Capstone Final Report – M-Planner

Engineering Honors, Winter 2023

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Introduction

Over the course of their education at the University of Michigan, students encounter a plethora of new experiences, from unforeseen challenges, to impressive achievements. Unfortunately, these new experiences tend to introduce some level of stress into the lives of those who encounter them. This increased stress can have a variety of negative impacts, from losing sleep to deteriorating mental health.

One such area that can cause immense stress for students is scheduling their classes, especially for those who do so well in advance for every semester they plan on attending the University. This stress, though, does not stem from a lack of access to potential resources. From university-provided resources such as Wolverine Access or the various advising centers to tools such as Atlas, a dedicated student potentially has access to everything that might be needed to plan out their expected undergraduate classes in advance. However, while these resources are technically available, learning to access, understand, interpret, and use them can be a time and energy intensive process which can repeat every semester.

These problems, as well as others that will be elaborated on in following sections, inspired the idea for an entrepreneurial exploration of a resource which could collate the vast array of available data and automate the process of building potential schedules. By collating resources, students would need not experience stress about trying to gather every single available resource and build applicable schedules, and by automating the construction of these schedules, the tool would alleviate some of the burdens of time and energy placed on students every semester. Note that, due to time and knowledge restraints, this solution was narrowed to servicing aerospace engineering undergraduates.

Overall, this project was not intended to create a brand-new, perfectly working tool in the span of one semester. Unfortunately, the skills to do so, including development of somewhat sophisticated automation software or web-app design, were untenable to learn in the provided time. Instead, it was created to be an exploration of the entrepreneurial process, including customer discovery and data analysis, followed by the production of a workable prototype. Doing so would lay a strong, documented, research-based foundation for the eventual production of a complete product, making it incredibly valuable regardless of complete implementation. Additionally, the process would provide a guiding structure as to the eventual shape of this final product when developed in the future.

This report will have four major sections, each correlating to an important step in the entrepreneurial process. The first of these sections will focus primarily on problem development and discovery. This will include why the target user-base, and thus the scope of the project, was narrowed. The discussion will center first on finding the potential problem and, more specifically, determining the exact questions and sub-problems associated with it. It will

then shift to talking about researching the proposed problem area, with a focus on tools and solutions that already exist in the space, as well as those that could be used to help solve the problem. This will be paired with a discussion of how these resources were examined for strengths, weaknesses, and elements that were missing from the entire ecosystem. The section will then conclude by addressing the creation of an actionable problem statement based on the aforementioned research.

The second section will then discuss the collection and analysis of data for this project. This portion of the report will begin by discussing the methodology of data collection, as well as the important steps therein. Then, the results of gathering data will be shown and discussed, especially those pieces of information which were most influential towards the final prototype. Finally, the deliverables derived from this information, such as the product proposal, will be explained.

The penultimate section will then focus on the development of a prototype, referred to as a Minimum Viable Product (MVP). This will include discussion of tool selection, implementation of the data gathered in the previous section, building a first draft, and refining that draft into a more complete MVP. Additionally, this section will focus on how said prototype was iterated on and improved using further data gathering and user feedback.

This report will then conclude by explaining the conclusions gleaned from this project as well as discussing the potential future steps to fully realize the potential of the product. This section will specifically focus on what questions were able to be answered and which problems were solved, new or significant information and challenges experienced through the process, and, finally, the most important pieces of information I learned.

My hope is that, through this report and the deliverables associated with this project, I can impress upon those reading the importance of a product such as this. The environment and culture of the University of Michigan inspires success and ambition, but every step to reach said success can be steeped in stress. By creating forward-thinking tools usable by all students, one of the most ubiquitous student experiences can be made easier, leaving those affected with more time and energy to pursue the greatness that is possible at Michigan.

