Keylekh: A Keyboard for Text Entry in Indic Scripts

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Abstract

Typing in an Indian language is currently not an easy task. Significant training is required before one can achieve an acceptable speed and only professional typists make the investment.

Part of the complexity arises due to the structure of Indic scripts and large number of characters in each script. Solutions to input text in Indic languages have been around for a while, but none of these are usable enough to emerge as the de-facto standard.

Here we describe the design of a new keyboard based on the structure of the Indic alphabet. The project went through cycles of design, prototyping and user evaluation. The evaluation was done by multiple techniques – usability tests, informal demonstrations, road shows and a typing competition. We particularly found the road shows and the competition useful for gathering feedback for this type of products.

Categories and subject descriptors: H.5.2 [Information Interfaces and Presentation]: User Interfaces –input devices and strategies, evaluation/methodology; B.4.2 [Input Output and Data Communication]: Input/Output Devices; D.2.2 [Software Engineering]: Design Tools and Techniques — user interfaces;

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Keywords: Indian language computing; text input devices; iterative design; road shows; competition; appropriate design; multi-cultural design; digital divide.
Industry / Category: Input devices, Indian language computing.

Problem statement

India is a major provider of Information Technology services to the developed world. Ironically, the advantages of Information and Communication Technologies (ICTs) remain unavailable to a majority of common people in the Indian subcontinent [8]. The PC penetration in India is a low 9 per 1000, and is largely concentrated in urban areas. In the second half of 2003, the top 4 metropolitan areas accounted for 50% in new PC sales [3]. It is notable that these metropolitan areas represent about 5% of Indian population and a high concentration of English speakers.

Significant factors contributing to this digital divide are:

- High costs
- Poor infrastructure of power and connectivity
- Illiteracy and
- Lack of computing devices in Indian languages

Many efforts are being made in the area of technology development in Indian language computing. However one area where still a lot remains to be done is that of text input in Indian languages. Whereas solutions to input text in Indian languages have been available since 1986 [3], none of these have proved to be usable by common users. Current Indian language typing solutions have a steep learning curve. According to Arjun Mahanto, the Hindi Officer in IIT Bombay, learning to type requires approximately fifty hours of training and practice for a person to reach speeds of 25 words per minute. This is too much of a barrier for ordinary people and only professional typists are willing to make this investment. Computer usage in India is almost entirely in English and is restricted to the English-speaking, upper and upper-middle class people.

This stands in direct contrast with the demand for communication in Indian languages. Census data for the year 1991 shows that English is the first language for only 0.02% of Indians and second and third language for 8% and 3% respectively [1]. Hindi TV programs claim all the top 10 slots in television program ratings [4]. Circulation of daily English newspapers had a market share of 15% in the year 2002 [7].

Our experience shows that for most Indians, English is not the preferred language for informal communication such as face-to-face conversation, phone conversation, hand-written letters. Where English is used in such communication, a good proportion of it tends to be bi-lingual. On the other hand, almost all computer mediated communication (email, SMS, chat) happens in English alone or in the rare case, an Indian language phonetically transliterated in the Roman script.

Better, more usable devices for text input will enable the people who are currently on the ‘other side’ of the digital divide to express themselves. This will make possible bi-directional flow of information through a computer. In this paper we describe the design of an alternative keyboard for text input in Indic scripts.

Background/Project participants

Work for input devices in Indic scripts at IIT Bombay started with a Masters level project of Amit Rathod, a student of Industrial Design [6]. The project was guided by Anirudha Joshi and Prof. UA Athvankar.

Meanwhile, Media Lab Asia, a not-for-profit organization sponsored a research project in IIT Bombay called 'Interfaces for all'. Work on text input in Indic scripts was taken up as one of the activities in this project.

In this paper we describe one concept design of a keyboard that came out of this project. This concept was earlier called **Barakhadi**, which later was renamed as **Keylekh**. It underwent several iterations of evaluation and redesign. Table 1 summarizes the milestones in the development of Keylekh.

