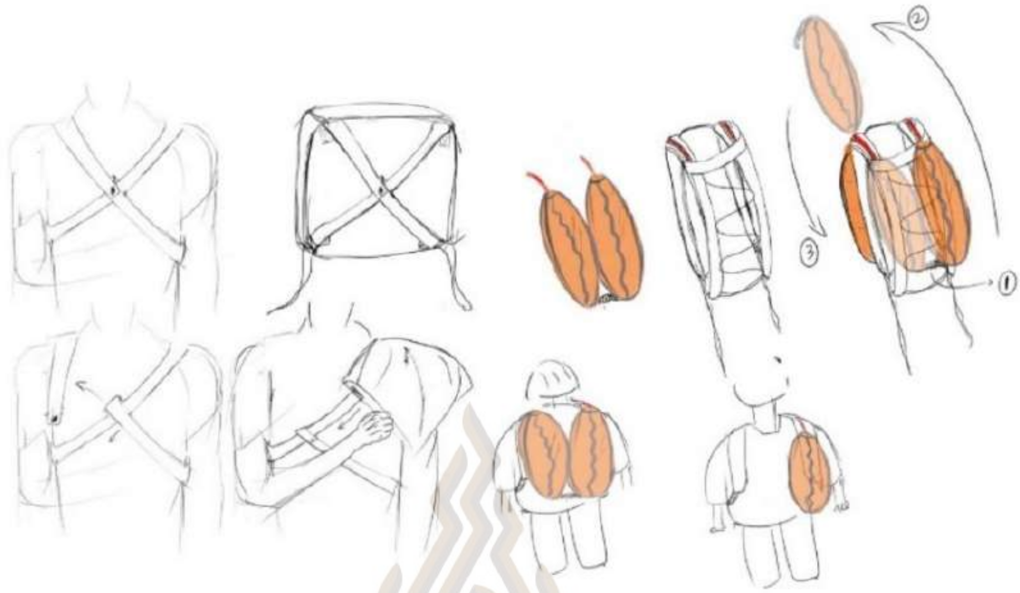

Figure 4.10 Backpacks Designed for Children

Notes: A child needs to undo one of the shoulder buckles and then pull the shoulder straps towards the front chest to the waist to pull the backpack to the front chest for use(left). The backpack is made into two bags, so that when one is needed, the buckles can be undone and it can be placed on the front chest, and the frame on the back has a tacky back, which stabilizes the backpack from wobbling when the backpack is placed on the back(right)

4.3.2 Designed for Women

In Figure 4.11, backpack designs specifically cater to women, considering their narrower skeletal structure. These backpacks enable women to access the entire content of the backpack by flipping it forward over their heads from the lumbar buckles. An accessory backpack is also proposed, designed to fit over a standard backpack, facilitating easy access to common items.