Problem Development and Discovery

As discussed in this report's introduction, the impetus for this project was devising a ubiquitous solution to simplify and partially automate the process of long-term schedule building. However, since this is such a large concept, some major guiding questions were also created and the associated problems were identified. The most important of these questions were:

- To what extent do students at the University feel pains centered around the creation of class schedules? Additionally, what resources are they using currently to try and alleviate said pains?
- What pieces of information and data currently exist which students are able to access to help them create schedules? Are these resources generally collated and/or easy to access?
- Do resources exist to allow students to easily plan for the long-term, such as deciding which classes to potentially take in four to six semesters?
- If a student has a major change in their plans, such as switching majors, how simple is it for them to devise a new schedule that will allow them to graduate as soon as desired?

The first step towards answering these questions was to do research on which resources currently existed in the ecosystem of the proposed problem area of class scheduling. Additionally, the strengths and weaknesses of each of these major resources were examined. Note once more that this project was narrowed to focusing on aerospace undergraduate students. The rationale for this was two-fold: the scope of the project would be too large if the entire student body was taken into consideration, and my educational experience is in line with this group, making the discovery process more efficient and effective.

The first of these resources was the slate of sample schedules provided by the University of Michigan, such as those on the Engineering Advising Center website. These are, as the name suggests, single PDFs or Google Sheets documents which display a potential schedule for students to follow. One major strength of this resource is that it is both explanatory and simple; if someone were to stick to the schedule exactly and pursue only the selected major, it is almost certain that they will graduate on time. Additionally, the PDFs break down the many requirements into easily-understandable sections, such that the number of credit hours expected are simple to see. Third, it provides a snapshot of a four-year education, which can be very helpful for long-term planning. However, while this is a helpful resource, it has some fairly impactful drawbacks. First, it is entirely inflexible; if someone decides to pursue a minor or came to the University with some credits fulfilled, it might quickly become impossible to build a schedule that lines up with the provided one. The second drawback is that the schedule can present semesters that might be much too difficult for most students. For instance, the sample aerospace schedule suggests taking an advanced calculus class, physics 240, and a design-build-fly class in the same semester, each of which is intensely difficult on its own.

The second major resource which is very heavily relied on are advisors and the advising

centers, such as the previously-mention Engineering Advising Center. These resources and advisors, which tend to be invaluable for students who have schedules more complex than a single major, generally offer a wellspring of information for students. Department-specific advisors can be especially helpful, as they can generally offer an explanation of which classes are important to take and suggest alternates if needed. Another strength of these resources is that they are much more flexible than the sample schedules discussed previously. Instead of having one set path, advisors can look at each student's individual goals, requirements, and completed courses to help personalize a schedule for that specific student. Lastly, advisors are able to ensure that a student did not miss an important requirement or barrier, such as the fact that one can't double-count two computer-science minor classes for their selected major, ensuring that everyone can graduate when expected. While these upsides are great, there are a few downsides that make it untenable for a student to only rely on them. The most major of these is that an advisor's time might be extremely limited, meaning they can only meet with you once or twice in a semester. Thus, if a major change occurs, a student might need to find alternate resources to help.

A third resource examined in this problem development phase was a generally understated one: a student's peers. One major upside of asking a peer for help with scheduling is that they have generally taken the required courses more recently, meaning that they can provide additional context such as a professor's teaching style or which classes to avoid taking at the same time. Additionally, by taking classes in tandem with their peers, a student can develop strong educational circles which they can rely on for help if a class becomes difficult. However, due to peers generally being fellow students, one major downside is that their advice can be tinged by bias or a lack of knowledge, such as not liking a specific subject or not knowing which semesters a certain class is generally offered. Additionally, peers' ability to help can vary, meaning a student needs to put in time and energy to ensure the information they recieve is valid and applicable to their specific circumstance.

The fourth and final major resource to be discussed in this section is Atlas, an online tool that many students use to research and schedule their classes. The most major benefit of this tool is that it provides an incredible amount of data about almost every class at the university, such as teacher ratings and past grade distributions. Additionally it can provide exact times of classes one semester in advance, making backpacking a much easier process. However, one major downside is that, due to it primarily being a tool to research and backpack courses, Atlas is much less helpful if a student does not already know which of these courses they plan on taking. Additionally, the tool's scope is limited, as it can only look at the past and one semester ahead.

