# Bringing devices to the masses: a comparative study of the Brazilian *Computador Popular* and the Indian *Simputer*

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## Abstract

The goal of empowering underserved populations to use technology has resulted in hardware solutions worldwide that have been deployed to varying levels of success. Despite the differences in the devices and their technology, their employment, and the benefits motivating the exploration of such solutions, there have been some common threads connecting such projects. The Computador Popular was a project in Brazil to bring computers to the urban poor in Brazil; the Simputer is a mobile computing device made for poor rural populations in India,. Studying these two projects generates some underlying hypotheses about top-down approaches to technology and regional development

## 1   Introduction

Computador Popular was a project initiated by the Brazilian government with the goal of increasing access to computers and the Internet to low-income populations, by bringing down the cost of computing machinery by a significant factor. It was to be a simplified desktop computer running open and free software, backed by production incentives from the government and a convenient line of credit to the population, to provide basic internet access and productivity software.

Simputer is short for Simple Inexpensive Multi-lingual (and Mobile) Computer, a device created by a group of researchers at the Indian Institute of Science, Bangalore. The Simputer was originally designed[1] as a scalable handheld device to be usable by low-income, low literacy rural populations in India – aiming to provide 'Universal Access'. It was to be appreciably simpler to use than a standard computer, with text-to-speech capability, comparatively inexpensive, and both small and mobile. The vision behind universal usability was one of overcoming the digital divide through a variety of purposes, including both primary user and mediated user models of interaction.[2]

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[1] According to a CNET article "The Simputer moves upmarket", John Lui, Nov 6,2003, Ravi Desiraju, the CEO of Encore Technologies, a Bangalore-based computer selling Simputers, the company is trying hard to overcome the rustic image of the device. In the words of Desiraju, "It the beginning, it was portrayed as a computer for the common man. They had pictures of farmers in India holding it, but it was for publicity." However, the research team from the Indian Institute of Science, Banglaore, that created the Simputer and markets it through another agency – PicoPeta Simputers, stands by its original goal of developing a device for the masses. Desiraju was not part of the original team of scientists and entrepreneurs involved in the development of the Simputer.

[2] In the primary user model, the user would interact directly with the technology, whereas in a mediated model, a trained user would be an interface between a client of the technology and the utility available through it. One of the key papers that preceded the development of the Simputer listed out a variety of ways in which infrastructure in India could be improved, and the ways in which specific devices could be useful in this purpose. Thus, scattering easy-to-use and potentially standardized devices through the rural and urban landscape of India, with a variety of uses ranging from basic communications to transportation control were seen as potential points of intervention.  Chandru, Vijay and Swami Manohar, The Global Village: Aspirations and Opportunities for Developing Economies (October 1998), http://www.seas.upenn.edu/~chandru/BIT.html (Last Accessed February 20, 2004)

This study is an attempt to trace a parallel between the two projects, in order to examine the commonalities and differences, both in the environment in which they were conceived, and in the nature of the devices themselves. This analysis allows us to draw some conclusions on the reasons for the initial outcomes of both projects, and to outline some factors that may increase the probability of success of similar projects. The type of device and the populations served are different, yet the projects shared a significant commonality – they were both projects meant to address the technology need of a population that was not perceived as being adequately served. Both projects were conceptualized in a top-down fashion, at around the same time, and did not enjoy the initial successes that were originally envisioned.

Our discussion is structured as follows. In Section 2 we give a broad description of the context in which each project was set, looking at relevant political, social, and infra structural characteristics of both Brazil and India. Section 3 then describes the projects themselves, how their conception assumptions were based on the environment and target population, what technology was used, and their outcomes as of late 2003. Having set the context for our inquiry, we move on to discussing some theoretical perspectives in Section 4, which is followed by our conclusions.

## 2    Environment – social and technological aspects of the environment targeted by each solution

### 2.1    Introduction

Brazil and India are among the world's top ten largest nations both in terms of size and populations. Both have massive modern urban hubs, contrasted against sparsely populated and underdeveloped rural stretches. As markets for consumer products in general, and computing products specifically, the two are still small, though their prospects for the future are considerable. As technology corporations spread their wings to include developing nations, Brazil and India have been recognized as major markets for technology products – a number of companies are devising emerging market strategies and guiding research efforts to expand beyond top tier consumers in the two nations.[3]

In this section we provide a high level characterization of the socio-economic environment of both countries, focusing on aspects more relevant to and affected by the use of Information and Communication Technologies (ICTs) by the population. Both countries share some important characteristics, but at the same time present striking differences. These are reflected in the assumptions and goals of both projects. The table below lists some key indicators that are relevant to our inquiry, and we elaborate on specific aspects in the subsections that follow.

|  | Brazil | India |
|---|---|---|
| **Per Capita Income (PPP)** | ~$7625 (PPP) | ~$2358 (PPP) |
| **Population** | ~170.4M | ~1006M |
| **Regional Infrastructure** | Densely populated and developed South-East coast. Sparse population, primary-sector economy in northern and central regions<br><br>Population ~80% urban | Population density evenly balanced. More development along the coastal areas and in the south / west.<br><br>Population ~30% urban |

