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Sirplus - A Task Management System for Individuals with Executive Dysfunction

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Sirplus - A Task Management System for Individuals with Executive Dysfunction

By Thomas Roberti

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Fine Arts in Industrial Design

School of Design
College of Art and Design
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Abstract

A significant portion of the population struggles with executive functioning and task management. This project explores the pain points for organizing, initiating, and finishing tasks and proposes a design to address these problems.

The objective of this project is to relieve the stress and anxiety people with executive dysfunction often experience with tasks.

The design process for this project considered different product and interface strategies to help users with their tasks through positive motivation and rewards. Initial user testing showed that information overload and forgetfulness were barriers to setting and managing tasks. Furthermore, the act of crossing an item off of a list was found to be satisfying and encouraged users to keep completing tasks.

The final solution employs a three-part internet of things (IoT) system which incorporates a device for building the habit of setting daily tasks, a user interface (UI) which prevents users from being overwhelmed or overstimulated, and a gratifying, tactile task completion action.

Keywords: Task Management, Executive Dysfunction, Executive Functioning Disorder, Attention Deficit Hyperactivity Disorder (ADHD), Internet of Things (IoT), Productivity

Introduction

Writing a to-do list or keeping a calendar for upcoming events is a common way to stay on top of your work and life in general. For many of us, this is simple, intuitive and effective. However, this is not the case for those who struggle with executive function–a set of mental skills that includes working memory, flexible thinking, and self-control. These individuals find it very difficult to manage this aspect of their lives. In particular, individuals with autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD) or generalized anxiety disorder (GAD) tend to experience these issues.

Although there are many task management solutions on the market, a vast majority of them do not address the specific needs of individuals with executive function issues. These solutions may also overwhelm users with a plethora of charts, functions, and colors. This often leads to frustration, which serves as a substantial barrier to adoption.

Whether it be a traditional pen and paper notepad or a software program, current solutions require users to do much of the leg work in order to reap the benefits of using them. Users are asked to manually input their tasks and prioritize them. Then they are expected to do the same the next and the next, in perpetuity. This process quickly becomes a task in itself; one that is the first to fall to the wayside when the work starts piling up.

Background

Executive function (EF) or executive control is an umbrella term that captures a set of cognitive processes that direct behavior regulation and orchestration of attaining a future goal.[1] There are a number of groups who tend to struggle with EF, namely people with autism spectrum disorder, attention deficit hyperactivity disorder, and generalized anxiety disorder. It is difficult to know the precise number of people with executive dysfunction largely due to the fact that this term is not a true medical term. However, there is data that demonstrates that executive functioning problems are commonly seen in individuals with one or more of the above-mentioned disorders.[2] In the U.S. alone, there are nearly five and half million adults with ASD, more than 10 million adults with ADHD, and over 40 million adults with an anxiety disorder.[3]

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[1] Marilyn C. Welsh and Bruce F. Pennington, “Assessing Frontal Lobe Functioning in Children: Views from Developmental Psychology,” *Developmental Neuropsychology* 4, no. 3 (1988): pp. 199-230, https://doi.org/10.1080/87565648809540405.

[2] Lauren Kenworthy et al., “Understanding Executive Control in Autism Spectrum Disorders in the Lab and in the Real World,” *Neuropsychology Review* 18, no. 4 (2008): pp. 320-338, https://doi.org/10.1007/s11065-008-9077-7. , (Willcutt et al. 2005), Yair Bar-Haim et al., “Threat-Related Attentional Bias in Anxious and Nonanxious Individuals: A Meta-Analytic Study.,” *Psychological Bulletin* 133, no. 1 (2007): pp. 1-24, https://doi.org/10.1037/0033-2909.133.1.1.

[3] “Key Findings: CDC Releases First Estimates of the Number of Adults Living with Autism Spectrum Disorder in the United States,” Centers for Disease Control and Prevention (Centers for Disease Control and Prevention, April 7, 2022), https://www.cdc.gov/ncbddd/autism/features/adults-living-with-autism-spectrum-disorder.html., (“Attention-Deficit/Hyperactivity Disorder (ADHD),” n.d.), “Anxiety Disorders,” NAMI, accessed March 10, 2022, https://www.nami.org/About-Mental-Illness/Mental-Health-Conditions/Anxiety-Disorders

Front End Research

1. Executive Dysfunction

Human beings are driven by either a necessity (food, sleep, etc.) or through rewards. Anything can act as a reward (objects, activities, events, etc.) as long as it motivates or elicits pleasure in the individual. When a reward is expected, neurons that release dopamine are activated. This is known as the “reward system.”[4]

One of the main reasons that individuals with ADHD and other disorders have difficulty with EF is due to a deficit in these reward-motivation pathways in the brain.[5] Essentially, less dopamine is released when mundane tasks are completed, meaning the perceived reward is less. This leads to the individual having significantly less motivation to initiate or follow through with the task[6].