Date	Milestone
Jun 2002	Prototype of Barakhadi 1
Nov 2002	Usability evaluation of Barakhadi
Jan 2003	Barakhadi 2 desktop version
Feb 2003	Usability evaluation of Barakhadi 2
Mar 2003	Barakhadi 3 with QWERTY, Inscript compatibility
Aug 2003	Keylekh 1 with 'swapped' layout
Sep 2003	Keylekh road shows and competition
Sep 2003	Keylekh 2 redesigned vowel block
Nov 2003	Keylekh 2 usability studies
Dec 2003	Keylekh 3 'split' keyboard version
Ongoing	Keylekh longitudinal study, pilot deployment, commercialization

table 1: Keylekh project milestones

Key contributors towards design of this keyboard were Anirudha Joshi, Amit Rathod, Ashish Ganu and Vikram Parmar. Electronics and software development was done by Dr. Hayatnagarkar and Abhinav Gupta. Anirudh Ojha, Gaurav Mathur, Aditya Chand, Gautam Vaswani, Abhishek Thakkar and several others were involved in generating ideas, usability evaluation, soliciting user feedback and other activities surrounding this project.

Challenge

Three issues related to Indian languages pose challenges for the design of input devices:

- Structure of Indic scripts
- Cognitive styles of writing and typing
- Large number of characters

Structure of Indic Scripts: Keyboards were originally designed to input text in the Roman script. The Roman script can be almost completely represented by 26 keys on the keyboard. Each lower case character is achieved by one keystroke. Each upper case character is available on the 'shifted' position of the corresponding lower case key. This arrangement poses almost no cognitive load on even the first time users. As Norman puts it, "Walk up to any regular keyboard and you can use it right away. Just search for the letter you want and push the key." [5]

Unfortunately, this ease of use is not applicable to Indic scripts. Indic scripts have a unique structure which necessitates the user to type multiple keystrokes to enter one character. We will explain this with respect to Devnagari, the script used in Hindi, Marathi, Konkani and Sanskrit languages.

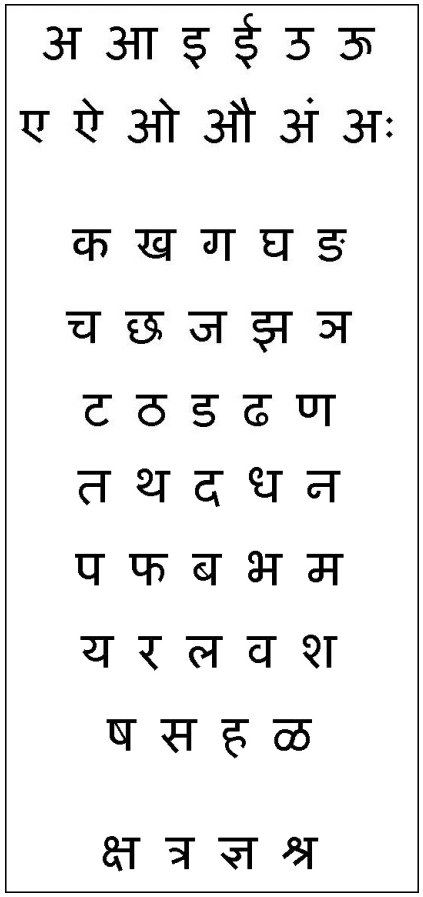

figure 1: The Devnagari *Varnamala* showing the most frequently used 12 vowels, 34 consonants and 4 conjuncts.

Figure 1 shows the Devnagari alphabet called *Varnamala* with frequently used consonants and vowels. Devnagari has 53 base letters – 34 consonants and 19 vowels in addition to numbers and punctuation marks. The last nine of the 34 consonants are also known as semi-vowels.

