On-boarding the Next Billion: Issues, Approaches and Technologies for Expressive and Inclusive Interactions

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Emerging economies such as India proffer a number of challenges to market and user researchers, HCI practitioners, as well as technologists not only in terms of diversity and size of the user population, but also complexity in the nature of problems and issues to be addressed. In this paper we briefly discuss some of these challenges, and describe two technology solutions - Gesture Keyboard and TVPrintCast - that address two key challenges (i) text input and (ii) distribution and access to information.

Keywords: Emerging market challenges, indic-script input, broadcast infrastructure.

1. INTRODUCTION

With growth rates stagnating in the developed markets, developing countries such as India have become attractive market places for technology products and solutions because of their sheer size and potential volumes. The BRIC report [1] and the Fortune at the Bottom of the Pyramid [2], as well as other reports, studies and books have effectively managed to convey the opportunity and the excitement these markets have to offer. The promise of 'Co-creation' [2][22] – conceiving of relevant products and solutions in context, and together with customers and end users - has resulted in numerous research labs and offices being established in these markets with the aim of creating technologies for the “next billion”. These efforts – however well-meaning and well-directed – must address numerous interesting, unique and complex challenges that are revealed upon a closer look at the characteristics of these markets.

In this paper we briefly describe some of these characteristics, and their repercussions for technology, using India as an example. We then describe two specific challenges – (i) text input given the nature of Indic languages and scripts, and (ii) distribution and access to information, in view of the inadequate network infrastructure – and technology solutions that respectively address these challenges - Gesture Keyboard [4] and TVPrintCast [5].

2. INDIA – KEY CHARACTERISTICS

India is often noted as a country of diverse landscapes, languages, cultures and people. This diversity has traditionally posed significant challenges to market researchers and technologists looking to adapt established models, practices and technologies to the Indian market. Some of the key factors that characterize India are mentioned below.

2.1 Population

India is a country of 1,028 million people (532.1 million males and 496.4 million females) as per the 2001 census [3] and this is projected to grow to 1,528 million by 2050 [6]. The sheer size of this population means that any technology solution that touches end users has to be **scalable** to address the needs of the world's second most populous nation.

Of equal or more interest is the projected average age of the population [7][8]. It is estimated that by 2020 the **youth population**, those below 15 years of age, in India will outnumber that in every other BRIC country including China. This implies a large population that will be productive, and

hence will not only have the buying capacity, but also be a very demanding customer and consumer of technology. At the same time the **60+ population** will be a large enough segment not to be ignored.

As per the 2001 census [3], approximately 72% of the Indian population lived in the villages and the remaining 28% in urban areas. However this is changing rapidly and it is projected that by 2020 there will 140 million people moving into the cities, and the urban population will grow to 700 million by 2020 [9]. Hence being able to address **densely populated land areas** with appropriate technology and solutions will be an important issue.

2.2 Literacy

The literacy rate in the country as per as the 2001 census was 64.84 % (75.26% for males and 53.67% for females) [3]. At the state level, literacy ranged from a high of 90.86 % in Kerala to a low of 47 % in Bihar [10]. This means that technologies and solutions have to address and be accessible to users with various **levels of literacy**, not to mention literacy in a number of languages.

2.3 Languages

India has 22 National Languages recognized by the Constitution of India (Hindi is the Official Union Language) and there are 844 different dialects that are spoken in various parts of the country [11]. This more than any thing else means that technology solutions attempting a pan-India user base - especially those that entail **input, output, and querying** - have to potentially address the 22 official languages! **Input** in Indian languages is an identified problem, given that the different languages and dialects are written using at least 10 major scripts, each of which is based on a large number of syllabic characters formed by combining consonants and vowel diacritics called *matras* [4].

While it is estimated that close to 3% of the population is formally English literate, the number of people able to speak and transact in English may be higher. However the fact remains that by and large, most users are familiar with, and literate in only their native languages and scripts.

