A Service Design to Assist People with Buying Used Cars

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Master of Science in Industrial Design

A Service Design to Assist People with Buying Used Cars

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ABSTRACT

This thesis was inspired by international students facing challenges buying used cars in the United States. Buying a used car can be a stressful experience for many people. For international students in particular, the challenge is augmented by factors such as language barriers, time pressures, etc.

People buying used cars may experience stress due to different challenges or they may feel mentally paralyzed. Multiple decisions must be made during the buying process. The goal of this thesis was to develop a digital tool based on user-centered research and to design a process to assist people in performing proper inspections when choosing a used car. Based on the research there were opportunities to redesign an OBD2 scanner that fits in the scenario.

Four phases of research were used to achieve these aims. In the first phase, a direction was determined by reviewing previous publications, conducting an online survey, and analyzing existing tools. This phase revealed the typical challenges that international students face when buying used cars. Furthermore, findings from this phase showed that performing a proper inspection can be difficult, as individuals must consult multiple resources. The information acquired during this process is not always understandable or memorable. One potential solution for this problem is to get digital assistance with inspection tips. Learning about the proper inspection could improve most people's buying experience and help them make a vehicle selection.

During the second phase, a mobile application and OBD2 (Onboard Diagnostics 2) scanner concept were developed as a means to improve the used car buying experience. These tools were designed to help the user find a reliable used car. Functions of the tools included

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descriptions of the inspection steps, tips, and assistance with locating nearby inspectors to assist users with car inspections.

The mobile application was developed through three iterations and tested with potential users. Testing verified the usability of the mobile application and revealed the need for it to create a faster and more effective solution. Results were analyzed, and a final design was confirmed in the fourth phase. Through four phases of research, this study created an application and a tool that can help international students perform proper inspections and find a reliable used car.

Keywords: International student, American car culture, used car market, buying a used car, car inspection, OBD2 scanner, UI/UX

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

The number of international students in the United States surpassed one million for the third consecutive year. A record high of 1,094,792 was observed last year according to the 2018 Open Door Report on International Educational Exchange.



Fig. 1 Source: Institute of International Education (IIE), "International Student Enrollment Trends, 1948/49 – 2016/17"

The United States has been the top destination for international students (International Students in the United States, 2018). Explanations for this preference include the high quality education system, welcoming culture, and relatively open labor market in the country. When international students come to the United States, they face many challenges including culture shock, language barriers, transportation difficulties, meeting new friends, class expectations, finances, and so on.

Transportation is one of the most significant challenges that international students experience (6 Challenges that International Students Must Overcome). The car occupies a central position in American life, and it is an indispensable tool in most cities, with few exceptions. The car is essential for many families; they are not able to complete their daily activities without a car. For example, they would not be able to commute to work, make an income, or take care of other daily errands. Without a car, going to school, the grocery store, or the cinema, eating at a restaurant, and attending all kinds of social activities becomes extremely inconvenient. The United States is extensive and sparsely populated, and its inhabitants live in a scattered distribution, which explains why car use is so high. The vehicle is virtually synonymous with modern American life. Residential areas, shopping malls, and office buildings are all built with the vehicle in mind. The emergence of the automobile influenced the overall landscape of the United States, in that it facilitated the growth of suburbs and the expansion of metropolitan areas.

Although cars are central to American life, not everyone in the US has the means to afford a brand new car. Used cars are an important part of the market for individuals and families who require transportation but cannot afford a new vehicle. Buying a used car is very challenging for most people. For international students, purchasing a used car can be more challenging due to issues such as the language barrier, budget concerns, time pressures, negotiation skills, and limited knowledge of car inspections. In the first part of this study, I evaluated the instruments people use to inspect a used car, which included checklists, inspection apps, and OBD2 scanners. Each of these tools has its advantages and disadvantages. Due to a lack of other known options, potential used car buyers continue to endure complications related to these instruments. Ultimately, when buyers conduct

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unreliable inspections they may face severe risks including the risk to their personal safety that can result from an unsafe or unreliable vehicle.

1.2 RESEARCH METHODOLOGY

To investigate the problems and potential solutions associated with used car inspections, the present study employed a mixed methods research methodology. Many researchers have proposed the integrated use of quantitative and qualitative methods. The distinction between quantitative and qualitative methodologies has received significant debate. Presently, many studies prefer a more holistic approach to research that includes a combination of the two approaches. The mixed methods approach aims to obtain a more complete and reliable view of the phenomenon under analysis by using both explicit and implicit feedback to gain an in-depth knowledge of people's expectations, behaviors, and needs.

| Implemented Research Methods | | |
|------------------------------|---------------------------------------------------------|--|
| Phase 1: Discover | User survey and interview | |
| | Literature review | |
| | Problem identification | |
| | Determination of requirements & | |
| | constraints | |
| Phase 2: <i>Explore</i> | Review design | |
| | Task analysis | |

| | Prototype feedback & testing (clickable |
|--------------------------|---------------------------------------------------------------|
| | digital prototypes and OBD2 scanner |
| Phase 3: Test and Listen | Prototype feedback and testing |
| | (clickable digital prototypes) |
| | Qualitative usability testing (in-person) |
| | Usability survey |
| Phase 4: Summarize | Analytics review |
| | Review of findings |
| | Proposal of an end solution |

Table 1 Research Methods

During Phase 1, a literature review was conducted to identify and frame the problem and determine an overall direction for the present study. The direction was then refined through surveys and individual interviews to help determine the requirements of the application/tool. Existing solutions for assisting used car buyers were examined to look for areas that could potentially be innovated.

Phase 2 explored critical issues identified in Phase 1, and proposed a concept that could alleviate these issues. Prototyped solutions were designed and analyzed in Phase 3 through usability testing, and an end solution was refined and summarized in Phase 4.

