

SE499 Report - Cued App

Justin Pezzack
jjpezzac@uwaterloo.ca

April 6th, 2020

Contents

1	Introduction	3
1.1	Purpose	3
1.2	What is a Habit?	3
1.3	Project Scope	3
2	Research	3
2.1	Do people even need a solution?	3
2.2	The Habit Loop	4
2.3	Building a Habit	5
3	Engineering a solution	6
3.1	Scope	6
3.2	Product Requirements	6
4	Technical Stack	8
4.1	Technologies Used	8
4.2	Implementation	8
4.3	Potential Expansions	10
5	Conclusion	11
6	Next Steps	11

Acknowledgements

Thank you to Katherine Lu, Nikola Vasiljevic and Tyler Zhang for bringing me onto their FYDP team given my unusual circumstances. With this document being directly related to our SE491 project, a large portion of the research and information being discussed is a direct result of their time and effort throughout the winter 2020 term.

Thank you to Derek Rayside for motivating us to pursue this project as well as our academics during COVID-19.

1 Introduction

1.1 Purpose

In terms of development, this project is considered abandoned. With that being said, the purpose of this report is to present to the reader the process **Team Cued** undergone during the winter 2020 term, as well as provide knowledge and structure for future groups to expand the project as a prospective SE490/491 project (SE2021, SE2022 etc.).

1.2 What is a Habit?

The Merriam Webster's dictionary definition of a habit is as follows: *a settled tendency or usual manner of behavior* or as a more technical definition *a behavior pattern acquired by frequent repetition or physiologic exposure that shows itself in regularity or increased facility of performance*. If we look at the second definition, we see the phrase "physiologic exposure that shows itself in regularity", remember this, it will come back later.

1.3 Project Scope

The scope of the project is to create an application that allows users to discover and track habits that they a) want to form, or b) want to eliminate. Some examples of these types of habits include "wanting to make my bed in the morning", or "stop biting my nails". There are many habit managing apps that exist on the Google Play and Apple App stores allowing one to track similar things, however we found that they were either fairly lackluster or extremely bloated. On one end of the spectrum we discovered solutions that were glorified checklists, without much depth under the surface. On the other, we discovered various solutions that employed the concept of gamification, a well-known user experience concept that utilizes elements of game playing to encourage engagement with a product or service. The problem with these apps is that they encourage the user to perform (or not perform) the habit as a means to progress in the game, rather than for the lifestyle benefits. The common theme among all of these apps is that they allow the user to track habits, yet they lack justification for why the app is allowing them to make lasting changes. The app lets the user check boxes or collect trinkets, thus giving them a sense of achievement in building their habit. In this work we specifically investigate the scientific proof behind these validations of positive re-enforcement.

2 Research

2.1 Do people even need a solution?

When searching for a group of people who are looking to build or a change a habit, New Year's resolutions came to mind. Analyzing this group was appropriate for our study due to the diversity of habits being formed. One thing we aimed to avoid was scientific principles that only applied for a specific set of habits, rather than principles that can be generally applied. Our search led us to a study conducted by researchers at the University of Scranton which discovered that there is a steep drop in how long New Year's resolutions are pursued. "Seventy-seven percent of the resolvers studied made it through a full week, then 55 percent stuck with their goals for a month. By June, six months into the New Year, only 40 percent of those who had made a New Year's resolution were still sticking with the goal". This study confirmed our assumption that people want to build habits, but they struggle to keep them. This constant cycle of failure can be detrimental to one's overall livelihood and well-being. "Every time we fail, we damage our own self-esteem," says Janet Polivy, a psychologist at the University of Toronto.

On the surface, forming simple habits such as making ones bed in the morning seems rather trivial. However, the issue is that one's willpower, their capacity to do additional non-essential work, is very limited. Unlike computers, humans are inconsistent, and so is our limited motivation. The conviction to become a better version of yourself that you experience one day is quickly dispelled by the next. "Apps can give you reminders, accountability, guilt trips, or even a personal habit coach, but in the end you still have to do the

work — you can’t app your way to a better self”¹. Between the preliminary research that was done and the lack of habit apps applying actual psychological research, we decided that a new solution was necessary to fill this void. Moving forward, the research shifted towards finding a science-backed methodology to improve habit forming abilities.

