



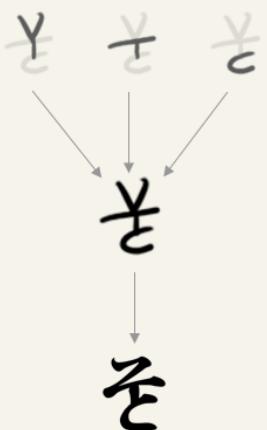
TIANCHENG YANG
PORTFOLIO



COVER BACKGROUND STORY

The cover background is my personal logo. I took my initials and created an original character.

杨添程
Yang Tian Cheng



M E N U

Formula SAE

Designed and manufactured a race car, and raced it

Automotive Engineering



Best of Time

Designed a service to bring back the improve the browsing experience of photo albums

UI/UX, Product & Service Design

Worthy Mentions

Various class projects and photography works

Engineering / Design / Photography



SusProg3D Redesign

Redesigned the main interface of Susprog3D, a vehicle suspension analysis and design software

UI / UX Design

Gamification

Examined how gamification is linked to behavior change and how effective some techniques are

Individual Research Project

1



FORMULA SAE

Car Racing Competition

Design Challenge:

Leading the suspension team to design the suspension system for Leigh University Team's race car, namely **X48**, for the 2018 Formula SAE racing competition

Automotive Engineering
Team Project - Suspension Design Lead

/01. Analyzing X47

The X47 is our previous generation race car. It finished the 2017 Formula SAE competition at the 10th percentile. Analyzing the X47 is the first step for designing the X48.

Lacking Tire Performance

By analyzing the tire data and suspension geometry settings with Matlab and SusProg3D and comparing the results with our lap times and tire wear, we realized that we did not use the tires' full potential due to imperfect suspension geometry and actuation settings.

Under-tuned Vehicle Set-up

Due to the delay in manufacturing delivery, we lost a lot of time for testing and tuning. The X47 was severely under-tuned. This led to an unstable vehicle dynamics, which gave the driver a hard time.

Overweight Body

The X47 is the heaviest among similar non-aero cars. Over-engineered and under-optimized parts take most responsibilities.

Goals for X48

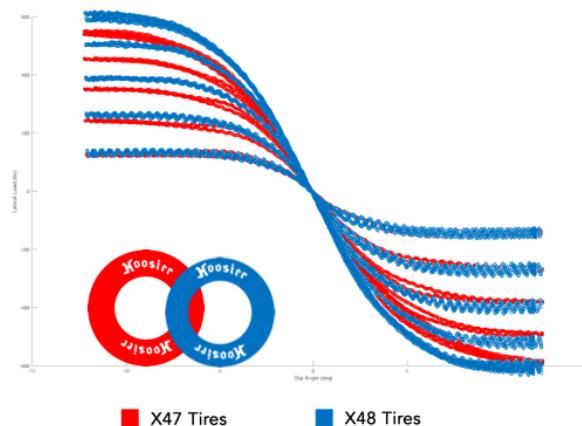
- Optimize geometry and actuation to fit tire characteristics
- Finish manufacturing the car early for testing and tuning
- Reduce weight by at least 10%

/02. Engineering & Designing X48

Grippier Tires

Visualizing tire data with Matlab

Lateral Force vs. Slip Angle at Different Vertical Load (10psi)

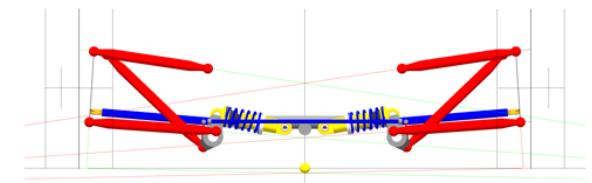


Hoosier, a performance tire manufacturer, released its new tires by the time we started designing the X48. By analyzing the data provided by them, we found that the new tires generate about 550lbf/deg of lateral force, 20lbf/deg more than the old ones.

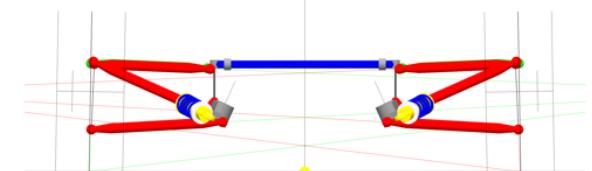
New tires were 16 inches in diameter, 2 inches smaller than the old ones. The smaller size cuts the weight down by 22% and increases tire stiffness by 4%. Less weight allows faster acceleration, and higher stiffness makes vehicle dynamics more sturdy.

Nimbler Vehicle Dynamics

Optimizing geometry & actuation with SusProg3D & SolidWorks



Front Geometry Front View



Rear Geometry Front View

We came up with 10+ geometry and actuation layout proposals with the help from SusProg3D and SolidWorks. The best one was picked based on:

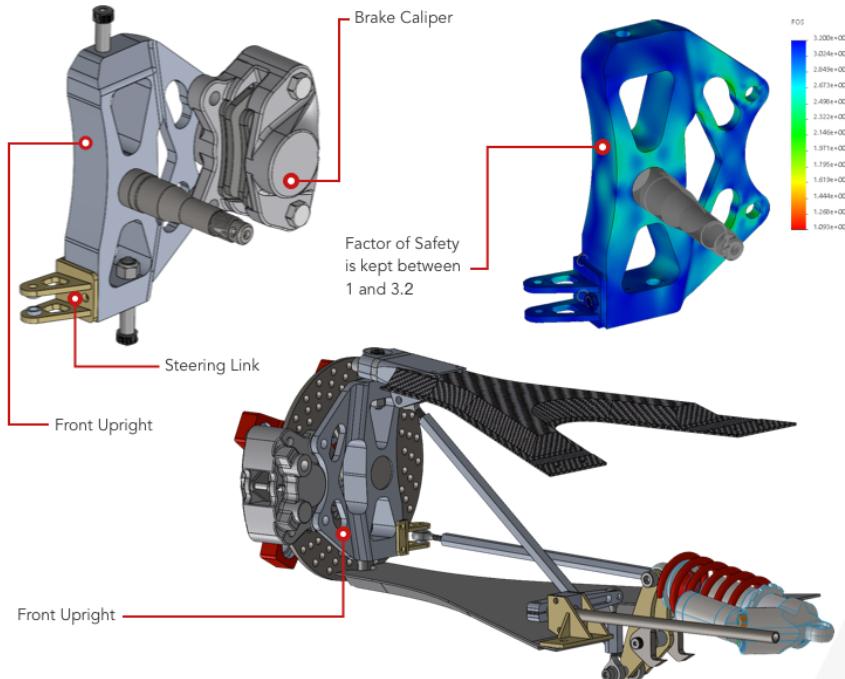
- Ground clearance (if any of the parts touches the ground in any condition)
- Parts clearance (if any of the parts touches other parts in any condition)
- Geometry characteristics (if the tires are put under the best condition at all time)
- Actuation efficiency (if we have used all the potentials of the springs and dampers)
- Accessibility (if we can change settings quickly enough)

Optimized geometry and actuation generate higher mechanical grip and stabler vehicle dynamics. The connection between the driver and the car is greatly enhanced.