1.3 RESEARCH QUESTIONS

During the first two phases of research, there was an ongoing focus on identifying the problem and difficulties for international students buying used cars, and looking for opportunities to improve these buyers' experiences. The third phase was used to verify the relevance of the proposed solution. The research questions developed throughout the first three phases are summarized in Table 2.

| Research Questions | |
|--------------------------|----------------------------------------------------|
| Phase 1: Discover | • Where do specific difficulties exist? |
| | • How can negative impacts be relieved? |
| Phase 2: <i>Explore</i> | • What type of solution can help people become |
| | familiar with how to inspect a used car? |
| | • How can design be used to give the user a |
| | pleasant experience while inspecting a used car? |
| Phase 3: Test and Listen | • Will this solution help the user become familiar |
| | with the inspection steps and tips? |
| | • Can this solution positively impact user |
| | experience? |

Table 2 Research Questions

1.4 SIGNIFICANCE OF THE STUDY

This thesis aimed to develop a digital tool to assist used car buying through usercentered research and to design a process to help people who are looking for a used car to improve their buying experience. Besides the digital application, an OBD2 scanner was designed to improve the used car inspection process as compared to existing tools. Survey results showed what type of tool is helpful. Based on the survey results, common issues that international students were having while buying a used car and the most information for them to learn was identified. For example, surveys showed that participants were highly unsatisfied with the car inspection process, indicating that there was room for improvement in this area. Findings from usability testing supported the idea that a digital tool could be helpful for people when buying a used car. The participants in the present study appreciated a mobile app that would decrease the need to visit multiple websites and applications to gather the knowledge for inspecting a vehicle. These findings suggest that the mobile application developing could be useful for other international students too.

CHAPTER 2: LITERATURE REVIEW

2.1 INTERNATIONAL STUDENTS IN THE UNITED STATES

Our inspiration for this project started with international students who were reporting having challenges buying a used car in the U.S. The U.S. remains the country of choice for many international students; the country hosted a new high in 2017 of 1,094,792 students according to the 2018 Open Doors Report on International Educational Exchange. In 2018, this number continued to rise and reached 1,201,871 (2018 Open Doors Report on International Educational Educational Exchange). Explanations for why international students prefer the United States include the country's welcoming culture, quality higher education system, and relatively open labor market. The next two most popular host countries, the United Kingdom and China, hosted 11% and 10% of the world's international students, respectively.



Fig. 2 International student top host destinations

The total number of international students rose again by 0.9% from 2018 to 2019, but the new student enrollment has slightly declined (2019 Open Doors Report on International Education Exchange, 2019). This decline could have been caused by several factors. According to U.S. News, some schools are having trouble bringing new students to campus, and this may be partly due to (1) the cancellation of Brazilian government scholarship, (2) Saudi government increasing restrictions on students going to the U.S., and (3) competition from other countries, who are taking initiatives to attract non-native students to their universities. Additional factors include the increasing expense of U.S. higher education, visa delays or denials, and "an uncertain U.S. social and political climate." The latter includes, among other things, concerns about the Trump administration's travel ban and personal safety in the U.S.

2.2 AMERICAN CAR CULTURE

International students in the U.S face many challenges, such as overcoming language barriers, academic issues, homesickness, staying active, transportation, meeting new friends, and getting accustomed to new foods. Transportation is a central challenge, because solving the issue of transportation can ease many of the other challenges. The United States is vast and sparsely populated, which may be different from some international students' countries and cities of origin. The vehicle is essentially synonymous with modern American life, as residential areas, shopping malls and office buildings, among other spaces, are all built with the car in mind.

American automobile culture can be traced back to the 1950s, a decade which began with 25 million registered automobiles on the road. Most of these vehicles predated World War II and were in poor condition as no cars or parts were produced during the war due to rationing and restrictions. The American manufacturing economy switched from producing war-related items to consumer goods at the end of World War II. From 1955 onwards, the national highway system expanded with the development of interstate highways as part of the strategy to support US national defenses by improving transportation. As the interstate system expanded, so did the automobile industry. Investment in infrastructure such as highways and bridges coincided with the increasing availability of cars that were suitable for the high-speed travel that was made possible by better roads. Land developers continued to buy land just outside the city limits of larger cities to build mass quantities of inexpensive tract houses. As this great change unfolded, the U.S. became the world's largest manufacturer of automobiles. A new generation of service businesses sprang up during the decade, including drive-through or drive-in restaurants and more drive-in theaters. By 1958, there were more than 67 million cars registered in the U.S., which was more than twice the number that had been recorded at the start of the decade. Cars facilitated the new-found mobility that permeated ways of American life and culture. The automobile and the Interstate became American symbols of individuality and freedom. For the first time, automobile buyers accepted that the car they drove indicated their social standing and level of affluence. Their vehicle of choice became a statement of their personality and an extension of their self-concepts. By the end of the 1950s, one in six working Americans were employed either directly or indirectly by the automotive industry.

In the present day U.S., having a car is still indispensable in most cities, however more and more cities are moving towards a design that makes it easier for inhabitants to live without a car. Cities that are moving in this direction include New York City, San Francisco, Boston, Portland, Philadelphia, Chicago, and Seattle. Those cities are making their streets

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more walkable and creating easier ways for residents to bike or take public transit instead of driving.

2.3 THE AMERICAN USED CAR MARKET

The US used-car market is more than twice the size of the new-car market and is outpacing its growth. The Cox Automotive Used Car Market Report (2018) stated that 2017 was a good year for the industry. The demand for personal transportation was active in 2017, with more than 56 million new and used vehicles sold. Economic conditions improved throughout the year, and with them came used and new car sales that were only slightly below recent record levels. Used vehicle sales finished near 39.3 million units in 2017, up 1.8% from the previous year. However, new vehicle sales fell by nearly 2%. Given that the new vehicle market is in the late stages of its recovery, the modest weakening in demand for new vehicles is not surprising after reaching record peaks in 2015 and 2016. In 2018, used market increased to 39.5 million sales while new sales declined to 16.7 million. Although buying conditions are active for all vehicle markets, growth in used supply from off-lease vehicles coupled with record-high prices for new products and a modest pull-back in fleet activity, is steering new and used products in different directions.