One or more letters come together to form a character and one or more such characters come together to form a word. Consonants and vowels can be combined in different ways to form characters. Below we describe the different combinations, along with the method to achieve them on Inscript, the most commonly used solution to enter text in Devnagari:

- **(C+V):** In Devnagari, each character ends with a vowel. A 'simple' character consists of a combination of a consonant and a vowel (C+V). For example, the word (*paanee*) is made up of two characters (*pa*) and (*nee*). The character (*pa*) is made up of the consonant (*p*) and the vowel (*aa*), and the character (*nee*) is made up of the consonant (*n*) and the vowel (*ee*).

पानी	=	पा + नी	=	प् + आ	+	न् + ई
paanee	=	*paa + nee*	=	*p + aa*	+	*n + ee*

  Inscript adds the vowel (*a*) by default when a consonant key is pressed. If another vowel is desired, one needs to explicitly press the corresponding vowel key. To type the character (*paa*), one needs to type (*p*) key followed by (*aa*) key.

- **(C+C+V):** A more complex character (called conjunct) would consist of two or more consonants combined with a vowel (C+C+V). For example, the character (*pre*) in the word (*prem*) is made up of conjunct (*p*), the conjunct (*r*) and the vowel (e).

प्रेम	=	प्रे + म	=	प् + र् + ए	+	म् + अ
prem	=	*pre + m*	=	*p + r + e*	+	*m + a*

  To form a conjunct in Inscript, one presses the first consonant key, followed by a special key called 'halant' followed by the second consonant key, followed by the vowel key. To get the conjunct (*pre*), one needs to press the (*p*) key followed by the halant key followed by the (*r*) and (*e*) keys.

- **(C+V+V):** In some cases, two vowels are combined with one or more consonants (C+V+V). For example in the word (*paande*), the character (*paan*) is made up of the consonant (*p*), the vowel (*aa*) and the vowel (*an*).

पांडे	=	पां + डे	=	प् + आ + अं	+	ड् + ए
paande	=	*paan + de*	=	*p + aa + an*	+	*d + e*

  To form this type of character in Inscript, one needs to press the consonant key (*p*) followed by the two vowel keys (*aa*) and (*an*).

  Cognitive Styles of Writing and Typing: In some characters, there are differences in the **phonetic** sequence of consonants and vowels and the **visual** sequence in which one writes the corresponding glyphs on paper.

- For example for the character (*pi*) in the word (*pitaa*) users write the glyph for the vowel (*i*) before the glyph for the consonant (*p*), but pronounce the (*i*) after the (*p*).

पिता	=	पि + ता	=	प् + इ	+	त् + आ
pitaa	=	*pi + taa*	=	*p + i*	+	*t + aa*

- In another example, in the word (*arth*), users write the glyph for the consonant (*th*) before the glyph for the consonant (*r*) though the sequence of pronunciation of the character is (*rth*).

अर्थ	=	अ + र्थ	=	अ	+	र् + थ् + अ
arth	=	*a + rth*	=	*a*	+	*r + th + a*

  Users are habituated to thinking in the visual sequence of the glyphs when they write. However computer storage formats such as ISCII (Indian Standard Code for Information Interchange) and Unicode require the users to type the phonetic sequence of consonants and vowels. Though occasional, these differences between typing and writing sequence are significant enough to baffle novices, require learning and put an extra cognitive load on users during typing.

Large number of Characters: Theoretically, infinite number of Devnagari characters can be generated by combinations of C+V, C+C+V, …, C+C+…V… structures. Actually, a smaller subset of characters is currently used in Devnagari. But even this small subset is quite large making it impossible to design a practical keyboard where one key corresponds to one character. It is necessary to have multiple keystrokes of the base consonants and vowels to generate most Devnagari characters. However, enough keys are not available on QWERTY keyboards even to represent the base consonants (34), vowels (19), and halant key which require 54 keys against the 26 that are available.