/02. Engineering & Designing X48

Lighter Weight

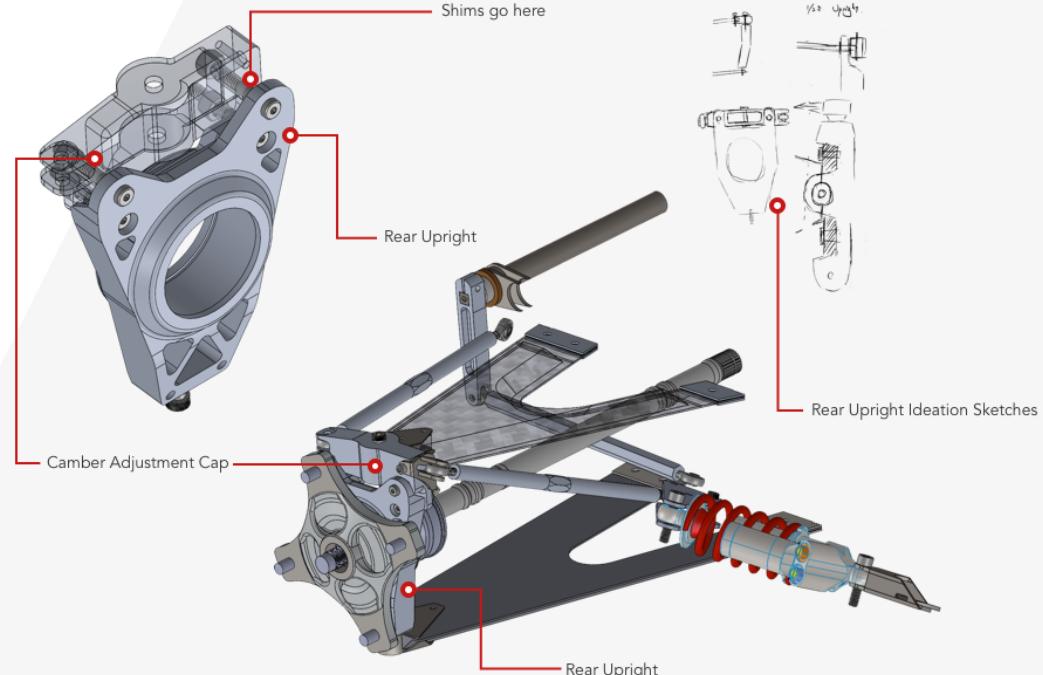
Taking out unnecessary material by finite element analysis



15% of the weight was cut down by redesigning the front and rear uprights. We did finite element analysis with SolidWorks to see the load distribution and cut out the areas not taking loads. To lower the material used as much as possible while keeping it from failing, the factor of safety was kept between 1.5 and 3.

More Flexible Adjustments

Adding camber adjustments by implementing shims



To exploit more potential out of the new tires, we decided to make rear camber adjustable, which means adding a camber adjustment mechanism to the rear upright. Two solutions, **eccentric bolts**, and **shims** were proposed. Although eccentric bolts allow quicker and continuously variable adjustment, it is harder to manufacture and more prone to failure. Shims, on the other hand, suit us better with its reliability and manufacturing easiness.

/03. Testing & Tuning

By delivering the car on schedule in March, we had a sufficient two-month period to test and tune our car before the competition starts.

First, we made sure every part on the car works and is reliable. Then, suspension settings were tested intensively to find the most optimized solution. Spring rates, damper parameters, anti-roll bar stiffnesses, camber angles, and many other parameters were tuned repeatedly for maximum grip and neutral-steering in corners, acceleration, and braking.

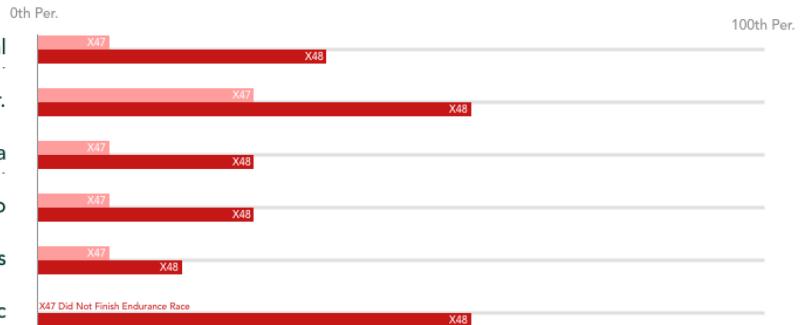
Together with better engine performance, we dropped about 0.8 sec in skidpad and about 3 sec in acceleration compared to the X47.

	X47	X48
Skidpad	6.24 s	5.60 s
Acceleration	8.14 s	5.34 s



/04. Racing

The weather on the racing day was unstable in Michigan International Speedway. Some teams ran on a dry circuit, and some, including us, ran on a wet one, or even in the rain. The rain caught us off-guard and started to pour when we were running skidpad. Missing the chance to switch to rain tires, our team finished the race in the worst condition. In terms of which, the finishing time differences between dry and wet conditions can create large gaps between teams. However, we finished the competition by improving our rankings in every aspect:



/05. Visioning for X49

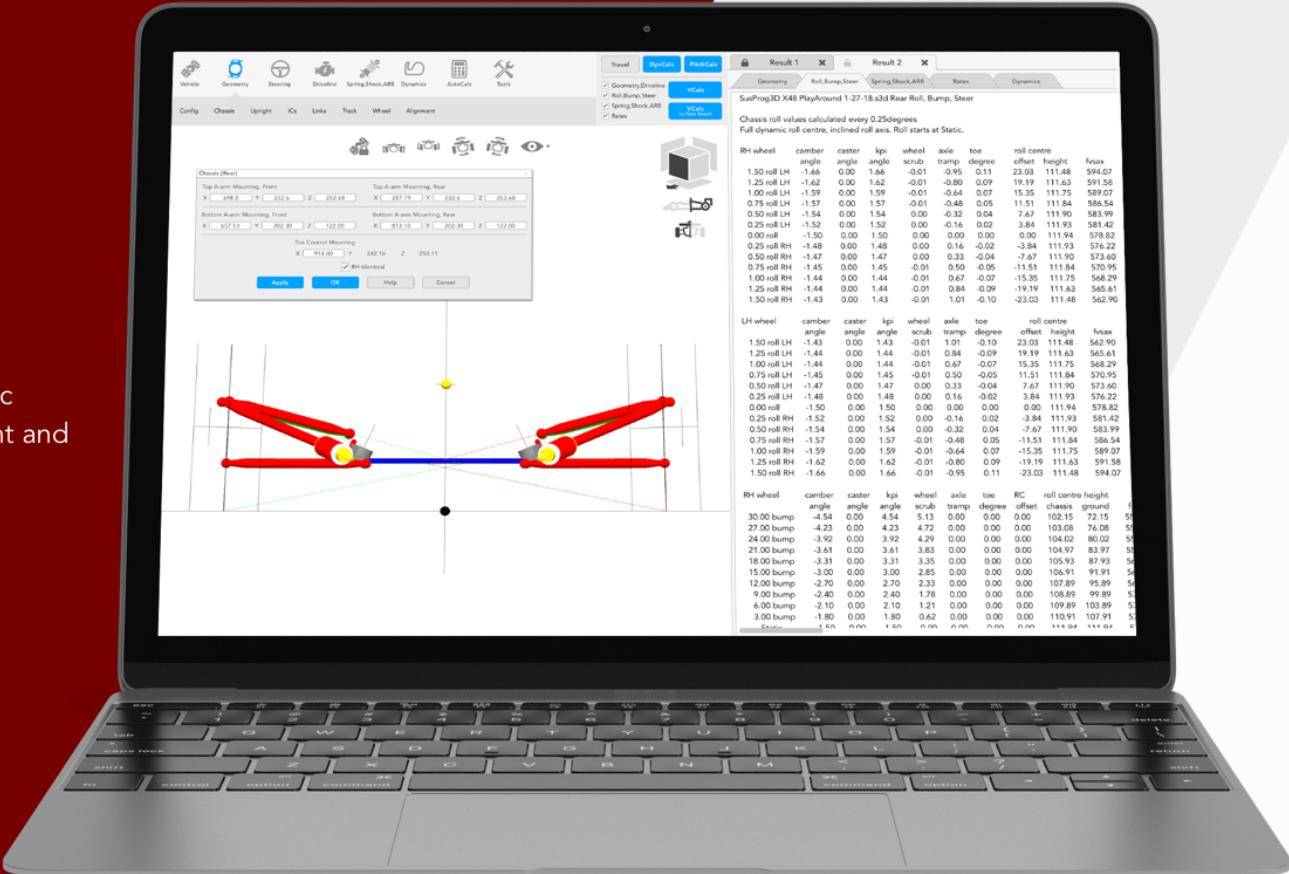
Immediately after the 2018 competition, another round of reviewing, brainstorming, troubleshooting, and problem-solving process began. By the time you read this, the X49 is probably already fully designed, manufactured, and is running in a parking lot of Lehigh University with the latest innovations.

SUSPROG3D ReDesign

Design Challenge:

Making the use of SusProg3D (a premier kinematic suspension design and analysis tool) more efficient and effortless for users by increasing the usability and readability of its main interface

UI / UX Design
Individual Project



/01. Research

Understanding SusProg3D

SusProg3D is a premier kinematic suspension design and analysis tool. It is very useful for designing Formula SAE suspension. However, I noticed many imperfections in usability while using it. To improve, I started with analyzing its interface:

The main interface can be divided into three parts:

1. Adjustment window

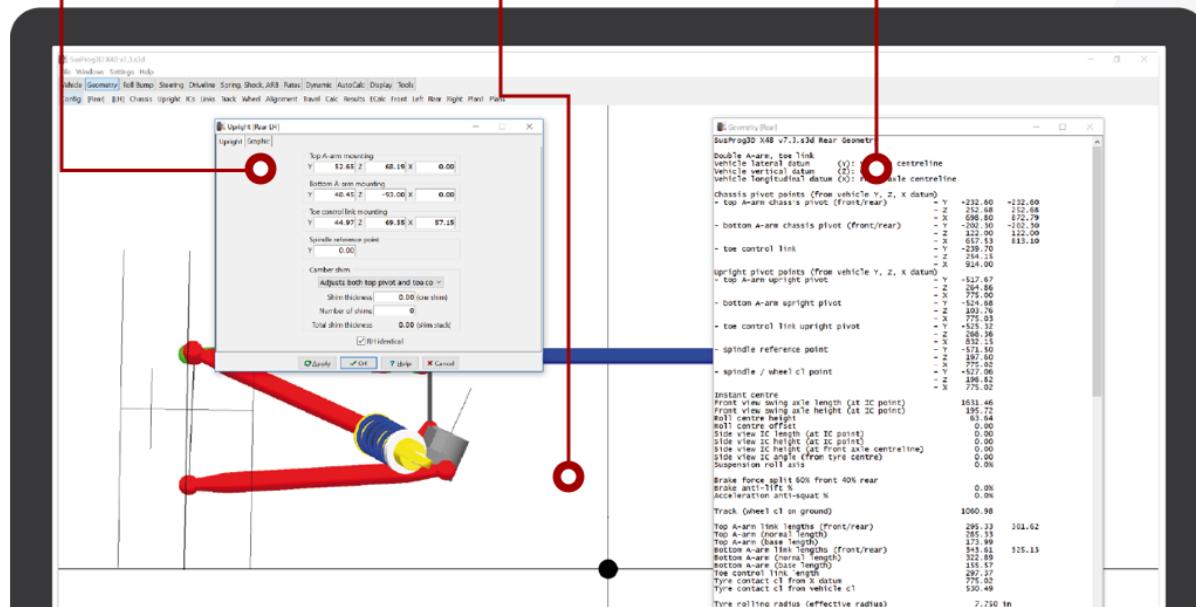
The Adjustment window is made up of vehicle configurations and settings, in which users can modify the parameters of the design. It contains various functionalities with a series of components that users can choose from.

2. Display window

Display window, as the main screen, visually showcases a simplified model.

3. Result window

Results window displays all numerical data of every possible vehicle condition.



Conducting User Research

To gather and validate users' pain points, I interviewed two Susprog3D users for their experiences and feedbacks with a list of questions. The pain points I collected have been listed in the sticky notes below:

Function	Display	result & readability	UI	comparison	learning time
a lot of options it fulfills basic functions dedicated to vehicle dynamics	display of suspension movement display is only useful for validation	Result is hard to read easy to make mistakes	tab layout: hard to move around frequently used functions are separated bad layout options lost trying to find initial setup options	take very long to find a function roll/bump is possible when put somewhere else have to copy/paste before/after	1 month to learn 1.5month to learn learn as going tab by reading help

Some Major complaints are:

"Readability is bad, especially in the Result window"

"Frequent switch between main menus to view diff. results"

"Comparison between results are difficult"

"Unintuitive interface makes it hard to learn"

"Some buttons' name do not match its contents"

...

