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Master's Thesis
Academic Year 2019

# ParavenTo
# Redefining the Personal Work Space and Renovating the Portable Partition for Better Work Efficiency

Keio University
Graduate School of Media Design

Ziqing Wang

A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

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Abstract of Master's Thesis of Academic Year 2019

# ParavenTo
# Redefining the Personal Work Space and Renovating the Portable Partition for Better Work Efficiency

Category: Design

## Summary

The movement towards a more intellectual and informational society has demanded more attention for improving the working conditions of knowledge workers, who are and will be the main characters for this modern economy. Traditional office designs are no longer satisfying for many, and knowledge workers are on the look for new solutions for creating a more personal and comfortable work space. This paper wishes to focus on especially the group of knowledge workers in Japan, where most office still utilize the traditional open office design, with little privacy for each individual. ParavenTo is a solution for each and every knowledge worker, who wants more privacy, penalisation, and organized workspace for better efficiency. As our society advances with new immersive technology, redefined notion of spacing, privacy and modernized understanding of corporate efficiency, revisiting theories developed in the late nineties can not only shed new light on the relationship between behaviors in private spaces versus that within a more public area, but also provide new approaches as to ways of maximizing efficiency, a much-desired benefit for students, workers, and declining economies around the world.

Keywords:

Design Thinking, Work Efficiency, Knowledge Work, Office Design,
Smart Workspace, Japanese Styled Office

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# Chapter 1
# Introduction

## 1.1. The Importance of Knowledge Work Efficiency

Progress with modern technology has changed much about the way of which we live our lives in a modern society. Labor and/or work required of humans are shifting away from repetitive, manual processes, to more knowledge or creativity-based ones. In other words, the global economy is advancing beyond an industrial one, a model that was first triggered by the Industrial Revolution across Europe and the US, to a more knowledge-based one. Although the notion of knowledge work is not new to the business management realm, it is only within recent years, with the rise of strong emerging economies around globe, did knowledge workers become one of the strongest voices in the modern work force. Office of the industrial economy derived from its template from the factory floor, from Fordism and Taylorism and from the close observation of process tasks and manual labour [1]. Such office spaces will not be able to satisfy the demanding working environment of a twenty first century knowledge worker, and will need to redesigned. Creativity, communication and efficiency all require a more flexible approach to the relationship between the space and those within.

Manual labor efficiency was increased by as much as fifty percent thanks to better tools and changes in factory layout. Meanwhile it is extremely difficult to measure and quantify the working efficiency of a corporate analyst, a designer or a marketing director. Industrial economy results in actual products that could be counted for their quantity and tested for their quality, while knowledge-based economy generate ideas, blueprints and creations that are more than mere data points on any chart. Such results, however, can more be simply measured by the

quantity, therefore making quantifying efficiency a very difficult task. Nonetheless, the eternal subject of maximizing that efficiency still remains. Updating that outdated factory-like office space therefore become s a major point of renovation, which could in turn have huge effects on work efficiency.

## 1.2. Motivation

As Thomas Davenport and Francis Duffy both point out in their separate works, little is known about knowledge workers [2] [3]. Hence the revolutionary solution for maximizing work efficiency has yet to surface. This paper does not seek to explore the vast possibilities of office design, physical space organization or layouts that could potentially influence all workers in a shared space, but rather want to focus on creating a portable personal working space, which can be easily used and stored away for a variety of situations. Through my own experiences of working in open offices, studying in libraries and cafes, I noticed several factors that have impacted my ability to work detrimentally.

**(1) Noise and Ambient Sound** One of the most irritating problems I have encountered is the noise and other ambient sounds that are plentiful in public working spaces. Personal preferences for the ideal noise level may vary, regardless of one's preference, it is often hard to adjust a public environment to suit those needs. I tend to fall on the quieter end of the spectrum, especially when I need to focus, and it is been quite difficult to find suitable spaces unless it is within the luxury of my personal space or public libraries. Obviously that is difficult to achieve for most work situations as such noise poses as one of the most major problems for a high-efficiency work environment. Ambient sound, on the other hand, has been recognized as having no direct effects and annoyance among workers [4]. It helps generate a more realistic environment for some and there are numerous apps nowadays to help create that. With all that said, I have decided that my first priority with this project would be to solve the problem of noise affecting work efficiency negatively and to be able to control the level of optimal ambient sound for maximizing efficiency.

**(2) Peripheral Vision** The second problem coming up would be the actions happening in the background of my peripheral vision. Open spaces do very little

to help limit my vision to only what I am working on at the moment, therefore, I tend to be easily distracted while not using all of my energy to focus, especially when there are big-scale active movements. It ranks as my second priority, after noise, as I find it easier to ignore movements around me than loud sounds in the background while I am working. The solution should also be portable since I do not want to be completely oblivious to my surroundings, as I may need to communicate with others, or provide assistance to others.

**(3) Olfaction, Taction and Other Distraction** The third problem is really quite a minor annoyance compared with the first two, nonetheless, it does become an obstacle to achieving the maximum amount of output that I generate. Although it is often strongly discouraged, I can always encounter someone with very strong perfume/other cosmetic products, food or drinks with strong smell. Most of the time, these are honest misunderstanding situations as in "one man's poison is another man's treasure" situations, they are annoying nonetheless. Also, there could just be that chair which is super uncomfortable, or a really inconvenient placement of the charging socket, etc. etc. There are always numerous obstacles to the road of an ideal working space in a public area, and I really wanted something that could help me with creating my own comfort zone within the larger space. Therefore, my third goal is to have my product suitable for a wide variety of problems, preferably with some DIY features that can be customized to suit personal needs.

**(4) Privacy** Privacy has become an increasingly pressing issue, especially with the advancement of technology within the work space. I believe that every knowledge worker should be able to do his/her own work whenever and wherever without having to worry about his/her data being stolen either through remote hacking or simply someone looking over his/her shoulders. This is definitely a relevant problem when working in a public space. Of course, it is not extremely common to have malicious data-stealing parties sitting next to me at all times, but it is important to maintain that awareness and safeguard my work. So the last pillar I have for my project would be to able to offer some protection against simply security breaches such as over-should peeks.

With all of the above, I was only focusing on situations when I needed to do some quiet knowledge work, which usually does not involve collaborating, or generating

creative ideas with others. There are also numerous other occasions when I needed to speak with colleagues, classmates and friends to perfect my rough ideas, or even conduct some initial brainstorm sessions. The quiet and peace of my own home or the library offers would not be suitable for these situations. I wanted my product to be able to offer that flexibility, along with portability, so it can be beneficial for a broader range of users under more circumstances.

**(1) Knowledge Work** For the purpose of this paper, knowledge work refers to the kind of intellectual work, whether it be making Excel files, writing reports or conducting background research, that require the worker's concentration and usually can be completed alone. In other words, consider this type of the work the "typical" desk job, scientific research, or code-writing. This term will be used mostly in contrast to creative work, which will be introduced below.

**(2) Creative Work** Creative work, as mentioned above will be the direct opposite of knowledge work for this paper and my research. This is what comes to mind when one thinks of designers, artists and anyone doing anything that require a fair amount of collaboration and improvisation with others. Of course, this type of work can obviously be completed by one's lonesome, but here I would like to consider creative work a rough equivalent to collaborative, stimulative group work that aim to generate new ideas and designs.

**(3) People Work and other Craft Work** People Work refers to face-to-face work, i.e. communicating with clients, colleagues, interviewing, serving etc. and Craft Work is the work of crafts, such as the works of carpenters, electricians etc. They are quite the opposite of one another, as the former requires a tremendous amount of communication and problem-solving skills, while the latter solely depends on the craftsman's expertise and experience within his/her own field.

There are many other types of work that I will have to choose to neglect for the purpose of this paper. For the purpose of this research, I will be introducing the design of my product and exploring possible solutions for creating a better personal working environment within a larger public space.

## 1.3. Research Goal

This research will be focusing on such environment descried above and trying to solve the problems it has, especially for those who are working in an open Japanese office or similar environments.

While the open environment has several benefits, such as better communication among colleagues, more efficient usage of available space, and better management results, the problems are also very obvious. The most important one that this paper wishes to focus on is the difficulty for individuals within in large open and public space to focus on his/her own work. Provided if there are some outside distraction, and there usually are as auditory, visual, olfactory distractions and privacy concerns are often at stake within such environments, the knowledge worker will be interrupted and disturbed during his/her work.

The goal of this research therefore, is to zoom in and focus on the knowledge workers working in this environment and attempts to provide a solution by designing the product ParavenTo. ParavenTo will aim to be a product that can provide a personal space within a larger public space, that is immersive, safe, personalized, and space-efficient. These factors combined will create an environment that can provide a more efficient working environment, which will benefit the knowledge worker within the space. ParavenTo is also portable, therefore, the knowledge worker can use this product while on-the-go, and enjoy that personal experience, whenever and wherever he/she wants.

## 1.4. Significance

Adding the flexibility element to the office space, or any public space of which individuals need to focus on intellectual work, would be extremely beneficial for societies like ours. By maximizing work efficiency and creating a more focused space suitable to a variety of working situations, knowledge workers will be able to produce works of better quality in a shorter period of time. The infamous overwork by death problem, or perhaps the concept of overtime in general, will see improvements as workers have become more focused and efficient by using my product. Most assuredly, these serious social problems have deeper roots

than mere low work-efficiency, nonetheless, clearing the obstacle of having a low production rate working space will significantly help with the problem of having difficulties focusing during work due to issues of working in a less than ideal office space.

The portability, flexibility, and multi-functionality of this product is an attempt at a problem bigger than any individual. Yet, it stems from a "trickle-up" mentality of solving the individual's problem first. Eventually with everyone's efficiency increased by a certain percentage, a collective of any form or size, will be moving towards the better working environment that all knowledge workers around the globe deserve. An insignificant gesture of using a new kind of partition screen, ParavenTo, will indeed shed new light on a new way of creating a personal space within a much larger public space, which in turn leads to a new way of becoming more efficient.

## 1.5. Organization of Thesis

The following paper will be organized into five chapters.

- Chapter One, written above, illustrates the current lack of attention paid to better work environment for knowledge workers, lists some potential problems of doing knowledge work in a public space and proposes the idea of ParavenTo.

- Chapter Two discuss three main foundations for this research, the field of proxemics, the concept of knowledge work and work efficiency, and various office design and partitions. The discussion includes both review of academic articles and display of illustrated design examples.

- Chapter Three describes the design process of ParavenTo in the order of design thinking process, which includes target persona, concept scheme, concept sketching, use case, making story, key paths, customer journey and concept drawing.

- Chapter Four evaluates product designed in Chapter Three by conducting user tests and further modifies the product based on user feedback.

- Chapter Five draws conclusion, reflects on limitations of the research, and prospects future works and potential collaborations.

# Chapter 2
# Related Works

This section provides some background information on the concepts frequently used by the author. The concepts are explained in detail in historical contexts, as well as contexts specifically catered towards the purpose of this paper. This section starts off with the definition and history of knowledge work, and explains the significance of knowledge workers to a modern economy. It then shifts gears into explaining the possible methods of measuring knowledge work efficiency and experiments conducted to quantify work efficiency. The second topic introduced is the history of design of modern offices, some current common examples, and innovative futuristic designs as the society progresses. Lastly, the concept of proxemics, a segment of non-verbal communication is introduced. Utilizing interpersonal distance and how humans perceive space is the underlying core of this research. After all, understanding human behavior within a certain space and utilizing that space to maximize work efficiency is the ultimate goal of ParavenTo.

## 2.1. Knowledge Work and Work Efficiency

### 2.1.1 The History of Knowledge Work

The term "knowledge work" and "knowledge worker" and the concepts associated with these terms are in fact not new, as it is easy to get the impression that it is so. Fritz Machlup[1], as early as 1962, while observing development in American society, established knowledge-based activities as a crucial area of modern economics for research purposes. Famous economists Peter Drucker [5] and Daniel Bell [6] subsequently popularized the idea beyond academic circles. Almost si-

1 Machlup was an Austrian-American economist 1902-1983.

multaneously, Japanese researchers foresaw a future society, one which would be dictated by information (*johoka shakai*).

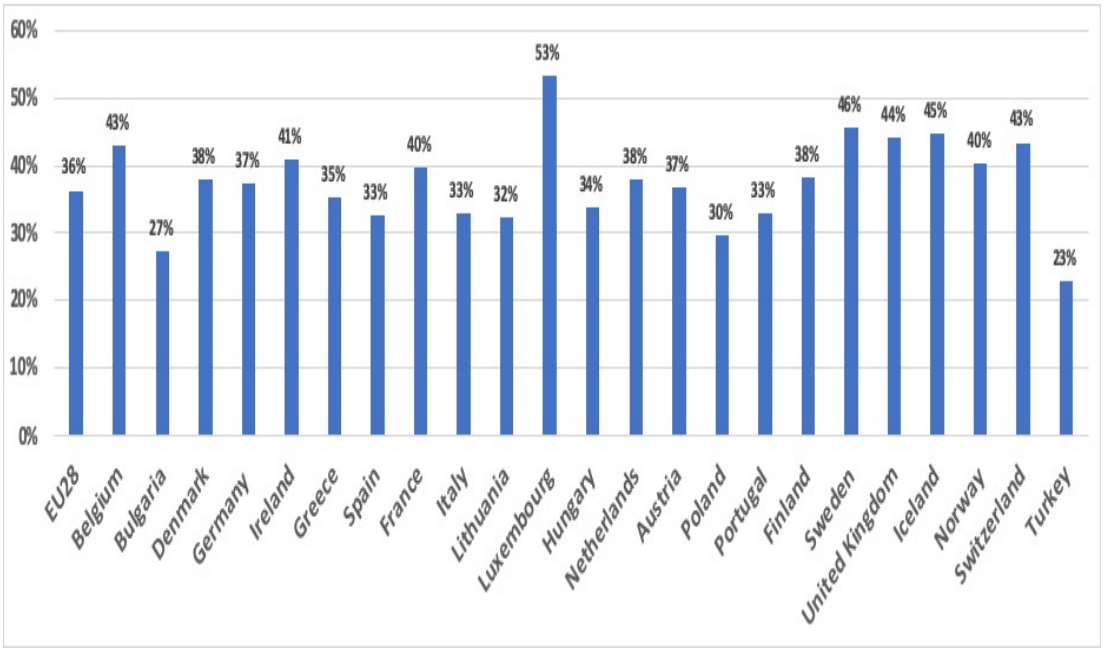
These early schools of thought all had different roots from a variety of academic fields and cultural contexts, but it is obvious that the modern society was transforming to be a more information based one as global economy was going through an informational revolution. More information services and goods were becoming a relevant part for people's daily lives and communication systems constituted one of the fastest growing and most desirable area of economy that nations are hungry to develop. Meanwhile, leading economies worldwide also witnessed the rise of knowledge work as major trend in labor markets, as it became "a major factor that distinguishes globally competitive economies from their weaker rivals" [7]. Eventually fast forward a few decades to today to a more globally connected, complex and specialized information societies around the globe, this development of information and knowledge work "signals the terminal demised of industrial man, typified by the Fordist worker who has become a minor player in the overall pattern of economic life" [8]. The era and the aftermath of the Industrial Revolution is over, as the world welcomes a new era of information. With that said, the terminal demise is not only to the industrial man, but also the factory-based design of the modern day office. It is no longer effective and satisfactory for the era of new knowledge workers, as the work demands significantly different skills from those of the industrial man.