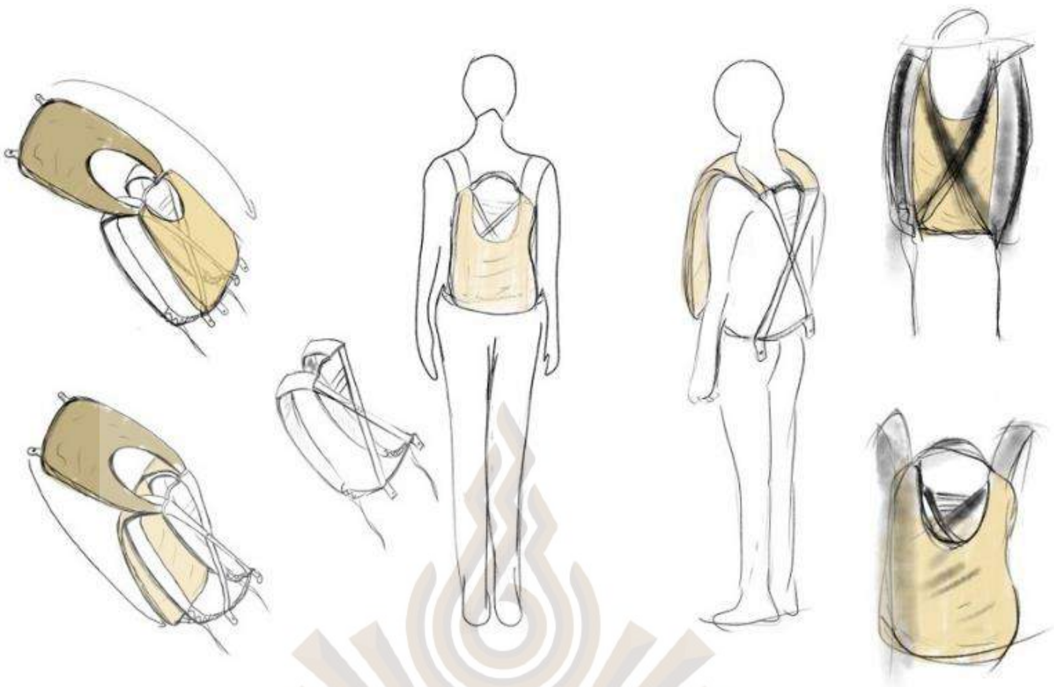

Figure 4.11 Backpacks Designed for Women

Chapter 5

Conclusion and Recommendations

5.1 Conclusion

The backpack designed for curious explorers, with a capacity ranging from 20 to 30 liters and expandable features, offers convenience without compromising balance. Key attributes include waterproof and dirt-resistant materials, lightweight construction, and load-bearing capabilities. A primary focus is on easy access to the backpack's contents, which is achieved through an innovative design allowing the backpack to be split into two pouches placed on the chest for quick access. This design departure from traditional backpacks draws inspiration from the BackTpack (BTP) concept, as seen in Figure 2.2 (Nontraditional backpack - BTP).

Furthermore, elastic straps integrated into the backpack serve to reduce the load by enabling it to swing up and down, counteracting pressure, much like a soft stretcher's motion. It's important to note that the practicality of these elastic straps is limited, as they may lose elasticity over time, necessitating ongoing maintenance or suitable replacements in the future. In subsequent designs, the goal is to discover or develop elastic shoulder straps that retain their elasticity for a longer duration, contributing to a lighter overall backpack weight.

Moreover, the adoption of Dyneema fabric offers a promising avenue for reducing backpack weight. Looking ahead, the design range could be expanded to accommodate various user demographics, including children, women, men, and individuals with diverse body types. Additionally, exploring professional applications for these backpacks is an exciting prospect for the future.

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Appendix

Backpack Design, Production, and Improvement Process

In this appendix, we detail the process of designing, making, and improving a backpack, including six versions of the improvement journey. The aim of this backpack project was to create a modern backpack that is practical and meets the needs of the target user.

Design Phase:

During the design phase, we collected user feedback, market research data, and functional requirements. Our design goals included practicality, lightweight, and large capacity. Through comprehensive analysis, we determined the materials, structure, and functional features.

Production Phase:

The backpack is made with high-quality, abrasion-resistant nylon fabric, reinforced stitching, and durable waterproof zippers. The interior divider design provides multiple storage spaces to accommodate a variety of uses. The stretch fabric was used for the shoulder straps and back connection parts to test if the user has a lightweight feeling. The production process includes template design, material cutting, sewing, and assembly.

Improvement History:

1. **First Version**: Figure 1-a shows the first prototype, originally made from fabric, which was divided into two parts with pocket zippers where the back would touch, making it very secure and hiding the pocket openings. Figures 1-b and 1-c show the design and the actual effect of the backpack. All the prototypes in the first version were handmade by the author, allowing for flexibility in design changes. In the back and strap connection part, I used an elastic fabric connection. During walking with a certain weight of the backpack, the author observed that the weight of the backpack would sway up and down with the elastic fabric. Figure 1-d shows the internal structure of the backpack, with the distribution of the pockets. However, it differed

from the actual result in Figure 1-c. Feedback from the advisor indicated that the elastic would lose its effectiveness at times and quickly and that the pack needed more internal dividers and pockets. The backpack material was also seen as needing better waterproofing.

