



**Empowering Autism Creativity**

## **Final Project Report**

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The City College  
of New York



Cultivating Resources  
for Employment with  
Assistive TEchnology



**Goodwill  
NYNJ**

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## **Abstract**

Autism Spectrum Disorder (ASD) refers to a variety of neuro-developmental disorders. Some of these disorders can affect a person's ability to communicate, socialize, behave, and develop. They may be faced with challenges in social skills, repetitive behaviors, and verbal or nonverbal communication. People with autism are often visual thinkers, and art can help those with autism express themselves through a soothing activity. However, there are not many applications developed for people with ASD. We at Nusketch aim to develop an application where people with ASD can improve through art therapy and close the gap for job inclusivity. Our solution allows users to experience artistic and communicative growth by taking pictures of the real world and converting it into a traceable sketch, which can then be colored. This allows for endless creativity for users to help express themselves. Additionally, our application allows users to create visual cards of objects and concepts; people with ASD can use them to communicate and provide structure and routine in their lives. Through this we are able to allow companies to create visuals on how to do certain tasks which helps with inclusivity in job training. People with ASD are often visual learners and we want to create a platform that will help them with wellness.

## Background

There has been an increase in children diagnosed with ASD over the span of 18 years [7]. In 2000, 1 in 150 eight-year-old children were diagnosed with ASD, as compared to 2018 data which shows 1 in 44 eight-year-old children were diagnosed. ASD is a developmental disability caused by differences in the functioning of the brain. People with ASD often have problems with social communication and interaction, restricted or repetitive behaviors and or interests. People with ASD may also have different ways of learning, moving, or paying attention [1]. While not every autistic person is a visual learner, they are common among the autistic population. Studies show that around 17% of autistic children have special artistic abilities including drawing and music [9]. Art therapy has the ability to promote emotional and mental growth. Visual arts can assist in the improvement of cognition, visual and spatial discrepancies, fine motor skills, and coping [2]. Despite rapid growth in technology, there are not many applications developed for people with ASD and not all companies include job inclusivity training. A survey of 500 companies showed that 79% of employers perceived the amount of work to train to be greater than that for non-disabled coworkers [19].

The developmental approach teaches them in improving life skills while they develop, this is provided to the people with ASD that are participants at Goodwill NYNJ. From the observed activities in our site visit to Goodwill, they had art and Zumba, where Zumba would be part of the physical therapy. Studies show that when provided with this form of treatment earlier the parents noticed higher language, social, and learning skills in their children [12]. The educational approach is what is applied in classrooms where public schools would have teachers for special needs. People with ASD can have trouble communicating, and visual aids can help them express their thoughts more clearly.

A group survey conducted at Goodwill showed that people with autism enjoyed entertaining themselves with drawing and coloring during their free time. Coloring apps like Colorscape [10] provide the same features as what we propose. *Colorscape* allows users to take already taken photos and convert them into coloring pages, and convert the pages into PDF format. The app also provides a slider for detail/noise, converting images to pencil art that could be colored.

## **Problem Statement**

With how fast diagnosis of ASD increased, there is more of a need to provide applications that aid them and provide them with accommodations [12]. With Nusketch we aim to facilitate visual learning for both autistic people as well as their employers, by using image processing to create visual aids and sketches.

Two examples of this type of application, *Colorscape* and *Happy Color* provide an outlet for creativity for their respective audiences. Colorscape's main goal is to convert images that are already taken into sketches and then exported as PDF files (Fig. 1). However, this application is not available on Android. Studies show that around 71% of the population uses Android as their operating system compared to around 27% of people using iOS [13]. *Happy Color*, on the other hand, allows users to fill in the pre-labeled colors given on the template (Fig. 2). They are allowed to color within the app but are not allowed to convert pictures or export the images as PDF files. There is a lack of applications that allow users to have a higher degree of customization. With Nusketch users can have the best of both worlds, they are allowed to color more personal and more relatable images in their daily lives compared to a preset template, and

are not restricted to a pre-labeled box either. This design idea supports a greater degree of creative freedom.

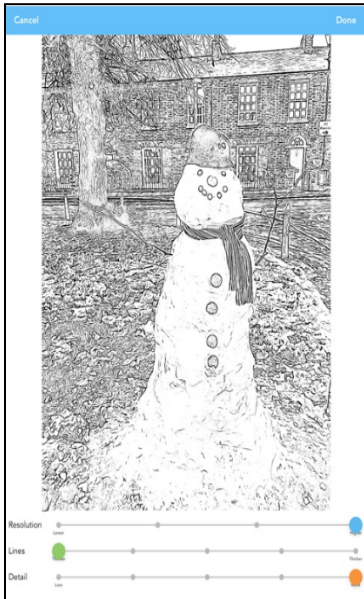


Fig. 1. Colorscape example [11]