Existing Devnagari text input solutions handle this problem by force-fitting some base letters on the shifted positions and by using the punctuation keys. In Roman scripts, the relation between shifted and un-shifted characters is that of upper and lower case. There is no such easy correspondence in current Indian language keyboards. This adds to the cognitive load while typing.

To summarize, typing in Indic scripts presents a significant cognitive load on the users. QWERTY keyboards are not a suitable hardware platform. Current solutions do not address this problem and are all based on the QWERTY hardware. Long training hours are needed to learn to type in Indic scripts. This discourages most Indian users and they seek professional typists each time something needs to be typed in their own language.

Goals

These were the goals identified for the design of Keylekh:

- Any person who can read Devnagari should be able to type in Devnagari.
- The keyboard should present a straightforward conceptual model and minimize the cognitive load while typing.
- The keyboard should have a gradual learning curve.

Our primary objective was to design a new keyboard that is easy to use and easy to learn. We also wanted it to be perceived to be easy to use. The target audience consists of literate people who are not professional typists. We hoped to design a 'walk-up and use' keyboard that needed minimal or zero instructions. Our secondary objective was speed of use. The typing speeds should be acceptable for both first-time and long-term use.

Solution summary

Keyboards still are favored text input devices. Alternatives to keyboards, such as voice, stylus, key-pad etc. for Indic scripts are being considered separately within our group and elsewhere. Still more work needs to be done in this area. However, no robust alternative has emerged till date in any language that has replaced keyboards in all situations. We therefore feel that it is important to design a keyboard that suits the needs of Indian users.

Current QWERTY keyboards are not suitable for input in Indian languages. We started our project by removing the constraints imposed by this de-facto hardware standard and thought afresh of alternative solutions.

The layout of the Devnagari alphabets, *Varnamala* shown in Figure 1 above is used to teach the alphabet in pre-schools. All who can read the language are familiar with this layout. We started with the premise that if this *Varnamala* layout is replicated on the keyboard, it will be easy for people to recall and it will also be perceived as easy to use.

On this premise, design concepts were developed and converted into prototypes. Feedback was taken from the users by several methods, including user tests, expert reviews, informal demonstrations, road shows and a typing competition. These interactions triggered several design ideas. The product was successively redesigned to accommodate the findings.

Solution details

We started with designing a 'walk-up and use' keyboard to be used in self-service devices such as ATMs and ticket vending machines. Figure 2 shows the layout of **Barakhadi 1**, the first version.

Barakhadi 1 has a block of keys for the consonants and semi-vowels on the left and a block of keys for the vowels in the middle. The consonants and semi-vowels are organized exactly as in the layout of *Varnamala*. The vowels are arranged in a 'visual' order in which they appear in the glyphs. The balance keys are distributed in a suitable manner.

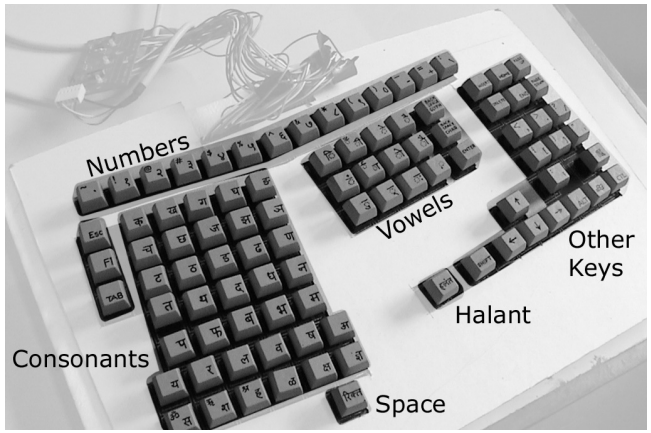

figure 2: Barakhadi 1, the keyboard for Devnagari text input based on the *Varnamala*. This keyboard was to be used in a standing posture on self-service devices.