### 2.1.2 The Rise of Knowledge Workers

There has been a significant rise in the number of knowledge workers employed around the globe in recent years. Figure 2.1 referenced below shows the employment statistics for selected European countries in 2018.

#### Innovation and Technology

A crucial factor for societies to move towards a more information based one is the development of technology, which in turn drives the need for innovation. In his work, *The Work of Nations*, Robert Reich[3]introduced the concept of what he calls symbolic analysts, explaining that this category of workers include designers and




(Source: Eurostat [2])

Figure 2.1 Employment in knowledge-based industries in Europe 2018

other expert workers that need to utilize creativity and innovation to complete their work. Subsequently, Reich in his analysis divided the workforce of the US, as well as other developed economies around the globe into three distinct groups: 1)routine production services, 2)in-person services, 3)symbolic-analytical services [9].

Without going into too much daunting detail, the three divisions are summarized as below.

- **Routine production services** means repetitive tasks guided by standard procedures and codified rules, which includes traditional blue-collar jobs in factories, but also supervisory positions with strict routines. By 1990, this section compromised about one-fourth of the US workforce, and the number was steadily declining.

- **In-person services** as the wording suggest, means routine tasks and services provided on a person-to-person basis, instead of products produced by routine production services that could be sold worldwide. Jobs within the hospitality industry, as well as hairdressers, secretaries, all fall under this category. By 1990, this group accounted for about 30 percent of the US workforce, and the numbers were rapidly growing for this particular group.

- **Symbolic-analytical services**, similar to the concept of symbolic analysts, entail all the problem-solving, innovative activities that are non-standardized. These services can be traded worldwide, unlike the in-person services, and are thus susceptible to global competition. Symbolic workers usually work in small teams and prize the skill of critical thinking, as well as innovative problem solving.

The usage of technology, such as laptops and personal digital assistants, is no longer uncommon, and the choice for such devices is also an important differentiating factor for different types of knowledge workers. This approach can be limiting, however, as many other factors, both as preferences and as requirements are also influencing the choices of knowledge workers. One such factor is mobility,

3 Robert Reich is an American economist, professor of political science. He was the Secretary of Labor from 1993 to 1997 under Bill Clinton.

which is a requirement for some and dictates and influences the choices of which technological devices knowledge workers carry around with them [10]. The needs of an individual who frequently travels and only drops by the office for several hours on a weekly basis has a completely different demand for gadgets as a low-mobility office worker who spends most of his/her eight-hour workday within the office. As a result, technology not only changes the style of which knowledge worker produces value, but also the way in which they react with the work space as a whole.

## 2.2. A Story of Modern Office Design

Figure 2.2 A Typical Design of the *Burolandschaft* Office [11]

As the awareness for office design and work efficiency for knowledge workers rise, the modern office is also slowly transforming in its design. While from 1910-1940s, the dominant image of the office is the assembly line, it has been slowly transforming. As early as 1911, Frederick Taylor explained in his *Principles of Scientific Management* that the hallmark of office design is efficiency. The furniture layout within the office that minimized "wasted" movement was the goal,

because it would in turn reduce wasted time and money [12]. This concept still serves as a guiding pillar a century later, as modern offices continue to evolve to be more friendly, and more efficiency-oriented, with an updated definition of the word efficiency.

Figure 2.3 Example of an open-plan Office
[11]

Several alternatives were proposed along the way of slowly moving away from the assembly line design (some offices even had conveyor belts for moving around paperwork and other objects) [13], such as the private offices, integrated office layout and a variety of open offices. While the private offices featured privacy and quiet working space for the occupants, the open office layouts promoted communication, participation and equality. By 1960s, the time was just right for *Burolandschaft*(Figure 2.2), or "office landscape" to be introduced in the United States. It is an "entirely open office arranged for efficient work-flow, convenient communication and minimal indications of status" [11]. While the private offices were all about using physical separation as a symbol of status, the *Burolandschaft* was all about denying that mindset. The *Burolandschaft* eventually also evolved into several formations, one of which is called the *open-plan office*, shown in Figure 2.3. It is an integrated form of the modular office, and some open space for

more collaborative work.

Complaints, however, were always present, throughout the course of this historical developments. Private offices, received criticisms from critics such as too rigid in form, a mere symbol of status, and basically a waste of space and efficiency. Meanwhile the open office started receiving negative feedback from office workers, despite the general praise of critics for its design for issues such as noise from co-workers, lack of privacy, unable to show status and the movement of others occupying the space. Eventually office workers from a variety of industries became disenchanted with the purely open office design, and some even reverted back to the private office layout. More, however, chose to proceed with a more hybrid solution, as at least one legacy of the open-plan office remained - the modular work space for the individual [14] [15].

### 2.2.1 Examples for Common Design Today

This section will introduce some common design that are generally utilized in offices around the world today. Figure 2.4 and 2.5 shows two of the most common designs utilized around the world, and Figure 2.6 subsequently shows the Japanese variation of the open office design, the island office (*shima ofisu*).

The cubicle design still has the legacy from the open-plan layout, as this design is mostly utilized in western companies and countries, for industries that require more individual work while workers are at their individual stations. Its benefits include less distraction from outside environment, as the cubicle is able to block out visual, as well as some auditory distraction, more privacy for each individual and more efficient use of the floor space than providing private offices for everyone. With this design, obviously the more collaborative and communicative work has to be taken elsewhere, as groups of workers need to move to another meeting room of some sort in order to effectively communicate with one another on a face to face basis. It is also at time a bit problematic for the management of the floor, since the cubicles do divide the space up visually, what each and every employee is currently doing is hard to grasp for those who want to keep a tight watch.

Another popular design is the open office design, which also has a long history of being utilized in a variety of industries and are still quite popular today, especially in Japan. It has even evolved into another format, with a more Japanese twist

Figure 2.4 Classic Cubic Design

named the island office. As mentioned before, the open office has several benefits including easier access for better communication, less differentiation among all the workers to show equality, and less space wasted as all the furniture is placed together to create big rows of tables. It also offers more convenience for those in charge, as managers can easily see what their employees are doing. The disadvantages are also abundant, as it lacks privacy for the individuals within the space, has way too many outside distraction factors and can easily become a messy and untidy environment for many.

The Japanese version, however, deviates from the original design, and while inheriting some of its disadvantages, turn some goods into bads. In a Japanese office, the most senior member or member with the highest level (who is usually the most senior member) sits at the "head" or tip of the table, furthest away from the door, while the rest of the members sit according to seniority, with the most junior member closest to the door. This way, the most junior member is put into the position of welcoming guests, should there be any, and run errands for the entire group. Surprisingly this variation of the open office, shows clearly the status of each member as the seating arrangement is very much telling. Management

Figure 2.5 Classic Open Office Design

Figure 2.6 Japanese Island Office Design

benefits still remain, and as the Japanese office culture is on the quiet end, there are generally less conversations and movements from the workers. The privacy issue still remains but other forms of distraction are greatly cancelled out by the office culture. Regardless of its advantages and disadvantages, the island office remains one of the most popular office design in Japan, as it is deeply rooted in Japanese corporate and business culture.

### 2.2.2 Design-Conscious and Smart Modern Office Spaces

While most designs fall on the spectrum of private, open, or of the hybrid nature, it is inevitable that office designs, a format of interior design, are difficult to manipulate physically. Furniture is difficult to move around, therefore many companies provide different rooms for different working scenes. Some designers and companies are willing to be more innovative and especially with the growing influence of technology within the workplace, there are many flexible and smart designs for a different kind of office layout.

Figure 2.7 Clover Design

One such example would be the clover design [16]. It is sometimes referred to

as American-styled island, which derives from the Japanese island office design. It features four small, movable table that can be rearranged for a number of purposes. It is certainly a good effort and breaks the wall of office furniture being immobile. The downside is the tables being too small for a real workstation, and as a result these tables and chairs seem like a temporary solution. Another one is the fact that the clover design is essentially an open design, all the distractions that are present in an open office are still present.

Tech companies and startups are especially fond of creative, smart and new designs. Google, for example, is well known for its bold office designs with its offices around the world, each featuring a different kind of design. Figures 2.8 and 2.9 show some examples of Google's bold offices in Sydney and Budapest. Each office of Google feature a different theme and over the years Google has constructed some very creative workspace for its employees. The space however, is one of several options that Google employees have at their disposal for work, as Google's offices are known to be spacious. In the end, while these offices are bold and futuristic, the creative option is only one of the options for employees to choose from, and is almost impossible to replicate by other companies. Therefore the benefits are limited for those who do not work for Google and other firms of this caliber or with similar cultures.

Figure 2.8 Google Office in Sydney. Courtesy of Google.

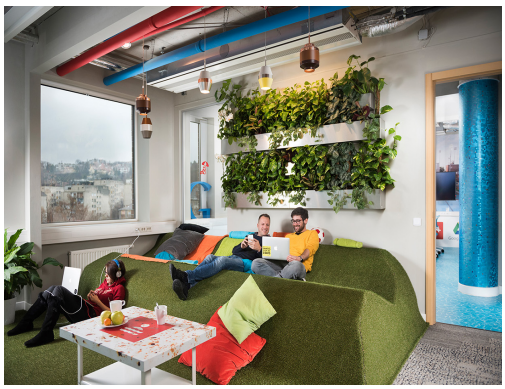


Figure 2.9 Google Office in Budapest. Courtesy of Google.

## 2.3. Current Partition Products

While the office design is being improved for better comfort and awareness for knowledge workers, many efforts are being made in the non-renovation department. Because renovating and redesigning the office space is such a huge project, and can only be completed on a macro level, partition products became the best alternatives for individuals who thrive for a better environment. This section will introduce a few of such products and showcase how ParavenTo will be offering a different experience than that of these existing products.

### 2.3.1 Interion Standard Office Cubicle Partitions

The Interion® partitions are an excellent example of the standard office partitions, just as the name suggests [17]. Its main feature is to separate an open office into smaller cubicles and create a little bit more private space for the individuals occupying that space. There are three variations of this standard product, the all fabric panels, the panels with partial window and the panels with whiteboard. The all fabric panel is the most basic model and is constructed solely for its partition purpose, while the other models offer a bit more functionality, with the window for communicative and the whiteboard for efficiency purposes.


Figure 2.10 Interion®Standard Office Cubicle Partitions

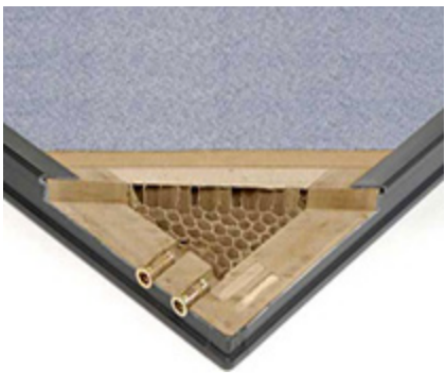


Figure 2.11 Inside Structure

| COMPARE | PANEL | | DIMENSIONS | | STANDARD | | | |
|---|---|---|---|---|---|---|---|---|
| | COLOR | FEATURE | W" | H" | IMAGE | MODEL | QTY | PRICE |
| | White | Whiteboard | 36-1/4 | 60 |  | WG694926B* | | $171.95 |
| | White | Whiteboard | 36-1/4 | 72 |  | WG694927B* | | $207.95 |
| | White | Whiteboard | 48-1/4 | 60 |  | WG694928B* | | $206.95 |
| | White | Whiteboard | 48-1/4 | 72 |  | WG694929B* | | $228.95 |
| | Blue | Full Fabric | 60-1/4 | 42 |  | WG240226BL | | $142.95 |

Figure 2.12 Examples of Ordering Options

The products are straightforward and built for usage within the office. The dimensions of the panels as seen in Figure 2.12 are fairly large, and the wooden material makes it very difficult to be portable outside of the office. Customization is also lacking as there are only two options, the window and/or the whiteboard. They are certainly useful features, but the window has only limited communicative functions and a full whiteboard can be hardly utilized to its full potential. One last point is that the partitions hardly provide any privacy for the user. The example usage shown in Figure 2.10 provides absolutely no coverage from the side opposite of the laptop, which could be potential problem for some situation where the user needs a bit more privacy. ParavenTo, can help solve the above mentioned problems and provide the portability, the flexibility of adding more features and the privacy of the user's rear with its design.

### 2.3.2 Pinchettes

The Pinchettes Collection [18] is a collection of room dividers designed by Luciano Dell'Orefice in 2014. It has three products, the SHIELD, the MASK and the CAP, each featuring a different size and usage for providing personal space.