2.4 Information, Computing and Communications infrastructure

A collection of recent (2008, except where mentioned) ICT statistics is reproduced below [12]:

Fixed telephone lines per 100 inhabitants	3.20
Mobile cellular subscribers per 100 inhabitants	29.24
Computers per 100 inhabitants. (2007)	3.17
Internet users per 100 inhabitants. (2007)	6.93
Broadband Internet subscribers per 100 inhabitants	0.45
International Internet bandwidth (Mbps) (2007)	35'747
Radio sets per 100 inhabitants. (1997)	11.96
TV sets per 100 inhabitants (2005)	13.70
% population covered by mobile signal (2006)	60.90

TABLE 1 Information, Computing and Communications infrastructure

While it is true that there is a segment of the Indian population that services the IT industry worldwide and hence has access to good ICT infrastructure, for the most part, the penetration of personal computers still remains very small, when compared to the penetration of television and increasingly, mobile phones. Computers, with their desktop metaphors and WIMP paradigm, have proven difficult to use, as have the Indic language QWERTY overlays and specialized Indic keyboards that have been devised. A perhaps even more important issue has been the perceived lack of a key value proposition for computers. The lack of suitable online content in local languages has also adversely impacted the penetration of both computers, as well as the internet.

On the other hand, both television and mobile telephony have strong and singular value propositions and have been able to gain popular acceptance across age groups, economic strata, and urban and rural areas. It is likely that mobile data services, which are in the early stages of deployment, will quickly surpass internet data access from homes. These technologies provide channels for delivery of services to a large and highly distributed population.

3. DEVELOPING APPROPRIATE TECHNOLOGY FOR THE EMERGING MARKETS

The previous section touched upon some of the factors to be considered, and issues to be addressed, while creating technology solutions for emerging markets, specifically India. We present Gesture Keyboard [4] and TVPrintCast [5], instances of technology solutions we have developed at HP Labs India to address specific issues: input in Indic languages, and access to and distribution of information respectively.

3.1 Gesture Keyboard – Text input in Indian Languages

Text input of Indic scripts poses a unique challenge, because of the large number of syllabic characters formed by combining consonants and vowel diacritics (called matras). Typing in Indic languages using an Indic keyboard layout typically translates to pressing more than one key simultaneously or sequentially, making text input a complex and tedious task. The Gesture Keyboard (GKB) solves this problem in a novel way using an inexpensive digitizing tablet peripheral device [4]. The keyboard allows the user to enter isolated vowels, base consonants and some symbols by tapping with the stylus on their respective locations in the layout printed and pasted on the digitizing tablet. For the input of syllabic characters corresponding to consonant-vowel (CV) combinations, the user can write (gesture) the corresponding matras at the consonant location using the stylus. The GKB for Devanagari (Hindi) for instance supports a set of 19 Devanagari matras in different writing styles (a total of 23 gestures) and one special gesture (strike-through). The gestures are recognized and combined with the base consonant to form the syllabic character as depicted in Figure 1. Since handwriting input is constrained to a relatively small number of gestures, nearly perfect recognition can be achieved when compared to the unconstrained input of characters or words.

Figure 1 Gesture Keyboard

GKB represents a significant paradigm shift from the multi-stroke keyboard input required to enter a single CV character using a conventional Indic keyboard. Not only it is much easier to use, it is similar enough to conventional writing using pen on paper, to be able to learn quickly. These properties of superior learnability, retention and reduced cognitive load have been demonstrated by extensive user testing [21]. It is well known that with gesture or handwriting based interfaces, recognition accuracy is a critical determiner of success or failure in the marketplace. Given the strategy of recognizing only the gesture, GKB achieves accuracies exceeding 95% - which is the acceptance threshold indicated by various user studies [16]. Gesture Keyboard has been successfully licensed and now available as a product in the Indian market under the brand name of [uRekha](#).

3.2 TVPrintCast- providing access to information over existing broadcast networks

Providing access to information and bridging the digital divide are key objectives in most ICT initiatives. Lack of infrastructure, adequate bandwidth, appropriate and affordable technology, computer literacy, and the requirement for an adequate and intensive training to use and operate the systems efficiently are some of the issues oft cited in the evaluation of ICT initiatives [19][20].. A review of the various Information and Communication Technology (ICT) initiatives across a country like India reveal that one of the major challenges faced towards scalability and sustainability has been the lack of infrastructure [16]. While efforts are on to increase the availability of bandwidth and the network foot print, it may be worthwhile to evaluate how existing networks and infrastructure can be leveraged to ensure a speedy integration. TVPrintCast [5] is one such technology that leverages existing broadcast television infrastructure to broadcast printable data along with the program content.

TVPrintCast enables simultaneous broadcast of data, along with audio-visual content – that can be printed at the consumer end, without disrupting the TV viewing experience. The viewer will have a printer attached to the TV set through a TVPrintCast interface – a Print ready Set Top Box. This enables the viewer to receive additional or supplementary information related to the audio-video content. This can be printed, stored and retrieved. It enables the broadcaster to pass on information to the end user through a new medium with the complementary qualities of hard copy. A solution like this not only leverages existing infrastructure but also surmounts the issue of learnability as it leverages existing behaviour and use of the remote control, a device most users are familiar with. Figure 2 depicts the TV PrintCast set up at the uplink and the downlink ends.