2018 should be an average year, with robust volumes and stable prices for car sales. Used cars offer a relatively countercyclical safe harbor from the dramatic sales highs and lows seen among new vehicles.

The US used-car inventory is becoming both newer and more expensive. The market has seen a strong shift toward later-model vehicles. Our analysis projects that, between 2017 and 2022, the used-vehicle profile will become increasingly new. There are significant drop-offs occurring in cars seven years and older as more people frequently trade up their vehicles.

Used cars that are three years old or less will increase from 51% of the total in 2017 to about 60% in 2022. A key part of this age shift will likely result from the greater supply of off-lease vehicles, many of which fall into the category of newer certified preowned (CPO) vehicles (The Cox Automotive Used Car Market Report, 2018).

Used-car prices are rising due to the richer mix of available SUVs (Sport Utility Vehicle) and pickup trucks. For example, more customers are choosing full-size pickup trucks and midsize or larger SUVs among three-year-old vehicles, which caused prices to rise 4.0% and 2.2%, respectively between 2012 and 2017. Hence, while the prices of used three-year-old midsize and compact cars declined by 1.3% and 1.6%, respectively, the overall used-vehicle-market average transaction price increased by 2.7%. This shift is likely an early reflection of the auto industry's general move away from cars toward light trucks and SUVs in the new-vehicle market.

2.4 HOW TO BUY A USED CAR

To buy a used car, one can go to a dealer or purchase from a private seller. The benefits of buying from a car dealership include the increased likelihood of being provided with a vehicle history report, increased assurance about the quality of the vehicle, and the increased security that comes with dealers' certifications for pre-owned cars. On the other hand, buying directly from a private seller allows one to avoid hidden fees, and this may be the best option if low price is the primary goal. Buying from a private seller may also be more comfortable than negotiating with a professional seller; private sellers generally want to finish the sale and get back to life, meaning a ready buyer who can pay immediately will probably get a good deal. This is not true in the case of negotiations with a car salesperson, whose job is to be on the lot all day. They are not in a rush, and they know that buyers will come in all day long. One of the most important jobs to do when buying a used car is to inspect it. This inspection can be a big challenge for international students when purchasing a used car.

CAR INSPECTION:

The best way to avoid buying a defective or unsafe car that is in poor condition is to do a proper car inspection. The easiest way to do this is to find a dealer that provides prepurchase inspections. A pre-purchase inspection is an independent, third-party professional service that evaluates a vehicle's condition before a purchase offer is made. The prospective buyer hires a qualified evaluator who examines the target vehicle for defects, hidden damage, maintenance history, and safety, and then typically provides a written evaluation report. This service provides factual information that the prospective buyer can use to support their decision on vehicle purchase. The pre-purchase inspection charge tends to cost around \$100. Buyers who do not want to spend \$100 can instead learn to inspect cars themselves. There are multiple online resources one can use to learn about this topic, including YouTube videos that explain how to inspect a used car. The various available websites and videos teach prospective buyers to inspect a used car from the exterior, tires, engine, interior, and test drive experience. It may be challenging for new buyers to remember all of these elements, therefore, they can also download checklists to keep track of what to inspect.

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| CLAL | |
|-------------------------------------------------------|------|
| The Car Basics: | |
| Year | |
| Make | |
| Model (any options?) | |
| Asking Price/Phone# | |
| Trade in Value | |
| The Body: | |
| Scratches | |
| Dents | 10 |
| Windshield (chips or cracks?) | 43.3 |
| Headlights (foggy?) | |
| Inspection Sticker Current? | |
| Rusty Brake rotors? | |
| The Wheels: | |
| Tire Tread | 17 |
| All 4 tires/wheels the same? | / |
| Wheel damage? | |
| The Interior: | |
| Rips on scats | |
| Car Options (Navi, surroof, etc) | |
| Headliner (saggy?) | |
| Automatic/Manual | |
| Steering wheel (wom?) | |
| Inder the Car: | |
| Leaks (near engine and rear diff) | |
| Rust (exhnust, frame, body, etc) | |
| Suspension (tie rods, hall joints, shocks, avle, etc) | |
| Frame Damage (from collision) | |