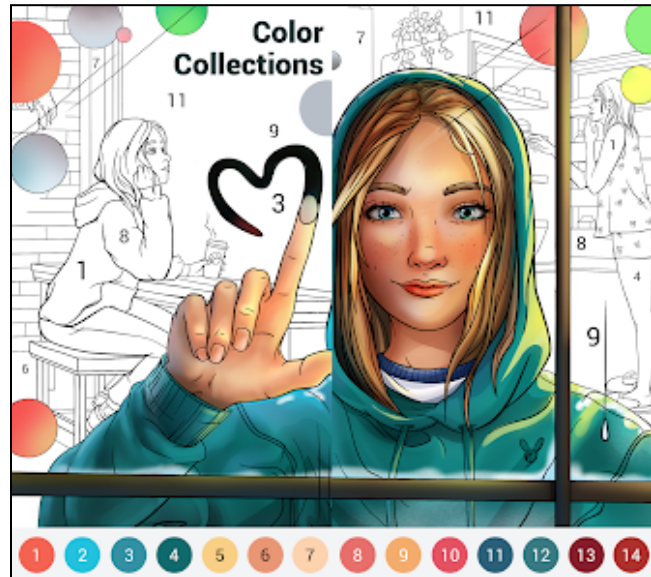


Fig. 2. Happy Color example [11]

## Rationale

With Nusketch the possibilities of art are endless as users are allowed to capture anything and turn it into a sketch or visual. This can improve a user's artistic abilities and also allow users to go out and interact with the environment. Users can have a high degree of freedom in terms of the subject and coloring, all on a mobile device. With these features, Nusketch aims to inspire people with ASD to become their most creative selves. Art therapy is founded on the principle that expressing yourself through the creative process can provide therapeutic value to anyone seeking a deeper understanding of themselves and their environment [4]. This will then translate into the workplace where they are able to apply these deeper understandings. Art therapy can help people with ASD explore their emotions, manage behaviors, develop self-awareness, and improve social skills [2]. It can help with the improvement of cognition such as learning,

attention, motivation, and intelligence. It can improve fine motor skills because the muscles in the fingers, hands, and wrists are exercised and strengthened [5]. People with ASD may have visual and spatial discrepancies and art therapy can help improve the ability to render/model in both two and three-dimensional spaces [6]. Art therapy also provides a coping mechanism for relieving stress, anxiety, and depression.

In Nusketch, users are able to build portfolios to showcase their artwork and their own visual aids. Users need to include descriptions of their artwork. This allows the user to think of descriptive language and improves written communication skills. This allows them to build and express themselves which improves employability and expression. This way, users can improve their written communication skills and can show employers that the user can clearly state what they are thinking and want to convey.

Along with creating sketches, Nusketch lets users create their own visual cards. Visual cards for adults are difficult to find compared to children's cards (figure 3). Nusketch allows people with ASD to create their own personalized visuals with either something they find online or a picture they take. It is also something that is more personal and may be more effective at self teaching.

Nusketch's inclusion of visual card creation provides a practical solution for companies to build task-specific portfolios. This feature plays a crucial role in bridging the gap between companies, where 79% of them acknowledge a discrepancy in the training and supervision received by workers with learning disabilities compared to their non-disabled colleagues.

Nusketch, with its unique features, not only allows for creating visual cards but also has the potential to support art therapy and inclusive job training. Through Nusketch, individuals can engage in art therapy, a practice known for its positive impact on mental well-being and

self-expression. Additionally, the platform's focus on creating task-oriented visual portfolios can contribute to inclusive job training by providing a user-friendly and accessible medium for individuals with diverse learning abilities to learn and showcase their skills effectively. Nusketch brings together the worlds of art therapy and inclusive job training, offering opportunities for personal growth, empowerment, and inclusive professional development.

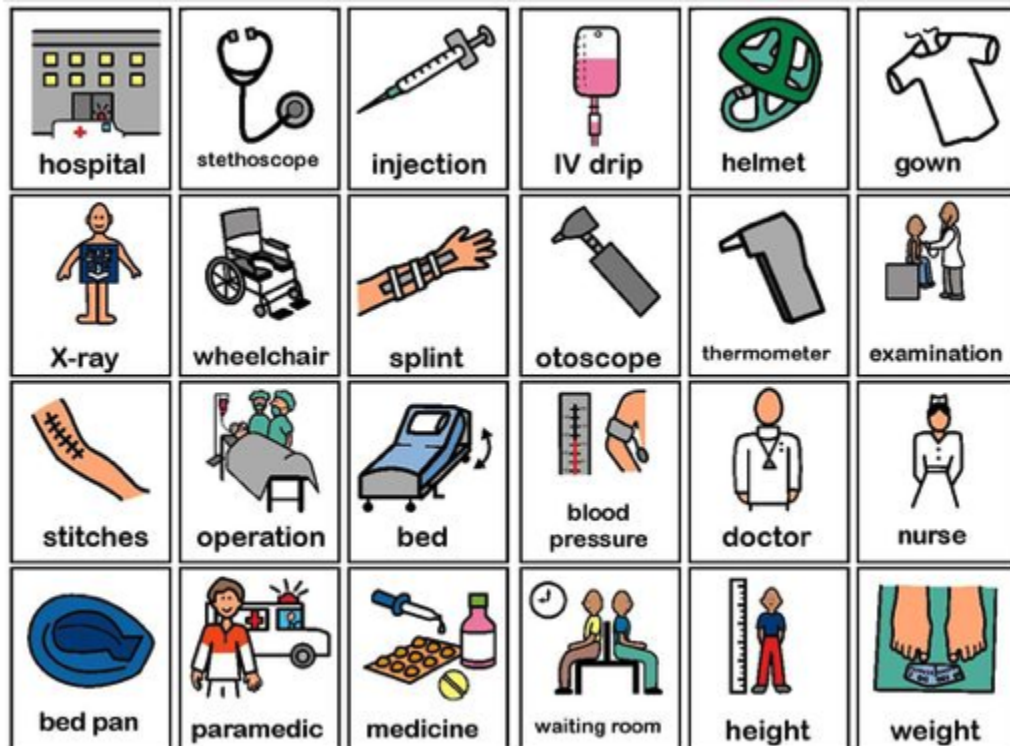


Fig. 3. Children's Visual Cards Example [18]