2.2 The Habit Loop

After weeks of research in behavioural psychology, in particular, researching a book known as the *The Power of Habit* by Charles Duhigg, we had found what we believed was a solid foundation to build off. Duhigg suggests that the key to building good habits that one is likely to execute consistently, day after day, is the psychology construct known as the Habit Loop. The Habit Loop is a simplified schematic that represents how our brain operates when we have a habit. Studies have shown that almost all habits can be broken down into a series of steps, and works like *The Power of Habit* help readers understand this process, develop their own habits, and more. Though people have easy access to the formula, many still struggle to follow it. The reasoning for this is that though the habit loop itself is simple, the steps to change a habit are not, and can be a daunting task for many. A user study we did among students attending the University of Waterloo, confirmed our assumptions.

- “Sounds cool but it seems like a lot of work, I’d probably forget after a couple days”
- “I want to try it but I don’t know if I have time to read a book”
- “There are a lot of steps”

This made it become very apparent to us that for our software engineering solution to be effective it needed to be easy to use and not overwhelming, but still informative and useful. As Duhigg puts it, “Individuals and habits are all different, and so the specifics of diagnosing and changing the patterns in our lives differ from person to person and behavior to behavior. Giving up cigarettes is different than curbing overeating, which is different from changing how you communicate with your spouse, which is different from how you prioritize tasks at work. What’s more, each person’s habits are driven by different cravings”². This makes the formula to change a habit generic; there isn’t one magic infallible solution, and because of that, each person needs to put in effort to build their specific habit loop for the habit they want to create. Fortunately, there is a general framework one can follow. Research performed at the Massachusetts Institute of Technology discovered that at the core of every habit is a neurological loop that consists of three parts: a cue, a routine, and a reward.

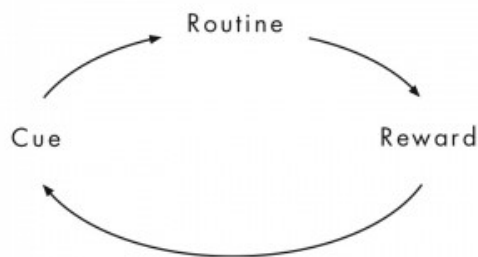


Figure 2.1: The basic habit loop

The next issue many encounter is that identifying all the elements of a habit is tricky. For example, a cue related to a habit can consist of many pieces of information, perhaps a time, a place, an emotion, or even

¹<https://www.vox.com/2014/12/29/7434433/new-years-resolutions-psychology>

²<https://charlesduhigg.com/how-habits-work/>

a person, the list is endless. This makes it very difficult for people to pinpoint what their exact habit loop looks like. Though people may estimate, accuracy is imperative here. This made the focus of our application more clear; instead of simply allowing users to track their habits and habit loops, our application actually help users discover their unique detailed habit loop.

We studied the methodology Duhigg lays out in the book, and decided that integrating it into a piece of software would be perfect in creating a habit tracker that 1) employs the concepts of the habit loop, and 2) is educational and allows people to discover their actual habit loops, as opposed to having them blindly enter what they *believe* is their habit loop.

2.3 Building a Habit

Step One: Identify the Routine

The first step in diagnosing a habit is determining what the exact habit is. In particular, the action that is repeatedly being performed is defined as the routine. For example, one may immediately open the Instagram app on their phone in bed when they wake up. Thus, the routine here is opening Instagram on their phone. A common approach taken by many in efforts to break this habit is trying to ignore the habit by getting out of bed immediately. This may be effective for a couple of days before going back to their old ways. Though seemingly harmless at first, thoughts such as "I have lots of time to get to work", and "what is another 5 minutes" may feel good for a while, but eventually will turn sour. Ultimately, a cyclical "I will do it tomorrow" attitude is created.

Needless to say, identifying the routine is the first step towards creating a habit loop. The routine is often rather obvious, however the following steps can be quite the opposite.