| Timo ang mere yau robust nu cut? Why are you reling it? Does reverything work/any problems? Any service recends, what have you done aim 5.) What did you use the car for? How many milles did you put on it when you 7.) What car are you looking to get now? Why? age to Bridge OBDU Taxamer - Magnet - Flashlight - | ce owning the car? owned it? |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ogs to Bring: -OBDII Scatter - Magnet - Flashlight - | a harmonia a second |
| | Paper towel -Pen |
| om your Research: | |
| Value of the Car (trade in value): | |
| gine (start cold, let warm up, go for Scan Engine with OBDH Scanaer (P1000 Before Startus | ride) codes cleared recently) |
| | Trease and the second s |
| Hood pops open casily? | Hood support/struts work? |
| Hood pops open casily? Frame (straight, no kinks) | Clean vs Dirty (was the engine detailed) |
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| Head approgram cashly? Frame (straight, and skilds) Inspect for leaks (eil, costant, tranns) Oil level and oil (no metal, nor floothy) Cheld Startup Any strange noise/simteke' locking, printing, etcl Does the motion mene a lot (doil notice mounts) | read support: met source Cenas vo Silor, (one she sugges detailed) Any damagerines parts Oil Cap (no 7mh under cap) Tloses, lettus, buttery post, wirer, etce Dest it Hake too long to starr? Check under oil cap (starr) |
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| terior | |
|----------------------------------------------|---------------------------------------|
| Seats: Front and rear | |
| Damage, rips, tares, stains, smell | Solid/no movement |
| Adjust properly (forward, back, tilt) | |
| Carpet: Front, rear, and trunk | |
| Clicck Under Carpets (rust, water) | Floor mats? |
| Stains, holes, cuts, snell, dampness | |
| Trunk: | |
| Spare (holds air, not rusty) | Jack with lug wrench |
| Spare tire carrier round (no indents) | Lug nut key (locking lug-outs) |
| Water marks, damp carpet? | |
| Vehicle Options: | |
| Power Windows (roll updown, seratches) | Window tint (bubbles, legal) |
| Power Mirrors (heat and movement) | Power Locks (all doors lock/unlock) |
| Radio (an/fm/clock set right: speakers work) | AC/Heat (all settings, all vents) |
| Navigation (make sure it locates) | Sunroof (opens/closes, no leaks) |
| Rear View Mirror (auto-dim) | Parking Sensors (beep in reverse) |
| Lights (glove box, map, dashboard, etc) | Emergency Brake Holds ear in Neutra |
| Heated Seats | Wipers and washer fluid work |
| Check for Owner's Manual | All Ganges Work |
| Headliner: | |
| Sagging? | Water Damage. Burns, damage |
| Wear and Tear: | |
| Gas/Brake Pedal | Steering Wheel |
| Shift Knob | Seats/Carper |
| xterior | |
| Lights | |
| High Low Beams | Front Running Lights |
| Front Fog Lights | Front Turn Signals |
| Brake Running Lights | Pressed Brake Lights (3" brake light) |
| Rear Turn Signals | Rear Fog Lights |

| Bodywork | |
|---------------------------------------------------------------------------|------------------------------------------------------|
| Panel Gaps | Paint Seams on edge of panels |
| Bondo (magnet and tapping methods) | |
| Tires | |
| Turn lock to lock | Inspect tread-wear |
| Inspect camber/toe angle | |
| est Drive (go for a regular driv | e city and highway) |
| Acceleration Test: smooth, no knocks | or hesitation, |
| Regular Acceleration | Hard Acceleration |
| Turning Test | |
| Stationary- ten lock to lock (noise/feel) | Moving- turn 360 (noise/feel both ways) |
| Turn back and forth in motion to sway car (convolled, squeaks, knocks) | Hard turn while moving (coatioffed, squeeks, knocks) |
| Brake Test -smooth, no pulls, no noisea | no vibrations |
| Regular Braking | Hard Braking (try to activate abs) |
| ABS Light on dash? | Noise/pulling? |
| Highway: stop and go, bumps, turns, slo | wer |
| RPM (top gear/overdrive) | Smooth/controlled/comfortable/solid |
| Noises (thuds, squeaks, whines) | Downshift at cruising speed |
| Cruise Control | |
| City: stop and go, bumps, turns, slower | |
| Noises (thuds, squeaks, whines) | Vibrations |
| Does the car feel good to drive? | Shifting (smooth, crisp, no slipping) |
| Scan Engine after Test Drive | |



Along with a checklist, it is recommended that prospective buyers bring several tools when to go to inspect a car, including an OBD2 scanner, a magnet, a penny, a flashlight, and paper towel.

An OBD2 scanner is a device for diagnosing and troubleshooting car problems. It is a standardized system in trucks and cars. Its software regulates and monitors a car's primary functions. It can send commands to different systems to maintain a car's overall health. It can also self-correct anomalies in fuel mixture and vehicle ignition. This device can present data about a vehicle's engine RPM, coolant, air temperature, crankshaft position, throttle, and road speed.



Fig. 4 Bluetooth OBD scanner

Bringing a magnet is useful for checking the major panel of the car's exterior. It can be used to identify if the panel has been repaired with Bondo, fiberglass, or another nonmetallic dent filler. However, this technique may not apply in all cases, as some particular panels are nonmetallic or nonmagnetic. Bumpers and grilles in modern cars tend to be molded from plastic.



Fig. 5 Magnet for Bondo check

A penny is useful for checking the tire depth. To do so, one should insert the penny into the tire's tread groove with Lincoln's head upside down and facing the user. If all of Lincoln's head is visible, tread depth is less than 2/32 inch, and the tires are due for replacement.



Fig. 6 the Penny Tire Test

2.5 NEW PLATFORMS FOR USED CAR BUYERS

As the US used-car market continues to grow, new tools are being developed to help people buy used cars. New platforms such as Carvana, Fair, and Vroom, among others, are getting popular. Carvana is an online used car retailer and technology business company, and it is known for its car-sized vending machines. Vroom is a used car retailer and e-commerce company that enables consumers to buy sell and cars online. These companies employ a range of sophisticated digital capabilities, like big data analytics and advanced digital platforms, which set them apart from conventional used-car dealers. Furthermore, they contribute to protecting and growing this important source of American revenue.



Fig. 7. Carvana vending machine

2.6 SERVICE DESIGN

Service design is a process in which the designer focuses on creating optimal service experiences. This requires taking a holistic view of all the related actors, their interactions, and supporting materials and infrastructures. Service design often involves the use of customer journey maps, which tell the story of different customers' interactions with a brand, thus offering deep insights. The five basic principles from the book This is Service Design written by Marc Stickdorn and Jakob Schneider underlie service design were, user-centered, co-creative, sequencing, evidencing, and Holistic. To employ a service design process, a designer uses a wide range of design tools for exploration and creation. Qualitative research methods for service design are similar to general user-centered research methods: observations, contextual interviewing, etc. Using such methods, designers can envision a spectrum of situations in which users may interact with brands, from discovery to conversion and attendant issues such as customer reengagement.