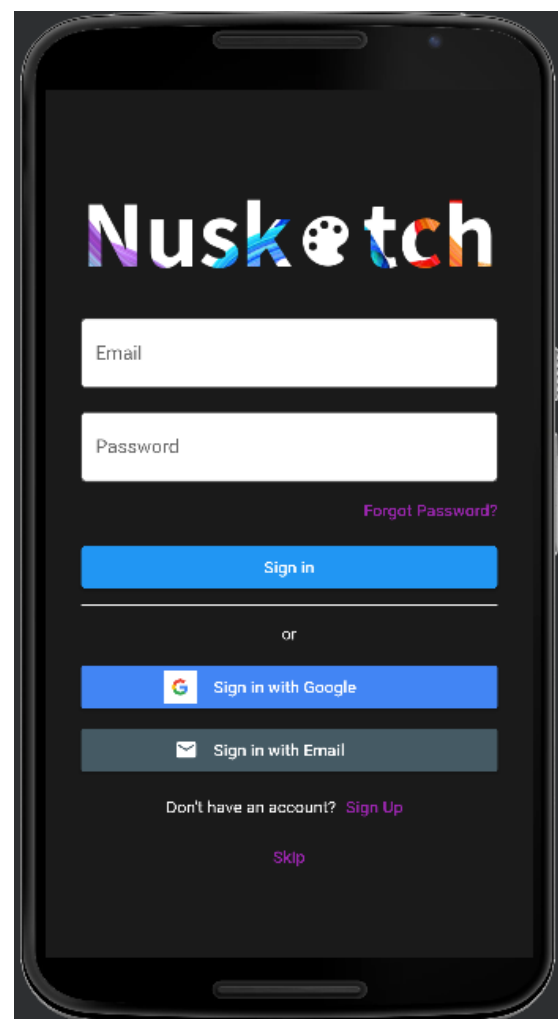
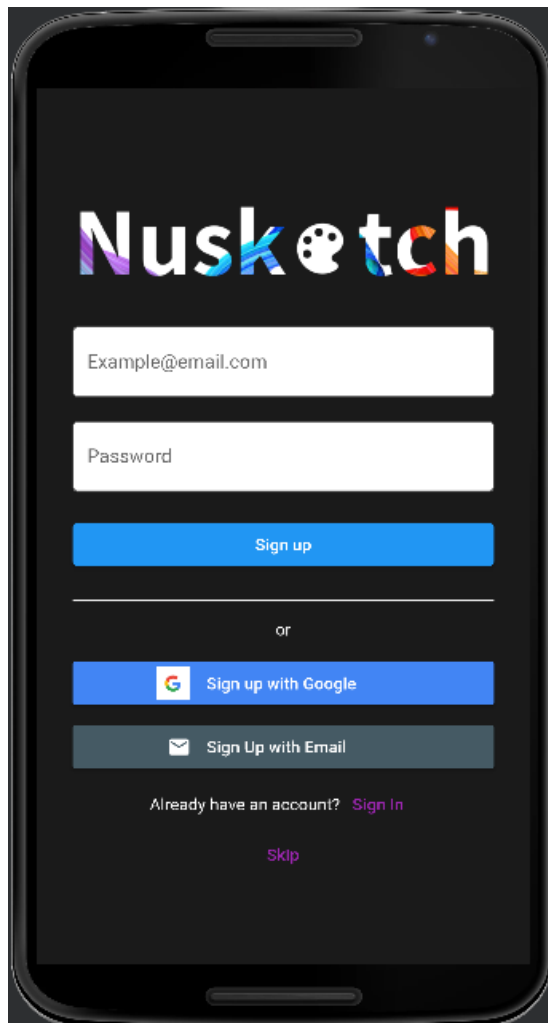
## Design & Development

The main technical design element is image processing. Two key image processing methods are needed for this kind of design, contour extraction, and texture rendering. There are different solutions for this problem utilizing different techniques and algorithms to generate pencil sketches from an image. Some focus on rendering individual pencil strokes, aiming to show the hand-drawing process. Others put a greater focus on contour detection to generate the basic outlines in an image. And some utilize machine learning and artificial intelligence techniques to make corrections in the contouring process depending on the image.

Nusketch is a cross-platform application, meaning when deployed it would be available for both iOS and Android Devices, phones or tablets alike. We used an open-source Google framework and programming language: Flutter and Dart to develop this project. This allows us to write one codebase and it would compile to native code for each individual platform. We also used another Google software, Firebase. Which is a cloud-based backend as a service which gives us the ability to store user data such as login information for user authentication and also sharing of sketches among users within the application itself. Finally, we used OpenCV, which stands for Open Computer Vision. It is a free library for image processing and computer vision which allows us to use functions to turn images into sketches.

