# Assignment M2:

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***Abstract*—Keyboards are currently the most common electronic input device people use when typing text on a computer. Despite the large number of users worldwide, the keyboard designs only target the English proficient speakers. Although it is possible to change the language of typing on a computer, the keys on the keyboard only show the English letters. This poses a huge burden on people who desire to type letters of a different language. The current project aims to investigate this issue, find the needs of the user, propose new ideas to efficiently re-design the keyboard layout, and finally evaluate them systematically.**

## 1 NEEDFINDING EXECUTION1- NATURALISTIC OBSERVATION

The information collected via naturalistic observation was collected from three different groups of people that I had access to. These groups are described as follows: 1) three bilingual and two multilingual friends who use keyboards to type in different languages including English, French, Spanish, and Farsi, 2) three bilingual coworkers who uses a keyboard to type in English and Spanish, 3) A multilingual classmate who uses a keyboard to type in English, French, and Mandarin.

### 1.1 Raw results

Raw results are given in Appendix 1.

### 1.2 Summarized results

The collected information can be categorized as below:

1. Visualization: From the collected information, it seems like the letters visualized on the keys (in both mechanical and on-screen keyboards) assist users in typing.
2. Pace: It was observed that the typing speed reduces when typing non-English letters on a keyboard with English-labelled keys.

3. Specific Language Requirements: It was observed that the requirements are language specific. Some languages such as Mandarin require a larger number of keys since the original language includes a larger number of letters. Some other languages such as French and Spanish require the same English letters but with different accents.
4. Specific types of Keyboards: It was observed that the users not only use mechanical keyboards, but also on-screen keyboards as well. These keyboards are slightly different in design. Also, working on Windows or Mac keyboards is different when typing.

It is however required to get users' feedback on the above-mentioned items to confirm the validity of the observations.

### 1.3 Steps to control the biases

In order to avoid biases in my observations, I asked my partner to observe a couple of coworkers when using a keyboard to type in English and other languages and write down his observations in bullet points. I then compared my notes with his and included both matching and new observations to my report.

Although I compared my notes with partner's and included both views in this report, it is still possible that the results are biased. For example, I could have been more curious about seeing users have similar issues as mine when writing non-English letters on a keyboard.

Also, the people included at this stage of the need finding are limited to nine people who type in five common languages in the world. It is highly possible that the requirements to type in other languages are missing in the report.

## 2 NEEDFINDING EXECUTION3- SURVEYS

The information collected in the naturalistic observation step was used to generate a survey. 27 people participated in this survey.

### 2.1 Raw results

Raw results are given in Appendix 2.

### 2.2 Summarized results

The collected information can be categorized as below:

1. Visualization: Users confirmed that visualizing the letters on the keypad is efficient when writing in non-English languages.
2. Timing and Pace: It was observed that users spend much more time typing in English rather than other languages. It can be hypothesized that the slower speed of typing non-English letters is related to the time users spend working on these specific keyboards.
3. Specific Language Requirements: The differences between specific language requirements were frequently mentioned by the people who took the survey. This suggests the possibility that the design of the keyboard requires to be compatible with the specific language.
4. Specific types of Keyboards: It was observed that the most common keyboard to type in English is the mechanical keyboard; however, both mechanical and on-screen keyboards were popular among people who type in other languages.

### 2.3 Steps to control the biases

The following are the steps that were followed to control biases: 1) kept the questions short and clear. 2) Avoided using leading adjectives that are leading to a certain direction. 3) Used interval questions and provided answer options such as “strongly agree”, “agree”, “neutral”, “strongly disagree”, “disagree”. 4) Surveys were anonymous, 5) asked for feedback about possible biases from two friends before publishing the survey.

The above-mentioned steps limit the bias to a great extent. However, it is still possible that the survey is tailored to people who type the languages identified by myself or my friends who reviewed the survey.

Also. People who took the survey had a good English proficiency level. In order to control the bias, it would be great to include participants who do not speak English as well.

## 3 NEEDFINDING EXECUTION2- INTERVIEWS

The information collected in the naturalistic observation and survey steps were used to generate interview questions. 5 people participated in this survey.

### 3.1 Raw results

Interview questions and the highlights of the interviews for each question. are given in Appendix 3.