Redesign Goals

Based on the research insights, I listed the following redesign goals:

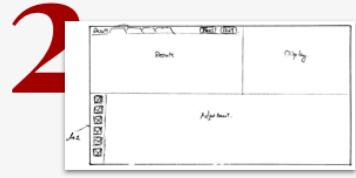
- Integrate Result window
- Optimize Result window format
- Eliminate mismatch between tab names and functions
- Reconstruct information architecture
- Downsize the area of Display window

/02. Ideation

Based on the research and the redesign goals, four different proposals were produced:



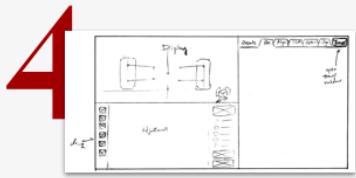
- ✓ - Showing all three windows without overlapping
 - Leaving enough space for each window
- ✓ - Using result tabs to show different results
- ✓ - Fixing calculation panel
- Allowing multiple adjustment windows open at the same time



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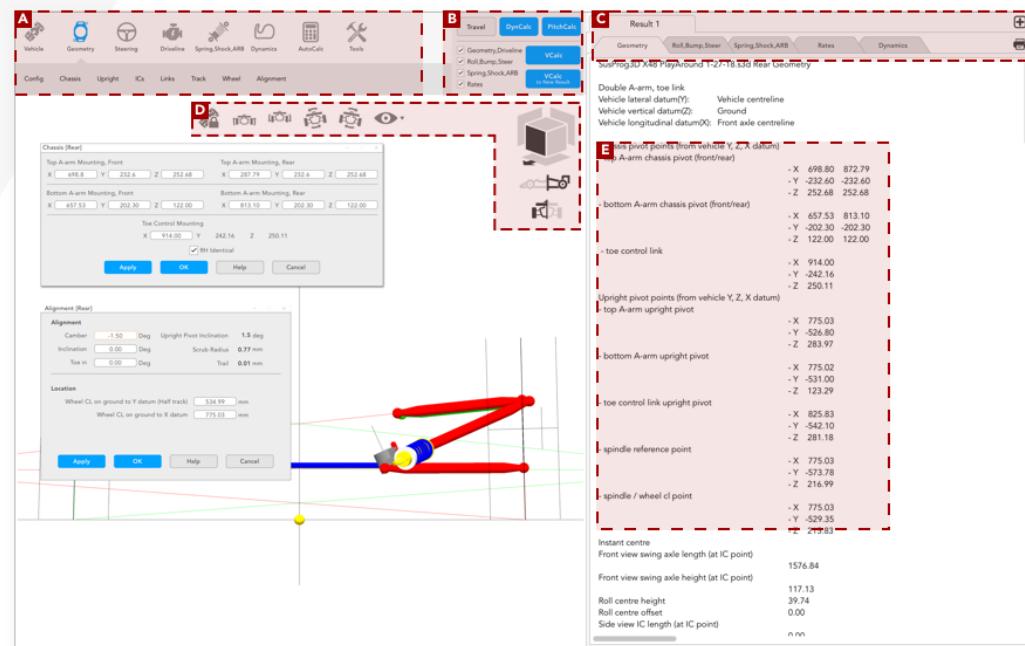
- Showing all three windows without overlapping
- ✓ - Leaving enough space for each window
- ✓ - Using result tabs to show different results
- ✓ - Fixing calculation panel
- ✓ - Allowing multiple adjustment windows open at the same time



- Showing all three windows without overlapping
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- ✓ - Fixing calculation panel
- Allowing multiple adjustment windows open at the same time

/03. Design

The redesigned interface is showcased below. It reduces cognitive affordance, while lowers the chance for operational errors.



A By creating icons and words and adding in arrows, the main navigation can be more self-explain.

B Fixing calculation window to a panel eliminates the risk of accidentally closing it.
“VCalc to new result” creates a new set of result automatically, which makes comparison much easier.

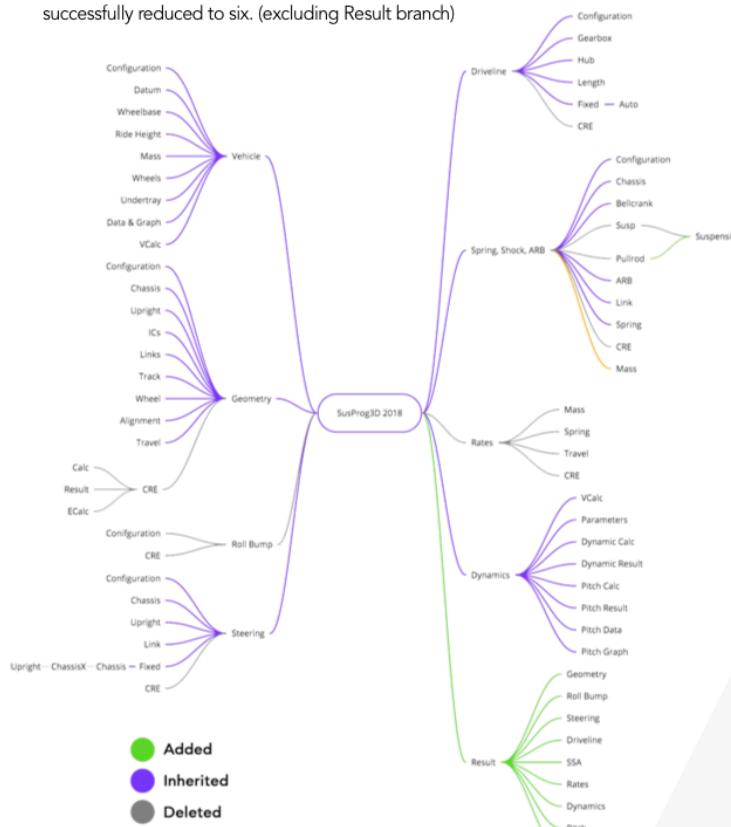
C Result tabs show before / after clearly and allow quick switches between different types of results.

D Display controls are moved to the Display window from the menus and are more intuitive with graphic icons.

E Reformatted result contents help avoid misreading by leaving space and following XYZ order.