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[3] Hewlett Packard has an Emerging Market Solutions division, which focuses on India and Brazil as two of its major markets in developing nations

| Government | 3 level government, federal, state and municipal level. The three levels have autonomy for carrying out projects for the population. There are examples of projects for increasing the reach of ICT at the three levels. | Strong central political control, but economy more centered around states. Many states significantly richer and politically more open than others. At the local level there are village councils that can make economic decisions. |
|---|---|---|
| **Domestic Infrastructure Challenges** | Literacy and Housing are not a major infrastructure gap in Brazil. The gaps represented in the statistics reflect the urban-rural differences in economic and infrastructural facilities. There is an approximate 20% difference between urban and rural areas on home electrification.<br><br>• 93 % homes were electrified<br>• 86 % persons were literate[4] | Both Literacy and Housing are major infrastructure gaps in India. In cities, there are large slum areas with temporary housing, these percentages are higher in villages. Electricity access is limited.<br><br>• 55.5 % housing were reliable, permanent [5]<br>• 55.8% homes were electrified<br>• 58.8% persons were literate[4] |
| **Entry Barriers for technology products in the mass market** | **Language**: Portuguese is spoken by practically 100% of the population, and is the only official language. Product customization is not difficult due to the existing efforts in Portuguese language environment development.<br><br>**Price Sensitivity**: Very High<br><br>**Financing**: Limited for the lower income population | **Language**: There are 20 major languages – 10 with over 30 million speakers. Hindi, English, Telugu, Bengali, Marathi, Tamil, Malayalam, Gujarati are most spoken. Currently almost all computer users speak English.<br><br>**Price Sensitivity**: Very High<br><br>**Financing**: Very limited consumer financing options |
| **Hardware Market** | Significant market for assembled PCs. 75% of the market dominated by gray market[6]. Local manufactures (Itautec, Metron) face international competition from HP, IBM, Dell[7].<br><br>Computer Penetration: ~12.46[8]%<br>PC Sales (p.a.):3M[9] (48% of LA market) | Significant market for assembled PCs in household use, strong local manufacturing and sales, especially to government. Overall market leaders are HCL (Hindustan Computers) and HP. Current use of Handhelds is very low – most locally available models priced at ~$300-$500 range.<br><br>Computer Penetration: ~3%<br>Handheld Sales: ~20K[10] |

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[4] Age 15 and above, data from 2002, according to the United Nations Educational Scientific, and Cultural Organization (UNESCO) Institute for Statistics, Literacy and Non Formal Education Sector. 2002. *Special Estimates and Projections of Adult Illiteracy for Population Aged 15 Years Old and Above, By Country and By Gender*. Paris: UNESCO.

[5] This includes Burnt Brick housing, Concrete Housing and Stone housing. Mud and Unburnt brick are not considered permanent housing. All figures are from the 2001 Census of India

[6] According to IDG Computerworld Brasil, http://idgnow.terra.com.br/idgnow/business/2003/07/0097 (Last Accessed: December 13, 2003)

[7] Gartner Group. Market share, August 2003: HP, 4.3%; Metron, 3.5%; Itautec, 3.1%; Dell, 2.9%; IBM, 1.8%. Source: http://www.resellerweb.com.br/shared/print_story.asp?id=37637 (Last Accessed: December 13, 2003)

[8] IBGE (Brazilian Institute of Geography and Statistics, PNAD 2001)

[9] IDC Brazil

| | | PC Sales (p.a.): 2.3M[11] |
|---|---|---|
| **Software Market and Skills** | Market size: US$7.7B, 1.5% for export. 56% services, 44% products.<br><br>Brazil has a strong local market, with demanding clients. Expertise areas include telecom, ERP, e-government and e-commerce, banking, security. There is strong competition between local and foreign companies, attesting a maturity of the market<br><br>There is very qualified human capital for producing indigenous software | Market size: US$8.2B, 76% for export. 80% services, 20% products.<br><br>The local industry is not focused towards selling within India. Very few widely used Indian-language software products currently in use. Software Piracy is fairly rampant.<br><br>There is very qualified human capital.<br><br>Most government functions still on windows platforms, although government has been indicating interest in open-source systems. |
| **Telecom Penetration** | Considered high among developing countries. The country experienced a considerable growth after 1997, with the privatization of the sector. The government, as a regulator, sets universal access targets that must be met by the service providers.<br><br>Teledensity ~ 38.5 % | India's low teledensity is also an indicator of high growth potential in this sector. Due to the privatization of telecom networks and the opening up of new markets with WLL technology. India's total teledensity is expected to double within four years.<br><br>Teledensity ~ 6 % |

## 2.2 Brazil

### 2.2.1 Infrastructure and access to technology

Access to key infrastructure in Brazil has increased significantly in the last decade, a factor that has a substantial impact on the assumptions and on the nature of solutions targeted to increase access to ICTs.

In Brazil, 93% of the homes were electrified in 2002. If we look at the differences between rural and urban areas, we see that 81.4% of the homes are in urban areas, and of these 99.1% have electricity. Located in the rural areas are 18.6% of the homes, of which 75.4% have electricity. There is also some considerable variation in rural electrification among different regions of the country.

The number of telephone lines per 100 people (fixed and mobile) in Brazil was, at the end of 2002, 38.5. The country saw an enormous growth in the access to telephony in the late 90's through a massive privatization of the sector, in which the government shifted its role from a monopolistic provider to that of a strong regulator. The establishment of universal access goals to be met by the providers[12] also contributed to a decrease in the disparity of access among the different regions, from a difference of 10.5 times between the regions with the smallest and largest teledensity in 1994 to 4.3 times in 2002.

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[10] IDC estimated approximately 20,000 Handheld sales in 2002, up from less than 10,000 units sold in 2001. The figures are estimated to have risen substantially for 2003.
http://www.idcindia.com/pressrel/Show.pressrel.asp?prpath=PRI20020065.htm (Last Accessed: December 13, 2003)

[11] IDC, July 2003. http://www.idcindia.com/pressrel/Show.pressrel.asp?prpath=PRI20020064.htm

[12] The service providers must, by the year 2006, have installed, for example, subscriber's mainline service in every locality with more that 300 persons; have, in such localities, 6 public access telephone terminals for every 1000 people, with a distance of no more than 300 meters to these terminals.

There is also a very large presence of television as a medium to disseminate information, as 87% of the homes have a television set. This is in part due to a set of strong broadcast TV stations that produce high quality Portuguese language content with national reach.

The number of computers per capita, has yet to grow significantly, from the estimated 6.2% in 2001. The number of Internet users per 100 people was around 4.6% of the population in 2000. Internet use tends to be higher in urban areas, in larger cities, and among the wealthier people.