The smallest of the three is the MASK, a sound absorbing felt workstation screen desktop partition. It has the closest concept and size out of the three to

ParavenTo. Figure 2.13 shows the MASK in use on a table and Figure 2.14 shows the detailed parts of the MASK.

Figure 2.13 MASK in Use

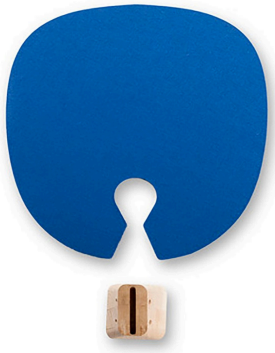
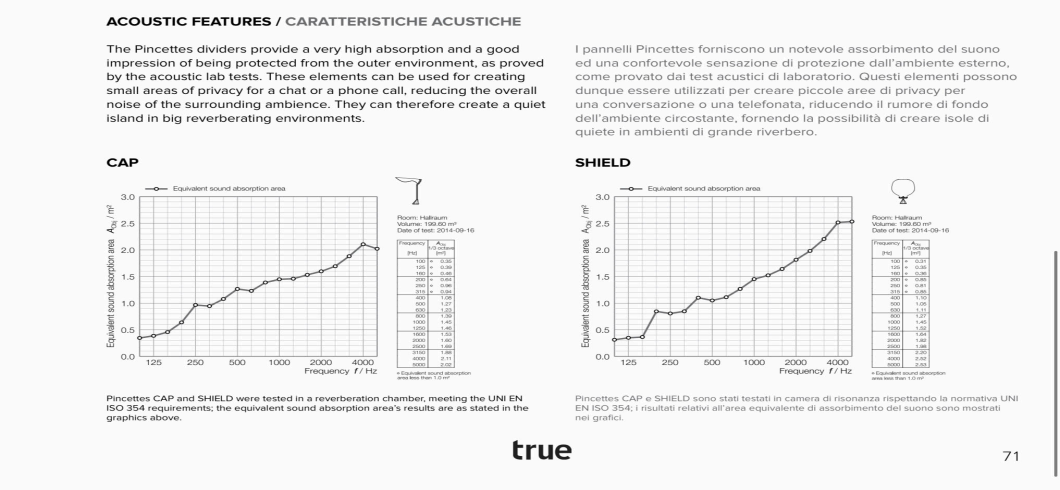


Figure 2.14 MASK Product

The product measures 50cm in height and 45cm in width while weighing a total of 3kg. The acoustic panel is made of polyester and textile, while the base is solid wood, hence making up for the bulk of the weight. The acoustic panels boast a very high absorption of noise, as the results are shown in Figure 2.15.

The other products of the collection, the SHIELD and the CAP are much bigger than the MASK. The SHIELD is basically a bigger version of the MASK, as the product is described as a mobile free standing felt workstation screen on its website. The CAP is an overhead version of the MASK, as it is called an acoustic felt office booth. Examples of all products are provided along with the technical specs in the figures attached below.

The MASK is a great product with innovative design and acoustic features, its weight of 3kg and the way the acoustic panel is built makes it very difficult to carry around. It also only provides protection from one side, which may cause some concerns for privacy. ParavenTo aims to solves these problems and at the same time provide features that are provided by the Pinchettes series in a more portable, versatile fashion.



**ACOUSTIC FEATURES / CARATTERISTICHE ACUSTICHE**

The Pincettes dividers provide a very high absorption and a good impression of being protected from the outer environment, as proved by the acoustic lab tests. These elements can be used for creating small areas of privacy for a chat or a phone call, reducing the overall noise of the surrounding ambience. They can therefore create a quiet island in big reverberating environments.

I pannelli Pincettes forniscono un notevole assorbimento del suono ed una confortevole sensazione di protezione dall'ambiente esterno, come provato dai test acustici di laboratorio. Questi elementi possono dunque essere utilizzati per creare piccole aree di privacy per una conversazione o una telefonata, riducendo il rumore di fondo dell'ambiente circostante, fornendo la possibilità di creare isole di quiete in ambienti di grande riverbero.

**CAP**



**SHIELD**



Pincettes CAP and SHIELD were tested in a reverberation chamber, meeting the UNI EN ISO 354 requirements; the equivalent sound absorption area's results are as stated in the graphics above.

Pincettes CAP e SHIELD sono stati testati in camera di risonanza rispettando la normativa UNI EN ISO 354; i risultati relativi all'area equivalente di assorbimento del suono sono mostrati nei grafici.

true

71

Figure 2.15 Pinchettes Acoustic Lab Test

Figure 2.16 SHIELD in Use

Figure 2.17 SHIELD Product

Figure 2.18 CAP in Use

Figure 2.19 CAP Product

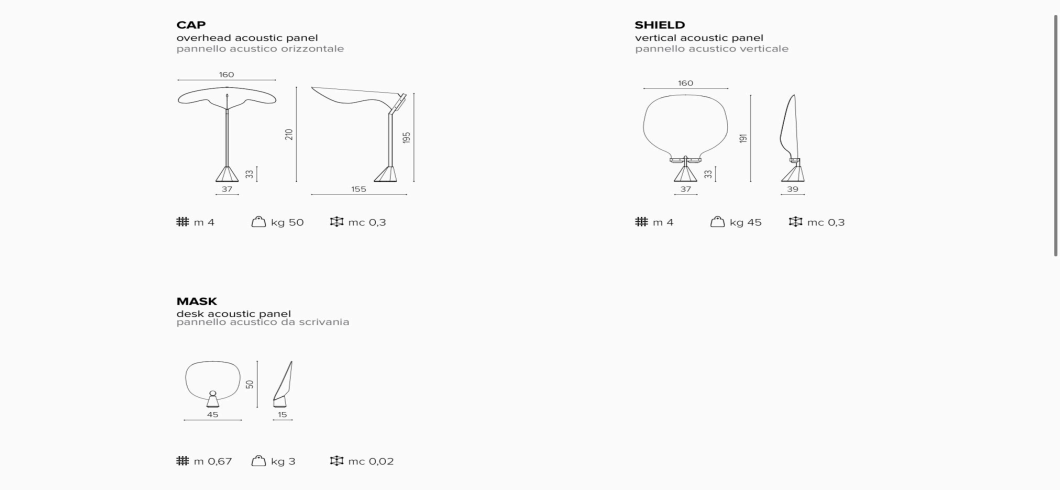



Figure 2.20 Pinchettes Technical Specs

# Chapter 3
# Design

## 3.1. Design Objectives

### 3.1.1 What is ParavenTo?

ParavenTo is a solution to creating versatile, immersive, personal working space within a larger public space through the form of partition screens. It has a rectangular design that offers both privacy and efficiency, while also allowing for collaboration efforts with others around the user. ParavenTo is designed with three main keywords, immersive, private, customized, as guiding pillars. With these three components as the backbone, ParavenTo is a product that stabs at the problem of low work efficiency in the modern corporate office.

Stakeholders of this design include knowledge worker, supervisor, product designer, manufacturer, and corporate management teams. The knowledge worker, as the individual user of this product, seeks to create a more comfortable, and private working environment, which will enhance his/her work efficiency. The supervisor of the knowledge worker recognizes the need for a better environment for corporate employees and adjusts his/her management methods to achieve better results for the team/department as a whole. Corporate management teams are one level above the supervisor in the corporate ranking and have purchasing and implementing power for the whole department/corporate. The product designer designs ParavenTo and its peripherals, with the philosophy that this product would make a difference in the work place and hopes to increase the user base. Manufacturers produce the different components needed for ParavenTo and its peripherals, and assemble complete product. ParavenTo will focus on the relationship among hardware design decisions, privacy protection and the improvement of work efficiency by providing a more secluded personal environment. Listed below

are some challenges that the author wishes to address through this paper:

- Hardware Design- What is the appropriate range for the dimensions of ParavenTo so that it would be a product useful for users with different heights?
- Incentive to buy- What triggers individual knowledge workers and corporate management teams to buy and/or implement ParavenTo for the whole office?
- Implementation- How can implementing ParavenTo help the whole office and what is the optimal way of implementing it for the office?

## 3.2. Design Concept

### 3.2.1 Persona

Creating personas allows for a comprehensive understanding of all stakeholders involved in the design process of ParavenTo. The following section will introduce target personas to ensure maximum benefits for all parties. Target persona I is the knowledge worker, who wishes for a better personal working environment. Target persona II is the supervisor who wants to effectively manage employees and achieve good results.

#### Persona I

Yuto Alessandro Sugano-Piacentille is a new graduate from the Stern School of Business, New York University. His mother is Japanese and his father is American of Italian descent. He spent the first ten years of his life growing up in Tokyo, Japan before moving back to his father's hometown, Alpine, a small town in New Jersey, and attended the Keio Academy of New York, because he wanted to stay close to his Japanese heritage. Eventually he chooses to attend the Stern School of Business in New York, majoring in Finance and Accounting and decides to return to Japan after graduating for work. He likes to play baseball with friends and has been a member of his school's baseball team since elementary school. He likes his job, an entry level analyst for Nomura Holdings, but finds his office frustrating as he has practically no personal space. He wants to try to create a more personal

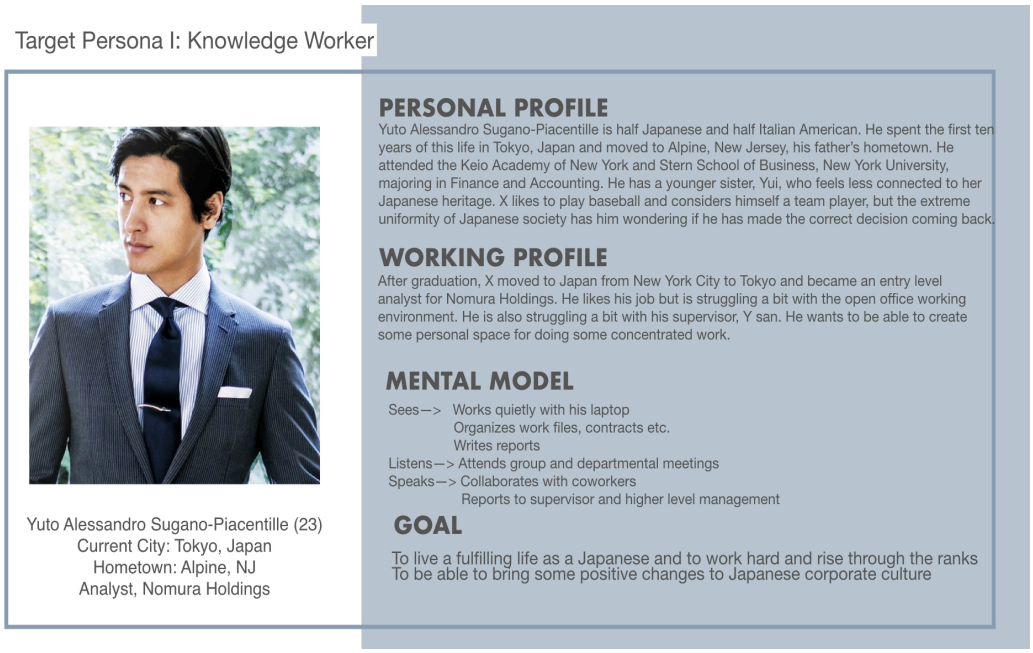



Figure 3.1 Target Persona I

space for himself so he can work more effectively, but feels pressured to follow corporate routines as he is the newest recruit. He also struggles a bit with his supervisor, Morita-san, a very old-fashioned Japanese man in his 40s due to his years of living abroad.

### Persona II

Tsuyoshi Morita is mid-level management for Nomura Holdings; he is meticulous, detail-oriented, and traditional. He does not like changes in his life, and believes that everything should be done a certain way. Innovation is one of his least favorite words as any deviation from the old ways is deemed as untrustworthy and simply wrong. His daily routine includes getting up at five, reading the morning newspaper during breakfast, and catching the same express train for Komagome. He graduated from the University of Tokyo and chose to buy a house in the same area because he wants his kids to go to the same university. He is currently married and has two children, a son entering high school this year, and


Figure 3.2 An Example of Yuto's Office

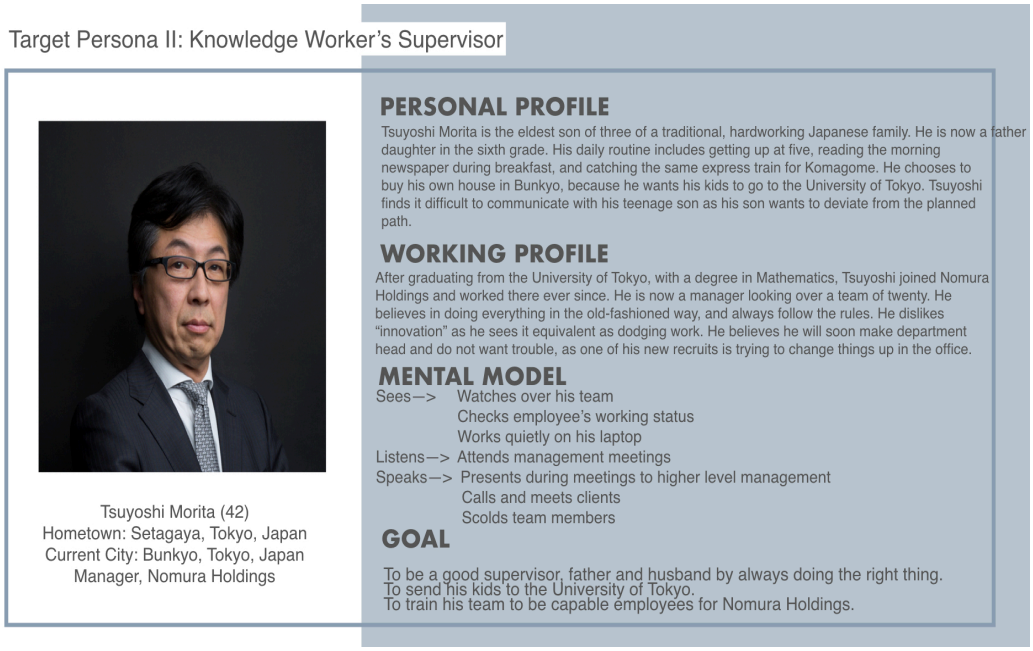



Figure 3.3 Target Persona II

a daughter in the 6th grade. Tsuyoshi is struggling a bit with both his son and his new recruit at work as they both want to deviate from what he considers the right path. He dislikes the idea of one person singling himself out at work, as it could cause potential problems for the management level.