/03. Design

With the solution, main navigation branches have been successfully reduced to six. (excluding Result branch)



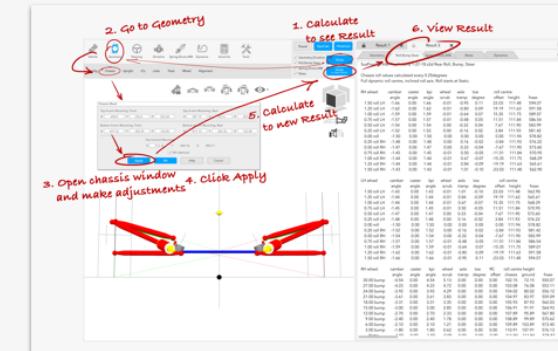
/04. Usability Test

Task

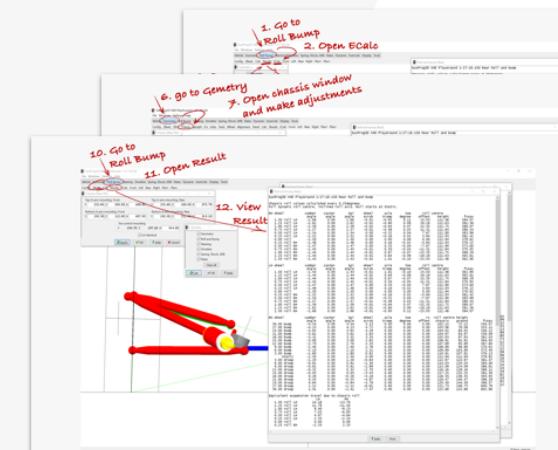
Using a set of paper prototypes of the redesigned interface, users were asked to move **front top A-arm chassis pick-up point** down by 200mm.

Findings:

Comparing with using the original susprog3D to complete the task in 12 steps, the users completed the task with the redesigned solution in 6 steps. The new design also presents users with well-differentiated results and a stable calculation panel that won't close accidentally.



User finished the task within 6 steps using redesigned SusProg (image above)



User finished the task with 12 steps using original SusProg (image above)

/05. Reflection

- Designing is a continuous and never-ending process. A design can never be perfect, only better than the existing one. In the design process, new ideas keep emerging, and old designs are constantly overthrown. You can never understand too much about your users.
- It is important to define the problem before starting the design.
- To avoid coming up with new ideas at the very end of the design process, designers should frequently go over user flow from the start to the end during the whole design process. Because as designers, we know what will happen, but users don't.

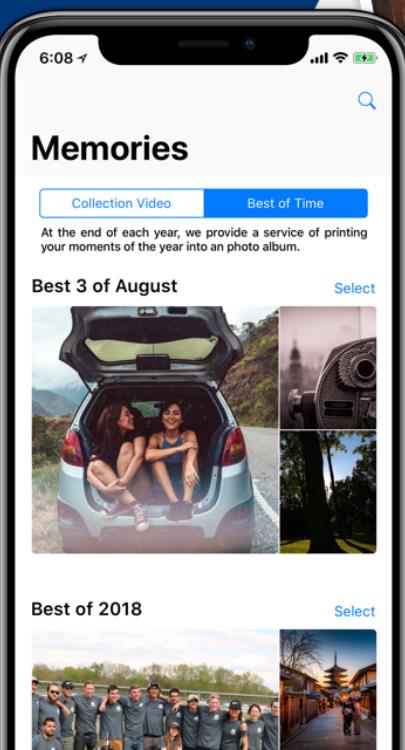
BEST OF TIME

A New Way to Cherish Photo Memories

Design Challenge:

Enhancing the photos browsing experience by better leveraging the capability and usability of mobile phone image asset and printed photo albums

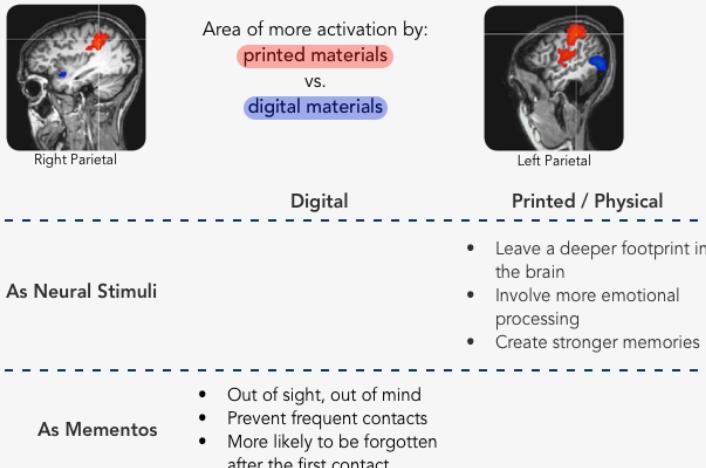
*Product & Service Design
Individual Project*



/01. Photo Browsing Experience

About ten years ago, most families had at least one physical photo album, and looking through the albums is one of the most emotional moments. But today, digital photography has delivered clusters of worthless photos left to be forgotten. This shift from physical to digital platform triggers me to explore the difference in browsing experience between digital and physical albums.

Digital Photos vs. Printed / Physical Photos



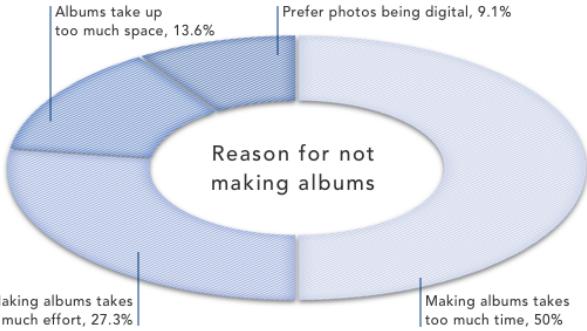
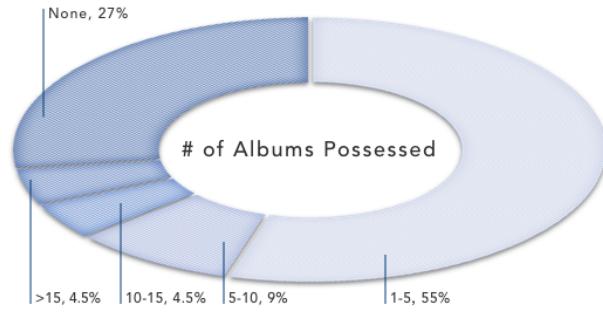
Design Opportunities

Based on the literature review above, we can conclude that:

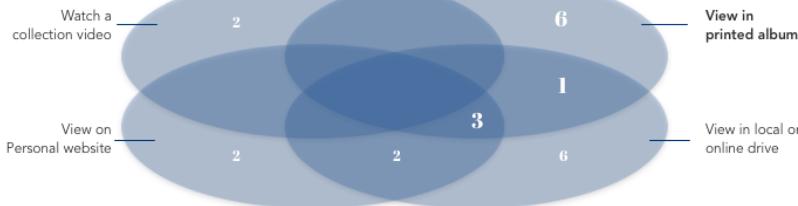
1 Combining the characteristics of printed materials and physical platform, printed albums create better emotional connections between users and their precious memories.

Survey on Millennials

Millennials are a special generation because they grew up with the evolution of digitalization, which makes them embracing the digital world while preserving some characteristics from the old fashion. It is interesting to know when and why they take photos, where they store their photos, and how they share their photos with their families and friends.