## 2.2.2   Society and other aspects

The Brazilian government has had an important role in promoting the use of ICT. Its current efforts focus on three major areas, digital government services, universal access to ICTs, and infra-structural development (integration of different networks, deployment, and security), and are based on the direction set forth by the Information Society Program, created in late 1999 by the Ministry of Science and Technology[13].

The usage of ICT by the government is arguably the most advanced of the three areas. According to the GITR[14], while the overall ranking of Network Readiness for Brazil out of 82 countries is currently 29, the country ranks 10th in the government usage sub index.  Current numbers[15] from the government indicate that 72% of the government services to the population are provided through the Internet, and can be accessed through a gateway Web portal – www.e.gov.br. The portal had more than 21,000 links for official information sites and 1,700 links for services from the federal and state governments in January 2003.[16] There are other efforts that have gained international recognition. In the 2002 presidential elections, almost 100% of the 115 million votes were cast electronically, in the largest such project in the world to date. Similarly, 93% of the federal tax filings were done over the Internet in 2002.[17] A large project underway is the deployment of a nationwide *Health Card* system, which, through a hierarchically distributed database, will allow all citizens to have his/her medical record accessible online in any affiliated health station. The government has also shown efforts to integrate the networks of different public sector service providers, such as the administration, postal, health, and education services, as well as general guidelines for the simplification and consistency of the Web interfaces for most provided services.

In the area of universal access, there is a lot to be done. According to the Digital Inclusion Map[18], 72% of homes with access to computers belong to the richest 20% of Brazilian households, while 3.5% of these belong to the poorest 40% households. Through strong regulation of the telecommunication providers, the government requires them to achieve goals in number and reach of public and private telephone lines. Policy changes are under way to include Internet access in the definition of universal access, and, consequently, in these goals. With the privatization of the telecommunications sector, a fund was created to receive 1% of the gross revenues of the companies, to be used for universal access initiatives and programs.

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[13] The program produced a document, *Information Society in Brazil – Green Book*, in September, 2000, which "analyzes a series of actions to foster the Information Society in Brazil in all of its aspects: expansion of access, means of connectivity, training of human resources, incentives for research and development, electronic commerce, development of new applications." The book is available in an abridged version in English, at http://www.socinfo.org.br/livro_verde/ingles/index.htm. (Last Accessed: December 13, 2003)

[14] Global Information Technology Report, published by the Center for International Development at Harvard University and World Economic Forum. Data current as of October, 2003.

[15] See www.governoeletronico.e.gov.br (Last Accessed: December 13, 2003)

[16] According to Roberval de Jesus, project manager for the *Secretaria de Logística e Tecnologia da Informação do Planejamento*, the government office responsible for the portal. See http://www.planejamento.gov.br/tecnologia_informacao/conteudo/noticias/noticias_2003/normas_disciplinam_egov.htm (Last Accessed: December 13, 2003)

[17] A large fraction of such filings were done through accountants, which explains how this fraction is much larger than the actual number of Internet users.

[18] Mapa de Inclusão Digital. Committee for Democracy in Information Technology and Fundação Getúlio Vargas, Brazil, 2003.

By October 2003, the fund amounted to more than US$ 800 million. However, some projects have encountered difficulties in turning plans into action, the Computador Popular being one such example.

Non-Governmental Organizations (NGOs) have played an important role in bringing ICTs for the poorest. We cite the example of CDI[19] as a highly successful one. CDI – or Committee for Democracy in Information Technology – is a non-profit NGO that since 1995 has been creating *Information Technology and Citizen Rights Schools*, in partnership with local community organizations. It provides free computers, software, and training. CDI developed a socio-educational approach to teaching information technology. Students learn how to use computers and software while discussing issues of particular interest to their community, such as human rights, environment, sexual education, health and non-violence. Each school is an autonomous unit, self-managed and self-sustainable through a symbolic contribution collected from its students. This model of a 'social-franchise' has installed 798 schools, and trained more than 460,000 people in technology and citizen rights. They are present in 17 Brazilian states, and have expanded to 10 other countries.

## 2.3 India

### 2.3.1 Infrastructure and access to technology

A problem in creating technology for India is surmounting the significant urban-rural divide over access to technology and basic services. Electricity and telecommunications lines are still a problem, but the country's late developments in these areas have also meant that the infrastructure being set up is optimized to current technologies and scalable to significant improvements.

Despite this, even in the long-term, much of the high-technology infrastructure in telecommunications and energy may be limited geographically to urban areas and major hubs, and the support infrastructure such as roadways, educational institutions, and markets may not complement these developments. Additionally, southern and coastal parts of India are developing at a measurably faster rate than northern and inland parts of India, partially due to the greater concentration of software and services industries in the southern and western states.[20]

Penetration statistics in areas such as teledensity are indicators of the exponential growth expected in the next two decades. With the opening up of the economy, electronic goods and telephony services are easier to get and much more affordable. The per capita income of the top 20% of India is also expected to rise within the next 4 years to about $2000 p.a. ($12,000 PPP) – which will raise about 200 million Indians to buying power comparable to middle-income nations. By 2008, India's teledensity and computer penetration will both double from 2003.

Arguments for entertainment as a means of education in India have persuasive statistical support in the reach of television as compared to communications technology. While the reach of electricity to households is itself low[21], if a home has electricity, the odds are it has a television as well. Approximately 50% of all Indians have home access to television. Estimates on the number of cable televisions in India range from 30-42 Million, with about 80 million television households in all, representing approximately 415 Million viewers.[22]

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[19] See http://www.cdi.org.br/eng_index.html (Last Accessed: December 13, 2003)

[20] On a small scale – often using satellite technology and alternate energy sources, it is possible to leapfrog many of the existing infrastructure gaps – to reach communications technology to geographically remote markets, often creating new hubs selectively. A loaded question, both economic and ethical, is whether the current leapfrogging approach towards development is appropriate given the need for basic infrastructure – more importantly, whether the leapfrogging will be a permanent means of exclusion, given the lack of complementary infrastructure development in other sectors.

[21] 55.8% according to the 2001 census.