Usability studies were conducted by comparing usage of this keyboard with two other keyboards by three Hindi school teachers. We found that Barakhadi worked best as a first-time use device among the keyboards compared. We also felt that the concept has potential as a 'desktop' keyboard for use in homes and offices as well. Additional user feedback was taken informally by letting many users type freely with the keyboard.

These were the specific findings:

- The *Varnamala* structure was useful for people to locate keys and to reduce the cognitive load. Even users who had 'forgotten' the alphabetical order could remember the local sequence of the letters they were searching for. For example, if they were looking for the (*n*) key, they would mutter an entire line of consonants '(*t*) (*th*) (*d*) (*dh*) (*n*)' before locating the key. Using a known alphabetic structure increased the probability of finding the key quickly, as it was easier to locate one row of keys out of seven rows than one key in the block of 34.
- The keyboard was too 'tall' (having 8 rows of keys in the left hand block), and the hands of an average user would not reach the top row of keys when the keyboard was kept on the table and the user tried it when seated. This was a particular problem in using this as a 'desktop' keyboard.
- While it was quite easy for users to find the consonant keys, finding the vowel keys was relatively harder. The 'visual' order (of the vowel location in glyphs) was noticed by users only after it was pointed out to them.

Barakhadi 2 was designed as a desktop keyboard. Figure 3 shows the layout of Barakhadi 2 along with a close-up. The design changes to Barakhadi 2 were:

- The blocks are reorganized to restrict the number of rows to 5 and to achieve the form factor of a standard desktop keyboard. The semi-vowels block of keys was broken out of the consonants block and was placed just above the vowel block. The space key and the halant key were incorporated in the space between the vowel and consonant blocks.
- The semi-vowel block and the vowel block had different alignments. The keys in the vowel block were painted to additionally differentiate the vowel block from the semi-vowel block.
- The key for vowel (*a*) was moved to the centre of the vowel block and was painted differently for easy identification. Other vowel keys were rearranged around (*a*) in a 'visual' location relative to their appearance in the glyph.

figure 3: Barakhadi 2, the desktop version of Barakhadi 1. Close-up of the semi-vowel and vowel blocks. The vowel block was painted to enhance its visual separation.

More user studies were carried out on Barakhadi 2. Reactions were also taken from those who have a high need for typing in Indian languages, but are not professional typists – for example from researchers in Indian language computing or field workers from non-governmental organizations in rural areas working in popularizing ICTs.

The findings about Barakhadi 2 were:

- The keyboard was easy to use as a desktop keyboard.
- Painting of the vowel block helped in bringing about the differentiation between blocks.
- Those who had a specific need to type in Devnagari, but were not trained typists were particularly happy to type on their own. Most were willing to purchase a keyboard at a large premium over the cost of a standard keyboard.
- Many people commented that they would need to occasionally type in English and they would not like to have a separate keyboard for that purpose. Even people, who had no need to type English content, will occasionally need to type email addresses, web site addresses or product codes for software.
- The consonant block of keys was on the left of the keyboard and the vowel block was in the middle. This was designed to create a 'natural' C-V sequence for the user, where she can first type a consonant followed by the vowel. But usability study and analysis of letter frequency revealed one shortcoming – this design required some of the most frequently used consonants to be typed by the little finger of the left hand.
- Observations revealed that users tend to cover the keyboard with their hands, thus hiding some of the keys near the side edges of the keyboard.

- The prototype was quite delicate, and it was not feasible to carry out longer studies in the field with this keyboard. It was desirable to design a more robust prototype for use in such field studies.

A new version of the keyboard, **Barakhadi 3**, was made by making two, mainly technical, changes to the keyboard:

- Barakhadi 2 needed a special piece of software that enabled Indian language input. This did not allow the user to input text in other applications. This flaw was corrected by making the hardware compatible with currently popular solutions for input in Indic languages. To start with support was provided for Inscript, which is available on Windows 98, Windows 2000, Windows XP and Linux operating systems and which is compatible with most applications on these platforms. Additionally, a mechanism was put in place to support other layouts if and when the need arises.
- Rudimentary QWERTY support was added to allow users to type in English. The last three rows of the keyboard were designated as the regular QWERTY keyboard.