2. Task Management and Productivity

Research demonstrates that habit performance is not affected when will power is low. In fact, people tend to default to their habits when their willpower is depleted. This effect is not limited to “good” habits however.[7] This is especially relevant for individuals with ASD, ADHD and GAD

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[4] *Brain Facts: A Primer on the Brain and Nervous System*. Washington, DC, USA: Society for Neuroscience, 2012.

[5] Nora D. Volkow et al., “Evaluating Dopamine Reward Pathway in ADHD,” *JAMA* 302, no. 10 (September 2009): p. 1084, https://doi.org/10.1001/jama.2009.1308.

[6] Sydni Rubio-Weiss, “Motivation, Dopamine, & ADHD: Why It's Hard to Get Motivated & 6 Techniques to Help with Motivation,” *YouTube*, 11:59, https://www.youtube.com/watch?v=28q6-nsHQ9I.

[7] David T. Neal, Wendy Wood, and Aimee Drolet, “How Do People Adhere to Goals When Willpower Is Low? the Profits (and Pitfalls) of Strong Habits.,” *Journal of Personality and Social Psychology* 104, no. 6 (2013): pp. 959-975, https://doi.org/10.1037/a0032626.

who often find themselves with limited willpower. This means the adoption of positive rituals is even more crucial for these individuals.

One example of a positive ritual is writing the following day's to-do list before sleeping. One study found that this habit reduced stress and aided in the reduction of stress associated with future tasks and in falling asleep more quickly.[8]

[8] Michael K. Scullin et al., "The Effects of Bedtime Writing on Difficulty Falling Asleep: A Polysomnographic Study Comparing to-Do Lists and Completed Activity Lists.," *Journal of Experimental Psychology: General* 147, no. 1 (2018): pp. 139-146, https://doi.org/10.1037/xge0000374.

Concepts & Ideation

Early concepts developed in this stage were based on several learnings from the front-end research. Given there is often a lack of dopamine production in the brain for individuals with executive dysfunction, some concepts focused on increasing the dopamine response when completing tasks. Other concepts explored habit building and rituals. Finally, some concepts imagined ways to bring this task management on the go.