[22] Indiastat.com,

## 2.3.2 Society and other aspects

Since the late 1990s, Governments in India – both at state and central levels, have put in place a number of initiatives to promote technology in underdeveloped parts of the country. Among these is an initiative to provide 'IT for All' by 2008 – a policy that originated in 1998 and has been referred to sporadically after the initial draft proposals. The original mandate of this program was to ensure that every village in India had a telephone and an Internet connection. The village telephone scheme covered about 85% of Indian villages, with about 97,000 villages not covered for a variety of reasons.[23]

As the technology-related economy has grown in India, especially software, ICT for the poor has become a pet subject for the New Delhi government, as well as a number of state governments prominently including Andhra Pradesh, Madhya Pradesh and Karnataka. This has led to the framing of policies aimed at creating more equitable distribution of ICT resources, as well as state funding of projects in this general area of work. In an environment of charged enthusiasm for technology projects that fought poverty, there was an inordinate amount of lip service to anything even remotely connected to technology and development.

Since the 1998 IT for All pronouncement, one of the most prominent projects has been the Gyandoot initiative, prompted by a civil servant, Rajesh Rajora, working in the Dhar district of Madhya Pradesh, an underdeveloped and primarily tribal region of central India. The project, which set up telecenters for e-governance assistance, received the Stockholm Challenge Award (for Public Service and Democracy) in 2000 for its innovation, and became a poster child for rural info-center projects.

The role of private industry has been limited, but well publicized. HP helped create a networked community in Andhra Pradesh (strategically, in Kuppam, the tech-savvy Chief Minister's electoral constituency), IBM launched programs to teach computing to rural poor. Firms from non-IT sectors such as the Indian Tobacco Company set up projects that brought info-centers to remote villages.[24] Academia has played a small role in the research on technologies for development in India. The Indian institutes of Technology, the Indian Institute of Science, Bangalore, and the All India Institute of Medical Sciences (AIIMS) have made efforts to explore the use of technologies in bettering service provision in remote areas. Interestingly, though there has been some NGO interest in IT and development, it has been the state organizations that have been most prominent in this area. Ironically, education, an area which would intuitively have been one of the first places where technology projects could have been tried out, was ominously short-changed.

A critical element in the socializing of ICT for development projects in India has been the massive role played by the media in this area. With the software industry booming, there was a general expectation of the information economy to be India's pathway into the first world. Even the smallest projects[25] could receive hysterical press coverage and caricaturized images of the poor using computers became a regular feature of magazines. The scope of the 'bottom pyramid' was a press feast for a fair part of the early 90s.

In this environment, it was not surprising that the media quickly lapped up the idea of the Simputer, giving it phenomenal press, right from its conceptual stages. Whether this benefited the project in the long run is highly debatable.

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[23] According to 2003 data from Lok Sabha, August 6, 2003, there were 5931 villages not covered due to insurgent activity.

[24] http://www.echoupal.com (Last Accessed: December 13, 2003)

[25] NIIT's hole in the wall experiment, with one computer placed for open use in Delhi is one example of a remarkably well covered project of fairly modest proportions. The most significant example was that of the Nayla village in Rajasthan, which received international recognition (including Time and CNN articles) for a project that was a showcase for Bill Clinton's visit to India.

# 3 Project Descriptions

## 3.1 Computador Popular

By the year 2000 it was widely accepted in Brazil that one of the priorities to effectively transition to the "Information Society" was to provide universal access to ICTs to the population. The government also viewed its role as fundamental in providing access to ICTs for lower income populations, in order to prevent these very technologies from increasing the gap between the rich and the poor.\ In December of that year the government started looking for solutions for providing a lower cost computer to the population, and turned to academia to specify and build a prototype of a cheaper computer. The initiative turned into the Computador Popular (CP) – or *Popular Computer* – project, with a target mass production price of US$300. This price was 20% cheaper than a computer one could by, and would mean that an additional 10 to 20% of the population would be able to purchase it through financing.

CP, as proposed, was to come basically in two configurations, with different goals: a stand-alone machine, to be used mostly at home to access the Internet, and a networked version to be used in a thin-client style, with back support from a more powerful server. In both the goal was to provide a computing platform that provides the user with access to "digital information" in the forms currently exchanged over the Internet, i.e., mostly Web content and documents (word processor/spreadsheet) files.

It is important to understand the goals and assumptions that led to the design decisions. The design is for a desktop computer, to be used in a fixed location, with electricity and at least a phone line. In schools and telecenters, better connectivity was assumed, as was literacy in the Portuguese language. Given Brazil's demography, it seemed clear that a project scaled to these assumptions would cover a large portion of the population.

The design aimed at providing a straightforward user experience and interface. The graphical user interface was simplified, and the system software was stored in a read-only partition of the storage medium. This allowed the system to be resilient to power outages and computer viruses, for example, binging down the maintenance cost.

The final cost of the Computador Popular was to be kept down by a combination of factors:.

1.   by using commoditized off-the-shelf components, possibly of the previous generation;
2.   by removing some components (mostly  the hard drive)
3.   by using Free and Open Source Software
4.   by providing incentives for the companies producing compliant machines.

In the networked version, intended for use in schools, telecenters, and small and medium business, the cost of installing and maintaining a lab of CP's is measurably smaller than an equivalent solution using normal PCs. Given the appropriate connectivity with a central server, the client machines can be configured with no disk or permanent storage, by transferring programs and data over the network to the server.

The software system on the Computador Popular was solely based on Free and Open Source Software (FOSS), which did not add to the cost of the final solution by being gratis. However, the more important aspect of the FOSS software was its customizability to the exact needs of the project, and the possibility of the maintenance of an open specification that would not depend on commercial interests of individual companies. In the initial phase of the project, the academic sector, through a group formed at a federal university, would customize and maintain a standard software distribution based on GNU/Linux and other key applications, such as a Web browser and an office productivity software suite.