As is obvious from the resources described, as well as those that are not presented in this report, there are many benefits of currently existing scheduling tools. Additionally, the strengths of each tool can generally help alleviate the weaknesses of another. Despite this, there are some missing elements and identifiable problems in the entire ecosystem. The first is that the resources are generally scattered across different University of Michigan websites. For instance, to access the sample schedules, one must access the Engineering Advising Center website, navigate to the Resources and Assistance tab, and then locate the appropriate link amongst the many on the page. While this doesn't sound too complex, doing

this for each resource every time a question or problem arises can quickly consume a student's valuable time. The second major problem is that none of these resources individually provide a quick way to flexibly plan for the long-term.

This research, as well as the guiding problems identified in the previous paragraph, culminated in the formation of a problem statement to guide data collection and product development. This problem statement was:

> "Though ample data and resources are available to students about their potential upcoming courses, there is no service or tool which collates the information and allows students to use it without potential long waits or heavy investments of personal time or energy."

Data Collection and Analysis

Following problem development, data collection was performed in order to confirm the identified problem, identify the specific points of pain it caused, and develop a solution that would actually prove helpful. However, unlike most pure-engineering problems, it is difficult to apply numerical or experimental value to this more subjective problem and its requisite questions and sub-problems. As such, the overall data gathering was, overall, also subjective, consisting primarily of interviews and surveys of those identified to be most affected by said problem. Doing so allowed the interviewees and their responses shape the eventual product.

The first step in this methodology, however, was to identify the group most affected by the problem. As alluded to earlier, this was decided to be undergraduate students, and was later narrowed to aerospace undergraduates to make the scope of the project feasible. There were three main reasons undergraduates were chosen:

- Generally, undergraduates are new to the process of identifying classes and creating classes.
- The large number of undergraduates relative to other types of students means that bottlenecks, such as those to get advising appointments, can have more of an effect.
- Being an aerospace undergraduate myself made it easier to empathize with the interviewees and more narrowly focus the eventual solution

The second step was, as would be expected, interviewing members of the identified group. This was done through two major avenues: a survey via Google Forms and in-person follow-up interviews. The former garnered 23 responses from seniors, juniors, and sophomores in the department, over five percent of the overall aerospace undergraduate population. The latter helped to better understand what people said in their responses, and then refine their idea and integrate them with my own.

After the interviews were performed, the results were collated and important trends were identified. The three major important themes were whether the responses confirmed or refuted the identified problem, what specifically caused pain for those affected, and what would the ideal shape of the solution be.

The first major piece of evidence that the problem in long-term scheduling existed was that each semester students were spending, on average, almost 2.2 hours more on scheduling than desired. The following graph displays these findings:

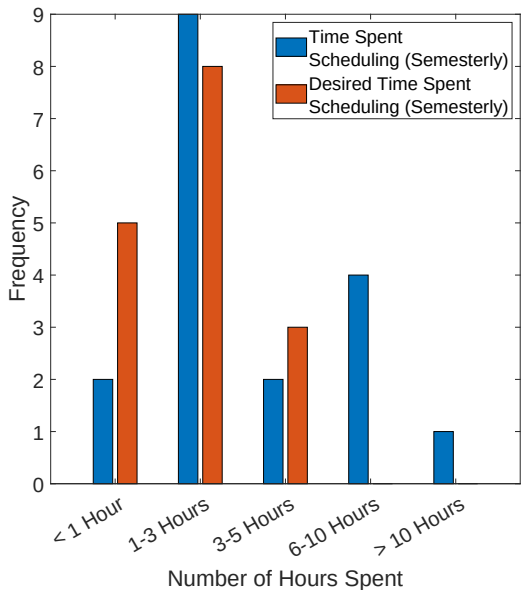

Figure 1: Time students spend scheduling each semester

As a corollary to this statistic, almost every person interviewed listed some or all of the resources discussed in section . This was a significant step in confirming the existence of the problem, as, despite the resources being known and available, people were still investing more time than desired into scheduling. Another interesting result was that, out of the resources probed during the survey, peer assistance was the most positively reviewed. Self-scheduling through resources such as the provided schedules and Atlas was often described as hard or confusing, and advisors were generally positive and informative, but also described as sometimes hard to reach.