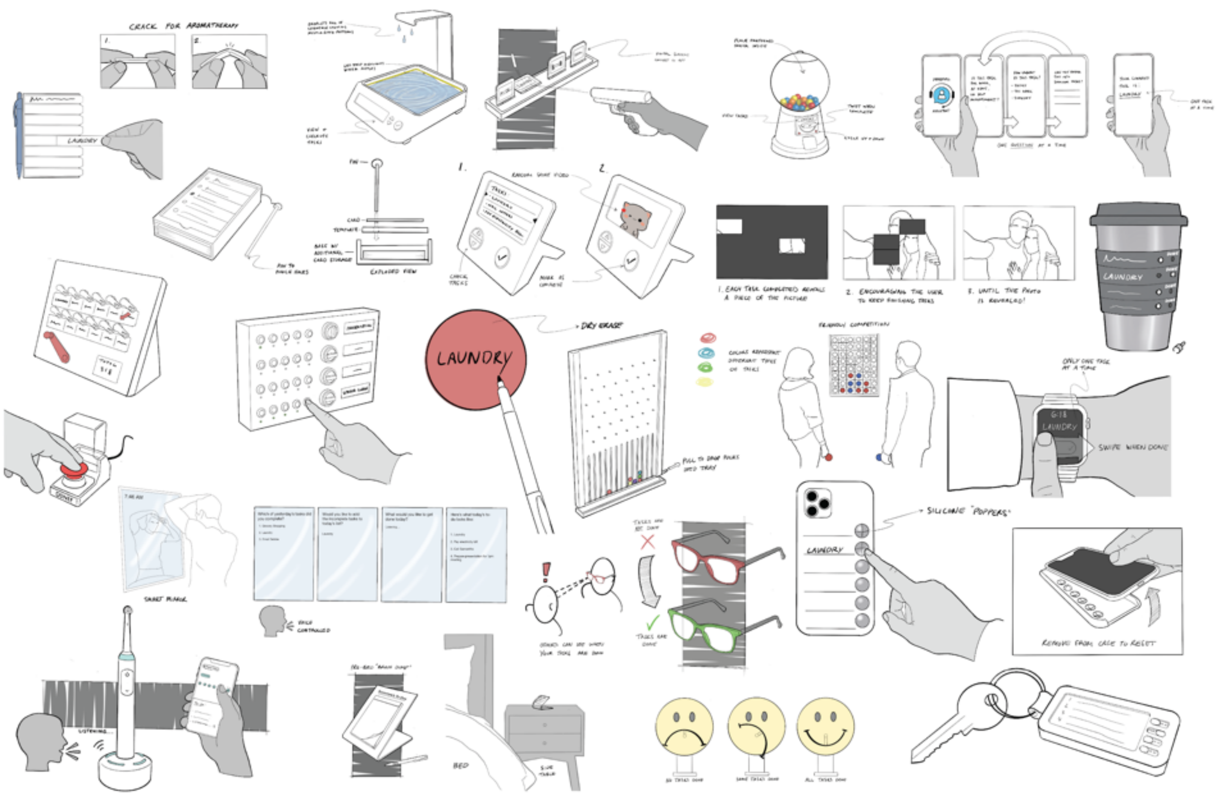
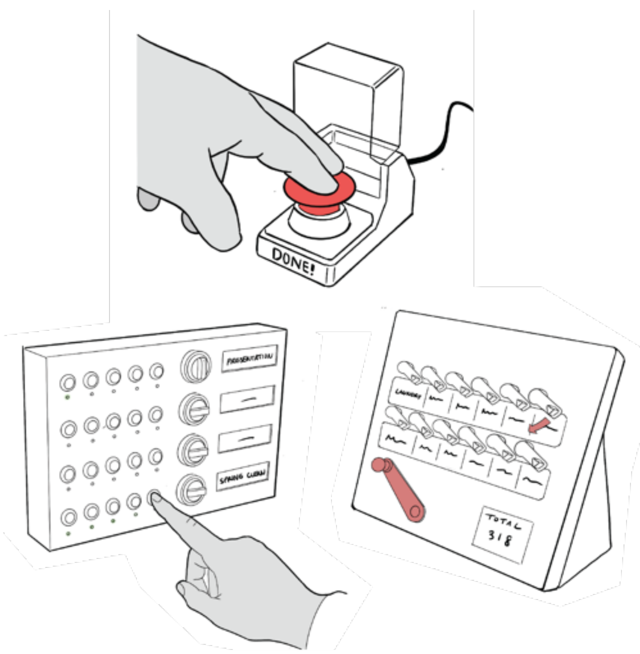


Figure 1 - Concept Sketches.

Validation of Preliminary Designs

Several interviews were conducted with industry experts including a spectrum support coach and the founder of an online ADHD support platform. Within these interviews, the concepts illustrated in *Fig 1.* were evaluated. The aspects of the most promising concepts were then developed into three concepts to be made into physical models.

The first concept was a tactile to-do list designed to enhance the feeling of satisfaction one gets when checking or crossing an item off a list.