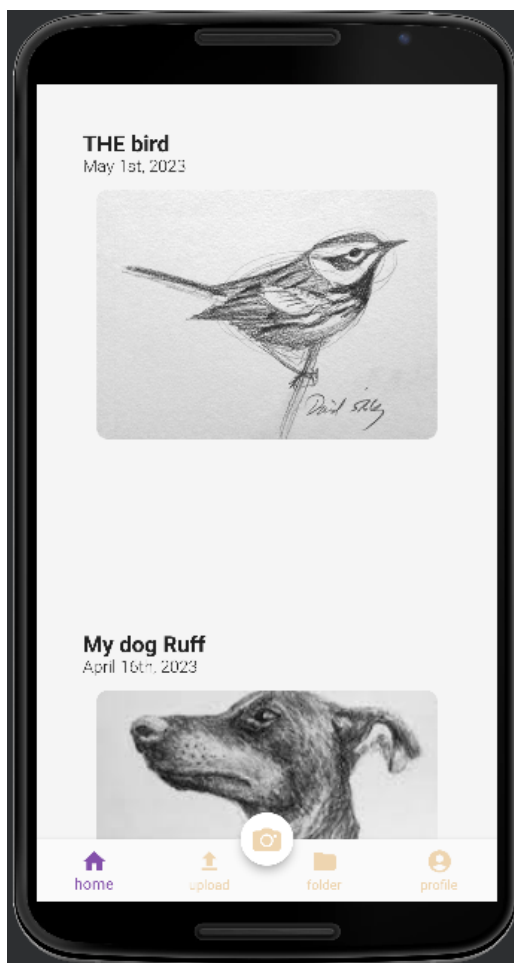
## Login/Signup Pages

To facilitate the sharing of portfolios, users or companies are required to create an account. This ensures a secure and controlled environment where individuals and organizations can manage and share their portfolios effectively. By creating an account, users gain the necessary credentials and permissions to securely upload and share their portfolios with intended recipients or target audiences. This account-based system enhances privacy, accountability, and provides a framework for portfolio sharing.

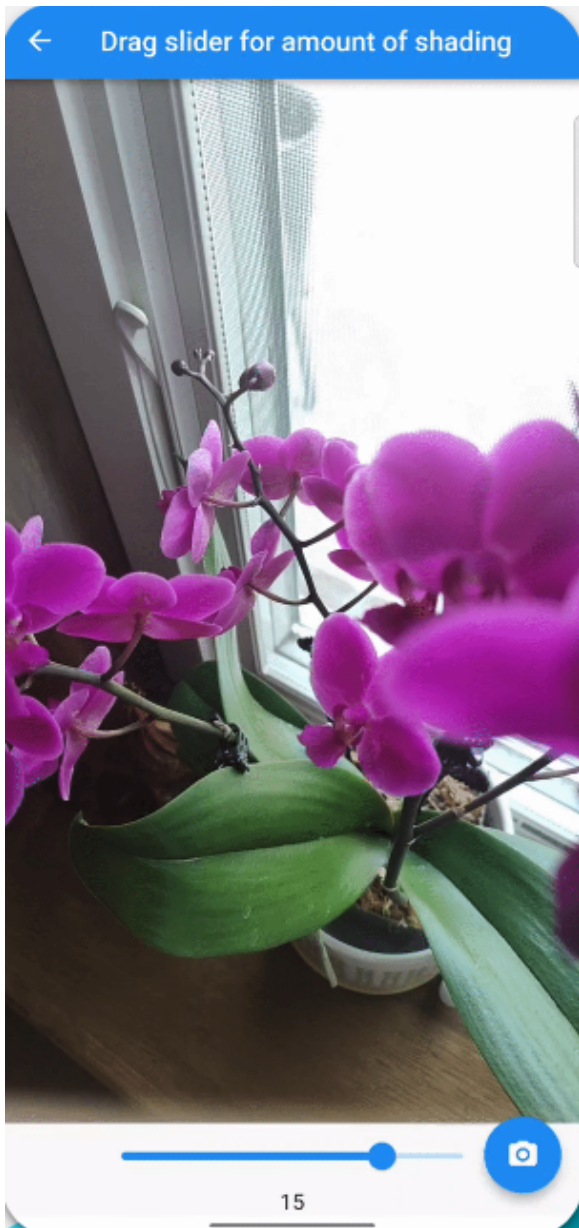


## Home Page

The home page displays sketches and tasks contributed by both friends and the user, which has a familiar layout of platforms like Instagram. Upon selecting a specific image, users are directed to a dedicated description page, offering comprehensive details such as the image's title, date of creation, and an accompanying description.