Figure 1-a: Prototype Version 1

Figure 1-b: Improved Prototype Version 1

Figure 1-c: Prototype Improved Version 1

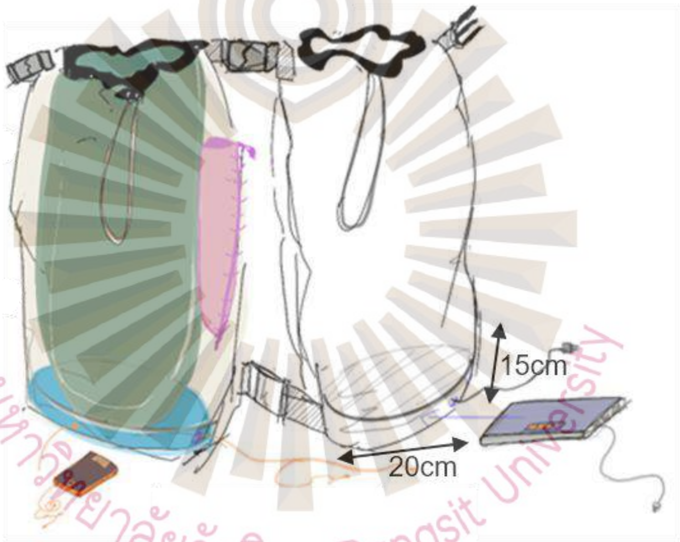

Figure 1-d: Internal Structure of Prototype Version 1

2. **Second Version**: Based on the feedback received, Figure 2-a shows the design with several different distribution locations for the extra pockets. The third row of design options was chosen for the extra pockets because it allowed for easy access and concealed the pockets when not in use. Figure 2-b enlarged the space at the bottom of the backpack, accommodating electronic products like cell phone rechargeable batteries and providing holes for data cables to pass through. Figure 2-c presents a detailed drawing of the interior space and exterior surfaces. Elastic shoulder straps

were eliminated due to concerns that the elastic fabric would lose its utility. The advisor suggested that the backpack was too large for the average day hiker.

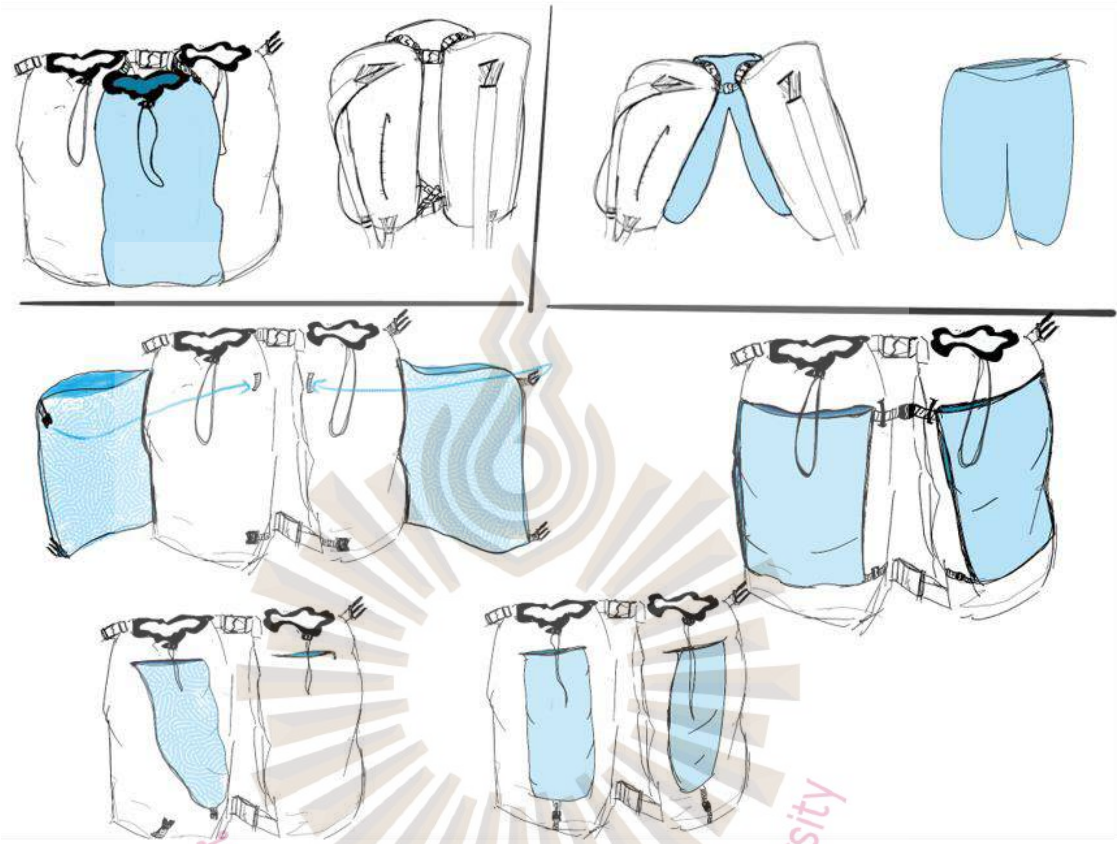

Figure 2-a: Design of Extra Space

Figure 2-b: Internal Structure of Prototype Version 2

Figure 2-c: Detailed Drawing of the Interior Space and Exterior Surfaces of Prototype Version 2

3. **Third Version**: This small-size backpack was created to make it less bulky to carry. However, due to its small size, it was not easy to use and could not be adopted. (Figure 3)

Figure 3: Prototype Version 3

4. **Fourth Version**: Attempting to make the backpack longer but narrower (Figure 4-a, Figure 4-b) proved less effective as it became harder to control, causing it to sink down towards the lower part of the body with weight. This version could not be adopted either.