Ideal way(s) to View Photos



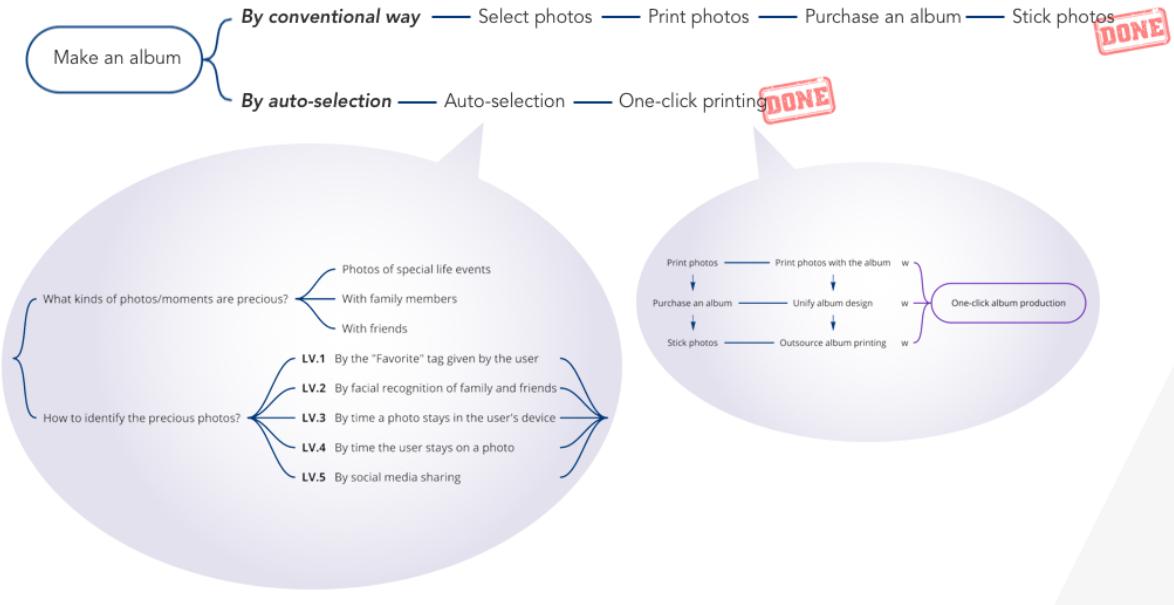
Design Opportunities

Based on the survey, we can conclude that:

2 As one of the best ways to recall memories, printed albums are still in demand. To bring them back, an effortless production process has to be developed.

/02. Bridging Printed Albums and Digital Photos

As most photos are stored in our mobile devices nowadays, the easiest way to produce albums is to link our devices directly to the printing mill. The following diagram addresses my solution:

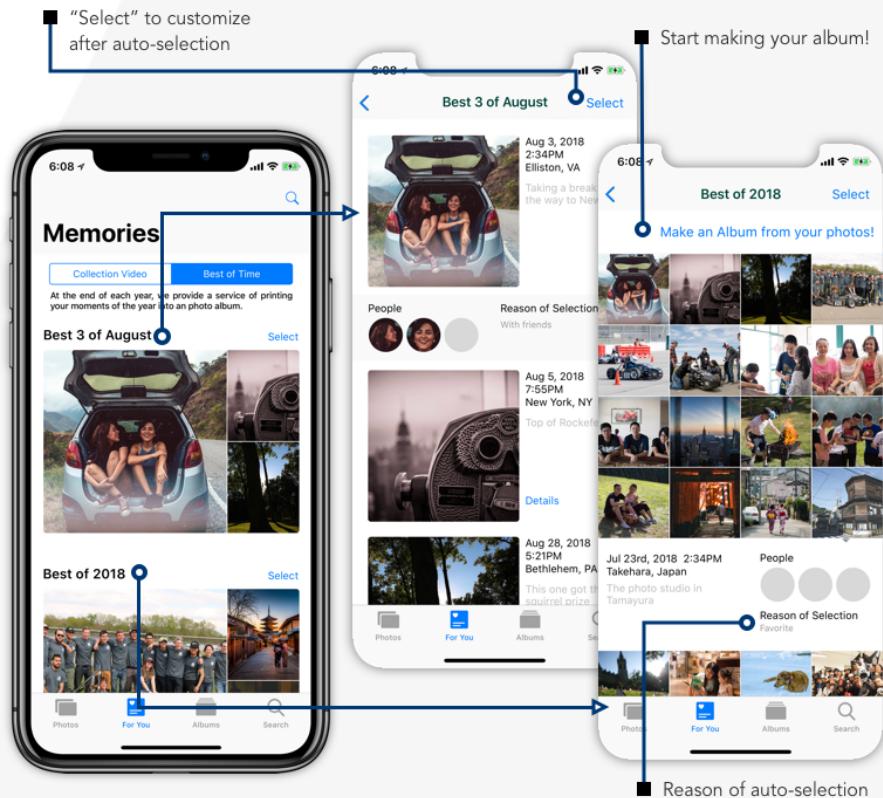


As we can see, through auto-selection and one-click printing service, a four-step photo album production process is reduced to a two-step process.

Each month, the user's mobile device auto-selects three most precious photos based on a list of metrics. The auto-selection process follows the 5-level weighing system. Photos fulfilling higher level requirements have a better chance to be chosen as the best three. By the end of the year, the device gathers all the photos, and ask the user if he or she wants to make an album. Of course, the user is allowed to customize photo selection.

Best of Time

I named the service "Best of Time" because it gathers all the best moments in our lives, and it builds up through time. The more time passes, the more valuable the moments get.