### 3.2 Summarized results

The collected information can be categorized as below:

1. Visualization: 4 out of 5 of the interviewed users revealed that they need to visualize the keys in order to locate their desired keys.
2. Timing and Pace: 4 out of 5 of the interviewed users suggested that typing non-English letters on a standard English keyboard is more time consuming and lowers the pace of typing.
3. Specific Language Requirements: All users confirmed that they are able to type their desired letters using the standard layout of the English keyboard. However, they stated the requirement to hold down two or three keys at the same time to type specific letters.
4. Specific types of Keyboards: All users at least used a mechanical keyboard. A user mentioned the physical difficulties with on-screen keyboards. One user mentioned a haptic device that uses hand gestures to type letters. Despite the interesting idea, they claimed that memorizing the hand gestures is not easy.
5. Users claimed to use their laptop or personal computer at work, school, or home office settings.

### 3.3 Steps to control the biases

In order to control for biases, the following steps were taken: 1) The interview questions were polished multiple times to make sure that the words used are not imposing any positive or negative impression on the user. Also, the questions were selected to be broad and general. No specific questions were asked. 2) Before initiating the actual interviews, I practiced the interview questions with two friends. This not only enabled me to rehearse my words and acts, but also realize possible pitfalls that may still exist in my interview questions. At this stage, I asked my friends to let me know if they feel any type of bias in either the words that I am using or in my body language.

Despite editing the questions and rehearsing the interview materials a couple of times, it is still possible that the tone of the voice for asking the questions seem

to have either positive or negative impression. The risk for this is even higher when interviewing people coming from different cultural backgrounds. The way that the acts and the tone of voice is perceived can be different in various cultures.

## 4 DATA INVENTORY

### 4.1 Who are the users?

According to the need finding studies conducted, the users defined in this study include people who use a keyboard to type in two or more languages. These people have a basic knowledge about typing on a computer using a keyboard.

### 4.2 Where are the users?

The naturalistic observations and interviews revealed that the users tend to either use their laptop or keyboard attached to a personal computer at work, school, or their home office setting.

Most users participated in the interviews mentioned that they look at their keyboard to be able to locate the desired keys. Therefore, the location of the users was bright enough to allow them to see the keys and distinguish them from each other.

### 4.3 What is the context of the task?

With the current need finding plans, there is still room to investigate more about the context. The three initial need finding methods discussed in this report were focused on the user needs in a more general context where the users have access to a keyboard and is able to type either in English or non-English languages. The impact of the context (e.g., noise in the environment) requires to be studied as well. This will shed more light on the design ideas that might come to the mind based on the current results of the need finding plans.

### 4.4 What are their goals?

The goal of the users is to type in different languages on a keyboard.

### 4.5 What do they need?

In the naturalistic observation phase, it was obvious that most of the users look at their keypad to locate the keys. This was also confirmed at the next stage in survey study. The users stated that visualizing non-English characters on the keyboard when typing in a language different that English is efficient. In addition, at the interview stage, most users mentioned that they look at their keypad when typing. Therefore, one need can be defined as being able to visualize the letters on the keypad.

Both in surveys and interview sessions, users mentioned the convenience of use of one keyboard for typing in different languages. Therefore, another need can be defined as the requirement to have a universal keyboard that supports different languages.

In the interview sessions and surveys, users hinted to the difficulties that they are facing with while having to press multiple keys to generate a specific letter. Therefore, there is need for a key that eliminates this issue to simplify the task of typing.

Having physical difficulties with typing on a on-screen computer was mentioned by a user during the interview sessions. Therefore, another need can be defined as having a keyboard that is not difficult to use or cause pain.

### 4.6 What are their tasks?

The task that the users try to accomplish can be defined as using a keyboard to type a desired language. For this purpose, users require to identify, locate, and press keys related to their desired letter(s). Identifying and locating the keys are cognitive tasks. However, pressing the desired key(s) is a physical task. No social components were identified.

### 4.7 What are their subtasks?

The subtasks identified from the naturalistic observation, surveys, and interviews include: 1) changing the computer systems' language for typing, 2) Either remember the language-specific letters or use the labels attached on the keys to find the desired letter(s), 3) press the desired key(s).

## 5 DEFINING REQUIREMENTS

### 5.1 Functionalities that the interface must provide

The keyboard interface requires to satisfy the needs identified in the need finding steps.

The users require to be able to visualize both English and non-English letters. The keyboard needs to support various languages. For example, one would be able to use the keyboard to type in English, French, and Mandarin. The user must be able to easily switch between these languages while they can still visualize the language-specific letters on the keys.