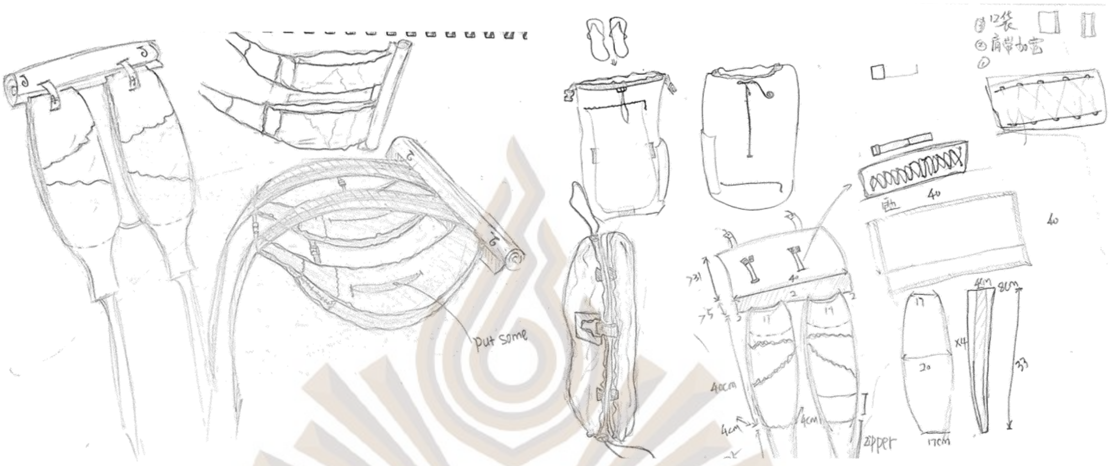

Figure 4-a: Design Prototype Version 4

Figure 4-b: Prototype Version 4

5. **Fifth Version**: Returning to the original size backpack, restraint straps were added to the extra pocket section to prevent it from jostling erratically while walking (Figure 5-a). Figure 5-c provides instructions for this addition. To reduce bulkiness during transport, tightening cords were installed on the sides of the backpack. Users could tighten the sides when less space was needed, making the backpack appear smaller. Straps that would have constrained the extra space were removed based on feedback from advisors who noted that these straps caused the backpack to sway while walking (Figure 5-b).

.

Figure 5-a: Design Prototype Version 5

Figure 5-b: Improved Design Prototype Version 5

Figure 5-c: Instructions for Prototype Version 5

6. **Sixth Version**: For stabilization purposes, a movable stabilizer (Figure 6) was mounted on the middle part of the backpack. The stabilizer remains horizontal when the backpack is worn on the back and can be turned to a vertical state when needed, functioning similarly to a magnet's suction.

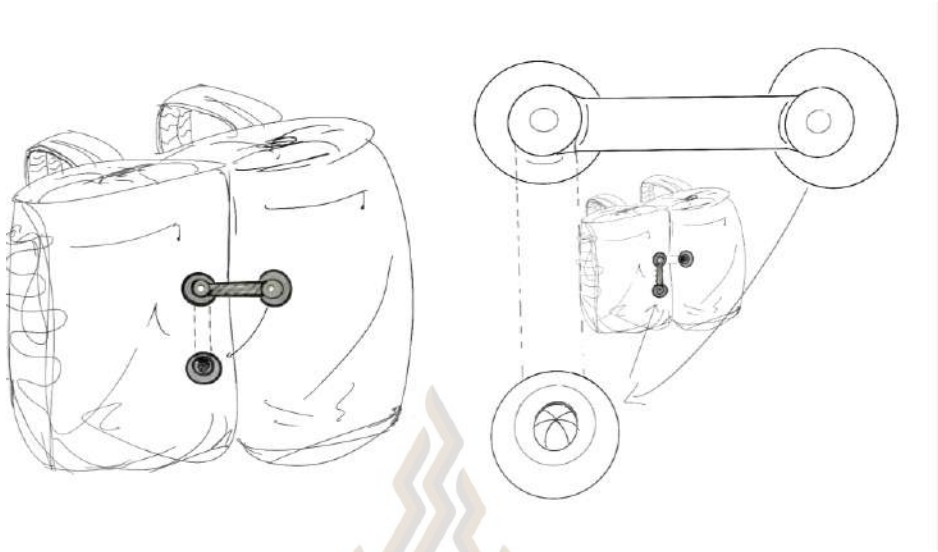

Figure 6: Prototype Version 6

Conclusion:

Through constant mentor feedback and my improvements, we developed a non-traditional backpack. This project demonstrates the complete process of design, fabrication, and improvement, exemplifying the importance of continuous optimization.

Biography

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