## Camera / Conversion Page

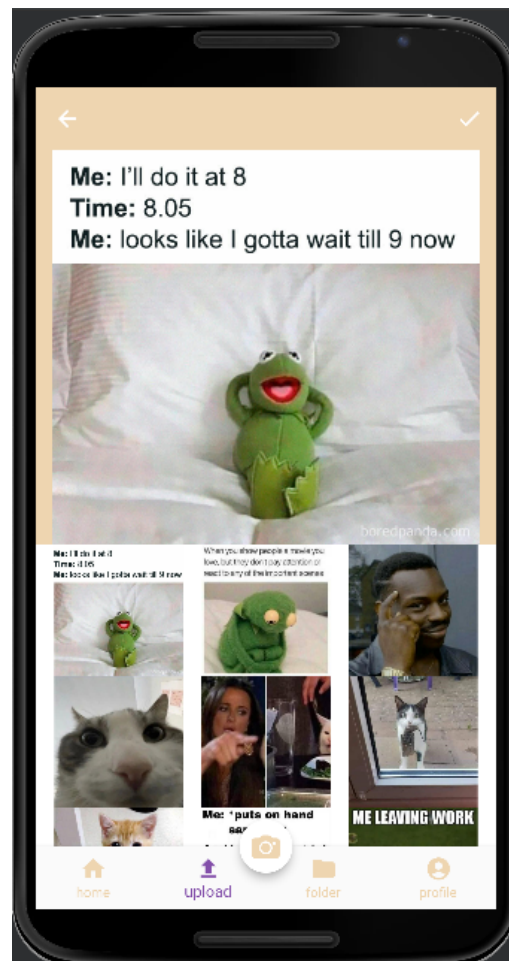


The camera page is the essence of this project, the camera icon is the largest and most pronounced in the bottom navigation bar for a reason, it is the page where we make conversions happen. This page accesses a device's camera, be it tablet or smartphone, and lets the user snap a

photo like any other camera. It also gives the user a slider they are able to drag to control the amount of detail in the resulting sketch. Once the camera button is pressed, the picture will be snapped and then be converted into a black and white sketch. The user can then do a number of things from here, such as adding text, coloring, printing, etc.

## Upload Page

The upload page streamlines the process of uploading pre-existing pictures, enabling users to effortlessly convert them into sketches and apply colors of their choice. This functionality is useful for companies, as they can easily upload images of tasks. Trainees can then engage in a hands-on learning experience by coloring these tasks, promoting active participation and knowledge absorption. The user-friendly interface of the upload page ensures a smooth and intuitive experience for all users.



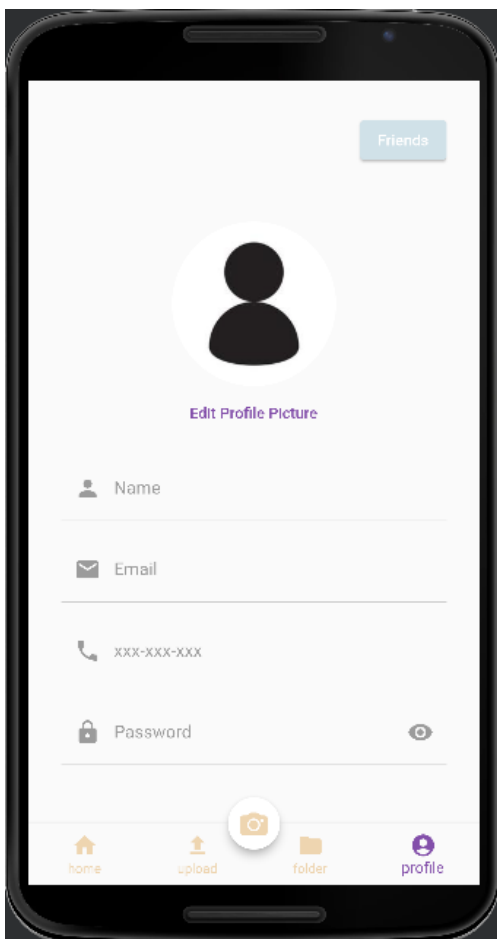
## Portfolio Page

The portfolio page provides a user-friendly interface with the ability to create and rename folders. Users can organize their content effectively by grouping related items together. This feature serves as a valuable resource, especially for companies aiming to provide visual learning materials to neurodivergent trainees. Additionally, it serves as a convenient collection for artists to showcase their artwork. By simply clicking on a folder, users can easily access and explore its contents.



## Profile Page

The profile page boasts a sleek and minimalist user interface, proficiently presenting vital user information including name, email, number, and password. Augmenting this refined design, a strategically positioned "Friends" button provides seamless access to the user's social connections and acquaintances.