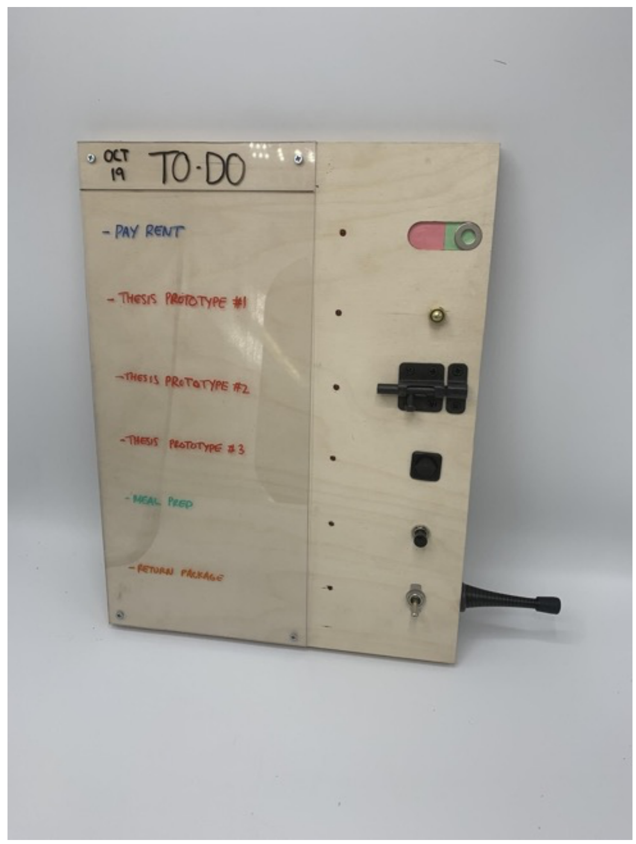


Figure 2 - Sketches that inspired Concept 1.

Figure 3 - Concept 1 mockup.

There were several sketches from the ideation phase that included tactile feedback (see *Figure 2*). The mockup for Concept 1 drew upon these concepts and served as an amalgamation of different tactile mechanisms.

The second concept was a desktop note-style to-do list. This concept incorporated tactile feedback, but its main purpose was to allow the user to visually track their progress.

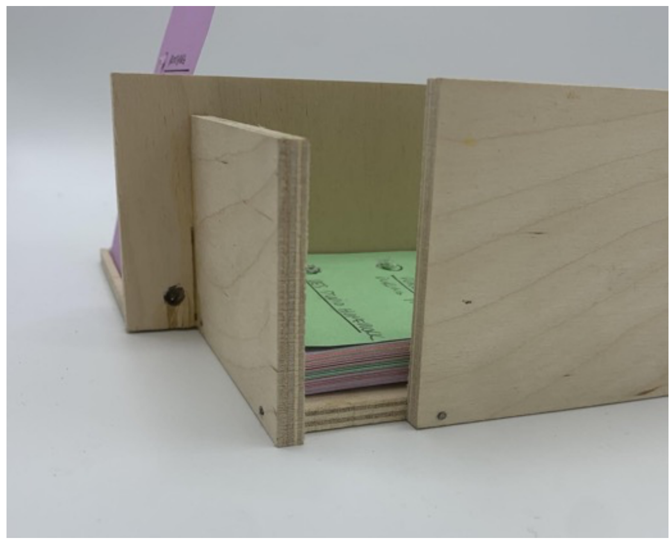


Figure 4 - Concept 2, Punching out finished to-do items.

Figure 5 - Visually tracking progress over time by seeing finished lists pile up.

Concept 3 was a virtual assistant smart speaker device built into a toothbrush. The idea was that since users often forget or don't find the time to record what they need to do, they could simply tack it onto their morning or nighttime routine when they brushed their teeth.

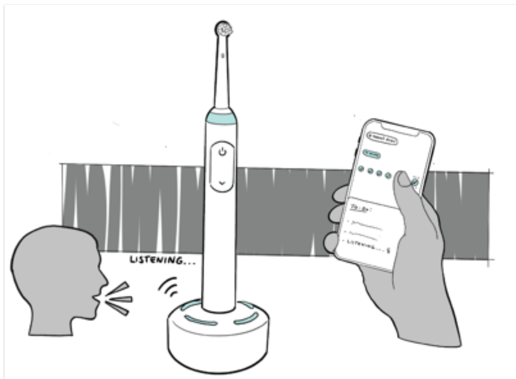


Figure 6 - Sketch of Concept 3.

Figure 7 - Concept 3 mockup.

Feedback on these three concepts highlighted the potential to merge aspects of each concept into an IoT system. The system would enhance the experience of checking off items through tactile feedback, make the process of task setting easier through a virtual assistant smart speaker, and track user's progress over time through a digital display.

User Testing

A series of three tests were conducted to evaluate the design direction. The first test involved five participants who agreed to test drive the app component of the IoT system.