Figure 2 Uplink & Downlink with TVPrintCast Equipment Integration

A pilot study to evaluate the user experience with TVPrintCast, also established the utility of such a deployment in the e-governance scenario.

One of the main SatCom programs conducted by the Abdul Nassir Saab State Institute for Rural Development (ANSSIRD), Mysore (Karnataka, India) is the Gram Panchayat Member Training Program [17]. 176 Taluk Panchayat training centres are the receive hubs of the SatCom network and are equipped with a satellite receive dish, a Set Top box and a Television set. Of the 176 SatCom receive centres 7 were augmented with the TVPrintCast setup. Data broadcasting as a facility is not available in present mode of TDCC network. The TVPrintCast technology was an added facility used on trial basis for data broadcasting.

The training program is aimed at educating and empowering newly elected members (novices inexperienced in governance) of their role, rights, responsibilities and duties. A mix of localized group activities, broadcast films, play acts, presentations, lectures and live interaction sessions are employed during the training. Printed material is prepared and circulated to the audience at the beginning of the training module.

Three specific groups of end-users were studied to evaluate the effectiveness and the ease of use of the technology trial:

- **Faculty:** The ANSSIRD Faculty at the teaching end. They impart training on the Panchayat Raj System to the elected representatives of the Panchayat Raj Institution.
- **Facilitators / Resource Persons:** ANSSIRD Facilitators / Resource Persons at the receive ends. The resource persons or facilitators have the role of facilitating the learning and application of the training.
- **Recipients:** The recipients in this case are the elected representatives of Panchayat Raj Institution.

The roles of and the dynamics between these various groups is depicted below in Figure 3.

Figure 3 The TV PrintCast User segments

While interactions with the various user groups was spread over more than a year, focused field work with the installation in place was carried out over a period of 3-4 months in early 2006. During the course of study, observations – participatory and passive, structured interviews, focus group discussion and depth interviews were conducted, with the help of team members, external agencies and ANSSIRD resource persons, staff and faculty [18]. A reece and dry run were conducted to iron out issues and to familiarise various user groups with the technology. A half a day hands on training was sufficient to get the users familiar with the set up and operate the technology.

The TVPrintCast system was used to send documents relevant to the specific AV being transmit. Print documents sent through the TVPrintCast system included Government Orders (GO), Gazette Notifications and Circulars pertaining to the course content. For example the module on Resource mobilization was accompanied by a Government notification which detailed and listed the resources that belonged to the Gram Panchayat. This ensured that not only were the recipients explained the content of the GOs and notifications, but they also received print outs of these documents via the TVPrintCast medium. This provided access to information hereto unavailable even to most functionaries.

The impact of the technology is evident from the data in Table 2 below [18]:

PERCEPTION ON PRINTCAST	% OF SUBJECT EXPERTS
User friendly	92.86
Cost effective	28.56
Helpful in training	92.86
Increases level of comprehension in participants	64.29
Increases level of retention in participants	71.43
Increases information sharing among peer group	78.57

TABLE 2: Faculty Perceptions on TVPrintCast

Figure 5 TVPrintCast in use

TVPrintCast was also perceived to have made the interaction between the participants and with the faculty richer and more confident. Documents printed during the training were used as the basis for affirmative action on the ground as was evident during the follow up interactions with the participants. The impact of the initiative was also evident in the way even non-trial centres requested for and received the documents printed through TVPrintCast. (Figure 6)

Figure 6

Post the successful trial of the TVPrintCast, there was considerable interest in the technology from end users and service providers. However external eco-system factors have not been conducive to the commercialisation of the technology. It is currently available as a working proof of concept.

4. SUMMARY

The emerging markets such as India proffer a number of challenges for HCI researchers, designers and technologists, which sometimes can only be addressed by new and appropriate HCI and technology innovation, and not by simple adaptation of available solutions developed for mature markets. We presented in brief, two novel technology solutions - Gesture Keyboard and TVPrintCast - that attempt to address some of the issues, and are inspired by the local context. We hope that these examples, while only point solutions, are nevertheless illustrative of the type of contextual innovation required in the design products and services that are likely to succeed in these markets.

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