Step Two: Experiment with Rewards

After identifying the routine, the user needs to determine what is so compelling about the routine, more precisely, what is the reward. These rewards can be extremely powerful as they often satisfy cravings. These cravings are quite often an unconscious desire, in the case of social media, there have been countless studies on how the brain develops an addiction. The result is that the person is then driven by an uncontrollable urge to log onto or use social media. At the end of the day, the reward is an occurrence that triggers one's brain to release dopamine.

Now, the key here is to experiment with alternative routines that trigger the same reward. Perhaps in the case of wanting to open Instagram, an alternative routine could be reading 5 pages of a book, or getting up and doing jumping jacks. The main objective is that whatever the activity is, it must be able to satisfy the craving, and finding something that is able to fulfill this, often takes experimentation. Perhaps the first day you try activity A, then B on the next, then C, and so on. The point is to test various hypotheses in efforts to determine what desire is actually driving the routine. Moreover, does the user crave going on Instagram, or are they just trying to procrastinate going to work? Unfortunately, Instagram is favorable as it happens to be a convenient distraction that does not require leaving your bed.

Step Three: Isolate the Cue

The third step is then to identify the cue, which can be difficult for many. "When you automatically turn your car left while driving to work, what triggers that behavior? A street sign? A particular tree? The knowledge that this is, in fact, the correct route? All of them together?"³. In the case of the aforementioned example, is the person going on Instagram because they think they want to look for something in particular, or is it just what they have become accustomed to do. The cue can be a very complicated to construct, and can consist of many things. Here are some examples of common cue categories:

- Location

³<https://charlesduhigg.com/how-habits-work/>

- Time
- Mood
- Thoughts
- Surrounding people
- A certain song

Step Four: Have a Plan

At this point the person has determined their habit loop. That which includes the reward, the cue, and the routine, from here they are able to shift their behaviour toward a successful alternative routine. To put it differently, a habit is a formula the human brain automatically follows: "When I see a **cue**, I will do a **routine** in order to get a **reward**". Essentially, the goal is to engrave this new formula. Now, the question for us as the engineers is how can we build a software engineering solution that enables people to follow these steps and achieve greater success had they not used our development.

3 Engineering a solution

Now that a concrete way to discover a habit loop had been pinpointed, the next step was to create a set of requirements for our solution. We learned from our initial user study that our solution must be:

1. Have low barrier of entry to utilize
2. Educate users on the habit loop
3. Make the habit loop discovery process easy
4. Make tracking habits low effort

3.1 Scope

Next we scoped down the problem to only include creating habits that best suit the Habit Loop methodology. The constraints are:

- Must be applied to change and replace an old undesirable habit
- Must be able to include a cue, a routine and a reward
- Habit goals are user-defined

In a future expansion of this project, it may be worthwhile re-evaluating scope. That being said there was a general consensus that adding more features for the sake of adding features would be determinable, and potentially pull away from the core idea of the habit loop. Later in this document some potential expansions are discussed.

3.2 Product Requirements

After deciding on both high level objectives and scoping, SE463 principles were applied to develop a finite set of product requirements. These requirements are listed below:

3.2.1 Education

Users can read about the cue routine reward methodology, with examples and explanations for each step

3.2.2 Habit Management

The user can see their “finalized habits” and their “to be determined/in progress habits”

1. Finalized \implies The user has discovered the cue, routine, and reward already
2. In Progress \implies The user is still experimenting with the cue, routine, reward