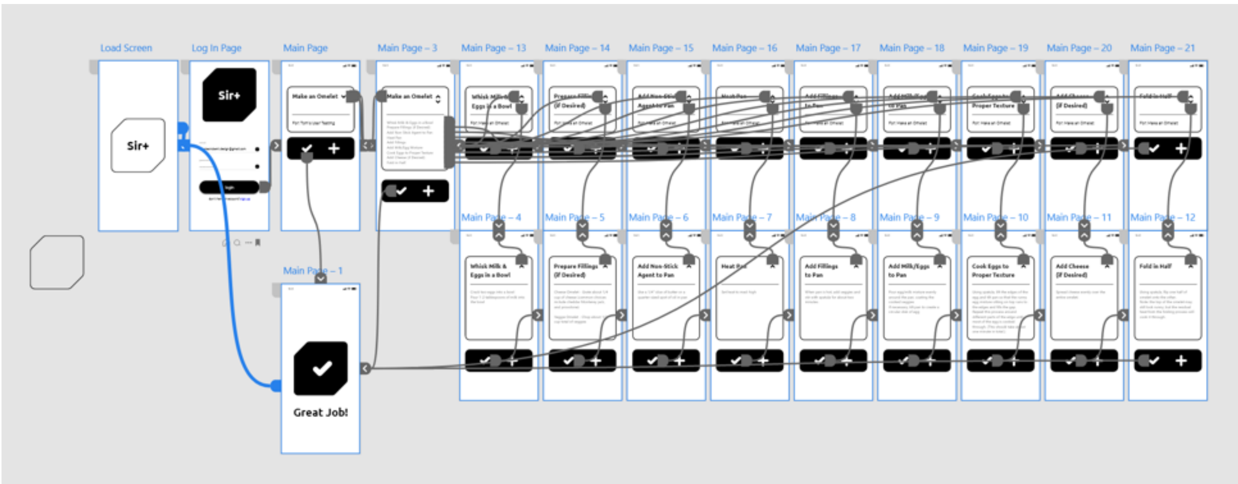


Figure 8 - The overall app flow which allowed users to expand or collapse the various subtasks.

Participants were asked to make an omelet and to use the app as needed to assist them. The act of making an omelet represented a task that a user might set for themselves in the app. Normally, such tasks might include “do laundry” or “pay electric bill,” but here the goal was to evaluate how well the app could adapt to varying user needs. Because there was limited access to individuals who would need extensive help on traditional “to-do” tasks, a cooking task was selected instead. In this case it was much easier to find individuals who ranged from having never made an omelet before to having done it many times.

Figure 9 - Test participants' self-documented experiences using the app and cooking.

The second test investigated the effect of habit adoption through association with an existing habit. A secondary function of this test also evaluated users' perceived satisfaction from tactile feedback. In this case, the test evaluated the validity of the virtual assistant smart speaker part of the IoT system.

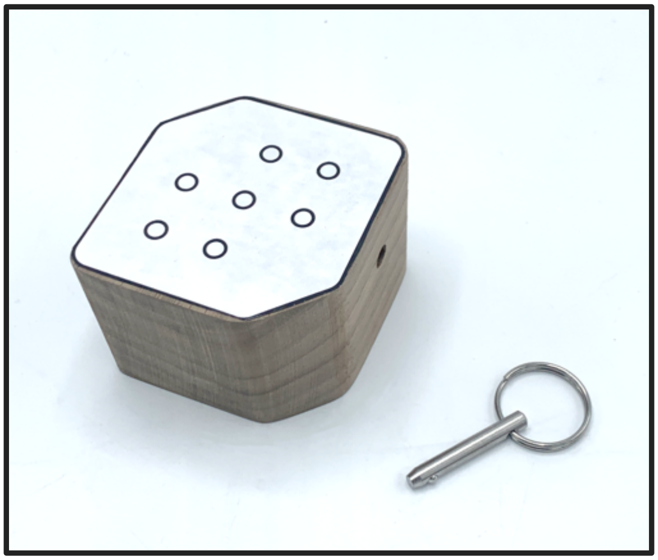


Figure 10 - The Wooden block and pin serving as a mock virtual assistant.

Figure 11 - Test participants' self-documented locations for their mock virtual assistant.

Here participants were instructed to place the mock virtual assistant (see Fig. 10) in a location within reach where they perform one of their daily habits. When they performed their daily habit—whether it be brushing their teeth, making coffee, or putting on their makeup—if they noticed the wooden block, they were told to write down their tasks for the day and punch a hole in the paper on the top surface. At the end of a seven-day period, users were interviewed to understand the effectiveness of the association of a new habit with an existing one.

The last of the three tests was to specifically understand what type of tactile feedback is most desirable.