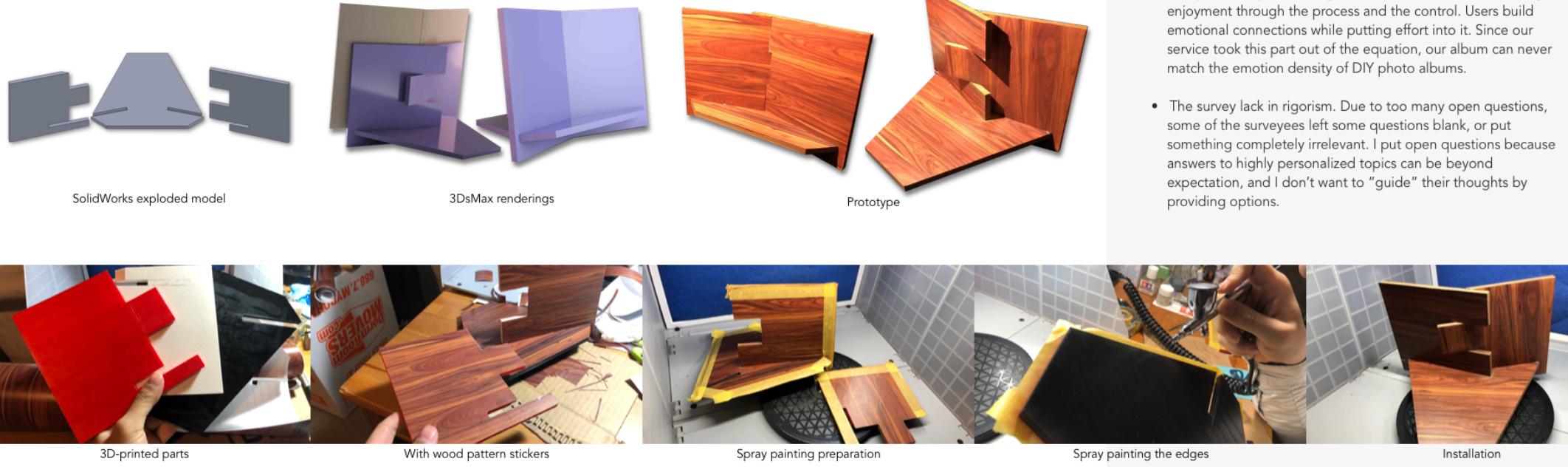


/03. Memories Showcase

Having printed photos collected in an album does not solve the “out of sight, out of mind” problem, as albums are usually put away from people’s eyesight, for example, deep inside a bookshelf or closet somewhere at home.

But I have a solution: An album stand.

An album on a stand combines the pros of albums and photo frames while avoiding their cons. Photo frames showcase photos, but only one at a time, and users tend not to change the photos in it. Albums contain many photos but provide much less exposure. Album on a stand contains many photos and prompts users to interact by flipping through pages. Frequently flipping and looking through the photos helps to consolidate the precious memories.



/04. Design Critique

- A while after finishing this project, I was told that Google Photos and Apple both have the service of printing photos and making albums. However, I think my project possesses some uniqueness by automatically selecting worthy photos. This proved that the direction I am going converges with the pioneers in the industry.
- Don’t make users think. By integrating the service into IOS Photos app instead of designing an entirely new app, we drastically lowered the required effort of learning to use this service.
- Many efficiency-enhancing solutions come at a cost of losing enjoyment through the process and the control. Users build emotional connections while putting effort into it. Since our service took this part out of the equation, our album can never match the emotion density of DIY photo albums.
- The survey lack in rigorism. Due to too many open questions, some of the surveyees left some questions blank, or put something completely irrelevant. I put open questions because answers to highly personalized topics can be beyond expectation, and I don’t want to “guide” their thoughts by providing options.



IS GAMIFICATION A PANACEA?

Study of effectiveness of gamification in mobile apps on behavior change

Research Focus:

Does gamification certainly relieve the pain of forming a habit? How does it help mobile apps change users' behavior?

*Research Project
Individual Project*

/01. Gamified Experience

To understand how gamification works, we need to first understand its origin: games. Based on Mark Prensky's book, *Digital Game-Based Learning*, there are six essential components that make a game:



If these components are put into a non-game activity to keep high engagement of users, we call it a gamified experience. In the digital environment specifically, Brian Cugelman provides a list of commonly used gamification techniques: *



Now we have linked gamification techniques to game components, then how do gamification techniques in mobile apps help change users' behaviors by always engaging them?

/02. Mobile Apps: From Gamification to Behavior Change

Most behavior change studies refer to the Behavior Change Taxonomy (BCT) as the most inclusive system concerning changing behaviors. The BCT organizes a list of 93 different approaches within 12 categories. Theoretically, if a gamification technique in any application can be linked to a behavior change approach, the technique should be able to change one's behavior with the least resistance. I closely examined each of the BCT approaches, and linked the closely related ones to the gamification techniques listed before:



Two of the techniques are particularly interesting: "**Giving Rewards**" and "**Telling Stories**".

Giving Rewards

60% of the gamification techniques are a form of "Feedbacks and Outcomes", and "Giving Reward" links to four different behavior change approaches. Seeing this technique being used in multiple platforms and apps, I wonder how effective this technique actually is.

Telling Stories

Human brain prefers to absorb information from a narrative form. Stories can create curiosity and loyalty and hence. I wonder how the story plays its role in a gamified mobile app and how it influences users' behavior.

To further understand the functionality of **giving rewards** and **telling stories**, I set up an experiment testing how different types of apps utilizing these techniques can have varied impacts on helping users form behavior changes.

/03. Experiment on Gamification Apps

To test the effectiveness of giving rewards and telling stories separately, I invited four participants to try out two groups of apps. After four weeks of adoption, I held a focus group to discuss about their experiences using the apps and preferences among the two if they have to choose one of them to build a habit.

Giving Rewards



Pocket Expense
Personal finance
Non-gamified

Pocket Expense has all range of expense record and tracking functionalities without any gamified element.



Fortune City
Personal finance
Rewarding

Fortune City gamifies bookkeeping with a fun city simulation game. It represented expenses by a virtual city. The richer the record is, the better the city grows.

Participants' Comments

"Intuitive"
"Takes little effort to navigate"
"Fully fulfills the need of book keeping"

"Good-looking animation"
"Creative"
"Takes too much time to learn"
"I don't know what the rewards are for"



3/4

Preference
Choice

1/4

FORUNE

Telling Stories



Pedometer
Pedometer
Rewarding

Pedometer keeps a record of the distance and steps, and reward users with a goal-and-badge system.



WalkUp
Pedometer
Rewarding
+ Storytelling

In WALKUP, user's walking distance is added up to a virtual world tour. The more the user walk, the more cities they visit, and the more scene they see.

Participants' Comments

"Simple"
"Health is better than this"
"What are these badges for?"
"Fun in the beginning"
"Pop Events' are dull and cliched"
"Unattractive goals"
"Better if there is competition"
"I don't feel motivated"



0/4

Preference
Choice

4/4



/04. Conclusions

- Individual element of gamification, when standing alone, does not apply to all circumstances, and it does not guarantee a more interesting and attractive experience.
- When the game content and the purpose of gamified experience diverge, giving rewards may tend to have less or no effect. Designers and developers should reward the consequence of the behavior, not that of the game.
- Telling stories in a gamified context can motivate users better than giving rewards. However, it does not guarantee long-term user engagement.
- Although the visual design of Walkup is outstanding, the lack of intriguing content and social attributes makes it a diamond in the rough.
- For future application designs, we should examine the usage scenario before applying gamification techniques.

/05. Discussion

- Third variables in the experiment include visual design, difference in game mechanisms, and content of the app. Thus, it is impossible for us to scope down on a definitive conclusion.
- I only
- More participants would be better if we want to draw a more reliable result.
- The participants are from similar demographic backgrounds, so the result may not apply to other groups.