### 3.2.2 Concept Scheme

Based on each target persona's mental model and goal, Figure 3.4 demonstrates the concept scheme of this process. The concept scheme lists all available resources, values proposed by the service provider, and expected co-created values produced by target personas.

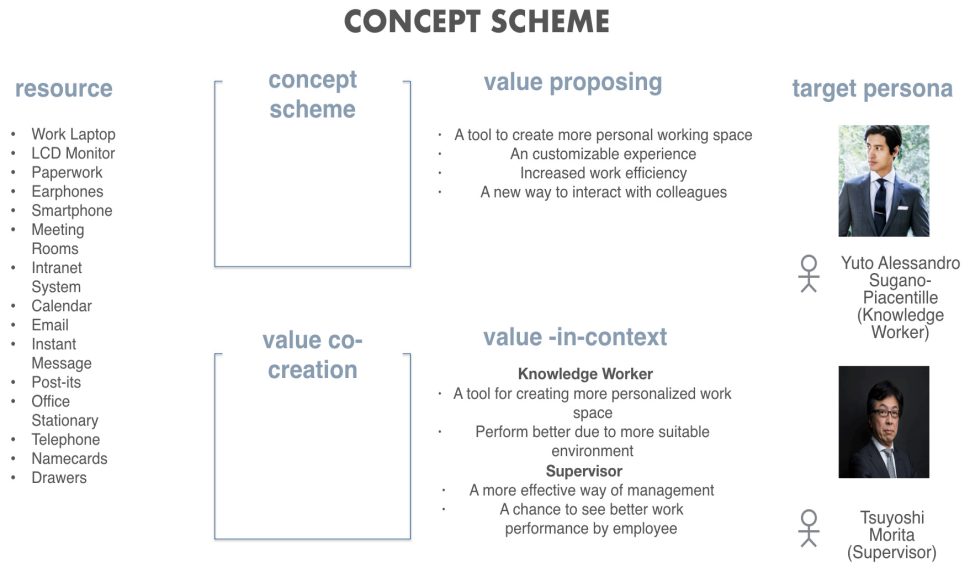



Figure 3.4 Concept Scheme

### 3.2.3 Concept Sketching

Based on the target personas created in previous sections, concept sketches are shown as below. In Figure 3.5, there are six important phases in the concept of


Figure 3.5 Concept Sketching

ParavenTo: understanding the product, purchasing, using, customizing, interacting with supervisor and coworkers, and spreading influence of the product.

### 3.2.4 Use Case

### 3.2.5 Making Story

Stories are written as the following in order to design in contexts, as well as view and value from different stakeholders' perspectives for a more complete vision for ParavenTo.

#### Individual User's Story

Yuto Sugano is a new graduate from the Stern School of Business, New York University, majoring in Finance and Accounting. He is half Japanese and half Italian American, and spent the first ten years of his life living in Tokyo, Japan with his family. He studies business and wants to connect with his Japanese

heritage, so he decides to work in Japan after graduating. Japanese companies are actively looking for bilingual talents, so Yuto secures himself a position in Nomura Holdings. Everything seems familiar and yet so different from the Japan in Yuto's memory, as that was more than a decade ago. Yuto enjoys his job, as he is interested in getting to know the market, his clients and building models to help understand the current economy. His colleagues are friendly, and he is very used to the *senpai-kohai* culture as he attended school in Japan as a kid. One thing that bothers him a bit is the lack of personal, private space within the office. Another concern is his relationship with his direct supervisor, Morita-san, a very meticulous, traditional Japanese middle-aged man. He decides to take at the personal space problem first. Yuto decides to take a stab at the work space problem first, as it seemed like a a easier problem to solve. He starts doing some research on the internet and sees that there are different kinds of partitions selling on websites such as ebay, Amazon, Yahoo Auction etc. Yuto decides to narrow down his options by listing up his criteria, which includes factors such as portability, privacy, visibility, ease of use and not bothering other colleagues sharing the same space. He finds that a product called ParavenTo seems to fit his criteria perfectly, and has bonus features of noise cancellation and customization. He immediately orders the product online and immediately receives a email from the design team of ParavenTo with a nice thank-you message and the team's design philosophy. The email also includes detailed instructions on how to set up the product and different scenarios, where ParavenTo could come into handy. Yuto finds the pamphlet very intriguing and cannot wait to start using his ParacenTo.

Two days later, Yuto finally receives his ParavenTo in the mail. He wants to set up the product in his apartment first and test it before actually taking it to work with him. ParavenTo opens to be a cubic partition with adjustable front panel for flexibility under different situations, as well as extendable, detachable side panels to ensure maximum privacy. Yuto's personal desk at home is a 120cm by 90cm deep desk, since he needs to keep several monitors to keep up with the market. The ParavenTo that Yuto ordered measures 70cm x 60cm. It is the standardized size and opens to be a rectangular partition. Yuto's chosen customization includes a magnetic adjustable front panel, and the default polyester sound blocking side panels. After a few tests and tweaks at home, Yuto is pretty happy with the

product and decides he should bring it to the office. Setting up at the office was also quite simple given ParavenTo 's portability and carefully chosen dimensions. Yuto finds himself in a comfortable personal space even though the office is a big open space. He can freely adjust the positioning of his screens, and can even attach the screens to the side panels. He can also make eye contact with the colleague directly across from him and to the sides of him due to the adjustable panels. The extendable side panels are also great at protecting privacy, and ensures maximum safety for the knowledge worker. Yuto is feeling confident already with this product and believes that it will help him to a better performance.

**Supervisor's Story**

Tsuyoshi Morita is a mid-level management for Nomura Holdings. He graduated from the University of Tokyo, majoring in Mathematics and entered Nomura Holdings as a new graduate twenty years ago. He is very traditional and meticulous, and sees any deviation from the rules as laziness and incapability. He is currently struggling at home with effectively communicating with his son, and at work with his new recruit Yuto. Tsuyoshi sees Yuto's "innovative" ideas as obstacles to better performance by the group and also bad influences to his management methods. After several very polite conversation initiated by Yuto on the subject of brining a partition to work, and also the pressure of mid-season assessment, Tsuyoshi is rethinking the situation both at work and at home. He is tryign to be more open to other people's opinions, as he realizes both his son and Yuto are not simply wasting time and dodging work. He decides to let Yuto use his partition at work, under the condition of not creating troubles for other people in the office, and also to produce good results. It has come to Tusyoshi's attention that even though some people look like they are working by looking at their monitors and typing, their results are not always the best. Therefore, he is willing to experiment a little with Yuto, since he is a new graduate and very passionate about his work.

### 3.2.6 Key Paths

Three key paths are identified from the stories of target personas. Value-generating moments are illustrated below in a series of close-up sketches. The most valuable

moment is marked in green.

### Key Path I

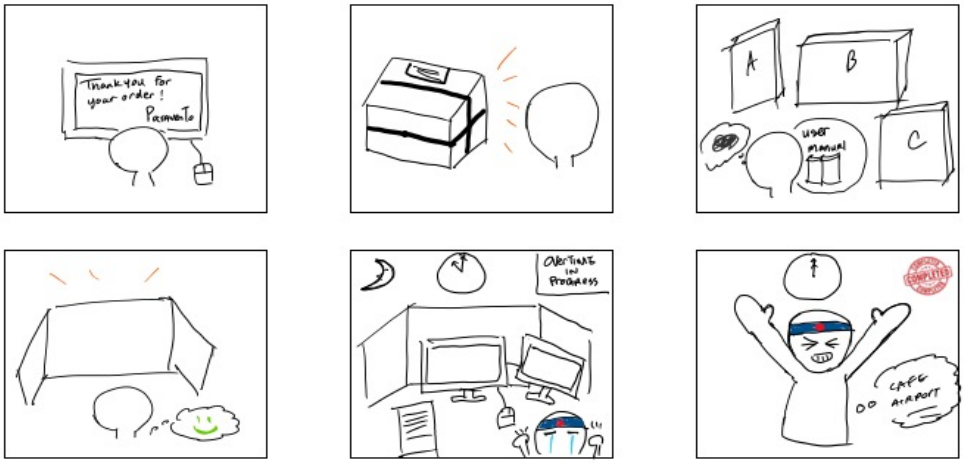



Figure 3.6 Key Path I

The first scene is about when Yuto first receives and assembles ParavenTo at home. After placing an order online, Yuto receives the ParavenTo package in the mail, and decides to try it at home first before bring it to work. The second scene shows Yuto assembling and playing around with ParavenTo in order to understand all of its features. Then, he decides to use ParavenTo at home for his evening market research before going to bed to better understand how it works. After using it for about an hour, he feels used to the product and wants to try it in other settings.

### Key Path II

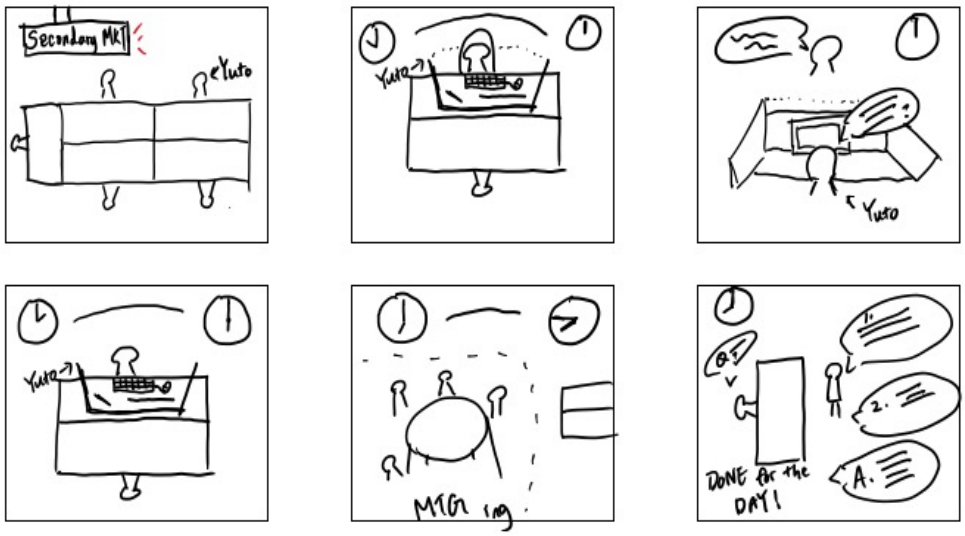



Figure 3.7 Key Path II

The second key path is about Yuto's usage of ParavenTo at work. He brings ParavenTo to work and sets up the product in the morning; then he begins doing some quiet work. Then Yuto briefly interacts with some colleagues using the adjustable panel feature of ParavenTo. The panel allows him to converse briefly with the colleague directly across from him, while still maintaining the partitioned space for doing private work. After the brief interaction, Yuto pulls out the extendable sides and enclosed himself for an even more private space. Yuto had promised Tsuyoshi to finish one of his projects by the end of this day, in exchange for the usage of ParavenTo in the office. The more isolated, quiet and private space allowed for Yuto's concentration and therefore better performance. In the end, Yuto ends his day by completing his deadline for a project and reports this to Tsuyoshi, his supervisor.

### Key Path III


Figure 3.8 Key Path III

The third key path shows a scene where Yuto brings ParavenTo to his business trip so that he could work on the go in public places. The first scene shows Yuto packing ParavenTo into his suitcase, which is a pretty easy process since ParavenTo folds easily. The second scene then shows Yuto at an airport coffee shop, using ParavenTo to quickly checking work emails and doing some quick fixes. Then Yuto packs up the ParavenTo and gets on the plane. He tries to see if he can use ParavenTo on the plane but find his model to be too big for the small plane seats. He makes a post-in note about checking out other smaller portable ParavenTo models. Yuto goes on to work some more in the duration of his business trip using ParavenTo and the scenario ends with him presenting his results in front of clients. Yuto is glad that he bought this product, which helps him focus in public places to achieve better work performance.

### 3.2.7 Concept Drawing

This section will first focus on the specific design, main functions, customization, logo design and naming of the brand ParavenTo. It also includes the prototyping process and the evolving design process of ParavenTo.

#### Specification Design and Main Functions

The main functionality of ParavenTo is to create a more private space within a large public space by partitioning. It is a physical barrier with ParavenTo being a physical product. The ParavenTo surrounds the user from the front, left and right side. The wide flanks provide extra security and privacy, as they not only hide the user visually, but also are able to absorb sound due to the polyester material. Morever, for those who want a little bit more protection than the normal three-sided coverage, ParavenTo also has that covered. Each side has a flexible extendable part hidden within and they can be used to cover the back of the user as well. This way, the user can enter extreme protection mode and can be more focused for doing work. Please refer to Figure 3.9 for full specs.

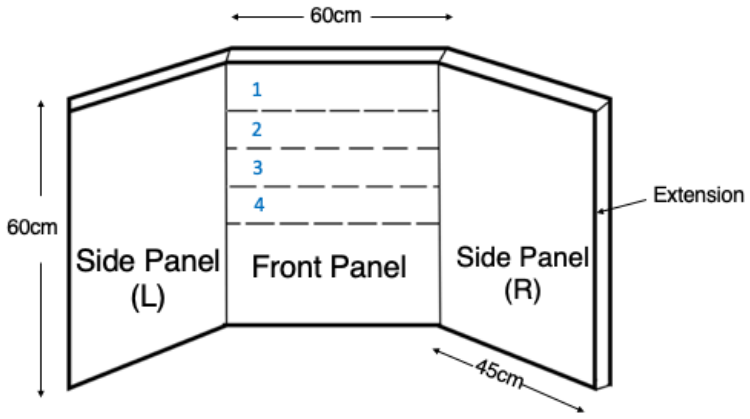



Figure 3.9 Design Sketch of ParavenTo

Here are some detailed description of each component of ParavenTo, the standard version.