CHAPTER 3: DESIGN DEVELOPMENT

3.1 PRECEDENTS

Phase one of the procedure was to interview international students who had experience buying a used car. Participants in the current study mentioned that a better buying experience would come from gaining a more natural way to inspect the used car. Survey and interview results from international students show what type of issues international students face when buying a used car. Interview results from the shop owners and staff also showed that they expected to benefit from improved buyer experience through growing business at their shops.

3.2 SURVEY AND INTERVIEWS RESULTS

To find out about the types of problems faced by international students buying used cars, 86 people were surveyed, and the results are shown below. (Fig.8 -Fig.2)



Fig. 8 survey



Fig. 9 survey

What are the most important factors to you when buying a used car?



Fig. 10 survey

What challenges do you face as an international student looking for a car?

34 responses



Fig. 11 survey

What resources did you use to look for information?



52 responses



How many cars did you see in person?

52 responses



Fig. 13 survey

Who did you go with?

52 responses



Fig. 14 survey

Who did you buy your used car from?

52 responses



Fig. 15 survey

What was the mileage when you purchased the car?

51 responses



Fig. 16 survey

What was the final price of your used car?

52 responses



Fig. 17 survey

Did you find any issues or problems after you bought the used car? ⁵² responses



Fig. 18 survey

How much time passed before you noticed these issues?

18 responses



Fig. 19 survey

If there was an App available to assist you with the car inspection and purchase process, would you use it?

86 responses





The results from the survey show that the biggest challenge international students face when buying a used car is that they do not know how to inspect the car. The factors they cared about most were the reliability and price of the car. Of the students surveyed, 36.5% had issues after buying the car, and 38.9% noticed the issue within a week. At the end of the survey, there were question asking whether participants would use an app to assist their car inspection if such an app existed; 96.3% replied that they would like to use it. The survey also asked participants what would make the car buying process easier for them, and more than 20 participants responded to the question. Seven of the respondents gave a similar comment: having more information on how to perform car inspection would make the process easier and less stressful for them.

Ten international students were interviewed from various backgrounds and ages to gather information about their personal experiences and identify common problems. These individuals were asked to describe the details of their experience while buying a used car and their driving history in their home country. They were also asked about the challenges they faced, how they inspected the used car, if they knew anyone who knows how to check cars, and how they decided which car to buy. Many of them had shared similar experiences as international students and used-car buyers. All of them lived off-campus, so they needed to buy a car as soon as possible. They had limited driving experience in their home countries, and the vehicles they had previously driven were their parents' cars. If the vehicle had problems, their parents took care of them, so they had had little opportunity to learn about car maintenance. The challenges they have faced while buying a used car in the U.S. included the language barrier, time pressure, uncertainty about inspection, difficulty negotiating, difficulty finding cars, complicated paperwork, and difficulty going to the location. Their friends who went with them also had minimal knowledge about how to inspect used cars. The procedure they generally used was to look around the car and take it for a test drive. None of them brought or used any tools to check the car. They made their decision based on feeling, price, whether the seller was nice, and other similar factors. They did not report using objective

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information based on an inspection to make their choice, because they did not know how to inspect cars.

SHOP OWNER AND EMPLOYEE INFORMATION

Four shop owners and employees were located and agreed to be interviewed. These individuals were asked to describe how often people come to the shop to request a prepurchase inspection, what kind of customers come to the shop requesting pre-purchase inspections, and they advertise these inspections. The interview discussed the idea of designing an app that teaches people how to do an inspection and having the function to help users locate professional inspectors nearby. How they felt about this idea and asked about the commission they would be willing to give from these orders. An interesting finding was that despite the fact that the used car market is rising, shops did not report experiencing increased business. They said they had old and new customers who came to the shop for a pre-purchase inspection, but that few people came to the shop for maintenance or repair parts. One of the participants reported that only three people came to his shop during the last nine months. Some of the participants advertised their services through their websites, but they found that this did little to augment sales. They were all very excited about the idea for the app and gave positive feedback on the app. They also noted the possibility that if any issues were found, the client might choose to get it fixed at their shop. Three of them were willing to give around 10% commission to the app, and the fourth one was willing to give up to 40% commission to the app.

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Fig. 21 Photo with shop owner



Fig. 22 Photo with shop owner
3.3 Conclusion

It is clear from the survey and interview results that international students are having difficulty inspecting a used car, and that a useful tool is needed. A helpful tool would be one that assisted them with checking the used car or helped them to find an inspector to do the checking for them. Such a design would bring benefits to people looking to buy a used car and bring business to the shop. From the survey and interview, the purchasing a used car journeys were clearly understanding. The journey map below helps to identify opportunities.

| | Doing Research | Meet with Seller | Inspection Used Car | Negotiation | Buy/ Leave | |
|----------------|-------------------------------------------|----------------------------------------------------------|----------------------------------------------|---------------------------------|------------|--|
| Key Activities | Look into website, Youtube Video | Meet with the dealer/ Meet with the private seller | Inspecting the car/ Test drive | Negotiation | Buy Leave | |
| Mood | - 3 | | | (3) | | |
| Touch points | Screen Computer | Phone / the seller | Car/ Seller / Inspecting tool / Phone | The seller | The seller | |
| Pain Points | Not sure where to find the information | How to get to the seller | Didn't know how to how to inspect the car | Didn't know how to negotiate | | |
| Opportunities | Mobile/ App informa- tion | Mobile/ App informa- tion | Mobile / App informa- tion | | | |

Fig. 23 Journey map

3.4 OPPORTUNITIES

Phase 2 of this thesis began by considering possible solutions that could alleviate the issues discovered in Phase 1. Based on the survey and interview results, a better tool was needed to benefit international students who wanted to buy a used car. Designing something that would help them become familiar with the steps of used-car buying and teach them how to inspect a used car. A common observation from the initial research was that those people buying a used car were inclined to conduct online research and consult multiple websites to

learn about used cars. They had to compile information from various sites and bring multiple tools to inspect the used car. Based on the research, an opportunity was identified: to develop a mobile application and a device to assist users in finding reliable used cars. There are some existing inspection apps that help people manage car inspections, but they are confusing and lack functionality, and they do not provide any information about how to do an inspection. For this study, a prototype mobile application (app) interface and a multifunction tool were developed to assist with these tasks. An app was developed, because in the present day people use their smartphone for almost everything and bring it with them everywhere they go. It would, therefore, be a convenient tool for people to use while inspecting the used car. The prototype app will have the potential to develop into a real app.