### 3.1.1 System Specifications

#### Hardware

The specifications that follow are those published for the prototype of the CP,[26] in 2001, and some alterations, as described from personal communication with involved members.

- Processor: AMD K6-II 500Mhz, on a SiS 530 motherboard
- Audio, VGA (SiS 6306), Ethernet, 56K modem, IDE interface integrated on-board
- Memory: 64MB RAM
- Storage: Disk-on-chip Flash, 32MB
- Slot for a second flash card
- Ports: 2 USB, mouse, keyboard, 1 parallel, 1 serial
- 2 USB ports, 1 parallel port, 1 serial port
- No hard disk

User files would be stored either in a second Flash memory device, or on the network, via possible service providers.

#### Software

The software in the CP was composed of the GNU/Linux operating system, together with general purpose applications, including a Web browser, email software, media player, and office software. The graphical user interface was based on the KDE desktop environment running on top of the X-Windows system. All of the software was free and open source. As we mentioned, this fact allowed for a great level of customization, which had two main objectives:

1. Remove unnecessary features so that the entire set of system software could be accommodated in the Flash memory of the device
2. Simplify the user interface, removing any excessive icons and menu items.

The simplifications involved the removal of non-essential programs, as well as of most configuration options for the user interface. The used programs can be started from a simplified launch bar, and the central element of the interface – the Web browser – is permanently and automatically running. The projects leveraged on a large body of software already localized to the Portuguese language, and the user interface had a look and feel that would be familiar to users with previous experience with Microsoft Windows, while remaining as simple and objective as possible.

Maintenance (or minimal need thereof) was also an issue, and the system software was actually in a read-only portion of the Flash memory, meaning that it could not be affected by abrupt shut downs, power failures, or even computer viruses. The motto was to ask as few questions as possible to the user, and have the user have as few questions as to the operation of the device as possible.

### 3.1.2 Outcome and Developments

As of 2003, no unit of the CP was produced. We discuss several factors that contributed to this outcome, some conjectured reasons, and also some indirect impact that the project had.

For a series of circumstances, the government abandoned the project. This was a decisive setback, because of the focal role expected of the government in propping the undertaking through the following:

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[26] Guedes, et al. , "Desafios para a Universalização de Acesso: nossa Experiência com o Computador Popular" (*Challenges for Universal Access: our experience with Computador Popular*). In Proceedings of the XXVIII SEMISH. Fortaleza, Brazil, 2001

1. Provide tax incentives to companies manufacturing 'CP certified' devices
2. Provide cheap financing to individual buyers of CP products, through one of the national banks

In 2001, a major energy crisis hit the country, forcing the government to prioritize its efforts in remedying the situation. Some key persons in the government who were pushing for the project were relocated, as were some important funds for the project. This suggests the *high vulnerability to political or circumstantial priorities, of projects which rely to a large extent on government action.* As a result, no concrete plan for the tax incentives, nor for the loan policy or certification process for industries were issued.

Another influencing factor at the time was a proposal, by the Ministry of Education, to install 280,000 computers in public schools countrywide. The request for proposals[27] specified that most of these computers would have to use the Microsoft Windows ME operating system, which precluded solutions based on the CP to be used. This contradiction points out the fact that *it is important to ensure that all government offices that may be involved in projects of this nature have a consensual view of the solutions.* The aforementioned request for proposals was considered illegal, but was never reissued.

However, it was not just the government who caused the project not to go forward. *The computer manufacturers in Brazil did not show interest in producing the CP.* From what we could grasp of the situation, this can be due to three main reasons. The companies feared that:

1. The CP would interfere negatively with the sales of their more expensive computers
2. The CP would face tight competition from the gray market computers
3. Linux would not be widely accepted by the consumers

To analyze the outcome, we find it useful to distinguish the two uses that were proposed to the CP, the residential, standalone version, and the institutional use.

For the first case, that of the standalone use, we conjecture that *there wasn't enough of a technology differentiation from the existing technology (regular PCs) to disturb the market equilibrium at the time.* Indeed, the gray market computers, responsible for 75% of the market in Brazil, have almost no cost due to taxes or to software.[28] Clearly, these devices would be strong competitors to the CP. At the other end of the spectrum, companies feared that consumers would buy the CP and then purchase other components to make it comparable in power to non-subsidized computers.

The situation was comparatively more amenable for the institutional use of the CP. As we noted, in this case the proposed technology provides a true and measurable reduction in cost when compared to traditional technologies. The scenario is that of installing a computer lab, or a community center, in which several workstations are to be made available. The *thin-client* architecture of the CP, in which applications and data reside on a central server, and computation is performed on the client machine, results in a lower initial cost, and lower maintenance/administration costs. Besides, a single CPU can be used simultaneously by more than one user, by connecting more than one set of interfacing peripherals (keyboard, mouse, monitor) to it.

Industry did show some interest in this application of the CP. There are at least two examples in Brazil of companies that are commercially pursuing solutions that are very similar to the CP, even though they do not bear the name. Itautec is developing the TC1000[29] thin client, which is based on work done by the CP team. First International Computer (FIC), a Taiwanese company, has set up a world class factory in Brazil and is developing the Genesis Thin Client. It is similar in concept to the CP, and is being targeted at schools of different levels, and marketed as a tool to reduce the digital divide. As a final example, HP has a solution based on Linux that allows four users to share a single CPU, reducing costs.

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[27] Brazilian Federative Republic, National Telecommunications Agency. 2001. Licitação N.º 001/2001/SPB/ANATEL. Request for proposals for the provision of universal telecommunication services to public high schools.

[28] According to ABINEE (Brazilian Electrical and Electronics Industry Association), computer parts are imported with very low declared values on the invoices, being highly undertaxed. As an example they found, a computer case had its cost declared as being US$0.01, while the true cost is around US$50. As for the software, the most common case for gray market computers is to have pirated versions of Microsoft Windows and Office.