As mentioned these results also helped shape the eventual product. One of these clearest pieces of evidence for this is that 80% responded that they would actively use a tool to help build long-term schedules. The specific results are shown in the following chart:

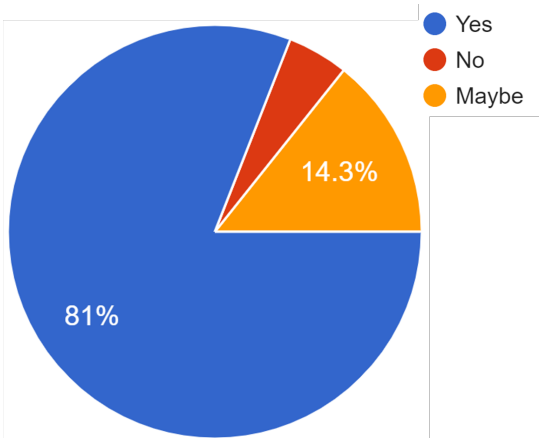

Figure 2: Students who would actively use an online long-term scheduling tool

Additionally, when asked what their primary concerns were in terms of long-term scheduling, the interviewees listed the following:

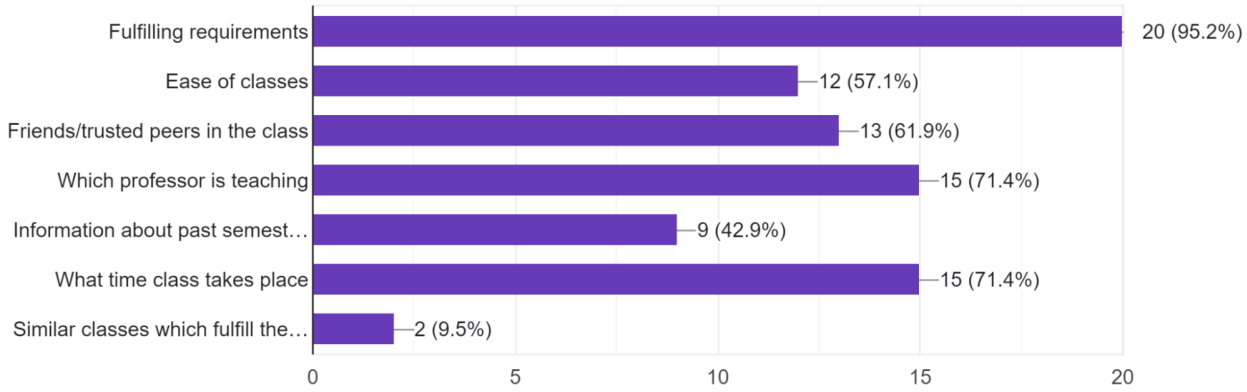

Figure 3: Important elements for schedule creation

Unfortunately, as much of the data was not numerical and was instead subjective opinions, not everything could be displayed on graphs or charts. As such, upon the completion of the user-discovery process, two deliverables were created. The first deliverable collated the findings, discussed how they conformed to the identified problems and questions, and concluded with a go/no-go summary. This last section was a result of the analysis of the data and the research done therein, and simply stated whether or not there was room and desire for an entrepreneurial venture. Unsurprisingly, in said document I concluded that the problem and project were valid.

The second deliverable was a proposal for the eventual minimum viable product. It synthesized my personal ideas and the results of the findings, proposed the general form of a solution to the problem, discussed what knowledge would be required, and laid out a potential plan for the path forward.

Product Development

The second major phase of this project was the development of a prototype or, in other words, a minimum viable product (MVP). As per the previously-discussed discovery and product proposal, this MVP took the form of a working model for an online, automated schedule-building app.