Typing special characters such as accents in French and Spanish require to be made easy. Currently, users need to press multiple keys at the same time to generate accents.

The keyboard should be designed in a way that makes it easy for the user to type, as opposed to some current keyboards such as on-screen keyboards on laptops that makes it hard for the user to type.

### 5.2 Learnability goals that the interface must meet

The user should be able to learn the way that they can use the keyboard interface in a short time. It is important to take advantage of what users already know or are familiar with. For example, keeping the key locations in the same place as the standard keyboard would help to a great extent.

### 5.3 Accessibility standards the interface must support

The interface should also be accessible for multiple groups of users. One example can be the Windows and Mac users. Another example is people who type in various types of languages, with different language-specific requirements.

### 5.4 Metrics or criteria used to evaluate the success of a prototype

Three different criteria will be used for this purpose: 1) compatibility: investigations will be conducted to evaluate the compatibility of the newly designed prototype with Mac and Windows. Also, the compatibility of the use of the prototype will be investigated for different languages. 2) compliance: the prototype will be evaluated to examine how it protects the user privacy. Investigations

will be conducted about collecting biometric data (e.g., use of fingerprint) for instance. 3) cost: the total cost to make a new prototype will be calculated and further used to compare with the other prototype(s).

## 6 CONTINUED NEEDFINDING

### 6.1 Remaining questions

The data inventory for this research still lacks information about the contexts in which individuals use the keyboard. There is room to expand the knowledge on this area as well. For example, questions to be asked can be: how much noise is in the room when users are typing? or how many tasks they are involved with when typing?

Also, investigating about the causes for change in typing speed can help in designing a more efficient keyboard. This is of great importance especially when it comes to typing in different languages using a single keyboard. The questions that can be asked can include: what affects the speed in typing? what are the requirements for positioning hands and fingers for faster typing?

### 6.2 Methods used in the next need finding phase

In order to investigate about the contexts, think-aloud or post-event protocol method can be used. I can ask participants to share their thought process when typing in different contexts throughout the day. For example, they might be at school in a class where the teacher is talking, and they are typing their notes at the same time. Another context can be the participants typing at work with printer's noise and co-workers talking around.

To investigate more about the typing speed, analysis of existing data can be used. There are currently a large number of journal papers published in literature. One can review and summarize them to get a better understanding of the users' need regarding a keyboard than enables users to increase their typing speed.

## 7 REFERENCES

1. www.maayot.com/blog/chinese-keyboard-and-how-to-type-in-chinese

## 8 APPENDIX 1

In this section, the raw results are presented for the natural observation step.

Almost all keyboard users, except for one user who types in English and French look at their keyboards to find the location of their desired key(s).

While the majority of the users use mechanical keyboards, some use on-screen keyboards to type non-English letters.

Out of nine users observed, three of them use non-English stickers on the keys of their mechanical keyboard.

Users were typing relatively faster in English on a keyboard than other languages; both on mechanical and on-screen keyboards. In order to type Chinese, one requires extra buttons as shown in "Figure 1".


Figure 8- Chinese Keyboard [1]

Writing in Farsi, French, and Spanish requires holding multiple keys together to generate accents (e.g., Á in Spanish).

The above-mentioned keys are different for Windows and Mac users.

## 9 APPENDIX 2

In this section, the raw results are presented for each of the survey questions.

- In how many languages you regularly type on a computer?
  16 people answered 2, 7 people answered 3, 1 person answered 4, 2 people answered 5
- How many hours do you spend typing English text on a keyboard per week?

13 people answered above 50, 6 people answered 40-50, 6 people answered 30-39, 2 people answered less than 30