Figure 12 - Testing apparatuses

15 participants evaluated 12 unique mechanisms ranging from sliding magnets to keyboard switches. They were asked to rank their top three choices.

Final Design

Figure 13 - Final design from the photoshoot.

The final concept is a three-component IoT task management system. The system works together to assist the user with task setting, task initiation, and follow through.

Smartphone Application

The first component of the system is the smartphone application. User interface (UI) design principles that apply to individuals with ADHD, autism, and anxiety were used to design the application.[9]

[9] Mike Harris, "An Introduction to Inclusive Design," Nomensa, October 11, 2011, https://www.nomensa.com/blog/introduction-inclusive-design.

Within the application, users can input new tasks or view their current one. When inputting a new task, users will be prompted with several questions—presented one at a time—which help the software categorize and prioritize the task. The following is a list of information learned by the app through the question process:

- When the task is due
- Roughly how long the task will take to complete
- The location of the task
- The task’s category (Schoolwork, Self-Improvement, Home maintenance, etc.)
- Smaller, subtasks making up the main task

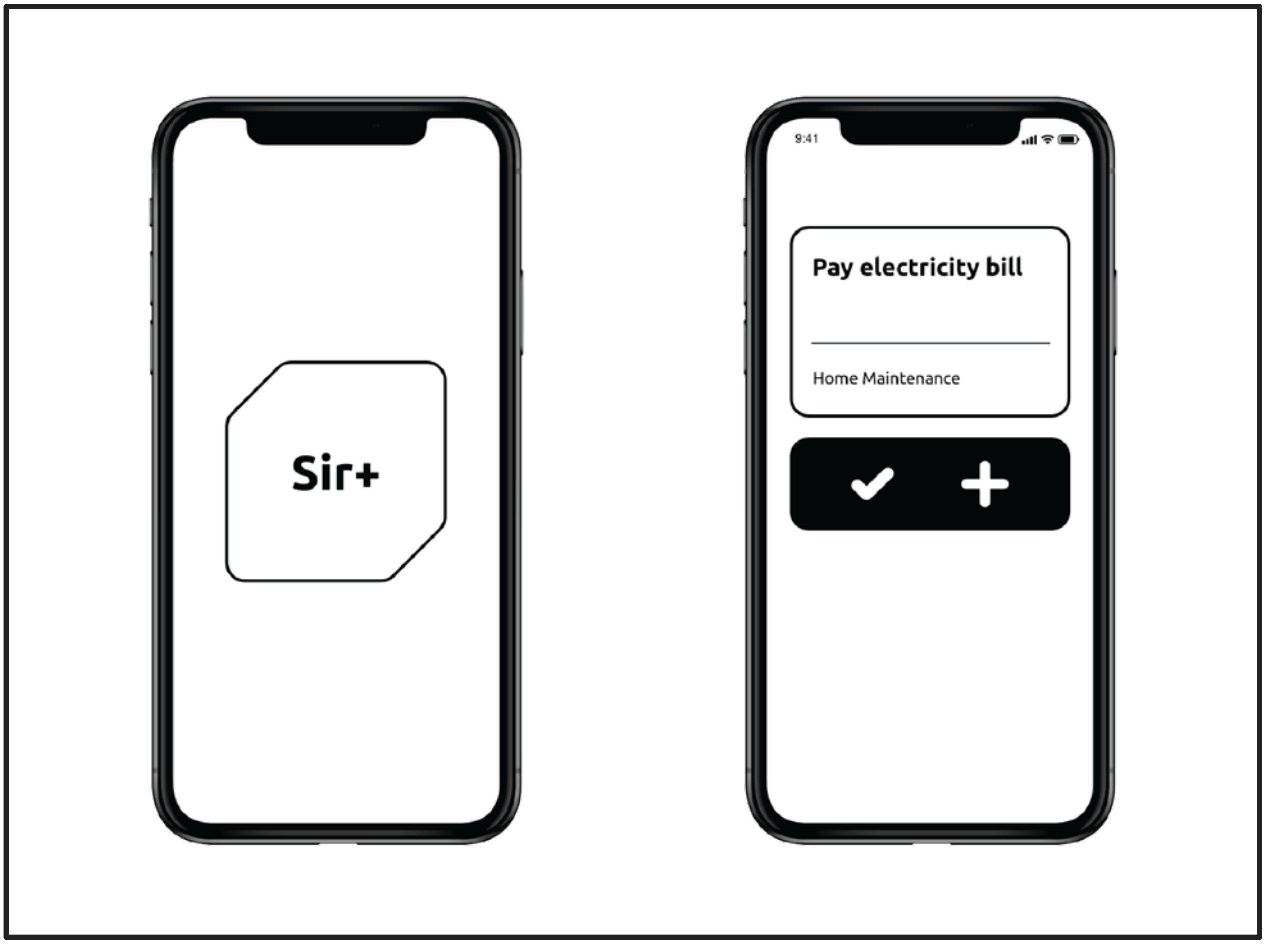


Figure 14 - Basic screens from the UI system.