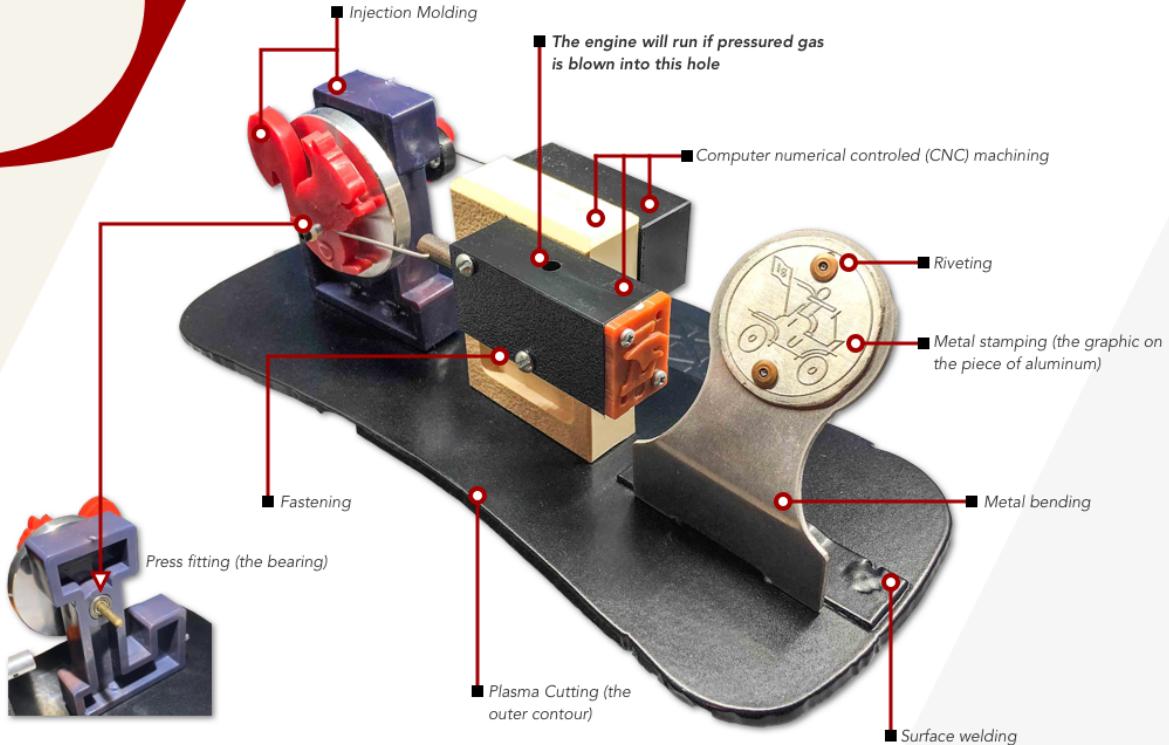
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WORTHY MENTIONS

Air Engine

I manufactured an air engine with 9 different manufacturing method. The engine runs when pressured gas is blown into the hole on the piston block.

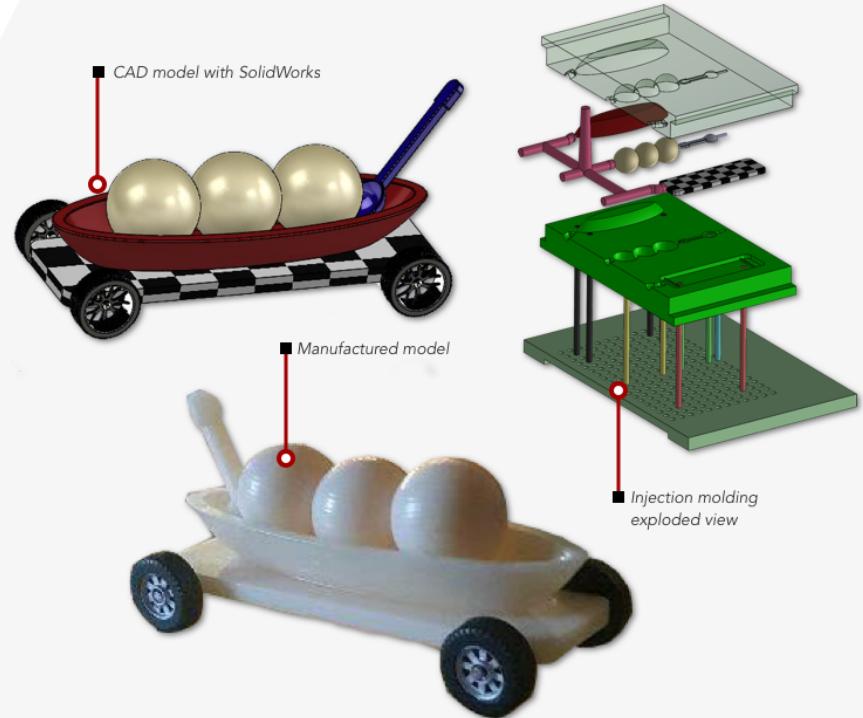
Manufacturing Class Project - Individual Project



Sundae Express

We modeled and injection molded a plastic (ABS) toy car based on a middle school student's design. It is a sundae cup with three ice-cream balls. I was responsible for modeling the design with SolidWorks and testing molten plastic flow with NX.

Manufacturing Class Team Project



WORTHY MENTIONS

One-piece Chair

We were challenged to make a chair from a 29"x47"x1/2" plywood board. I produced a number of design sketches including the final design and assembled the laser-cut parts.

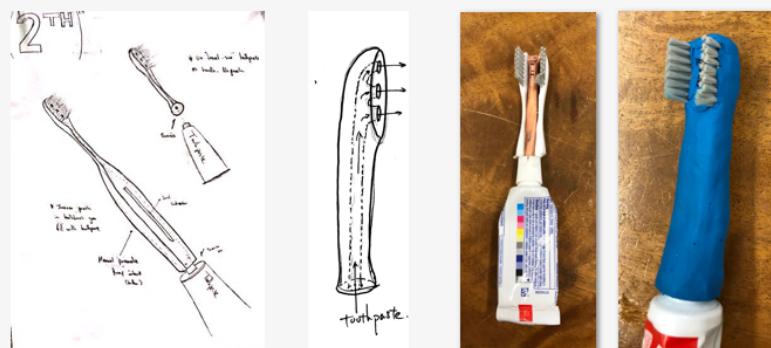
Product Design Class Team Project



The 2th

We were challenged to design a toothbrush that can speed up the washing up process.

Product Design Class Team Project - Concept Design and Prototype



Photography



T H A N K Y O U

TIANCHENG YANG
P O R T F O L I O