- **Front Panel:** The front panel is the most essential component of the ParavenTo. The standard dimension is 45cm x 60cm and is made of polyester. The standard version comes with adjustable parts that allows for interaction with others while still maintaining a relatively private space for the user. There are a total of four different heights available. They are: 1) full coverage of the user, 2) visibility of the forehead, 3) visibility of eyes, 4) full visibility of head. With these variations, the user, regardless of his/her height, and the height of the other party, can always adjust the ParavenTo to an optimal height for the situation.

  - 1) Full coverage is always for the maximum enclosure, as a height of 00cm is enough to cover even some of the tallest people in and around the office.
  - 2) The second level, visibility of the forehead, comes in handy when the user just wants some quick confirmation for a brief conversation, both work and non-work related. It is not important enough for maintaining full eye-contact, but it is nice to have some physical confirmation, such as being able to see the other person nodding or shaking his/her head. It is quick and convenient, without the user having to completely taking off his/her gaze from work.
  - 3) The third option is the eye contact option. Eye contact is a crucial nonverbal factor for communication and being able to quickly access this mode is very important for the work place setting. After all, ParavenTo should not be an obstacle for the user's inter-human relations. The quick setting for the eye contact mode is set at 00cm, which allows for a comfortable window for making eye contact with the persona directly in front of the ParavenTo user.
  - 4) The fourth level is the full visibility of the head. This mode is designed for effective and slightly longer communication for the user and those around him/her. Not only can the user and his/her conversation

partner see one another's facial expressions completely, but also both parties can see other nonverbal expressions such as hand gestures and other body languages clearly as well. Words sometimes cannot suffice as the only means of communication, therefore being able to have a full conversing mode for a partition product is crucial for maintaining effective work place communication with colleagues and supervisors.

The standard ParavenTo utilizes the fold-down mechanism for achieving the four different heights. The polyester of the front panel can subsequently fold down from the top into the four levels. This material can be replaced by other material, which allows for further customization detailed in the following section.

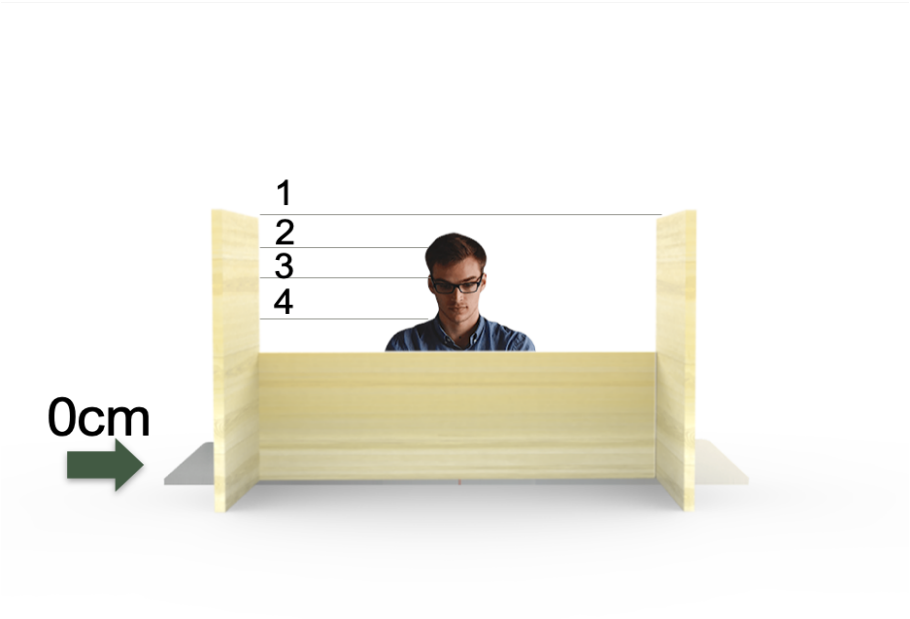



Figure 3.10 Four Levels of the Front Panel

- **Side Panels:** The side panels are not only the supporting sides for ParavenTo, they are also the main area for customization. It will be discussed in greater detail in the sections below. Side panels have the dimensions of 45cm x10cm x 60cm for both left and right. These panels are made of

polyester and have noise blocking effects. The angle of which these sides stand can be adjusted to achieve the wanted immersive level for the user, and ensure maximum stability of the stand. These panels are also a bit thicker than the front panel, due to the storage of extendable rears within. While not using the rear panels, the side panels are stand alone panels that are excellent for day to day use within the office and a variety of places.

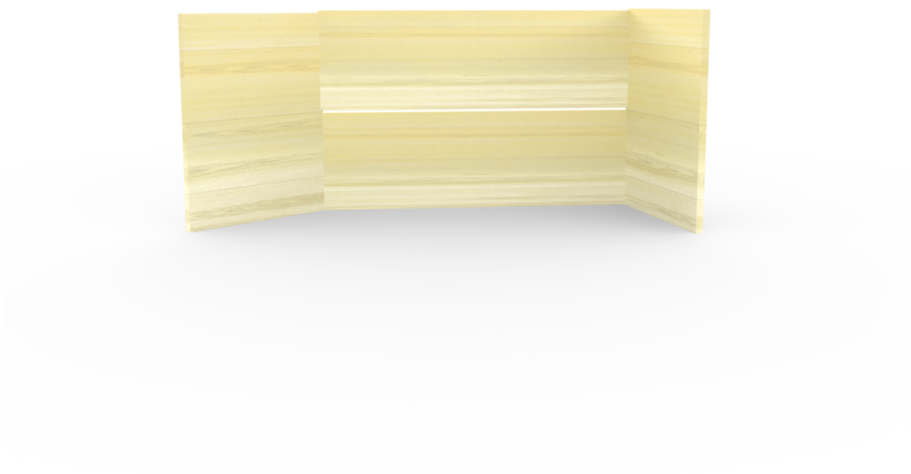


Figure 3.11 Side Panel Adjustable Angle

- **Extendable Rear:** The extendable rear comes out of each side panel and is a flexible addition for the usage of creating a more immersive environment for the ParavenTo user. They offer an extra 20cm extension on top of the 45cm length that the side panels already provide.While stored, the user will have a 180 degree coverage offered by ParavenTo, leaving his/her rear unprotected. To be able to offer that extra level of security is crucial for ParavenTo. Extendable panels can be pulled out from the sides and construct a surrounding space for the user. The rear panels extend to create a semi-circle with a radius of 00cm. The circular space around the user is

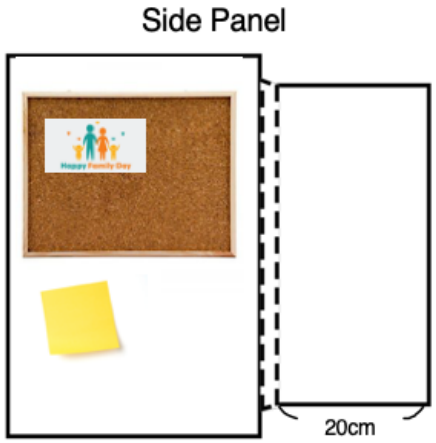



Figure 3.12 Detailed Side Panel

in contrast with the rectangular space in front, and create a more relaxing back area.

### Customizability and Accessories

The ability to customize is one of the unique features of ParavenTo, as it allows for maximum versatility and usability. There are several customizing options, and are mainly for the side panels. Customizability for the side panels can be divided into two main categories, 1) efficiency-based and 2) personal-based. The first one, efficiency-based includes adding multiple monitors and magnetic white boards. Most knowledge workers use at least one display monitor, aside from his/her own laptop, therefore, turning one, or even both of the side panels into that monitor required for work can help organize the user's desk as well as create a more immersive user experience. Possible customization include, display monitors (touch screen option available), E-Ink screens, magnetic white boards, calendars, corkboards etc.

The personal-based option can help the user put a more personal touch to the work place. It is preferable for most corporate workers to keep their work space clean in order to maintain good hygiene and to not create troubles for surrounding coworkers. Therefore keeping private effects as part of the ParavenTo is a great option for those who want to keep personal memories close by while working. Customizing options here include photo walls, various color schemes, changeable frames etc. Keeping personal effects within the ParavenTo, or as part of the ParavenTo has two benefits. The first one is to keep personal belongings and memories more private, and the second one is to be able to bring them along even while on the move.

Options for customizing the front panel are also available. As mentioned above, the folding mechanism is the default for the standard version, and users can choose to change the material of the front panel to have color-changing glass. Innovative materials will definitely be incorporated into ParavenTo as they become available, and ParavenTo will become more powerful with these updates.

Figure 3.13 Customization Options

While customization is mainly focused on utility, ParavenTo accessories are

mostly for portability and convenience. Accessories include clips for connecting the panels, magnets for putting up notes onto the panels, and other options to show character and love for ParavenTo. The accessories department, like the customization one has vast possibilities that will be further explored as a part of ParavenTo's future work.

### Naming and Philosophy

The word *paravento* means a folding screen in Italian, a kind of free-standing furniture originated from ancient China. They are designed to not only offer aesthetic beauty, but also served as partitions used to divide up rooms and create more private spaces. The choice of capitalizing the "T" is to infer the meaning of setting a personal trend with ParavenTo. "P" for private, personal and "T" for trend. ParavenTo users are indeed true trend setters as they are active in trying to create that most optimized space for themselves within public spaces and offices, as well as

With these two words in mind, this modernized folding screen is designed to fulfill its original duties, as well as some new updated ones. ParavenTo offers privacy, comfort, as well as the maximization of work efficiency. Simply partitioning a space is not enough, ParavenTo offers more functionality, creativity and customizability.

### Logo

The logo is composed of two simple capitalized letters of "P" and "T" in black. As mentioned before these two letters stand for personal and trend, along with some other concepts crucial to this product. One single simple zigzag line symbolizing the folding screen is placed in between the two letters. The logo as a whole shows a traditional folding screen and the emphasis of personal trend for ParavenTo.

## 3.3. Prototyping

The first prototype was created according to the design visions mentioned above. It was made of cardboard paper and had a rough finish to it. There were several


Figure 3.14 Logo for ParavenTo

kinds of rough prototype and the main usage was to test the user preference for the different kind of variety of partitions.

In the end, the rectangular/cubic design was deemed the most popular, as it is more portable, more usable, and also more friendly to others around the ParavenTo user. The rectangular design allows for simultaneous usage by several users sharing the same table space.

The construction of the prototype happened within KMD classrooms and studios. The actual prototype itself has four different eye levels, and also a carved out window for color changing glass. The LCD screen and other extra features are not included in this prototype, so that the product is more focused on blocking that side vision, and other possible distractions for the user. Examples of the prototype and its test usage are illustrated in Figure 3.17, 3.18 and 3.19.

Figure 3.15 Two Fold Design

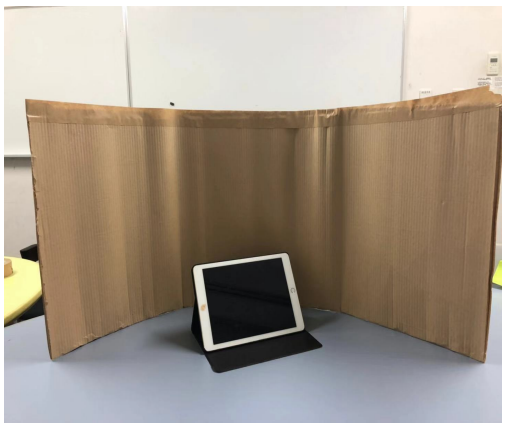


Figure 3.16 Curbed Design

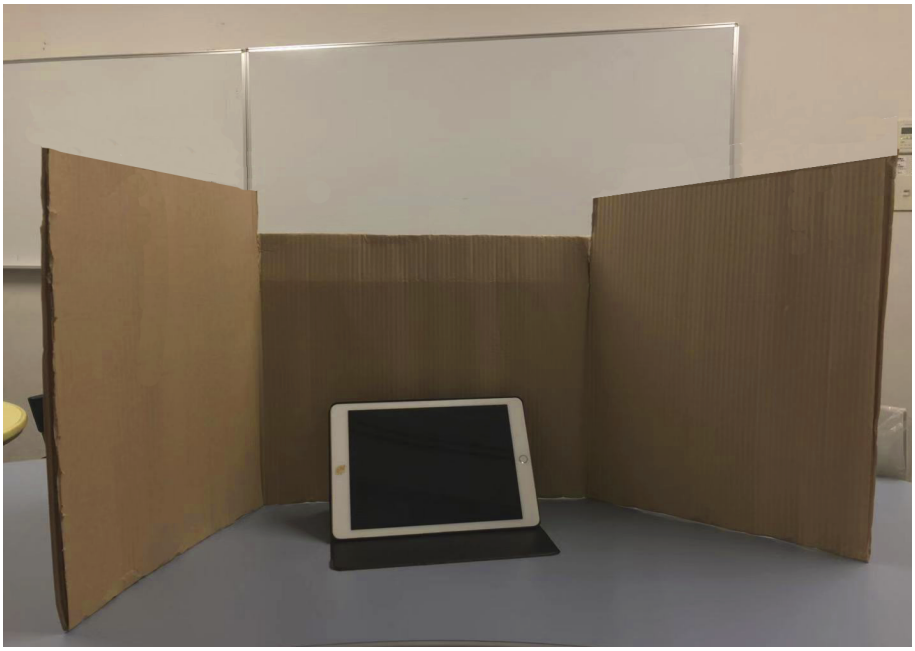


Figure 3.17 ParavenTo Prototype

Figure 3.18 ParavenTo in Use: Full Head Visibility

Figure 3.19 ParavenTo in Use: Tip of Head Visibility

# Chapter 4
# Evaluation

This chapter evaluates the aforementioned design concept by conducting observation and user experience interviews among users. The initial prototype was modified according to user feedback as well. This chapter is organized into the following sections: methodology, result, discussion and revised concept. Methodology section explains the methods used during the evaluation process in order to measure the effectiveness of ParavenTo. The result section lists and reorganizes feedback gathered from users. Discussion section analyzes and interprets the results from the result section and draws the conclusion for the purpose of this project. The last section revises the concept and design of ParavenTo to incorporate and reflect the feedback received from test users.