Based on the tasks entered and the questions answered in conjunction with them, the app presents the user with only their current task. This way, the app allows users to offload the duty of worrying about what tasks to do next and in what order. For example, a user might input that they need to buy milk. At a previous point in time, they may have entered that they need to mail a package. The app recognizes that the location for these two tasks that are nearby and suggests to the user to do them in one trip. Another example might be that a student has two tasks: a homework assignment due at the end of the week and a project due at the end of the month. Which task do they work on right now? One might say the homework assignment because it's due sooner, but perhaps the project requires much more work. Based on the due dates and the amount of work/subtasks each will take, the app will eliminate that confusion and tell the student what to work on at the present time.

Another feature of the app is its ability to conform to each user's needs. This feature applies to more generalized tasks such as "do laundry" or "mow the lawn." For many people without executive dysfunction, these "basic" tasks are already ingrained in their memory. However, this is not the case for everyone. Some users might forget and feel overwhelmed at the prospect of doing their laundry. When faced with this kind of feeling, users of the app will be able to freely expand and collapse the various levels of the task—from the most basic instructions all the way up to the top-level task.

Furthermore, the app will utilize machine learning across its user pool to create a database of commonly performed tasks. This will allow the app to provide suggested sub-tasks for a broader range of tasks. It will also improve the quality of these suggested sub-tasks.

Virtual Assistant Smart Speaker

Figure 15 - The virtual assistant smart speaker device.

The smart speaker serves two primary functions: to increase the likelihood of users setting their tasks and to reduce users' anxiety by allowing them to vocalize and record their tasks in order to organize them.

This is achieved by encouraging the user to think of a daily habit of theirs. Common examples might include: brushing teeth, putting on makeup or making coffee. Then, the user is instructed to place their smart speaker device within close proximity of where they perform this daily habit. Whenever they go through that daily ritual, they should use the speaker as a visual reminder to set their tasks. The speaker also features a tactile button used to activate it. This physical interaction between the user and the device is meant to be an enjoyable experience, leading to the release of dopamine in the brain. By providing this dopamine release in addition to the convenience of verbal communication, this system seeks to significantly increase the likelihood that is adopted into the user's workflow and lifestyle.

Wall-Mounted Display

Figure 16 - The wall mounted display.

The final component of the system is the wall-mounted display. The addition of this display to the IoT system is critical due to its ever-present nature. Where most digital applications require the user to remember to launch the application to interact and view tasks, this display is always there, making it much more difficult to ignore. In this way, it plays a similar role to commonly used whiteboards. However, unlike the whiteboards, the display is automatically populated with any top-level tasks entered via the app or the virtual assistant device. The display uses e-ink technology, which only requires power when refreshing the contents of the screen.

Where the application provides users with only the highest priority singular task, the display serves as an overview of the day before the user leaves as well as a debriefing when returning home at day's end. Here the user can do a final check off on the completed tasks. These check-offs are done via a tactile button on the device, which also serves to enhance the experience of finishing tasks.

The display also visually tracks the user's progress for the week. Each day all the top-level tasks are completed, the day's circle becomes solid. The satisfaction of seeing each of the circles filled incentivizes the user to keep up with their positive streak.

Conclusion

The information gathered from the research, interviews, and user testing, during the course of this project indicate that the proposed design solution would be an effective tool for individuals with executive dysfunction.

The final design leverages the functionality of modern technology while simultaneously creating a more tactile, personal experience that is often lost when interacting with the smooth glass screens of today’s smartphone age.

Through its simplicity and intuitiveness, this product provides a much more manageable learning curve for new users, reducing frustration and increasing the likelihood of sustained use. Furthermore, by giving new users a direct pathway to begin to form the habit of using the product, the impact on their current lifestyle is minimized, which provides for a more seamless adoption. At the same time, the system doesn’t allow itself to be forgotten by being ever-present, living on a main wall in the user’s home and nearby where they perform their daily rituals.