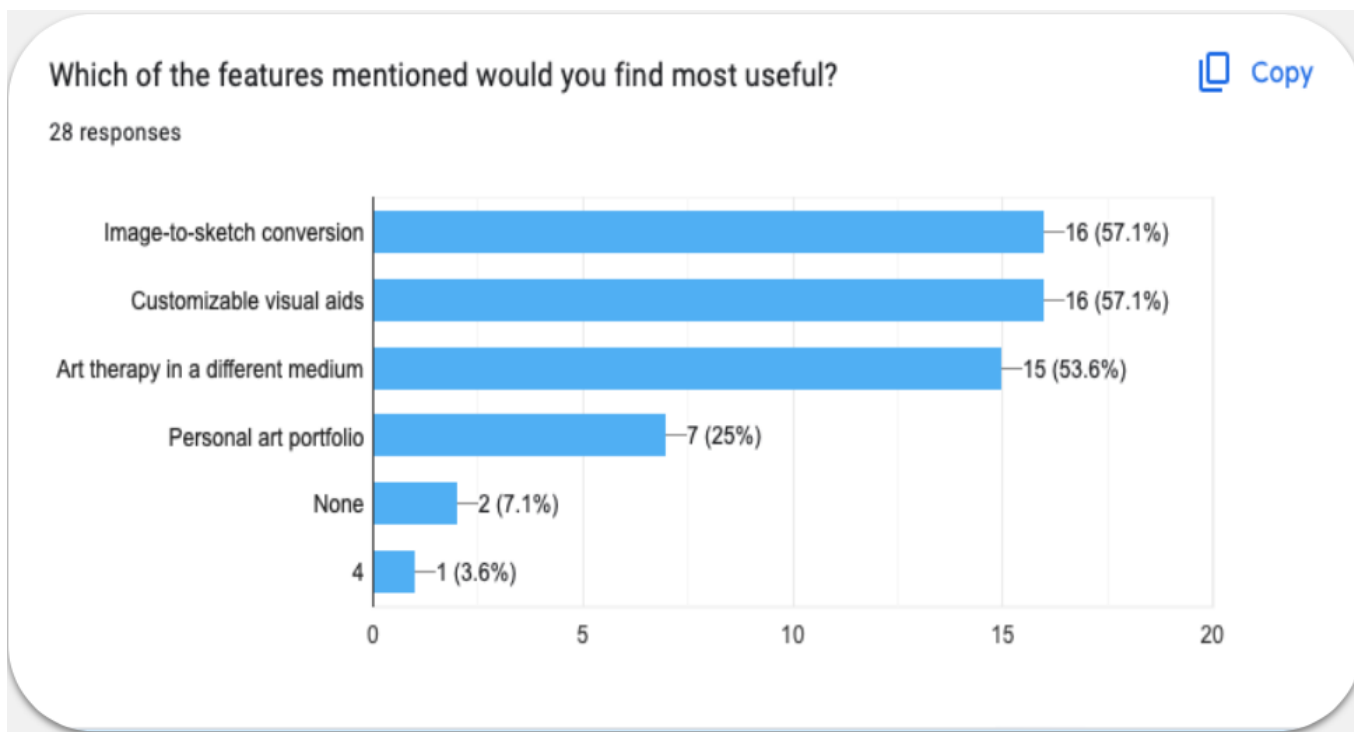
## Evaluations & Feedback

Our evaluation process helped us progress our idea and development from start to finish.

We took evaluations in the form of site visits, interviews, surveys, and user feedback.

### Goodwill

Our site visits with the Goodwill day hab center in Harlem gave us insight on how they try to increase the employability autistic high school graduates. Over the course of 3 visits and 30 interviews, we learned that visual cards for adults are difficult to find compared to children's cards since they're more common and are widely used in schools. Nusketch aims to ease and reduce the time it takes to create visual aids. Autistic people can use them to be taught ideas, terminology, and concepts using clear and simple visuals from their teachers, coaches, therapists, and job trainers. They can use Nusketch to create personalized aids for a class or for specific job functions.





## User Feedback

The figure shown above came from one of our survey questions where users rated the usefulness of our proposed features, showing that our intended features are generally accepted. Below is a collection of what some users said in interviews we conducted and wrote in survey responses.

1. "Perhaps this can be used by impaired students in educational settings."
2. "Visual Aid can be helpful for a person who's currently deaf so the person will need to hear visually for certain things."
3. "I could see it being useful. For me, personally, It would make it easier to explain to kids how medical procedures are done by making certain images be more kid friendly and less intimidating."
4. "Honestly, I see this as being huge, visual aids for non-verbal people whether it be by choice or by medical circumstances. I can also see this being used as a tool for children to better explain their symptoms and/or emotions."
5. "Maybe it can be used for people who need speech therapy or to improve one's vocabulary using words and images."

Some of this feedback was interesting to us because we did not foresee or think about other utilizations of our project. The reviewers suggested that the proposed features of the application can be useful for impaired students in educational settings, individuals who are deaf, children who need help understanding medical procedures, non-verbal individuals, and those who need speech therapy or want to improve their vocabulary using words and images. The application's visual aid features can help with these needs.

## Target Market

Nusketch aims to mainly target people with ASD since we are marketing for art therapy and employability. However neurotypicals can also benefit from this application as it can be universally used and enjoyed by any user who seeks to do digital art or create visuals for their children. So the user market can be broken down into the following categories:

1. Users with ASD Diagnosis
2. Caretakers (Therapists, Teachers, Coaches & Counselors)
3. General Users
4. Businesses

The CDC estimates there are at least 486,000 people diagnosed with ASD in NYC alone and a 7.6 million nationwide. The Office for People With Developmental Disabilities (OPWDD) also employs over 20,000 professionals in New York and there is an estimated 4,000+ active staff in NYC District 75 schools [8]. Additionally, art therapy tends to be expensive like other forms of therapy, costing at least \$100 per 60-minute session [14]. Nusketch can be a more budget-friendly alternative for individuals who cannot afford such services. Therefore users with ASD, caretakers, as well as businesses can use our application.

## **Future Work**

Due to the limitations and scope of this project, there is always room for improvement for any project. The first thing we would like to do next is to deploy our prototype to Apple's App Store and Google's Play Store. So that users can get their hands on the real product and begin using it, to fix any unseen bugs and implement what users really want out of the app. Next, we would like to add updates that extend a user's available visual aid creation tools, such as adjusting line opacity and thickness, adding preset or custom shapes, etc. We would also like to implement a more sophisticated image-to-sketch conversion utilizing deep neural networks for edge detection, facial recognition, and object detection. There are many online resources available with pre-trained machine learning models that we can perhaps use for this. Finally, we would experiment with a web-client version of Nusketch that would run on a browser.