Fig. 24 Existing app

CHAPTER 4: DEVELOPING THE DESIGN CONCEPT

4.1 CONCEPT:

The goal of this project was to develop a design solution that combined key aspects of how to improve the inspection experience. From the testing, an opportunity was observed, a specific type of tool with certain functions to improve the car inspection experience. It would have to be easy to use while doing the inspection. Two products, a mobile app and a multifunction OBD2 scanner, were developed:

Auto Spect (mobile app) Main Functionality

- Inspection Checklist
- Inspection Tips
- Inspector Matching

The app was designed with the goals of being as friendly and easy to use as possible. The app has a checklist about what to inspect, and information about how to inspect. Besides the app, the tools you can bring was also thought though, instead of carrying multiple tools, to make things easier. By putting those ideas together, a multi-function OBD2 scanner which works with the app came in mind.

OBD2 Scanner Functionality

- Built-in flashlight
- Tire Depth Gauge
- Built-in Magnet

The device will work like an OBD2 scanner and provide multiple functions for inspecting used cars. The OBD2 connects through Bluetooth and works with the app. The

OBD scanner also functions as a flashlight, tire depth gauge, and built-in magnet for checking the car bodywork.

4.2.1 USER INTERFACE DESIGN

The main goal of the current project is to achieve a better experience for used car buyers by designing a better tool for people. Taking great care when designing the Auto Spect user interface. As it would be what the users interact with, the design focuses on UX/UI with a pleasing look and friendly experience. The app design started out using Whimsical (an online wireframe tool) layout the ideas.

The final iteration of the interface was subsequently tested with 20 international students and eight car shop employees.

4.2.2 USER INTERFACE ITERATIONS

The very first approach was wire framing and creating simple shapes as placeholders for content, then giving them visual weight in greyscale. The app begins with a login screen on the first page. After login, there will be different functions to browse. The design focuses on the main two functions — the Car inspect and the Find inspector — but also listed some potential future developments.



Fig. 25 Auto Spect login page and potential function

One of the main focuses of the app is to inspect by yourself. Once you go into the Car inspect function, you can start adding the car you want to inspect. You can easily manage the inspected car. To start inspecting the car, you will click onto the Add button on the bottom right. Then you are ready to start inspecting the car. It takes you through the checklist for basic information, engine, interior, exterior, and test drive. You can take photos at any time during the inspection, and for some items on the list, tips are given to help users with the inspection. To get the tip, the user can click onto the item with a "?" icon next to it. Once you click on it, a pop-up screen will show up, and teach you how to perform the technique.



Fig. 26 The inspection process

After inspecting multiple cars on the manage page, you can use different filters to compare the cars, which helps you better choose the right car.



Fig. 27 Rate and compare page

If you do not want to inspect by yourself or if you want to double-check the car you inspected, you can use the Find inspector function. It offers you the option to find an inspector nearby easily. The registered inspector will show on the map. Click on the inspector, and you can see the inspector's profile and reviews. Place the order by putting the date and time.



Fig. 28 Find an inspector

4.2.3 APP PROTOTYPE 1.0

To let users try it, I initially developed an interactive prototype to test the basic functions and interactivity of the interface. The first version went through testing to discover any possible frustrations and flaws in the system.



Fig. 29 Main Function

In the first version, the app was designed with a dropdown list with presets to no issue, to help the user to inspect the car more efficiently. The pop-up tips were made simple and easy to learn how to perform each steps.



Fig. 30 Checklist and inspection tips

4.2.4 APP PROTOTYPE 2.0

The second version of the app involved improvements to the interface and more detailing of the app. On the function selecting page, the app was made easier for users to understand that they have different functions on two sides. The list was also improved by shortening the list, leaving the most needed ones.



Fig. 31 Old version on the left, new version on the right

In this version, drawing and taking notes functions were added. In note-taking, you can switch to preset questions that are commonly recommended to ask the seller.



Fig. 32 Drawing and Note-taking features

4.2.5 APP PROTOTYPE 3.0

the third version improved the user interface and switched the dropdown list to a checkbox with satisfactory and unsatisfactory. A dropdown list with more than two options can make people confused; therefore, it is best to make sure users can quickly understand all dropdown options so that they can pick the most appropriate one easily. With the *satisfactory* and *unsatisfactory* options, people could easily pick the correct response.



Fig. 33 3.0 Old version on the left, new version on the right

The font size and button were improved, and the menu was added. This change allowed users to easily go to different functions or skip backward and forwards. Additionally, the function of Note, Draw, and Photo at the bottom of the page. The Note function lets users take notes and provides some questions that they can ask the seller. The Draw function lets them visually record any damaged parts. The Photo button lets them capture a photographed image of the car. Tips are also provided for how to inspect a used car.



Fig. 19 Side menu and function



Fig. 34 Inspection tips

For the Find inspector function, after placing the order, the user waits for the inspector to confirm the order.



Fig. 35 Finding inspector process

The inspector then receives a notification from the inspector side of the app (Auto Spect). The inspector can accept the order, and they can also review the inspection checklist for users. Once complete, the customer will receive the report in their app.