## 4.1. Methodology

The main focus of this evaluation is to observe and understand users' reactions towards the product and improve user experience. Observing and interviewing users for their feedback reveals the perceived value of ParavenTo and values co-created by users and those around.

Five people participated in the testing of ParavenTo. The whole test lasted about 30 minutes, with each task taking up to ten minutes, and a ten-minute break within. The contextual interview is conducted after the test. Test users' age ranged from 20-30 with 2 males and 3 females. The maximum height is 186cm and the minimum height is 159cm.

The user tests [1] are conducted within KMD and users are asked to complete two

1 The following test was conducted twice to better simulate the environment of an office.

Table 4.1 Test Subjects in the ParavenTo Test

| Test Subject | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Gender | F | F | M | F | M | F |
| Age | 23 | 28 | 30 | 21 | 25 | 24 |
| Height | 160 | 169 | 175 | 174 | 185 | 159 |
| Occupation | Graduate Student | Graduate Student | Office Worker | College Student | Graduate Student | Graduate Student |

knowledge work tasks, one with ParavenTo and one without. During the course of the test, the author subjectively judge user's emotions and attitudes by observing user's facial expressions, head and body movements. After the user complete the first task, there is a brief break and the second task follows. The results of the tasks are then assessed both by accuracy and the user's own impression of how well he/she had done.

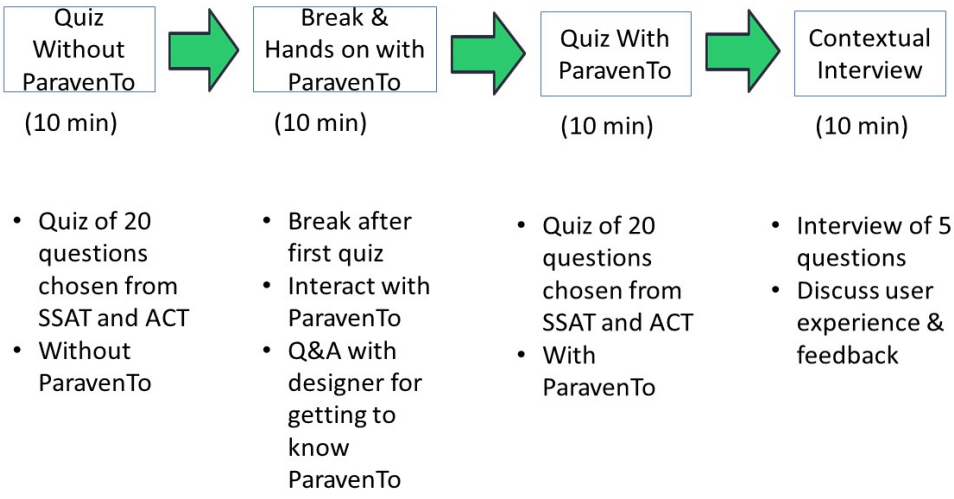



Figure 4.1 Testing Process for User Test

After the test, a contextual interview follows. The interview consists of five open ended questions, including the user's original working style and preferences,

preferred working environment, solutions for unsatisfying working environments, thoughts on using ParavenTo to complete the task, reflections on values co-created.


Figure 4.2 Observation and Interview Questions

### 4.1.1 User Test: Preliminary Test and Realistic Office Test

The four-step user test (Quiz Without ParavenTo, Break, Quiz With ParavenTo, Contextual Interview), was conducted twice in order to produce better and more realistic results. The first round is a controlled quiet test, with a minimum amount of disruption and disturbance during the test. The second round has more realistic distraction factors, mimicking that of a real office, during the test. Detailed testing conditions will be explained in 4.1.2.

Both rounds of test had the same 5 test subjects, A, B, C, D, and E as participants, and the quiz questions were slightly adjusted for better results. The same prototype of ParavenTo and the instruction sheet were also used for both rounds of testing. The tests will be differentiated by the different testing conditions, and referred to as the Preliminary Test and the Realistic Office Test, or the first round and the second round of testing, respectively.

### 4.1.2 Testing Conditions

The test was conducted within KMD and the Collaboration Complex Building as the original plan of conducting in a company was cancelled last minute due to the situation at the company. At KMD, however, the test was conducted once with a more disruption free environment to see how users behaved while working alone, while the test was conducted once more to simulate an environment more realistic to that of an office. The table below lists the different conditions of the two tests.

Table 4.2 Testing Conditions Compared

| Parameters | Preliminary Test | Realistic Office Environment Test |
|---|---|---|
| Locatoin | Collaboration Complex C3S06 | Collaboration Complex C3S04 |
| Time | 1300-2100 | 1000-1900 |
| Noise Level | 30dB-40dB | 43dB-60dB |
| Room Condition | Clean, Only ParavenTo and Test Papers | Clean with Other Personal Belongings |
| Working Condition | Alone (User/ Author) | Peers (User/Peers/Author) |

The testing environment is assessed by five different factors, 1. location, 2. time, 3. noise level, 4. room condition, 5. working condition. While the location remained the same, the second round of testing was conducted with details for the controlled variables intentionally mimicking that of a real office.

- Location: The test was conducted within the Collaboration Complex Building of Keio University's Hiyoshi Campus. The classroom used was C3S06 and C3S06.
- Time: The original tests were conducted during the hours of 1300-2100 as the availability of test subjects fell within this range. While overtime is also quite common for knowledge workers, the testing times of the second set of test were significantly adjusted so that test subjects were able to take the test during more traditional working hours.

Figure 4.3 Collaboration Complex C3S06

Figure 4.4 Collaboration Complex C3S06

- Noise Level: Noise is a significant distraction factor as previously mentioned, however the first round of testing was mostly conducted under quiet circumstances with none to minimum ambient sound. Converted into decibels, it was in between the range of 30-40 dB, meaning a quiet room with whispers or other quiet ambient sound of the environment. It is not suffice for fully testing the usefulness of ParavenTo due to the drastic difference between that of a real workplace. The second round was conducted with much more realistic noise level. The soundtrack for ambient sound was set at a volume of roughly 43dB, as it is the average level for an office environment. Other sounds include light conversations from others in the room, standing up and moving around, organizing personal belongings etc.

- Room Condition: The room condition was also improved to mimic that of a real office. While both rounds of testing was conducted within the parameters of classroom C3S06, the first round was within a cleaner and more organized environment. The room was setup free of personal belongings and paperworks, as only items related to the test were present on the table, including test papers, users manual of ParavenTo and ParavenTo itself. The second test saw some improvements as the table, as well as the room had more personal belongings, both related and unrelated to knowledge work at

hand. The room was also less organized and tidy as before but maintained the basic level of hygiene.

- Working Condition: Along with the previous factors, the working conditions also became more realistic during the second round of testing. The users were not isolated instead were allowed to work together with other peers in the room. Having other people in the same room was not only more realistic, but also allowed for the users to utilize the interactive functions of ParavenTo during the test. This was a significant factor for recreating the conditions of an office, as knowledge workers are rarely singled out and work without any surrounding peers.

Both tests followed the same format, which is a three-part testing process. The users are asked to take two quizzes including questions from the SSAT reading and math sections. The questions are selected by the author, with the following criteria in mind: 1.variety, 2. difficulty, 3. problem-solving or knowledge type.

Variety is a main criterion for the quizzes, as a knowledge worker makes use of several skill sets on a daily basis to complete his/her work. Choosing from both the reading and math sections asks the users to utilize more than one kind of skill, hence is closer representation of the kind of knowledge work that is done within the office. Difficulty is also a crucial factor to be taken into consideration as extremely difficult questions will not be suitable as the benchmark for testing the efficiency of ParavenTo. Questions were chosen from the SSAT because it is the standardized test used for entering private high schools in the United States, hence the material is perfectly answerable by graduate students and office workers who have completed their undergraduate studies at the minimum.

The third criterion is the types of questions selected for the quizzes. Some types of questions, such as vocabulary definition questions, and some math questions are knowledge-based questions, in a way which the answers are irrelevant to the test takers' concentration level. Defining a word without any context is solely depend on the size of one's vocabulary, and the solution to such problems is to improve and enlarge that vocabulary instead of using partitions. Therefore, these questions are deemed unsuitable for the testing of the usefulness of ParavenTo. Instead the questions chosen for the quizzes are problem-solving questions, with

the information needed to find the correct answer provided either in the text or within the prompt.

The questions were adjusted as well for the second round of testing, due to unsatisfying results from the first round. Instead of the math questions from the SSAT, questions from the Science section of the ACT, which is another standardized test used for college admissions in the United States. The Science section of the ACT is quite similar to that of any reading section of standardized tests. Most information is provided either in the text, or within the prompt. The goal of the test taker is to quickly identify the problem and sought out needed information from the sea of information provided.

Sample test photos are shown in Figure 4.5 and 4.6.

Figure 4.5 Testing Process 1

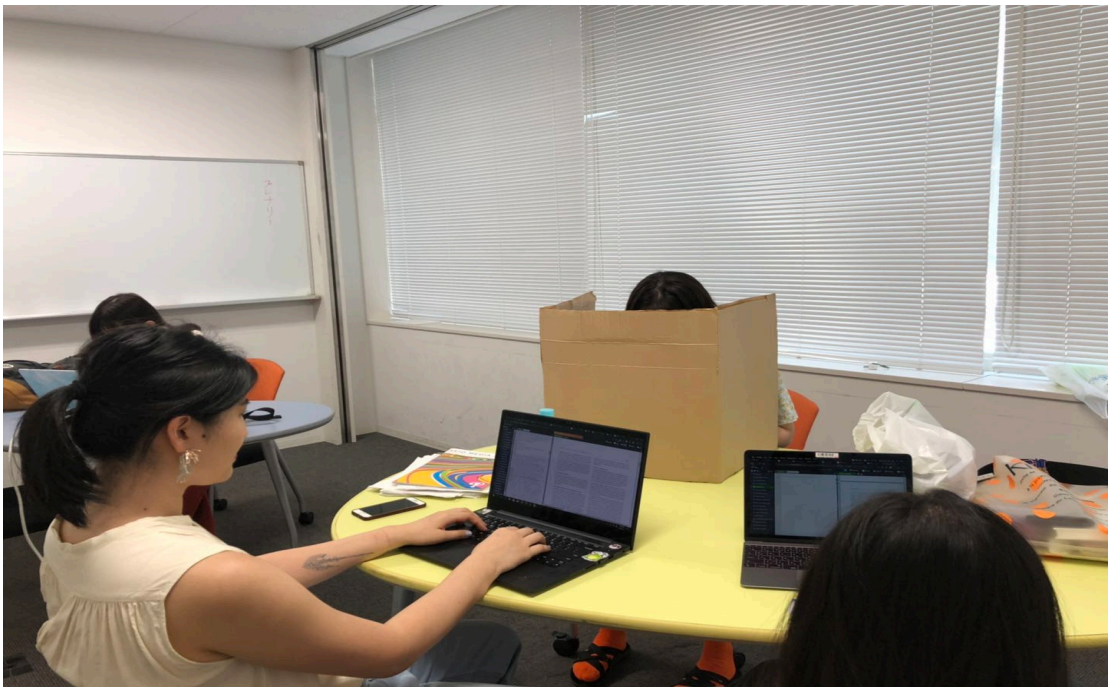


Figure 4.6 Testing Process 2

## 4.2. Findings

### 4.2.1 Observations

Assessment methods of the efficiency of ParavenTo consist of two parts, observations by the author and quiz results from the test sessions. This section will focus on the observations by the author. Vital measurements are not utilized for the purpose of this research due to two factors. ParavenTo aims to create a comfortable personalized space, hence the measurement of any single vital sign, or the combination of a few would be incomplete as the feeling of a person is a more wholesome experience than some numbers on the screen. The second factor is that the definition of a personal space and how it affect the work efficiency is largely due to personal preference. It is, therefore extremely difficult and almost meaningless to try to quantify that data, hence for this research, observations are used to assess the effectiveness of ParavenTo.

Some limitations to this method of course, include scrutinized results due to the test subjects' awareness of being observed, aka the Hawthorne Effect and the inability to "prove" a hypothesis due to lack of quantifiable data. However, the author believes that the subjective observations during the testing period, the objective quiz results, and the interactive contextual interviews afterwards make a strong combination of results.

The observation phase is also divided into two parts, as is the testing process itself. For both rounds of the ParavenTo user test, observation results remained somewhat consistent and the user behaviors were also aligned with the previous tests. The following paragraphs will describe the observations in more detail. It will be organized into two main sections, without ParavenTo and and with ParavenTo, and subsections including first test and second test.

For the without ParavenTo observations, the test subjects were generally more nervous with the body movements, especially during the test. Obvious body movements include but are not limited to head movement, shifting balance on chair, fiddling of pen, flipping through papers, and scratching head. The movements were of random timing and some test subjects constantly looked away from the test papers and were either checking the time or simply looking around. While the first round of testing only had the test subject and the author in the room, the test subjects were generally looking around randomly or checking the time. The second round of testing involved more parties within the room and the test subjects had more "materials" to look at, but were not looking for interaction of any sort. Test subject E, in particular was trying to ask for help on certain questions during the second round of testing but quickly realized that it was way too time consuming and had to give up to finish on time.