References

1. “Anxiety Disorders.” NAMI. Accessed March 10, 2022. https://www.nami.org/About-Mental-Illness/Mental-Health-Conditions/Anxiety-Disorders
2. “Attention-Deficit/Hyperactivity Disorder (ADHD).” n.d. National Institute of Mental Health (NIMH). https://www.nimh.nih.gov/health/statistics/attention-deficit-hyperactivity-disorder-adhd#part_2553.
3. “Key Findings: CDC Releases First Estimates of the Number of Adults Living with Autism Spectrum Disorder in the United States.” Centers for Disease Control and Prevention. Centers for Disease Control and Prevention, April 7, 2022. https://www.cdc.gov/ncbddd/autism/features/adults-living-with-autism-spectrum-disorder.html.
4. Bar-Haim, Yair, Dominique Lamy, Lee Pergamin, Marian J. Bakermans-Kranenburg, and Marinus H. van IJzendoorn. “Threat-Related Attentional Bias in Anxious and Nonanxious Individuals: A Meta-Analytic Study.” *Psychological Bulletin* 133, no. 1 (2007): 1–24. https://doi.org/10.1037/0033-2909.133.1.1.
5. *Brain Facts: A Primer on the Brain and Nervous System*. Washington, DC, USA: Society for Neuroscience, 2012.
6. Harris, Mike. “An Introduction to Inclusive Design.” Nomensa, October 11, 2011. https://www.nomensa.com/blog/introduction-inclusive-design.
7. Kenworthy, Lauren, Benjamin E. Yerys, Laura Gutermuth Anthony, and Gregory L. Wallace. “Understanding Executive Control in Autism Spectrum Disorders in the Lab and in the Real World.” *Neuropsychology Review* 18, no. 4 (2008): 320–38. https://doi.org/10.1007/s11065-008-9077-7.

8. McKnight, Lorna. “Designing for ADHD: in Search of Guidelines.” Digital Technologies and Marginalized Youth - IDC 2010 workshop, 2010. http://www.cs.uiowa.edu/~hourcade/idc2010-myw/.

9. Neal, David T., Wendy Wood, and Aimee Drolet. “How Do People Adhere to Goals When Willpower Is Low? the Profits (and Pitfalls) of Strong Habits.” *Journal of Personality and Social Psychology* 104, no. 6 (2013): 959–75. https://doi.org/10.1037/a0032626.

10. Rubio-Weiss, Sydni, “Motivation, Dopamine, & ADHD: Why It's Hard to Get Motivated & 6 Techniques to Help with Motivation.” *YouTube* video*,* 11:59. February 23, 2021. https://www.youtube.com/watch?v=28q6-nsHQ9I.

11. Scullin, Michael K., Madison L. Krueger, Hannah K. Ballard, Natalya Pruett, and Donald L. Bliwise. “The Effects of Bedtime Writing on Difficulty Falling Asleep: A Polysomnographic Study Comparing to-Do Lists and Completed Activity Lists.” *Journal of Experimental Psychology: General* 147, no. 1 (2018): 139–46. https://doi.org/10.1037/xge0000374.

12. Volkow, Nora D., Gene-Jack Wang, Scott H. Kollins, Tim L. Wigal, Jeffrey H. Newcorn, Frank Telang, Joanna S. Fowler, et al. “Evaluating Dopamine Reward Pathway in ADHD.” *JAMA* 302, no. 10 (2009): 1084. https://doi.org/10.1001/jama.2009.1308.

13. Welsh, Marilyn C., and Bruce F. Pennington. “Assessing Frontal Lobe Functioning in Children: Views from Developmental Psychology.” *Developmental Neuropsychology* 4, no. 3 (1988): 199–230. https://doi.org/10.1080/87565648809540405.

14. Willcutt, Erik G., Alysa E. Doyle, Joel T. Nigg, Stephen V. Faraone, and Bruce F. Pennington. 2005. “Validity of the Executive Function Theory of Attention-Deficit/Hyperactivity Disorder: A Meta-Analytic Review.” *Biological Psychiatry* 57 (11): 1336–46. https://doi.org/10.1016/j.biopsych.2005.02.006.