3.2.3 Discovering new Habits

The user can enter an interface flow to add a new habit

1. The user can add a routine
2. The user can track details to discover their cue
 - (a) The user is presented with six cue questions and a short text response
 - i. Location: Where are you? *Ex: At home, in my bedroom*
 - ii. Time: What time of day is it? *Ex: Around 2-3pm*
 - iii. Mood: What is your emotional state? *Ex: Confused & anxious*
 - iv. Thoughts: What are you thinking? *Ex: Thinking about what deadlines I have coming up*
 - v. People around you: Who is nearby? *Ex: My co-workers*
 - vi. Immediately preceding action: What did you do right before? *Ex: I ate a meal*
 - (b) The user can add/save instances of the above cue question answers (independent from each other; each records a response to all of the 6 questions)
 - (c) The user can view an aggregation of their cue questions in a visual way:
 - i. Location - Displayed as a list
 - ii. Time - Displayed as a calendar
 - iii. Mood - Displayed as a list
 - iv. Thoughts - Displayed as a list
 - v. People around you - Displayed as a list
 - vi. Immediately preceding action - Displayed as a list
 - (d) The user can then select one of their previously added cues (or potentially a combination of multiple) as the final cue for their habit
3. The user can experiment with rewards
 - (a) The user can track/add a reward theory: composed of a “craving” and a “reward”
 - i. User is presented with two questions to add a reward theory and short text response boxes:
 - A. Craving: What craving do you think you want? *Ex: I want to socialize*
 - B. What will you use to fulfill the craving? *Ex: Talk to my co-workers*
 - ii. The user can save/add multiple craving theories at first; then fill in the others later. This is for the use case where a user might have a bunch of theories as to what they actually want but not sure what to replace it with yet.
 - iii. If craving and the reward are both filled out, the user can indicate if their test was successful or failed.
 - iv. Successful rewards are indicated/highlighted somehow; failed rewards are shown in a greyed out or lesser version
 - v. The user can select one of their entered rewards as the final success for their habit
 - (b) The user can add additional notes for things which are not the above
4. Once a user has added their cue and reward, the user can turn those into a new habit instance, such that:

- (a) The cue \implies cue
 - (b) The reward craving \implies reward
 - (c) The reward fulfillment action \implies reward
5. The user can see the plan statement when they view their habit from the main app screen
- (a) The user needs to write this plan with a large amount of intention.
 - (b) Thus, force them to retype their plan as a sentence
 - i. Type out your cue, routine, reward to continue! “When *cue*, I will *routine*, so that I *reward*”

It should be important to note that these requirements are NOT a design specification, which comes after feature requirements are finalized.

4 Technical Stack

4.1 Technologies Used

For the platform to distribute our solution on, it was felt that a mobile solution was the most applicable. Ideally apps exist on both the Google Play Store as well as the Apple App Store, however due to time constraints, we chose to stick to one platform, that being iOS. A large part of that decision was doing to members of the group having experience with developing iOS applications and thus this would ultimately speed up development. Objective-C was chosen for development due to this past experience, however for future maintainers may decide to switch over to Swift, there are certainly benefits this language, but it did not make sense at the time.

4.2 Implementation

4.2.1 User Interface Design Process

The first step after identifying iOS as the most suitable platform, was to convert the product requirements to user experience flows. From there the design process begins with various steps:

1. Ideation
2. Sketches
3. Lo-fi mockups
4. Design Reviews

One aspect of design that was important to keep up with was the Apple Human Interface Guidelines⁴. Apple is quite strict on ensuring that apps on their platform follow this guidelines. There are six main design principles that need to be followed: Aesthetic Integrity, Consistency, Direct Manipulation, Feedback, Metaphors and User Control.

For building our these user experiences it was chosen to use a combination of Xcode Storyboards and as well as programming flows in code. In the future moving to SwiftUI⁵ would be a good decision.