[29] See http://idgnow.terra.com.br/idgnow/corporate/2003/08/0017 (Portuguese, Last Accessed: December 13, 2003)

There is a recent precedent in Brazil for such incentives from the government, in the automotive industry: the popular car (from which CP borrows the name). The program was aimed at increasing the affordability of lower end cars, by means of tax incentives for cars with engines with power below a certain threshold. In this case, the program was successful, and embraced by the industry. It is not completely clear whether some manufacturers would be interested in producing the CP had the government gone through with the tax incentives.

## 3.2  Simputer

The definition of the Simputer as a Simple Inexpensive Multilingual Computer is important in surveying its projected uses. The Simputer was originally planned to be a stand-alone computing device with a simple user interface, and features like speech synthesis that made it work for very low-attainment users. Various usage models were considered, but the key to the 'Inexpensive' aspect was the shared model.

The device was to enable large groups of users to share one device, possibly purchased communally. Individual users were expected to own smart cards that enabled them to store their information offline. A potential owner for a Simputer would thus be a village council, or a cooperative, or any group of people willing to share it. Public funds could potentially be applied towards such purchases.

The simplicity aspect was to be addressed through a very friendly interface with intuitive panels and graphics. The shared usage model also relied on the Multilingual feature. Speech-enabled devices in homes were expected to play an inclusive role in the more remote regions of India, where literacy can be low.[30] Users would also be enabled to use online communications through the devices for a variety of daily tasks that could be made easier using technology.

An alternate usage model was mediator-oriented, in which the end-users of the Simputer were to be traveling data gathering professionals, often working in remote parts of India. In this case, the Simputer would work much like a PDA, but enabled with its unique features, it offered a potentially easier learning curve for rural grassroots workers who may or may not be literate enough to use a standard PDA.[31]

Hardware Design decisions took into account the infrastructural shortcomings of India, yet, the device could perform its goals best given some minimum electricity availability and wireless connectivity. The cost saving of the Simputer would have to be seen in its comparison to personal computers – rather than other PDAs. The device itself was originally meant to be priced low by virtue of addressing an entire community's needs, thus having a lower per-capita cost than an immobile personal computer.

### 3.2.1  System Specifications

#### Hardware

The Simputer uses some off-the-shelf components, and is fabricated in India. Current versions of the Simputer come in a hardware-software bundle. The hardware specifications are as follows:

- Processor: Intel StrongARM processor
- Memory: 32 MB of DRAM, expandable up to 64 MB
- Storage: 32 MB of Flash memory for permanent storage, expandable up to 128 MB, CompactFlash being supported, for increased storage
- Ports: 1 USB and 1 serial
- Connectivity: internal modem, infrared port, supports for WLL (CDMA and corDECT), can connect with GPS devices, phone jack.

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[30] The speech capabilities were to be applied through "Dhvani" an open-source software to convert text to speech

[31] The founders of the Simputer were careful at the outset to differentiate a Simputer from a PDA – as a handheld device that fulfilled the need for computing applications.

The software on the Simputer is integral to the device; much of it having been tailored to perceived functions. The Simputer operates on a Linux platform, using the Malacca interface (in the case of the PicoPeta Simputers). This is based on IML standards (Integrated Mark-up Language).

Some of the highlights of the software include: a simplified interface, integrated with an efficient development environment for rapid and low cost development of custom applications and content. This also has the benefit of maintaining a consistent interface across applications. Also, the text-to-speech capabilities are useful for some of the intended application for end-users. The Simputer uses Dhvani for its regional language text-to-speech functions, and the Flite engine for English. Both softwares are open source, and at this stage, Flite is at a more mature stage of development than Dhvani.[32] The smart card interface allows for shared and authenticated use of the device. It has a PC-based simulator to test and debug applications. Native Development platforms include X-Windows, Perl/Tk, TCL/Tk, MySQL. (see Software note in appendix )

### 3.2.2  Outcome and Developments

From its initial conception in 1998, the Simputer project was primarily run by academic researchers. The team developing the Simputer included approximately 35 researchers, professional and students, who joined the team at various points during the history of the project. The core team of included Indian Institute of Science, Bangalore professors Swami Manohar, V Vinay, Ramesh Hariharan and Vijay Chandru, and a number of graduate students from the school. Two companies spun out of the project – Encore and PicoPeta, the latter being set up by the four professors.

After the initial funding by angel investors, the product did not make a significant impact on the venture capital industry. The project eventually received funding from the Indian government's Technology Fund, and arguably, was consistently supported significantly by the availability of university research community.

The design prototypes were ready for production by 2001, but getting the product to the market took until 2003. At the time of publication (December 2003), Simputers were not sold in the open market and could be obtained only through special orders. The original price was envisioned to be Rs. 5000 (~$100),[33] while the current prices for various models of Simputers from the two companies are in the range of Rs. 12000 – Rs 22000 (~$240 - $440). [34] A Simputer at these prices comes in at about thrice the cost of low-end PDAs. A higher number of units produced, at low-cost facilities (there is an existing tie-up with a Singapore firm) would significantly reduce the per-unit sales price. That the Simputer is still not widely available, underscores the growing gap between the device and other competitors in the PDA space.

After some angel funding[35] in early stages, the Simputer project was unable to raise adequate funding from the VC market. This was possibly an unfortunate start to the product's life, and perhaps testament to the weak innovation funding situation in developing nations. It is difficult to speculate if finding at the right time would have helped the company bring out a product that could truly compete internationally. Eventually, as recently as January 2003, the Technology Development Board of the Department of Science and Technology, Government of India assisted PicoPeta Simputers with Rs. 20 Million.

While ground-breaking technologies have often been government funded, these have usually been scientific research oriented or highly experimental in nature. In the case of the Simputer, the device did not exactly fit into either category, and should intuitively found takers in the financial markets. The Simputer's slow start would suggest that the existence of private funding may be a strong indicator in forecasting the success of a technology project that has a development motivation.

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[32] Dhvani was written by Prof. Hariharan, one of the founders of the Simputer..

[33] Manohar, Swami, The Simputer: Access Device for the Masses, http://www.simputer.org/simputer/history/paper.pdf (Last Accessed: February 20, 2004) The cost of the Simputer was later revised to about $200.