# Branding

## Evolution of Name & Logo

Our team developed an application called "Nusketch" with a thoughtful intention behind its name. We wanted to create a platform that not only enables art therapy through new sketches but also caters to the needs of neurodivergent individuals, making it engaging and beneficial for their job training inclusivity.

## Logo

First Version



Latest Version



The meaning behind the logo is that we wanted to represent the main thing which is camera and art, represented through colors, but we also wanted to tie in the idea of job inclusivity training. We then added hands to the logo as a way to say “here is a platform for you to grow”. We chose the colors blue, orange and purple which entails the values of trust and

reliability, energy and enthusiasm, creativity and individuality. For our name logo the same colors are implemented. We used the font “Assistant” which gives the letters a nice flat surface on the bottom giving off the feeling of stability and reliability. We replaced the “e” with an art paint tray which still gives off the meaning of “art”.

### **Splash Loading Screen**



## Member Contributions

### ❖ Overall Idea

- Brainstorming: Hussam Marzooq, Jessie Su, Willie Shi
- Defined Project Idea: Willie Shi
- Developed and Enhanced Project Idea: Hussam Marzooq, Willie Shi, Jessie Su
- Conducting Research: Hussam Marzooq, Jessie Su, Willie Shi
- Met with Professor Wolberg for Questions: Hussam Marzooq, Jessie Su, Willie Shi

### ❖ Logo Design

- Project Name: Hussam Marzooq
- Logo Designs: Jessie Su
- Slogan: Hussam Marzooq, Jessie Su
- App Icon: Jessie Su
- Splash Screen: Jessie Su
- Figma Designs: Jessie Su

### ❖ Evaluations & Feedback

- Google Forms Survey - Technology Solutions: Willie Shi, Hussam Marzooq
- Google Forms Survey - Branding & Interface Components: Willie Shi, Hussam Marzooq
- Google Forms Distribution: Hussam Marzooq
- Setting Up In-Person and Virtual Meetings with Goodwill: Willie Shi, Hussam Marzooq
- Attended in-person visits at Goodwill: Hussam Marzooq, Jessie Su, Willie Shi

### ❖ ZAHN Work

- Completed ZAHN Competition Application: Hussam Marzooq
- Completed ZAHN Assignments: Hussam Marzooq, Jessie Su, Willie Shi
- Attendance:
  - ZAHN Competition Interview: Hussam Marzooq, Jessie Su, Willie Shi
  - Orientation: Hussam Marzooq, Jessie Su
  - Milestone 1 meeting: Hussam Marzooq, Jessie Su, Willie Shi
  - Thursday Bootcamps: Hussam Marzooq, Jessie Su, Willie Shi

### ❖ CREATE Work

- Completed CREATE Proposal: Hussam Marzooq, Jessie Su, Willie Shi
- Retrieved Funding Card from Luis: Hussam Marzooq
- Reported to Megan about Funding Card Usage: Willie Shi, Hussam Marzooq
  - All Other Communications: Willie Shi
- Designed Poster: Hussam Marzooq, Jessie Su
- Contact Printing Service for Poster: Willie Shi, Hussam Marzooq
- Worked on CREATE Video: Hussam Marzooq
- Presented at Symposium in Albany: Hussam Marzooq, Willie Shi
- Mailed Funding Card back to Megan: Hussam Marzooq
- Completed CREATE Final Report: Hussam Marzooq, Jessie Su, Willie Shi

### ❖ Development

- Installed Dependencies: Hussam Marzooq, Jessie Su, Willie Shi
- Initializing:
  - GitHub Repository: Hussam Marzooq

- Flutter Development Environment: Hussam Marzooq, Willie Shi
- Xcode and Cocoapods Environments: Hussam Marzooq, Jessie Su
- Firebase Console: Hussam Marzooq, Willie Shi
- Login/Signup Page (With Backend Support): Jessie Su
- Home Page: Willie Shi, Jessie Su
- Upload Page: Willie Shi
- Portfolio Page: Willie Shi, Jessie Su
- Camera Page: Willie Shi, Hussam Marzooq
- Camera Slider: Willie Shi
- Sketch Conversion Algorithm: Willie Shi
- Coloring Sketches Page: Jessie Su
- Splash Screen: Jessie Su
- Sharing Feature: Willie Shi
- Early Version of UI: Willie Shi
- Dynamic Sizing: Jessie Su, Willie Shi
- Folder Structure Organization: Jessie Su, Willie Shi
- Redesigned and Revised UI based on Feedback: Jessie Su
- Profile Page: Jessie Su
- Merging Development Code with Main Branch: Hussam Marzooq, Jessie Su
- Testing on iOS Devices: Hussam Marzooq, Jessie Su
- Testing on Android Devices: Willie Shi, Jessie Su