Fig. 36 Auto Spect inspector interface

As the app was being developed, a business plan was also developed concurrently. To map all the components and aspects of the service design, a blueprint was created:



Fig. 37 Service design blueprint

The service came up with three ways to profit: (1) take a commission from the find inspector order, (2) offer an upgraded version of the app, and (3) sell the OBD2 scanner that can work with the app. The upgraded version would offer a more detailed checklist with more tips, a discount on finding an inspector, and a maintenance management function.



Fig. 38 In-app purchase

4.3 OBD2 SCANNER PROTOTYPE

Based on the research designed a multi-functional OBD2 scanner combining the tools needed for inspecting a used car. Then built some mock-ups to learn where to place the flashlight, magnet, and tire depth meter. From the mockups, learned the best place to locate the functions.



Fig. 39 OBD2 Scanner mockup



Fig. 40 OBD2 Scanner testing



Fig. 41 Auto Spect OBD2 scanning ideation

Based on the testing the best location to place the flashlight was at the front of the OBD2 scanner, which allows the user to easily locate the OBD2 scanner port on the car. The ideal location for the tire depth meter was on the back of the device, and the magnet on the bottom of the device. After making test models, starting to envision how would the OBD2 Scanner been build.



Fig. 42 Auto Spect OBD2 scanner dimension



Fig. 43 3D printed prototype

4.4 CONSIDERATIONS

One of the major drawbacks of the existing apps on the market is their lack of functionality and their poorly designed user interface. Bluetooth OBD2 scanners on the market can range in price from \$10 to \$100 and most of them can only be used to scan the car. Within this price range, targeting the multi-function OBD2 scanner at \$50 which sells in the app. The OBD2 scanner will need to be easy to manufacture on a large scale; therefore, it needs to be made from a material that is hard and durable while easily produced on an industrial scale. The material for the hard outer case of the Auto Spect OBD2 scanner is Acrylonitrile Butadiene Styrene (ABS), which is commonly used in commercial and industrial applications. The tire depth gauge will be made with aluminum to highlight the design.

CHAPTER 5: VALIDATION

5.1 USER TESTING:

The app has been tested with 20 international students (from different backgrounds and ages) and eight car shop employees.

Testers have assessed the physical prototype to see how it would work in a real-life scenario. All testing was doing in-person to observe the users' reactions and draw feedback from them. The first part of the test was simple; it included questions about their favorite and least favorite part of the app. The second part of the test was a usefulness questionnaire and usability test, which used a 7-point rating scale to address for responses. The test results were shown below.

Which of the issue below was the biggest problem during your experience with tha mobile app?



Fig. 44 International student survey

2. The app was missing feature I needed

More detailed description about the function of each section, provides some idea bout price accourding to the reported condition

More video tour, instruction or overview, using bigger photo to locate each part of engine, interior

An interface that can compare the cars condition on the same screen.

Adding normal.

Video instruction for person who do not understand the car.

Would like to have the funtion of revealing the expected conditions given selected used cars.

4. Other

The visualization of information can be difficult if you are not familiar with the subject.

Adding many information manually, no list for compare the different cars.





Fig. 46 International student survey



Fig. 47 International student survey

| Usability Questionnaire | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|-------------------------|------------------------------------------------------------------------------------------------|----------------------|---|---|---|---|---|----|---|-------------------|
| | The information provided in this app would help me become familiar with inspecting steps | Strongly desagree | | | | | 6 | .5 | | Strongly agree |
| | The app would allow me to learn mul- tiple aspects of how to inspect a used car | Strongly desagree | | | | | 6 | .4 | 5 | Strongly agree |
| | This app would help me decide which car should I pick | Strongly desagree | | | | | 6 | .3 | | Strongly agree |
| | Using this app would help relieve stresses related to buying a used car | Strongly desagree | | | | | 6 | | | Strongly agree |
| Usab | Usability Questionnaire | | | 2 | 3 | 4 | 5 | 6 | 7 | |
| 1. | Overall, I am satisfied with how easy it is to use this application (app) | Strongly desagree | | | | | 6 | .1 | | Strongly agree |
| 2. | It was simple to use this app | Strongly desagree | | | | | 6 | .0 | 5 | Strongly agree |
| 3. | I can effectively complete my tasks using this app | Strongly desagree | | | | | 6 | .5 | | Strongly agree |
| 4. | I feel comfortable using this app | Strongly desagree | | | | | 6 | .0 | 5 | Strongly agree |
| 5. | It was easy to learn to use this app | Strongly desagree | | | | | 6 | .1 | | Strongly agree |
| 6. | I believe I became productive quickly using this app | Strongly desagree | | | | | 6 | | | Strongly agree |
| 7. | The information provided in this app is clear | Strongly desagree | | | | | 6 | .3 | | Strongly agree |
| 8. | It is easy to find the information I needed | Strongly desagree | | | | | 6 | .1 | | Strongly agree |
| 9. | The information provide in this app is easy to understand | Strongly desagree | | | | | 6 | .2 | | Strongly agree |
| 10. | The information is effective in helping me complete the tasks and scenarios | Strongly desagree | | | | | 6 | .1 | 5 | Strongly agree |
| 11. | The organization of information on the app screens is clear | Strongly desagree | | | | | 6 | .0 | 5 | Strongly agree |
| 12. | The interface of this app is pleasant | Strongly desagree | | | | | 6 | .1 | | Strongly agree |
| 13. | I like using the interface of this app | Strongly desagree | | | | | 6 | .1 | 5 | Strongly agree |
| 14. | This app has all the functions and capabilities I expect it to have | Strongly desagree | | | | | 5 | .7 | | Strongly agree |
| 15. | Overall, I am satisfied with this app | Strongly desagree | | | | | 6 | .5 | | Strongly agree |
| 16. | Anything else you would like to share about the mobile app? | | | | | | | | | |





Fig. 48 International student testing out the app

Which of the issue below was the biggest problem during your experience with tha mobile app?