[34] Ganapati, Priya, Simputer: Not a Common Man's Device Anymore, Rediff Online Sep 17, 2002 http://in.rediff.com/money/2003/sep/17spec.htm (Last Accessed: December 13, 2003)

[35] Unconfirmed funders include: Anantha Nageswaran, Singapore, Sandeep Malik, Marakon Associates, Singapore, There was also some funding from the South Asia Foundation, Nice (not an angel fund)

In its currently active deployments, there is limited evidence of end-user consumer purchases in rural India. The Simputer has made ground in the mediator-use model, and some projects involve the use of the devices by data collection agents. The test projects have worked with Indian languages. PicoPeta has documented some case studies such as:

- Simputers being used in Gulbarga, Karnataka for electricity spot billing[36]

- Simputers used by village accountants in Bhoomi, Suggi as part of land records procurement project[37]

- Simputer-based learning project for rural children in Chattisgarh, India[38] (this project is less mediator dependent, and offers very interesting prospects for the future)

- Simputer-based data collection for loans and savings for farmers in Karnataka[39]

With the exception of the school project, none of the above projects make full use of the Simputer's capabilities. This raises a question of whether the Simputer's software could be used on other Linux-based handheld computers.

The Malacca environment (for the PicoPeta Simputer) is currently free, but not open source. There are several other projects using the mediator-use model, implementing healthcare and e-governance functions, these could technically use software designed for the Simputer, if the software were unbundled from the hardware. However, there are no immediate plans the separation of the Simputer hardware from the applications.

The Simputer was basically designed as a *general-purpose* device for a *specific audience* – those with limited literacy skills, or an inability or lack of context in operating computing devices that were oriented around the use of the English language.[40] Every additional element increases the complexity of design, therefore cost. Thus, theoretically, it is a handheld device that can manage a number of different applications. It is possible then that the design model and the usage model are not entirely aligned. Most low-attainment users would intuitively be using one or a very few specific applications, this means the Simputer probably is a far more powerful device than it may need to be. An examination of the device shows that with the exception of a smart card attachment, there is limited innovation on the hardware side, thus the device looks more or less exactly like a general purpose PDA. (see attachment)

While the economic and market related factors that affected the early adoption of Simputer are important, the limited evidence of the use of PDA-type devices by low-attainment users suggests that the hardware interface may have needed a lot more work, perhaps specific devising to the application to be used. The widespread use in low-attainment communities of mobile phones, cash registers, courier service scanners, television remotes or calculators suggests that even devices not optimized for specific populations, can be adopted effectively where there is a perceived need for the device. In each of these, there was already existing demand for the products before they reached the users.

Bringing the PDA interface to low-attainment users without the contextual establishment of their utility then seems like a quantum leap. This is a strong argument in favor of creating *general audience* devices for *specific purposes* with strong existing applications as a cheaper and more efficient design option.

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[36] http://www.picopeta.com/showcase/spotbilling.php (Last Accessed: December 13, 2003)

[37] http://www.picopeta.com/showcase/e-governance.php (Last Accessed: December 13, 2003)

[38] http://www.picopeta.com/showcase/education.php (Last Accessed: December 13, 2003)

[39] http://www.picopeta.com/showcase/microfinance.php (Last Accessed: December 13, 2003)

[40] According to Prof. V. Vinay of the Simputer Trust, "The Simputer was designed to overcome the digital divide and not the literacy divide alone. The other divides therefore being affordability, simplicity, multiple languages and the dominance of English in computing, local availability and finally, ongoing commitment to do all of this." (via e-mail on December 19, 2003)

## 3.3   Summary – Mission Critical Elements

| | CP | Simputer |
|---|---|---|
| **Cost** | @$300 per CP, the market is being undercut by about 15% | @$300 per Simputer, the cost is about 30% less than a PC. This is not an attractive price. |
| **Hardware Manufacturers** | The profit margin on each CP had to be at least equivalent to margins on the sale of existing products, and additionally not eat into markets of the firms other products. In addition, brand-sensitive companies with established product lines were less likely to participate in CP. | The Industry did not play as major a role in the case of the Simputer – the project did not try to encroach upon an existing market, rather it tried to reshape the way devices were used, thus no manufacturers were in direct competition. |
| **Proprietary Software** | Although there is no conclusive evidence that makers or proprietary software had any influence on the progress of the CP, the essential nature of the product would pit the producers against entrenched business interests of major software vendors. | There was no influence of other proprietary software manufacturers on the progress of the Simputer, PicoPeta's own environment was not open source. |
| **Learning Curve** | The perception of the Linux environment as one meant for advanced users has played a part in new users' adoption of computing technology in underserved regions. | Despite significant investment into the user interface design, in its current incarnation, the Simputer has a sharp learning curve for low-attainment users. |
| **Breadth of Applications** | The CP assumed a slightly smaller range of applications than a standard windows machine – the users were expected to be predominantly first-time buyers who used computers for browsing / office applications. | The Simputer can do a very broad set of applications by standards of an average PDA – including speech synthesis, r/w to smart card, applications, programming (Perl), Client-side scripting, WP, browser, spreadsheet, PDF viewer etc.<br><br>However, not many of these applications were valuable to the Simputer's intended end user. That a lot of applications could be developed for the Simputer continues to be extremely valuable. |
| **Customer Need** | The idea of the CP addressed a simple customer need – cost reduction. | The targeted customer did not have needs as originally seen by the Simputer visionaries. A number of the applications originally envisioned for rural users may however become commonly used applications for urban, richer users – a potential future space for the Simputer, if it can compete with other PDAs in the same space. |
| **Project Future** | The standalone version for residential use did not take off, for the reasons discussed in Section 3.1.2. The institutional version, however, finds very similar products being developed, such as the FIC thin-client and the HP 4-4-1 computer. | The Simputer has some good applications and two companies – PicoPeta and Encore and carrying on production and sales of the devices. PicoPeta is continuing with the low-attainment user model, whereas Encore seems more focused on enterprise sales.<br><br>Education is still an untapped area in India, a potential sector for the Simputer to make inroads. |