### ❖ **Capstone Work**

- Wiki Updates: Hussam Marzooq, Jessie Su



- Slide Deck Presentations: Hussam Marzooq, Jessie Su, Willie Shi
- Final Report:
  - Abstract: Hussam Marzooq, Jessie Su, Willie Shi
  - Background: Jessie Su, Willie Shi
  - Problem Statement: Willie Shi, Jessie Su
  - Rationale: Willie Shi, Jessie Su
  - Design & Development: Jessie Su, Willie Shi
  - Evaluations & Feedback: Hussam Marzooq, Willie Shi
  - Target Market & Future Work: Hussam Marzooq, Willie Shi
  - Branding: Jessie Su
  - Acknowledgements: Hussam Marzooq, Jessie Su
  - References: Hussam Marzooq, Willie Shi, Jessie Su

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Besides our capstone design advisor, we would also like to thank our industrial mentor Celina Cavalluzzi, for helping us coordinate in-person meetings at Goodwill and allowing us to visit Goodwill where our idea was born. Finally, the work in this project is our own. Any outside sources have been properly cited.

The work in this project is our own. Any outside sources have been properly cited. The project is supported by the CCNY CEN Course Innovation Grant.

## References

- [1] “Signs and Symptoms of Autism Spectrum Disorders.” *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 28 Mar. 2022, <<https://www.cdc.gov/ncbddd/autism/signs.html>>.
- [2] Autism Care Today. “The Impact of Art on Autism.” *Autism Care Today*, 21 Apr. 2020, <[The Impact of Art on Autism](#)>.
- [3] Holland, Kimberly. “What You Need to Know about Non Speaking Autism.” *Healthline*, Healthline Media, 1 Nov. 2021, <<https://www.healthline.com/health/autism/nonverbal-autism#diagnosis>>.
- [4] SafeSleep, Team. “Benefits of Art Therapy for People with Autism.” *Safe Sleep Systems*, 15 July 2020, <<https://www.safesleepsystems.com/art-therapy-for-people-with-autism/>>.
- [5] “Development of Fine Motor Skills Through Art.” *Philly Art Center*, 3 Jan. 2020, <[https:// phillyartcenter.com/blog/development-of-fine-motor-skills-through-art/](https://phillyartcenter.com/blog/development-of-fine-motor-skills-through-art/)>.
- [6] Jones, Hillery. “Art Therapy and Children on the Spectrum.” *Mental Health Match*, Mental Health Match, 15 Oct. 2020, <<https://mentalhealthmatch.com/articles/therapy/art-therapy- children-autism-spectrum>>.
- [7] “Data & Statistics on Autism Spectrum Disorder.” *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 2 Mar. 2022, <<https://www.cdc.gov/ncbddd/autism/data.html>>.
- [8] “New York State Autism Cost Study Report.” *OPWDD*, 8 June 2022, <[opwdd.ny.gov/system/files/documents/2022/06/autism-cost-study-report-3-7-22.pdf#:~:text=From%202016%20through%202020%2C%20the,growth%20rate%20of%207.2%20percent](https://opwdd.ny.gov/system/files/documents/2022/06/autism-cost-study-report-3-7-22.pdf#:~:text=From%202016%20through%202020%2C%20the,growth%20rate%20of%207.2%20percent)>. Accessed 13 May 2023.

- [9] Happé, Francesca. *Why Are Savant Skills and Special Talents ... - Wiley Online Library*.  
<[Why are savant skills and special talents associated with autism?](#)>.
- [10] Ltd., Herc. “Colorscape - Color Your Photos.” *App Store*, 16 Dec. 2015,  
<<https://apps.apple.com/ca/app/colorscape-color-your-photos/id1054822637>>.
- [11] X-FLOW. “Happy Color® – Color by Number - Apps on Google Play.” *Google*, Google,  
<[Happy Color®: Coloring Book - Apps on Google Play](#)>.
- [12] “Treatment and Intervention Services for Autism Spectrum Disorder.” *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 9 Mar. 2022,  
<[https:// www.cdc.gov/ncbddd/autism/treatment.html](https://www.cdc.gov/ncbddd/autism/treatment.html)>.
- [13] “Mobile Operating System Market Share Worldwide.” *StatCounter Global Stats*,  
<[https:// gs.statcounter.com/os-market-share/mobile/worldwide](https://gs.statcounter.com/os-market-share/mobile/worldwide)>.
- [14] “Fees and Payment Information.” *New York Creative Arts Therapists*
- [17] Reid, Stephen, et al. “How Haptics and Drawing Enhance the Learning of Anatomy.”  
*Anatomical Sciences Education*, vol. 12, no. 2, 2019, pp. 164–72,  
<[https://doi.org/ 10.1002/ase.1807](https://doi.org/10.1002/ase.1807)>.
- [18] “Customizable Choice Board with 15 Item Choices My.” *Etsy*,  
<[https://www.etsy.com/listing/1218107442/customizable-choice-board-with-15-item?ga\\_order=most\\_relevant&ga\\_search\\_type=all&ga\\_view\\_type=gallery&ga\\_search\\_query=autism%2Bcards&ref=sr\\_gallery-1-3&sts=1&organic\\_search\\_click=1](https://www.etsy.com/listing/1218107442/customizable-choice-board-with-15-item?ga_order=most_relevant&ga_search_type=all&ga_view_type=gallery&ga_search_query=autism%2Bcards&ref=sr_gallery-1-3&sts=1&organic_search_click=1)>.