⁴<https://developer.apple.com/design/human-interface-guidelines/>

⁵<https://developer.apple.com/xcode/swiftui/>

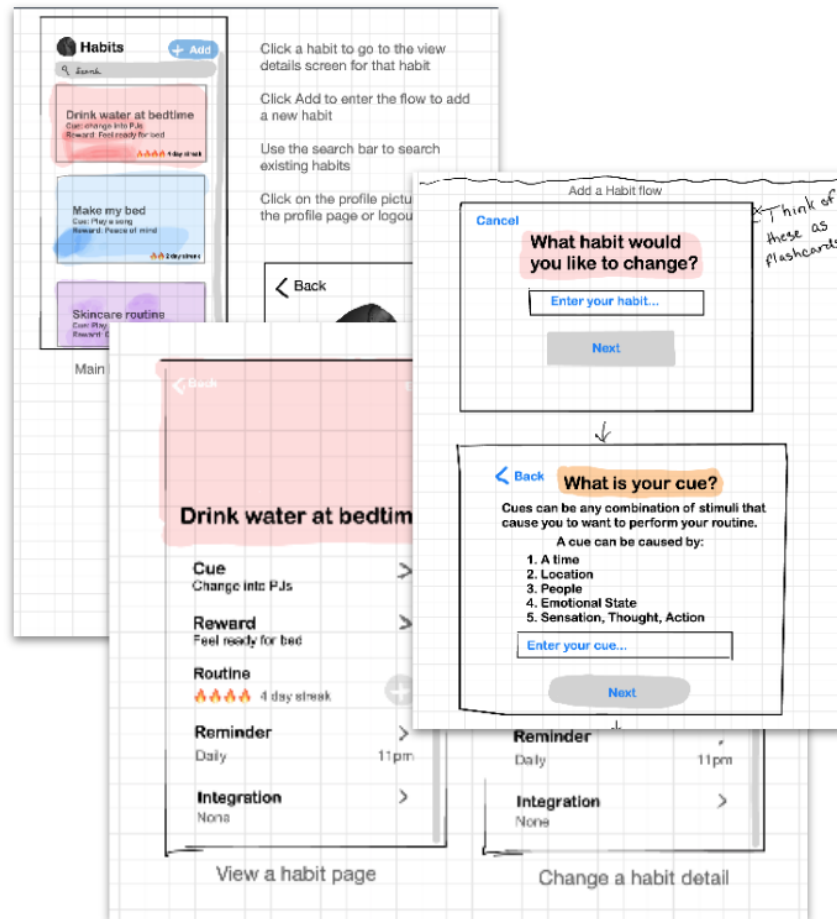


Figure 4.1: Early lo-fi mockups

4.2.2 Backend and Database Services

The current version of the iOS app utilizes Apple's CoreData and CloudKit services opposed to a tradition backend. CoreData is a local store that is effectively wrapper around SQLite. It is fairly light-weight and has great development tools in Xcode for building database schemas and having the ORM models in your codebase be generated automatically. CoreData stores all user information on the local storage of their iOS device, which is great from a security standpoint. CloudKit on the other hand, is used to sync data between all of the devices associated with a user's iCloud account. By using CloudKit habits added on someones iPhone, get pushed to their iPad, or even macOS devices (if there was a macOS app). Using both of these technologies was great, they were fairly easy to implement and get working consistently. The only downside is you are heavily locking your code into the Apple ecosystem. For a future iteration of this project, it may be worth while moving other to a dedicated backend solution, especially if there exists desire to create an Android version alongside the iOS.

4.2.3 Security and Privacy

- **Sign in with Apple:** This feature allows users to have peace of mind about their privacy. "Data collection is limited to the user's name and email address, and Apple's private email relay lets users receive email even if they prefer to keep their address private. Apple will not track users as they

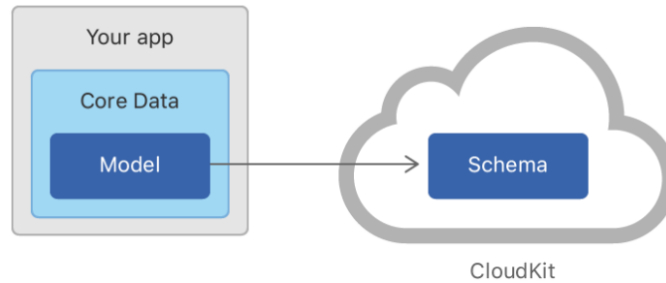


Figure 4.2: Basic CloudKit layout

interact with your app.”⁶. A benefit to using this feature, is that it moves the concern of data privacy from the application to Apple. Apple takes privacy very seriously so to have user data protected by their systems versus the applications is a great way to decrease the liability exposure of the application.

- **Habit Data:** As mentioned in section 4.2.2 the application utilizes Apple CoreData and CloudKit for handling user data. While CoreData stores data locally on a user’s device, CloudKit uses iCloud syncing to transmit information, thus the potential for a users habit data to get compromised. One easy solution is to allow users to toggle on/off CloudKit in settings. Regardless of whether multi-device sync is enabled or not, the application backend is never able to see a users habit information that they enter, thereby removing another potential liability for the application.