The findings from the lab-based short usability evaluations seemed to be saturating. Given the nature of the product, longer and more broad-based, field evaluations were felt necessary at this stage. Hence a field study was planned on the campus of IIT Bombay. It consisted of a series of road shows, a typing competition and pilot deployments in a few target user sites. We were hoping that at least some deployments would be paid for by users. It was decided to make about 100 pieces of the keyboard. For this purpose, a new version of the keyboard, **Keylekh 1**, was designed (figure 4). The main design features were:

- The positions of the consonant and vowel blocks were interchanged from Barakhadi 3 to allow the more frequent consonants to fall on the index finger of the right hand.
- The consonant and vowel blocks were color coded to highlight the differences.
- The rows of keys were staggered, to allow for a typist skilled with typing in QWERTY to type comfortably.
- For the purpose of robustness, plastic parts from a commercially produced keyboard were used to sustain the keyboard in the field. The internal electronics was suitably altered. Minor changes were made in the key layout to fit the available model of keyboard.

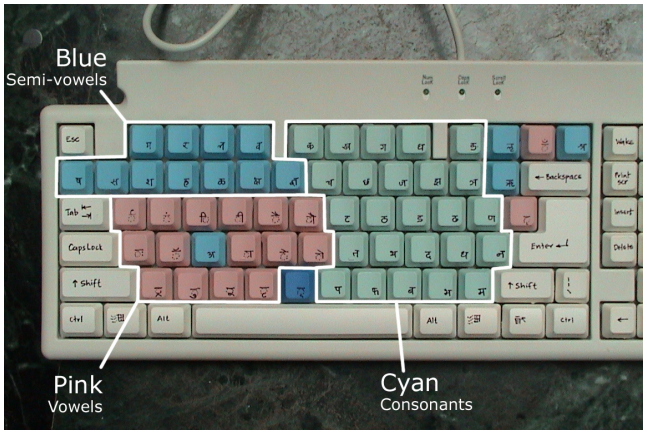

figure 4: Keylekh 1 keyboard made by using plastic parts from a commercially available QWERTY keyboard. The consonant and vowel blocks have been swapped. The colors of the blocks have been labeled for black and white reproduction.

Keylekh 1 was used in some road shows on the IIT Bombay campus to gather broader and deeper feedback from the users. The purpose of the **road shows** was to gather a reaction to the keyboard from a large number of users with respect to first-time use.

In a typical road show, computers were set up with a Keylekh keyboard in a public place such as a coffee shop, student hostel messes, a canteen, a few office lobbies etc. Passers by were encouraged to try out the keyboard and type out the following sentence after replacing 'Anirudha Joshi' with their name:

मैं अनिरुद्ध जोशी एक सामान्य नागरिक हूँ।

(I, Anirudha Joshi, am an ordinary citizen.)

The sentence was chosen because it has characters with all the desired combinations of consonants and vowels. User was allowed to explore the keyboard for a while and to type the sentence without help. Instructions were given to only those who could not proceed on their own. A pen was given away as a gift to each user who typed the sentence successfully.

The user was then invited to participate in an on-the-spot competition. In this, she had to type a sentence as fast as she can and beat the current best timing for that sentence. The person was allowed to practice the sentence for five to ten minutes before she was timed. If she could beat the currently standing record, she would win a T-shirt. Finally, the person was told about a bigger competition and was invited to participate.

Fourteen road shows were conducted in different places in the campus of IIT Bombay, each one lasting about two hours. Figure 5 shows some photos from the road shows.

figure 5: Images from the road shows.

The findings from the road shows were:

- About 450 people could successfully type the first sentence to win a pen. The participants were from the IIT Bombay campus and had varied backgrounds in terms of education, age, gender, social standing etc.