Fig. 49 Car shop survey

What do you like most about the mobile App?





What do you least like about the wobile App?1. Look and feel02. Navigation03.Functionality14. Content15. Other16. N/A5

Fig. 51 Car shop survey

| Usability Questionnaire | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|-------------------------|------------------------------------------------------------------------------|----------------------|---|---|---|---|----|---|---|-------------------|
| 1. | Overall, I am satisfied with how easy it is to use this application (app) | Strongly desagree | | | | | 6. | 2 | 5 | Strongly agree |
| 2. | It was simple to use this app | Strongly desagree | | | | | 6. | 5 | | Strongly agree |
| 3. | I can effectively complete my tasks using this app | Strongly desagree | | | | | 5. | 5 | | Strongly agree |
| 4. | I feel comfortable using this app | Strongly desagree | | | | | 6. | 6 | | Strongly agree |
| 5. | It was easy to learn to use this app | Strongly desagree | | | | | 6. | 7 | 5 | Strongly agree |
| 6. | I believe I became productive quickly using this app | Strongly desagree | | | | | 6. | 1 | 2 | Strongly agree |
| 7. | The information provided in this app is clear | Strongly desagree | | | | | 6. | 3 | 7 | Strongly agree |
| 8. | It is easy to find the information I needed | Strongly desagree | | | | | 6. | 3 | 7 | Strongly agree |
| 9. | The information provide in this app is easy to understand | Strongly desagree | | | | | 6. | 5 | | Strongly agree |
| 10. | The information is effective in helping me complete the tasks and scenarios | Strongly desagree | | | | | 6. | 3 | 7 | Strongly agree |
| 11. | The organization of information on the app screens is clear | Strongly desagree | | | | | 6. | 8 | 7 | Strongly agree |
| 12. | The interface of this app is pleasant | Strongly desagree | | | | | 6. | 3 | 7 | Strongly agree |
| 13. | I like using the interface of this app | Strongly desagree | | | | | 6. | 5 | | Strongly agree |
| 14. | This app has all the functions and capabilities I expect it to have | Strongly desagree | | | | | 6 | | | Strongly agree |
| 15. | Overall, I am satisfied with this app | Strongly desagree | | | | | 6. | 7 | 5 | Strongly agree |
| 16. | Anything else you would like to share about the mobile app? | | | | | | | | | |

Fig. 52 Car shop survey

5.2 ANALYSIS

From the testing, it is clear that the design is simple to use and users are quickly able to gain proficiency with the app. Based on the result there were positive feedbacks.

From international students

- The information provided in this app would help me become familiar with inspecting steps
- The app would allow me to learn multiple aspects of how to inspect a used car
- I can effectively complete my tasks using this app
- This app would help me decide which car I should pick
- The information provided in the app is clear

From the car shop

- I feel comfortable using this app
- It was easy to learn to use this app
- The information provided in this app is easy to understand
- The organization of information on the app screen is clear
- I like using the interface of this app

5.3 FINAL DESIGN

The final design would have to address the issues presented by the users after the testing. These issues included:

- Having an easier way to locate each the item on the car
- Having a function to compare cars
- Improving the inspection instructions

The design was improved to make it easier for users to understand where each part of the car was to facilitate an easier inspection. A feature was also added so that users can rotate the screen to compare the cars they have inspected.



Fig. 53 Final design

The inspection tips were improved to better understand how to inspect each part.



Fig. 54 Final design



Fig. 55 Overview of the app



Fig. 56 Overview of the app

FINAL DESIGN OF THE OBD2 SCANNER



Fig. 57 Auto Spect OBD2 scanner front view



Fig. 58 Auto Spect OBD2 scanner flashlight



Fig. 59 Auto Spect OBD2 tire depth gauge



Fig. 61 Auto Spect OBD2 exploded view



Fig. 62 Color options



Fig. 63 Tire depth gauge



Fig. 64 Flashlight



Fig. 65 Bondo check
CHAPTER 6: DISCUSSION

6.1 VALUE PROPOSITION

The Auto Spect App was created to fulfill the need for inspecting used cars. The app not only allows people to do their inspection, but it also allows users to easily find an inspector to examine the used car.

With the Auto Spect OBD2 scanner, you no longer need to bring multiple tools to your car inspection, as it is designed with a built-in tire depth meter and magnet.

6.1.2 SOURCE OF INNOVATION

The Auto Spect App is a novel approach to improve the experience of buying a used car. Thanks to the interface, which combines multiple functions in one app, users of the app can more easily navigate this challenging process. Furthermore, the Auto Spect OBD2 scanner boasts a mid-range price and provides multiple functions.

6.3 FUTURE OPPORTUNITIES

Due to the positive feedback received throughout user testing, there appears to be an opportunity for the solution to be further prototyped and developed into a functional mobile application and a business. Further insight can be obtained by speaking with larger groups and conducting additional rounds of usability testing.

CHAPTER 7: CONCLUSION

This original testing and intention of this thesis was for helping international students buy used cars, however, this could be expanded to include anyone interested in buying used cars. User experience design methods led us to design and prototype an application and the corresponding OBD2 scanner. Participants who tested the app were in favor of gaining a simpler way to do, learn, and manage the inspection process. They expressed appreciation for a mobile app that would help them decide on a used car and reduce stress during the car buying process. By teaching them how to do the inspection and removing their need to rely on multiple sources, the tools have proposed here could help users have an improved buying experience. Results from testing and surveys were able to conducted support the idea that such a digital tool could aid used car buyers. As this thesis has demonstrated, a mobile tool and an OBD2 scanner show significant promise. With further development and testing, these products could be introduced to the market to begin assisting those who are looking for and buying used cars.

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