- How many hours do you spend typing non-English text on a keyboard per week?
  6 people answered above 10, 7 people answered 5-10, 10 people answered 1-4, 4 people answered less than 1
- What type(s) of keyboard you use to type text in English?
  20 people answered mechanical keyboard only, 5 people answered both mechanical and on-screen keyboard, 2 people answered on-screen keyboard only
- What type(s) of keyboard you use to type text in non-English languages?
  12 people answered mechanical keyboard only, 11 people answered both mechanical and on-screen keyboard, 3 people answered on-screen keyboard only, 1 person answered virtual keyboard
- What is the difficulty level in memorizing keyboard characters in a non-English language?
  4 people answered very hard, 4 people answered hard, 13 people answered neutral, 2 people answered easy, 4 people answered very easy
- How comfortable is using keyboard language stickers?
  4 people answered very hard, 2 people answered hard, 17 people answered neutral, 2 people answered easy, 2 people answered very easy
- How efficient it is to be able to visualize non-English characters on a keyboard when typing in a language different than English?
  2 people answered not efficient at all, 9 people mentioned somewhat efficient, 12 people mentioned efficient, 4 people mentioned very efficient.
- Please include any additional feedback you may have regarding using a keyboard to type text to a computer in different languages.
  - My main difficulty is finding special common characters on different keyboards.
  - I believe this is dependent on the non-English language you are typing and the characters of the non-English language. Spanish keyboards have limited differences because of the overlap of the language spelling, while a language leveraging characters that are completely different can be hard to memorize as someone who may not be as familiar with the language.

- Typing in Japanese is easy because they have a system that utilizes the English keyboard, so there are some languages that are easy because of reasons like that (similarly, Chinese keyboards use this feature).
- I am not sure about other languages. For Mandarin, we use a system called pinyin where we can just use the regular keyboard to type what we want.
- I already have those keypads memorized when attempting on other languages.
- even with non-English language it could still use English characters as phonetic transcription which would not be a problem. But I do feel Windows make the switching input methods very troublesome. I often switch wrongly or unable to use shortcut to switch which is confusing.
- The accents on characters are the main problem, the system is to hold down the letter and then select from a list. It is a bit cumbersome at first but gets more efficient with practice.

## 10 APPENDIX 3

The interview questions and highlight of the interview are provided below.

- In what languages you type on a keyboard?
    - English, Farsi
    - English, French, Spanish
    - English, French
    - English, Mandarin
    - English, Spanish
- If typing in languages other than English, can you elaborate on your process of thoughts for typing each letter?
    - Think about the word, memorize the location of the letter on the keyboard, press the button, think about the next character – for special characters try to remember the combination of keys required to generate that character.
    - Think about the context, come up with the word, look at my keyboard, find the key- for French and Spanish, I need to hold down three keys on my Mac sometimes which make it a bit difficult.

    - French and English have similar number of letters. I only look at the keys and start typing.
    - For Mandarin, pinyin is used. You can create letters with different sounds with it. I need to first change the language of the system to Mandarin on my Windows desktop, then use the pinyin system to type, similar to English.
    - I do not look at the characters and letters on the keys. I memorized them well since I type a lot in Spanish. I just look at my monitor and start writing.
- Is there any difference between your process of thoughts when typing in English and when typing in other languages?
    - I need to memorize each letter corresponding to the language.
    - I type slower in Spanish and French. I can easily write in English without thinking.
    - Since writing in English and French are similar, I think about the letters that have accents only. This may cause some delays in my process of thoughts.
    - Writing in Mandarin requires my full attention. I need to remember which key corresponds to which letter/character.
    - There is not much difference as the letter are the same.
- What type(s) of keyboard(s) you use to type on a computer? Can you elaborate on the differences?
    - I use mechanical and on-screen keyboard. I find it harder to type on the on-screen keyboards. They might show the language-specific letters on the keys but them being on the flat screen makes it not easy physically. I prefer mechanical keyboard.
    - I use mechanical keyboard for study and work purposes. I use on-screen keyboard for communicating with friends. It is easy to work with on-screen keyboard on the phone but not on a laptop.
    - I use mechanical and on-screen keyboards. I also tried a haptic device that you can type letters using hand gesture, but it was super hard.
    - I only use mechanical keyboard. You can use exactly the same layout designed for the English keypad.
    - I only use mechanical keyboard. I have no problem remembering Spanish letters.

- Do you look at the keys on the keyboard when typing? If yes, what is the reason for it?
    - Yes, to locate the keys.
    - Yes, it helps me remember where the letters are. Since typing in three different languages, sometimes I need to press a few neighbouring letters to find the desired letter.
    - Yes, French is similar to English. To find the accents though, I need to pay attention more to which key is being presses.
    - Yes, Mandarin is a complicated language. I look at my keypad all the time to find the keys.
    - No, I know the keys by heart.
- In which location you use the keyboard to type in both English and non-English languages?
    - At home on my desk.
    - At work, on my personal computer, at school, on my laptop.
    - At work, on my personal computer.
    - At work and my home, on my laptop.
    - At work, on my laptop.