Very few people had prior exposure to typing in Hindi. The participants included students, faculty members, office staff and also non-tech savvy people such as security guards, mess workers, sweepers and other non-technical staff.

- All those who tried, could successfully type the first sentence with at the most 3 lines of instructions. Several could type without instructions, and majority needed only minor help. Many who had typed themselves once could easily help others to type the sentence completely.
- Many users when first approached were reluctant to participate, because they thought they 'could not type in Devnagari'. But when they saw that the keyboard was a new design, they changed their mind and gave it a try.
- A majority of the participants were typing in an Indian language for the first time. It was a liberating experience for them to be able to type in their mother tongue. The joy and excitement was visible on their faces.
- About 150 people participated in on-the-spot competitions and about 100 succeeded in winning T-shirts. In each road show, early winners were slow but the later winners had to put in extra efforts. They could reach timings ranging from 15 to 60 words per minute, with the average being about 25 words per minute.

Road shows also revealed some minor problems in the layouts of semi-vowel and vowel blocks. These changes were made in a version called **Keylekh 2** shown in figure 6.

A typing competition was conducted to evaluate the effect of practice on Keylekh usage. Keylekh 2 keyboards were installed in a few public locations accessible to all campus residents. The competition was widely publicized on the campus. Participants were encouraged to practice regularly. A first prize of Rs. 5,000 was announced. Some runner up prizes and special prize for non-tech savvy participants were also announced.

On the day of the final event, an elimination round was first conducted. Participants were given unpracticed sentences to type. All those who typed faster than 10 words per minute (5 words per minute for non-tech savvy people) passed to the next round. Qualifiers were asked to type unknown sentences in groups of 10. Competitive heats were followed by a final. A special heat was conducted for non-tech savvy users. Judges read the typed sentences after each round and added penalty seconds for any typing errors. Figure 7 shows a picture from the competition final.

figure 6: Keylekh 2, with modified vowel and semi-vowel blocks.

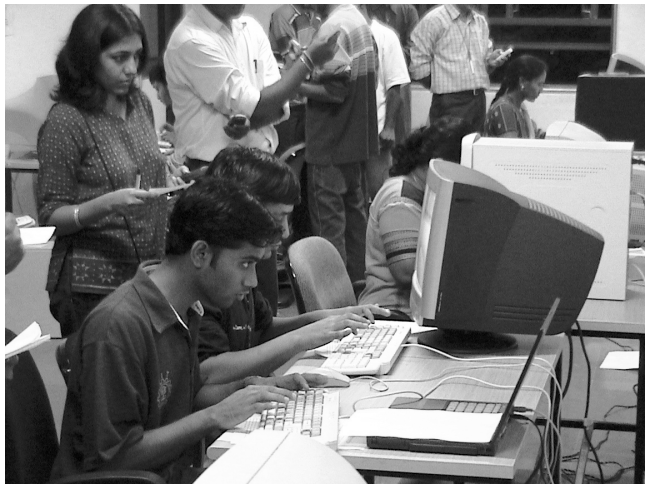

figure 7: Typing competition held using Keylekh 2. The contestants were timed for typing unpracticed sentences

The findings from the competition were:

- A total of forty seven people walked in for the competition. Twenty three people qualified for the heats having typed over 10 words per minute (four in the non-tech savvy category with over 5 words per minute).
- After the heats, 10 people competed in the final. In the final, the winner reached 20 words per minute and 8 people reached above 16 words per minute.
- Most finalists had practiced with Key-Lekh for about 2-4 hours, whereas one had practiced for less than 30 minutes.
- One finalist used eight fingers for typing, and most of them used both hands. All of them seem to have memorized the locations of most keys.
- Eight of the finalists had never typed in Hindi before they used the Keylekh keyboard. The other two were infrequent Hindi typists.
- While typing fast and reaching for the top rows, the participants occasionally pressed the keys in the lowest (sixth) row.