For the with ParavenTo observations, many of the body movements retained, as some movements are habitual movements for the test subjects. The timing however, was a major factor for the purpose of this observation. In comparison to the movements from the previous tests, the test subjects all exhibited the same trend in their movement behavior. Regardless of what they were doing in the previous tests completed without ParavenTo, the test subjects' movements became more organized with the help of ParavenTo. Due to the partition, the test users were able to "hide" from the author's observation to some extend, and were

able to have his/her personal space while doing the test, either with or without other people in the room. Therefore, the body movements observed from the without ParavenTo session of the test became more predictable and followed a certain pattern. For example, the body movements were generally random and happened at all different times during the test without ParavenTo. While using ParavenTo, the test subjects started only flipping papers or checking the time after completing the current question. In other words, ParavenTo was helping the test subjects to be more focused on the questions at hand.

### 4.2.2 Quiz

The quiz results of the testings are generally positive. The first round saw minor improvements, as the test was conducted under quiet conditions with minimal outside distractions. Subjects A and E saw the most improvements, 5% and 10% accordingly. Other test subjects saw only minor improvements during the first round. While reflecting on the test results, it became clear that even though the questions were not meant to be difficult or purely knowledge-based, the math section still proved challenging for some. Test subjects did not come from strong math and science backgrounds, and under the time pressure of the testing section, the math questions became the obstacle for improvements for some people.

With the adjustments for both the testing environment and the test questions, the quiz results changed and improved more drastically than before. Figure 4.8 illustrates the results as compared to the first quiz. In comparison to the first quiz, test taker generally had a worse start, due to the distraction put into place from the environment. The starting average was a mere 74% in comparison to the 81% from before. Every single test subjects had scored less than the first round and test subjects as a collective was able to improve more than before.

### 4.2.3 Contextual Interview

The contextual interview followed the quizzes and the test subjects were asked to provide feedback for their experiences with ParavenTo. They were also asked to provide their personal preferences as to working location, working style and solutions for unsatisfying work environment. Lastly the users were asked to reflect

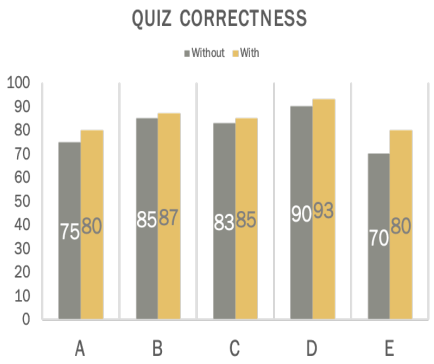



Figure 4.7 Quiz Results from First Test

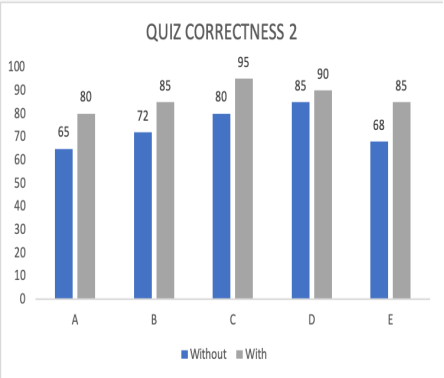



Figure 4.8 Quiz Results from Second Test

on any values created during the process.

For the background questions, refer to Figure 4.10 and 4.11 for summarized results. Questions were mostly short answers to avoid limitations by the choices provided. When asked upon working style, in the end the results came down to the question of working with a group or working alone. Preferences also include listening to music and snacking. Preferred working locations are also mostly common locations, such as school library, office or at home. Even though personal preferences varied according to different occupation, age and gender, all participants agreed that while doing knowledge work, i.e. writing reports or processing data, they preferred to have some extend of privacy in order to better focus on the work at hand.

User feedback for ParavenTo concentrated on the portability, ease of use, and the not yet implemented customization and accessories.

Portability came up four out of the five interviews conducted, as participants are interested in potentially using this product outside KMD and want to explore the possibility of carrying it around to different places. ParavenTo in its prototype state is by far from portable, as the cardboard and acrylic used for construction is difficult to break down. The front panel and side panels are one piece of cardboard, and therefore impossible to be taken down and reconstructed for the portability.

Usability is also an issue mentioned during the interviews, as the participants

**ParavenTo Interview**

* Required

1. **How would you describe your work style? Please include any preferences. (ex. Love working with peers in the room; listen to music while working; etc.)** *

2. **Where do you usually work?**
   *Check all that apply.*
   - ☐ Office
   - ☐ Library
   - ☐ Classroom
   - ☐ Home
   - ☐ Cafes
   - ☐ Other:

3. **What do you do when your working environment is unsatisfying?**

4. **Thoughts on using ParavenTo? Answer from 4 areas: 1.ease of use, 2.effectiveness, 3.improvments, 4.wanted features.**

Figure 4.9 Questions from Contextual Interview

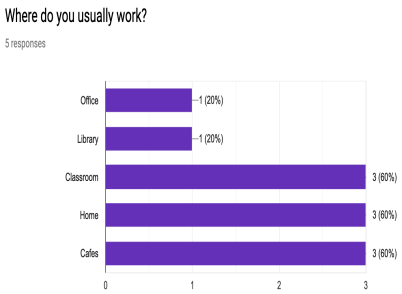



Figure 4.10 User Preferred Working Location

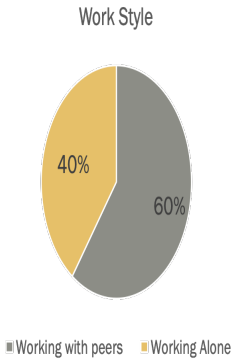



Figure 4.11 Working Style

found ParavenTo to be quite usable as a prototype, as the concept of this product is interesting to many. The potential of being able to have more features is definitely the main focus for the participants and will be explained in more detail down below.

Proposed but not implemented concepts include customization of ParavenTo and accessories. The goal for customization and accessories is to help the users be more efficient. While the front panels and side panels are used to create a space for the user, the customization and accessories are opportunities for users to really organize the space and convert it into a more personalized environment to become more efficient.

In the end, the contextual interview is a window of opportunity for the participants to communicate with the author and offer insights on ParavenTo. While the general feedback remained positive for ParavenTo, and the participants enjoyed their time with the product, they offered many advice and questions to be answered for the future.

## 4.3. Discussion of Findings

Based on the observations and the test results from both rounds of testing, users generally enjoyed the experience of using ParavenTo as they confirmed this during

the contextual interview. This section will break down the the findings from the previous section, 4.2, and discuss these finds as a whole for the results of this ParavenTo projects and some improvements for the future.

### Observations

The observation section can be summarized into two trends as changes in the body movements and the facial expressions of the participants will be the main focus for this part of the analysis.

Based on the actions observed during the test, a trend of general calmness shown in the body movements, was developed throughout the two rounds of testing. Even though the testing conditions are quite different for the preliminary round and the office environment simulation round, the body movements observed showed resemblance to one another. When not using ParavenTo, the participants showed a series of voluntary movements that are irrelevant to the task at hand, and these body movements are deemed to be a hindrance to a better work efficiency, which could lead to better quiz results. While using ParavenTo, the total amount of the extra body movements decreased, and the participants did become more focused on the questions, as reflected through their quiz correctness being higher with ParavenTo.

Facial expression was equally as telling as the body movements, as the participants had less anxious expression on their faces throughout the course of the test. For the without ParavenTo tests, combined with extra body movements, the participants were anxious as to the surrounding environment, the test itself, as well as the constant distraction from those around, these feelings of anxiety were reflected through facial expressions. While using ParavenTo, due to the more personal environment and the participants' mindset of not constantly being observed, the facial expressions were more relaxed, as the mindset of the participants were indeed more relaxed and calm.

In the end, the observations recorded throughout the two rounds of the three step testing (Quiz Without ParavenTo, Break and Quiz with ParavenTo) show the trend of participants being more focused on the task at hand, but at the same time more relaxed and calm. Observation results were then reflected through the quiz results, which will be discussed below.

### Quiz Results

As the second evaluation method of this user test, quiz results from the tests showed improvements for all test participants when using ParavenTo as compared to that of without ParavenTo. While the testing conditions and the content are still different from the real working environment and tasks, the user tests conducted above did show a trend of improvement through the results. The tests were also problem-solving based questions, and the participants did have to utilize intellect to complete them. As a result, the quizzes also showed a positive trend for the ParavenTo to be a product that can positively affect work efficiency.

### Contextual Interview

The results from the interview are difficult to to categorize, as they were not quantifiable data that can be tabled or graphed. However, the interviews did receive generally positive feedback for the usage of ParavenTo and the participants showed interest for continuing to interact with ParavenTo when it has more features. Results will be discussed from three areas, working habits, working location preferences of the participants and feedback on ParavenTo.

For the working habits, all participants mentioned the usage of music. 40% answered that they work with music and 60% without. It is not uncommon to see people wearing headphones and working while in noisy public places such as cafes and airports, as well as quite public places such as libraries and study rooms. While this option is entirely personal preference, it is clear that some people are more prone to accept outside sounds, or ambient sounds in general, while others prefer “absolute” silence for better concentration while working. Participants also listed habits such as prefer typing than writing or vice versa, more likely to focus when utilizing images, or are more likely to have new ideas while in a public location.

Working location preferences were also a question of pure personal preferences for the test users, as it is common for a knowledge worker to continue working in a variety of places, whether that be moving vehicle, or an active event site. Preferred places include school facilities, one’s own apartment, and cafes, while the office worker listed his office as his preferred location. While asked to explain his choice, the participant answered that his association of work and office is very

strong, as he constantly wants to keep work at work. Other participants are students and answered mostly school facilities, as they found studying with peers to be the most effective.

The feedback received from users on ParavenTo showed the general attitude towards ParavenTo to be positive. Interest for the product was unanimous and the request for more portability as well. Detailed feedback results are reflected in the improvements and feedback section in Chapter 5.

# Chapter 5
# Conclusion

## 5.1. Conclusion

The rise of knowledge workers and the shift of our society into an information dictated one calls for more attention to the working environment of knowledge workers. Although the concept of knowledge work is not new, the attention to knowledge workers in the work place is not nearly enough. This is where products like ParavenTo comes into play, especially in the case of trying to create a personalized work space without having to renovate the whole office.

Results and feedback collected from the user tests, it is clear that the need for ParavenTo is real and that the features it offers are called for by the work force. This research has shown that having a more personal partitioned work space can increase work efficiency for knowledge workers. Three design pillars, immersive, private, and customized are used as guidelines for the design of ParavenTo, as it shows that the combination of these factors can indeed create an environment positive for work efficiency.

Design goals mentioned in the beginning of Chapter 3 were met and initial user tests showed positive results. The main design pillars of ParavenTo include creating a versatile, immersive, personal working space within a larger environment. The prototype was able to provide these features to the users who participated in the tests and was able to help the users focus more on the task at hand. Test results from both rounds of testing with ParavenTo were better than the results without, while the body movements of participants observed were also more relaxed while using ParavenTo than while not.

### 5.1.1 Significance Revisited

After the whole design process and experiments of using ParavenTo, it is beneficial to revisit the significance of ParavenTo and differentiate it from the other partition, or work efficiency products on the market. The main characteristics that ParavenTo exhibits include personal, private, utility-oriented and customizable.

Singling out any one feature will not be able to differentiate ParavenTo from pack, as it will not be the best representation of ParavenTo as a product. ParavenTo's stronghold will be the ability to incorporate a variety of features, while it is easily portable and usable under all kinds of situations. In the end, this product is intriguing in that it is a nice combination of many much needed features for a knowledge worker, and it provides efficiency benefits that are crucial for the work of intellectual workforce, that is becoming the major workforce of advance economies and developing economies alike around the globe.

## 5.2. Limitations

This research has several unavoidable limitations. First, due to time and scale limit, the scale of the project and many stakeholders involved with the creation and usage of ParavenTo did not have any chance of implementation in the real world, aka corporates and offices. Even though the concept of ParavenTo was shown as effective at KMD, without testing in the real world and on a much larger scale, it is very difficult to attain the features needed to satisfy a larger pool of users under much more serious environment of the corporate or smaller offices.

Secondly, the user tests were conducted within the classrooms and meetings rooms of KMD, with KMD students around. Though the second round of testing saw significant improvements from the first round, in that the testings were conducted under much more realistic conditions. Still, without the real atmosphere of an office and colleagues around, it is very difficult to simulate an environment exactly same to that of a real office. Also, the mindsets of students during a known user test experiment are by no means close to those of the working class, who are concerned with meeting deadlines, putting food on the table for their families and other real world problems. In future studies, a more realistic environment within

the office and test subjects, who are corporate knowledge workers are required to produce more realistic results.

Thirdly, due to the limited resources available for the actual creation of the prototype, the ParavenTo prototype lacks several features that are envisioned, especially when it comes to the customization and accessories departments. The portability of ParavenTo, which is also one of the essential characteristics envisioned for this product is also limited due to this reason. Therefore, the user experience is incomplete and requires future improvement.

## 5.3. Future Work

Due to a number of limitations mentioned in the previous section, future work is required in order to provide the full user experience of ParavenTo. While initial testing shows positive results, the road to a better product is still long ahead. Future work will be categorized into three sections, hardware design, incentive to buy and implementation of ParavenTo. As the initial prototype and testing of ParavenTo was able to solve some of the design obstacles mentioned in Chapter 3, these obstacles still remain and will be guiding the direction of future work.

### 5.3.1 Hardware Design

Hardware design needs to be improved from three main areas, material, customization and accessories.

The material of the prototype include cardboard paper and acrylic boards, which are accessible and easily modified, which is crucial for the prototyping phase. Going forward, however, better material is needed for ParavenTo to realize its full potential. Future models should have a double layered polyester as the main material for noise reduction and portability reasons.

On the portability end, because of the panels will be connected to one another by removable hinges, ParavenTo will be able to be easily broken down by the users for convenient storage and portability. Double layered polyester will be a light but durable material ideal for a variety of situations.