4.3 Potential Expansions

If implementing these in a future expansion, ensure that there is sufficient justification to do so. Adding features for “the sake of adding features” or “because we need more technical complexity” is not valid justification. Excess bloat was one of the things that was found to be detrimental to many of the habit tracking apps on App Store’s today. The following are some ideas that were brought up during the development process but were never implemented.

4.3.1 Health Data

A lot of people try to make health related habit improvement. Drink more water, exercise more and eating less processed foods are some good examples. Thus the can take advantage of health data that may be stored on a users phone. Data from places such as the built in pedometer, water tracking and even 3rd party apps like MyFitnessPal, could be used. This could be extended to an Apple Watch companion app as well, which would make this integration more accurate and more powerful. For example the heart rate sensor in the watch can auto detect periods of exercise, so if one users habits involved “go for a run during lunch break”, the watch could auto detect and inform the app that the user has done their new routine.

4.3.2 Financial Data

Services like Plaid⁷ are easy for developers to use and can allow users to integrate with over 11,000 different financial institutions. This could be used to help people who want to create financially oriented habits like save and invest money. On top of Plaid, another app that was discovered, Alpaca⁸ is an online broker that has no market interface or GUI of any kind. You have to provide the full interface in Python yourself. It could be utilized to have users do automatic investing that apps like Acorns⁹ have been doing for years.

⁶<https://developer.apple.com/sign-in-with-apple/>

⁷<https://plaid.com/what-is-plaid/>

⁸<https://alpaca.markets/>

⁹<https://www.acorns.com/>

4.3.3 Location Data

Location data could be utilized by the app to assist in managing habits that involve a specific location as part of their cue. For instance the app could send a push notification when a user gets to a certain point in their commute to tell them to listen to an educational e-book or when they go to the grocery store, make sure that they buy healthy foods.

4.3.4 Spotify API

Spotify¹⁰ has an API that can be used to play music clips within an application, as well as a variety of other features. This would not be investigated into much detail, but there was motive that it may be useful for people that who have a music based queue. Ultimately the idea was dropped as it felt too niche if a cue to focus on for an early rendition of the app.

4.3.5 IFTTT

"If This Then That"¹¹ is a service that can be used to register webhooks with actions in a wide variety of application. It was not investigated in very much detail, but it could potentially be of use.

5 Conclusion

Developing this project turned out to be a challenge in multiple ways. With completely pivoting to this new project as late as January 2020, the amount of time to "symposium day" was extremely short. Fortunately, there was ample drive to complete the project, and within weeks of starting there were already tons of brainstorming occurring with the potential massive expansions we could add to the app. They were not implemented in the app in its current form, but to a future group wanting to take over the project they are definitely something to explore. On the technical side of things there was a strong bias towards Apple products and technologies due to a strong knowledge of them. For the purposes of the project they served very well. Ultimately however, the habit loop research performed by Charles Duhigg is what allowed this project to be so successful. From the research done by the team, it was clear that current habit app offerings are falling short. The goal of this project was to build an app not only allows people to track their habits using the habit loop, but encourage them to learn about the process and by doing so help them create long lasting sustainable habits. Ultimately, there is a amazing foundation for the design of an app that displays the habit research in an educational yet engaging format. By the end of the term it was fantastic that everything was able to come together and this document was produced in order to summarize the experience from not just a software engineering perspective, but also psychology research study as well.

6 Next Steps

As the purpose of this paper was to summarize the experience and serve as somewhat of a repository of information for a future maintainer, if there is a group that is interested in taking this over especially in SE2021 and even SE2022 or beyond, please reach out to me at jjpezzac@uwaterloo.ca. Would love to take the opportunity to go through things with you. The first low fidelity prototype of the app is available on GitHub at: <https://github.com/cue-d/cued-app>. A basic demo that highlights some of the main features that have been developed as of now is available at: <https://github.com/justinpezzack/se499-w20/blob/master/basic-demo.mp4>.

¹⁰<https://developer.spotify.com/documentation/web-api/>

¹¹<https://ifttt.com/>