The first step to develop this MVP was to identify the available tools. After researching the options available, such as the online website-building tool Wix, I decided to use Figma due to its ease-of-use, modularity, and powerful functional capability. Next, as a continuation of the same product proposal, the list of ideas and suggestions to implement into the MVP was pared down based on three main attributes which are generally relevant to entrepreneurship:

1. Relevant: Did the idea adress a concern expressed by interviewees?
2. Actionable: Could the idea be implemented in Figma or a similar program?
3. Timely: Could the idea be implemented in the provided time frame?

Once the ideas were gathered, the next step was to make an initial draft of the MVP. This draft had a few main purposes, but the primary among them were to implement important functionality and provide bare-bone aesthetics. For instance, during this time, the home-page had the following form:

Figure 4: Initial M-Planner Homepage

Additionally, although it could not be easily displayed, each "button" on this page was capable of transitioning to other pages through user-interaction, providing the necessary functionality for the app. The final step in the development of the MVP, after a complete first draft had been created, was to refine it by including advanced functionality and replacing placeholder sections with more complete images and text. For instance, after this process, the same main page from figure 4 evolved into:

Figure 5: Initial M-Planner Homepage

Although the MVP had been created, it was not yet finished. One of the most important steps was to allow the potential users to interact with the prototype such that they might find areas that may have been overlooked or propose further functionality or fixes, and then act on those suggestions. This period of iteration and improvement ensured that the users' needs were met and that the eventual product would be able to serve them effectively.

As an example, one of the biggest pieces of feedback was that users would appreciate being able to toggle whether or not others could see which classes they plan on taking, which would allow community building but also allow people to be private if they preferred. As such, a functional button was introduced to achieve that:

Figure 6: Page with the option to share ones classes

Another area of improvement was including more effective access to Atlas information, which was fulfilled by introducing hyperlinks to the appropriate Atlas pages when a class name was shown on the screen.

Conclusions and Discussion

As this project was, as mentioned, primarily an exploration of the entrepreneurial process as it pertains to an engineering application, many of my takeaways focus on said process. The first, and likely most meaningful, is that strong, research-based formulation of plans is incredibly impactful in creating a successful end-result. In other words, while it is possible to create something passable without doing the prior work, creating something truly meaningful takes much more. For instance, without deliberating on what resources were available, examining the strengths and weaknesses of current tools, and surveying with my peers, the product I delivered would have had half the functionality and, thus, little-to-no actual feasibility.

The second important conclusion is that entrepreneurship, along with engineering as a whole, are best when done with help from others. Advice from people such as my advisor Professor George Halow, to the peers who I interviewed, to friends who I asked to read over my presentation poster was invaluable in ensuring that the end result was as strong as possible, and that the ideas were expressed appropriately.

The third and final conclusion I reached is the importance of documentation for the survivability of a project long-term. It is unfortunate that, due to time and knowledge constraints, I was unable to create a fully-working application by the end of my senior year. However, I am confident that I layed the appropriate groundwork and kept strong notes, both of which will allow me to continue my work into the future.

Additionally, I would like to briefly confirm that the questions posed earlier in this report were answered in full. The need for a tool to help students plan their long-term schedules exists, and my proposed solution could help fulfill that need.

Finally, along with the successes presented throughout this document, it is important to also touch upon the challenges I faced. The primary one was, as has been alluded to, the simple fact that time was an extremely limited resource. The University of Michigan is a demanding place, and it is no less so for seniors. Were I able to dedicate all of my time to this project alone, I am confident my end-result would have surpassed what I did. However, I don't regret this fact, and instead treat it as inspiration for when I begin my life in the working world. The second major challenge was finding and encouraging people to participate in discovery. My peers are also busy, so getting them to engage with a project tangential to their current life was difficult. However, I did learn techniques and skills to help me better communicate with those who would be most helpful to the completion of the project.

Appendix: Deliverables

A comprehensive list of all deliverables, from the customer discovery survey to the completed Figma model, is located at this link.