Customization is an important distinguishing feature for ParavenTo. The concept is proposed but not implemented for this research, but remains a crucial part

for future ParavenTo work. Being to add a variety of components, such as LCD screens, cork-board for notes and photos, and numerous other possibilities will bring the usefulness of ParavenTo to the next level. Having an extra screen is extremely important for knowledge workers as most of their work nowadays are completed using a computer. Being able to have a screen built into the partition is absolutely a plus to work efficiency. Other options such as cork-boards, smartphone holders and others will also look to add organization, tidiness, and personality to the ParavenTo. Customization will not only be for utility but also personality for the users of this product. Possible opportunities with other brands will also be an option for the customization phase.

Accessories is another area that will require further attention. Like customizing, adding accessories will also be an opportunity for collaboration with other parties. Current accessories options include, magnets for putting notes and photos up onto the side panels, different clips from the default hinges and other options to show character and love for ParavenTo.

### 5.3.2 Incentive to Buy

The inventive to buy this product is also a design obstacle mentioned in the previous sections. It is always with any new product, an obstacle to appeal to a target audience and to simulate that incentive to purchase the product. ParavenTo, is no different. The advantage that ParavenTo has as a product as it joins a long list of office partitions is definitely its flexibility, both from its design and from the massive amount of utility it offers.

Flexibility here is not limited to the design of ParavenTo, but on other levels as well. ParavenTo is fit for a variety of situations, whether it is within the office, on the go or even within the user's own home. Due to its portability, it can be taken to different places with ease, and allows for maximum usage. It is also flexible in its features, offering a private personal space in its original state, and tons more with the customization possibilities.

The ability to not only use ParavenTo for one specific occasion or setting, but to be able to bring it along and use it for all kinds of situations for an extended period of time, especially with the customization features, would be the biggest incentive to buy for ParvenTo. The protection of privacy, the organization benefits, as well

as the fundamental feature of having a personal space to ensure efficiency are all real benefits that customers will get for their money. Ultimately, the utility of ParavenTo will be the biggest incentive and it will help ParavenTo gain a wide range of users.

While individual efforts will be crucial for solving this problem, to simulate incentive, future work in the marketing area needs to be completed. Collaborating with different retailers of electronics, furniture and even stationary goods will be the focus; as trying hands on and experimenting with ParavenTo is the best way to discover its utilities and usefulness. Rental plans can also be an option as some users might want more opportunities and time to experiment before purchasing.

### 5.3.3 Implementation

One other challenging area will be the implementation phase of ParavenTo. With all the benefits that this product provides, it is still a bit difficult for some to set up their own partition at work, especially for those with a more strict corporate culture. It could also be initially difficult to bypass the opinions of those around the potential ParavenTo user as their woking conditions will be affected by the setup of ParavenTo. Therefore the two major areas of difficulties of implementing ParavenTo within the office will be the pressure from corporate culture and the possible resistance of the user's colleagues around him/her.

While corporate culture around the world is generally becoming more relaxed and encouraging the show of personality of the knowledge workers, many companies, especially in Japan, are not only keen on keeping the design of the open office, but are also unwilling to let go of the old stiff corporate culture. Having one person trying to single him/herself out by using ParavenTo will definitely be difficult at first, however, the flexibility of being to quickly setup and remove the product will be able to gain some grounds for the potential user. Work will be needed to communicate with supervisors and management of the office, but the utility of the product will be a strong point of argument.

The other problem will be those who are immediately around the user of ParavenTo. They will definitely be the most directly affected as the ParavenTo will be setup around them. One simple solution for this problem will be effective communication again, initiated by the user. As ParavenTo is an utility product,

the features it provides are not intrusive by any means, therefore, effective communication by the user with those around him/her should suffice for solving the problem of initial resistance. Here again, the quick setup and removal will be especially helpful as if the neighbors find the product annoying in any way, the user can quickly dismantle it to avoid conflict.

Similarly to the buy incentive, implementation issues also need to be solved from a more trick-down approach. Collaborating with companies and offices will crucial for the success of implementation, especially within big corporates. Actively find cooperation and collaboration opportunities will be the key for success on both the macro and micro level for implementation of ParavenTo.

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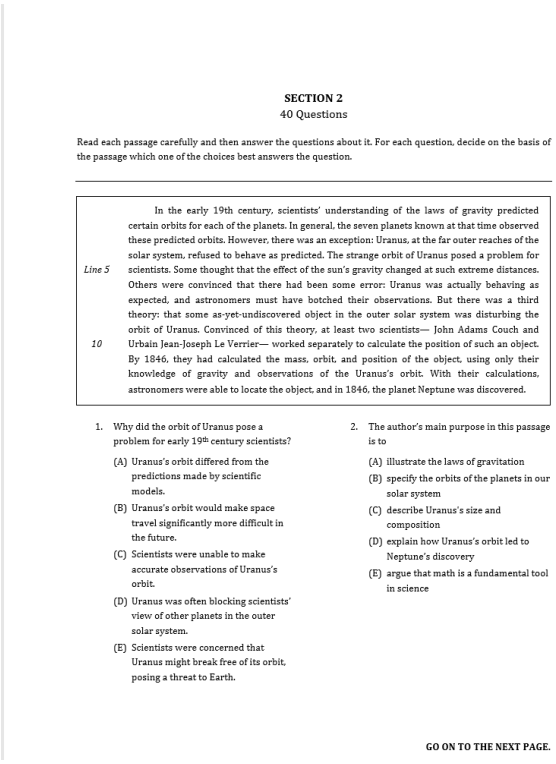
# Appendices

## A. Example Quiz Questions

### A.1 SSAT

[19]



**SECTION 2**
40 Questions

Read each passage carefully and then answer the questions about it. For each question, decide on the basis of the passage which one of the choices best answers the question.

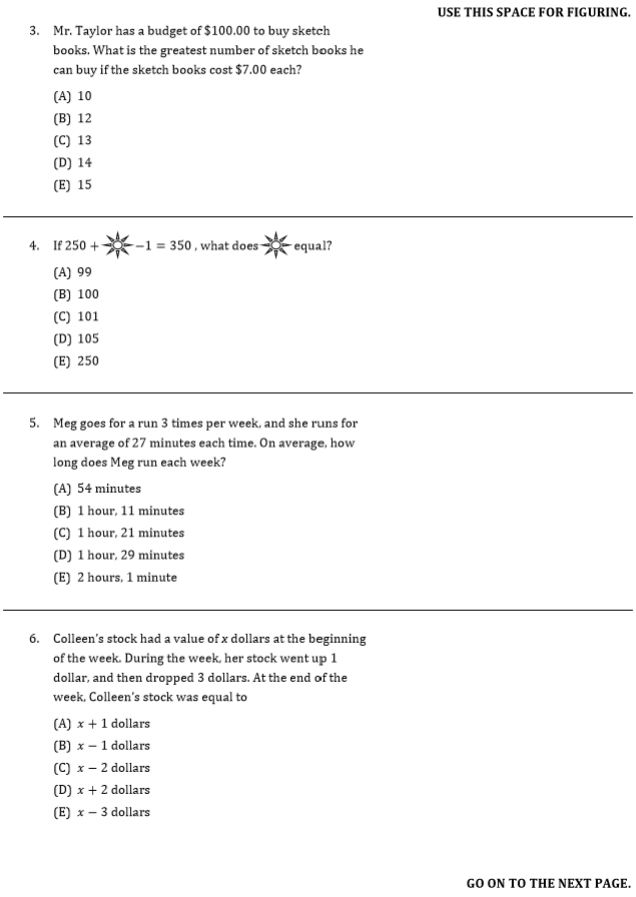
In the early 19th century, scientists' understanding of the laws of gravity predicted certain orbits for each of the planets. In general, the seven planets known at that time observed these predicted orbits. However, there was an exception: Uranus, at the far outer reaches of the solar system, refused to behave as predicted. The strange orbit of Uranus posed a problem for scientists. Some thought that the effect of the sun's gravity changed at such extreme distances. Others were convinced that there had been some error: Uranus was actually behaving as expected, and astronomers must have botched their observations. But there was a third theory: that some as-yet-undiscovered object in the outer solar system was disturbing the orbit of Uranus. Convinced of this theory, at least two scientists— John Adams Couch and Urbain Jean-Joseph Le Verrier— worked separately to calculate the position of such an object. By 1846, they had calculated the mass, orbit, and position of the object, using only their knowledge of gravity and observations of the Uranus's orbit. With their calculations, astronomers were able to locate the object, and in 1846, the planet Neptune was discovered.

1. Why did the orbit of Uranus pose a problem for early 19th century scientists?
   (A) Uranus's orbit differed from the predictions made by scientific models.
   (B) Uranus's orbit would make space travel significantly more difficult in the future.
   (C) Scientists were unable to make accurate observations of Uranus's orbit.
   (D) Uranus was often blocking scientists' view of other planets in the outer solar system.
   (E) Scientists were concerned that Uranus might break free of its orbit, posing a threat to Earth.

2. The author's main purpose in this passage is to
   (A) illustrate the laws of gravitation
   (B) specify the orbits of the planets in our solar system
   (C) describe Uranus's size and composition
   (D) explain how Uranus's orbit led to Neptune's discovery
   (E) argue that math is a fundamental tool in science

**GO ON TO THE NEXT PAGE.**

Figure A.1 Sample Reading Questions



USE THIS SPACE FOR FIGURING.

3. Mr. Taylor has a budget of $100.00 to buy sketch books. What is the greatest number of sketch books he can buy if the sketch books cost $7.00 each?

(A) 10
(B) 12
(C) 13
(D) 14
(E) 15

4. If $250 + \star - 1 = 350$, what does $\star$ equal?

(A) 99
(B) 100
(C) 101
(D) 105
(E) 250

5. Meg goes for a run 3 times per week, and she runs for an average of 27 minutes each time. On average, how long does Meg run each week?

(A) 54 minutes
(B) 1 hour, 11 minutes
(C) 1 hour, 21 minutes
(D) 1 hour, 29 minutes
(E) 2 hours, 1 minute

6. Colleen's stock had a value of $x$ dollars at the beginning of the week. During the week, her stock went up 1 dollar, and then dropped 3 dollars. At the end of the week, Colleen's stock was equal to

(A) $x + 1$ dollars
(B) $x - 1$ dollars
(C) $x - 2$ dollars
(D) $x + 2$ dollars
(E) $x - 3$ dollars

GO ON TO THE NEXT PAGE.

Figure A.2 Sample Math Questions

## A.2 ACT

[20]

**Passage I**

Unmanned spacecraft taking images of Jupiter's moon Europa have found its surface to be very smooth with few meteorite craters. Europa's surface ice shows evidence of being continually resmoothed and reshaped. Cracks, dark bands, and pressure ridges (created when water or slush is squeezed up between 2 slabs of ice) are commonly seen in images of the surface. Two scientists express their views as to whether the presence of a deep ocean beneath the surface is responsible for Europa's surface features.

*Scientist 1*

A deep ocean of liquid water exists on Europa. Jupiter's gravitational field produces tides within Europa that can cause heating of the subsurface to a point where liquid water can exist. The numerous cracks and dark bands in the surface ice closely resemble the appearance of thawing ice covering the polar oceans on Earth. Only a substantial amount of circulating liquid water can crack and rotate such large slabs of ice. The few meteorite craters that exist are shallow and have been smoothed by liquid water that oozed up into the crater from the subsurface and then quickly froze.

1. **Which of the following best describes how the 2 scientists explain how craters are removed from Europa's surface?**

   A. Scientist 1:Sublimation
   Scientist 2: Filled in by water

   B. Scientist 1: Filled in by water
   Scientist 2: Sublimation

   C. Scientist 1: Worn smooth by wind
   Scientist 2: Sublimation

   D. Scientist 1: Worn smooth by wind
   Scientist 2: Filled in by water

2. **According to the information provided, which of the following descriptions of Europa would be accepted by both scientists?**

   E. Europa has a larger diameter than does Jupiter.

   F. Europa has a surface made of rocky material.

   G. Europa has a surface temperature of 20°C.

   H. Europa is completely covered by a layer of ice.

3. **With which of the following statements about the conditions on Europa or the evolution of Europa's surface would both Scientist 1 and Scientist 2 most likely agree? The surface of Europa:**

   A. is being shaped by the movement of ice.

   B. is covered with millions of meteorite craters.

   C. is the same temperature as the surface of the Arctic Ocean on Earth.

Figure A.3 Sample Science Questions

Jupiter's magnetic field, sweeping past Europa, would interact with the salty, deep ocean and produce a second magnetic field around Europa. The spacecraft has found evidence of this second magnetic field.

*Scientist 2*

No deep, liquid water ocean exists on Europa. The heat generated by gravitational tides is quickly lost to space because of Europa's small size, as shown by its very low surface temperature (–160°C). Many of the features on Europa's surface resemble features created by flowing glaciers on Earth. Large amounts of liquid water are not required for the creation of these features. If a thin layer of ice below the surface is much warmer than the surface ice, it may be able to flow and cause cracking and movement of the surface ice. Few meteorite craters are observed because of Europa's very thin atmosphere; surface ice continually sublimes (changes from solid to gas) into this atmosphere, quickly eroding and removing any craters that may have formed.

D. ○ has remained unchanged for millions of years.

4. **Which of the following statements about meteorite craters on Europa would be most consistent with both scientists' views?**

E. ○ No meteorites have struck Europa for millions of years.

F. ○ Meteorite craters, once formed, are then smoothed or removed by Europa's surface processes.

G. ○ Meteorite craters, once formed on Europa, remain unchanged for billions of years.

H. ○ Meteorites frequently strike Europa's surface but do not leave any craters.

5. **Scientist 2 explains that ice sublimes to water vapor and enters Europa's atmosphere. If ultraviolet light then broke those water vapor molecules apart, which of the following gases would one most likely expect to find in Europa's atmosphere as a result of this process?**

A. ○ Nitrogen

B. ○ Methane

C. ○ Chlorine

D. ○ Oxygen

6. **Based on the information in Scientist 1's view, which of the following materials must be present on Europa if a magnetic field is to be generated on Europa?**

E. ○ Frozen nitrogen

F. ○ Water ice

Figure A.4 Sample Science Questions 2