Design of Keylekh 1 and 2 was constrained by the use of existing plastic parts from commercially available keyboards for robustness during the road shows and the competition. There were many lessons learnt in the process. But there were several compromises in the design. The differentiation between the blocks was not clear. Also, the blocks had irregular shapes. With the experience, and with additional experimentation, we designed **Keylekh 3**, a keyboard suitable for input in both Indic and Roman scripts. Figure 8 shows the prototype of Keylekh 3.

The main design changes were:

- The layout of keys was split into two blocks of keys – the semi-vowels and vowels on the left side and the consonants on the right side.
- The sixth row was used sparingly and a space was introduced between the space bar and control keys to allow the user to rest his palm while reaching the top row.

figure 8: The final design of the keyboard for entry in both Indic and Roman scripts – Keylekh 3.

Results – Conclusions about Keylekh

From our user studies we can conclude that:

- Keylekh could achieve its primary design objective – to make typing in Indic languages easy to use and easy to learn. Some first-time users could type with no instructions. All could type with minimal instructions. Instructions seemed to be easy to remember – users who typed once could spontaneously help others.
- The Keylekh road shows demonstrated that first-timers can achieve acceptable speed of use for small typing tasks. Users also perceived the keyboard to be easy to use on first glance.
- The typing competition showed that a motivated user can achieve acceptable speed of use with a few hours of practice on Keylekh.
- The most significant success of Keylekh was the empowerment and liberation experienced by the users because they could actually type in their mother tongue.

The design aspects behind the success of Keylekh are:

- Use of a separate key to display each base letter
- Arrangement of the letters according to the structure of the Indic alphabet
- Use of color coding and layout of keys into blocks to differentiate between consonants, semi-vowels and vowels.

Results – Notes about the design process

Keyboards are products that are to be used extensively and over long periods of time. Designing new keyboards intrinsically involves designing a new 'micro interface'. These were the insights gained from this project related to design methodology for such products:

- Such products need **several iterations** of design, prototyping, usability evaluation and field trials. It is particularly hard to predict beforehand the impact of design decisions on perception of users and on long term usage after practice. It is also hard to predict the cumulative effect of multiple factors on usability. Unforeseen issues crop up even in the later design cycles.
- For iterative, long term projects it is useful to have a **multi-disciplinary** team of designers, engineers, usability experts and subject specialists working together. This reduces cycle time for trying out new ideas.
- For such products, it helps to use multiple techniques for gathering user feedback. These techniques may be formal or informal, summative or formative. Use of

multiple techniques is particularly useful to gather data about user perception in addition to usability.

- We found field trials particularly useful when designers and usability professionals are jointly involved. Formal usability evaluation reports can capture only a subset of design issues. When designers are present during field trials, they can quickly learn several issues that may be missed in reports.
- **Road shows** and **competitions** are an interesting method of gathering user feedback on the design of a new product. Road shows are effective for gathering first reactions to a product, problems with first-time usability and for recruiting users for longer studies. Involvement of people during competitions generates qualitative data on effects of practice on usage of such products. It generates design ideas through active participation of users. Care needs to be taken to communicate to participants that the product is under development and may not be commercially available soon.
- Competitions also have drawbacks – not every parameter can be controlled. For example, we would have liked to control and monitor the amount of practice before the event that each participant puts in. This would have needed lot more resources than we had at hand. Another drawback is that all products may not be as 'close to the heart' as text input in one's mother tongue, and may not generate the same kind of enthusiastic response that we had.

Future Work

We are currently conducting a longitudinal study to plot the learning curve of Devnagari keyboards over a period of time. Here, we plan to compare Keylekh learning curve with other keyboard layouts. The study is being done in both urban and rural settings.

Pilot deployments of Keylekh have been made in several locations in urban and rural areas. We hope to commercialize Keylekh soon and get response from the market. We are also working on versions of Keylekh for other Indic scripts and on other input devices for Indic scripts.

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