# 4  Theoretical Perspectives

## 4.1  Technology versus Market-driven projects

The underlying concept of filling the affordability and access gap for computing products may indicate that Simputer was addressing a market-driven need. We argue, however, that the Simputer is fundamentally a technology-driven product. When seen as an information device, the Simputer was a *technology product* conceptualized and developed in a top-down fashion to be deployed as a potential information and technology solution, rather than a product that was derived as being the best possible solution for the information needs of the market it addressed.[41]

There is a risk of oversimplifying the complex demographics of the Indian technology product consumer and market. All computer users in India are functional English speakers. Functional English speakers are also the predominant chunk of the top 10% of the Indian economy.[42] Non-English speakers have relevant web content, but arguably not enough to merit recurrent owned usage (as opposed to occasional shared community usage). It is also not clear whether the information available through Simputers was conceived as the empowering utility, or whether the physical usage of the device, and the technological familiarity gained thereby was the basic perceived empowering benefit. Technologists are probably better equipped to deal with the latter case than the former – evidence in the case of both the Simputer and the CP indicates that creating a 'reason' for people without an innate use of technologies to devices is a far more complex issue.

During a field visit to a village computing center in the south Indian state of Tamil Nadu, we found that the four installed computers were being used mainly by two staff members who were running the center, and a large group of junior school children from a neighboring school, who despite not knowing English, had been visiting the community center to play games (including the non-trivial SimCity). Adults from the village had dropped by for information sessions, but seldom stayed to use the devices. Children, on the other hand, did not need a utility, or a relevant context for the information available through the device, and were happy to just drop by and play games. The empowerment here was basically through the technological familiarity that the children. For one, unlike adults, they weren't afraid of causing damage to the machines![43]

The Simputer group rightly rated the importance of user interface design as being a vital area of research. The key functionalities of the device were to be Transactions, Communication and Information.[44] Anecdotal evidence on the performance of rural information centers suggests that many of the early assumptions of how much farmers may individually value the information on remote markets (and resulting communications and transactions) may ignore the possibility that such information is relevant or valuable so long as there is a conduit connecting the information to the farmer's current infrastructure. To simplify, it was intuitive to conclude that Simputers could bring crop sale prices from thirty miles away to farmers in India and thus eliminate dependency on middlemen. But what role did the middleman really play in the farmer's life? A source of spot credit? A insurer for stable pricing? Similarly another popular tech for development initiative in the e-governance space - the replacement of patwaris, traditional administrative middlemen for villages, with online land-deed processes that are generated through a computing system,

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[41] In short, if the goal of the Simputer was to address certain information – then the product is technology-driven, if the goal is to put a device in the maximum number of hands, it is market-driven. If the goal is to address information needs by putting a device in the maximum number of hands, the goal assumes the technological device as being the necessary answer.

[42] Pal, Joyojeet, The Development Promise of Information and Communications Technology in India, Contemporary South Asia (2003) 12 (1)

[43] Visit to Villianur Computer Center of the MS Swaminathan Research Foundation. The four devices were housed in a small room at the village Hindu temple, right across from a school.

[44] Manohar, Swami, The Simputer: Access Device for the Masses (1998), Based on Discussions with the Simputer Group at IIS Bangalore. Manohar is one of the original founders of the Simputer. However, the patterns of demand for these functionalities were not discussed in the early available documentation; a statistical study of the computing penetration and teledensity in India, measured against the per capita income and literacy (especially English-language literacy) could have better contextualized the potential market for the device.

may in fact be replacing one middleman dependency with another, only the technological dependency is of a different kind.

Indeed, some thought behind the Simputer could have arisen from the way in which power users of technologies eliminate middlemen from their own lives using technology. This is a fundamental question of contextualizing achievable technology to its utility. The box-office scalper is clearly in professional danger, as perhaps are the typists who earn a living out of typing out court documents that need precise formatting, as word processing and e-commerce make life easier for millions. But the similar argument for low-attainment users, that access to information networks can free them from dependence on intermediaries requires does not seem to have operated on the same logic, though this in no indicator of the long-term feasibility of similar products.

If the model of usage is bringing the device all the way to the impoverished in India, the perceived material cost of learning to use a Simputer and owning a smart card has to be lesser than the perceived long-term cost of intermittent trips to government offices, or the marginal price improvement on produce. This is a complex economic problem, because it requires us to look into the decision-making process of people who are potentially at the poverty line, and do not have perceived long-term cost decisions structured in the same fashion. A top-down model of designing shared technologies for development is additionally prone to assumptions on group purchase behavior. (This argument may also pre-empt several other uses of the Simputer, which do not have a direct user-related economic benefit quantifiability)

CP comes from a perception, initially by the government (and development professionals), of the low penetration of computers and Internet access among the Brazilian population, and of the immediate need to increase the number of people with direct or indirect access to the Internet. The solution uses existing technology (commodity hardware and customized open source software), to address the perceived need. It is a top-down initiative.

Thus, the technology-driven component in both projects outweighed the needs orientation. While the failure of CP to take off may have had more to do with supply-side economics, there was no evidence that the market for computing products could have expanded rapidly at the $200 price point that CP was aiming to hit, given the fact that the solution offered at this price would be Linux-based, and thus different than the standard-use devices in Brazil. CP appealed literate Brazilians, starting in the dynamic metropolis of Sao Paolo. Many of the intended buyers were existing computer system users, who were needed the price incentive to turn computer owners. In the needs-driven argument for Brazil, that their experience with computing indicates a familiarity with a operating environment, most likely Microsoft, thus requiring an unlearning process in shifting to Linux. This is a non-trivial factor, as the consumer sees the lowered price of a product as coming with an additional price tag of an unfamiliar operating system, and resulting learning curve.[45]

And while the economic side of market-drive in the case of the Simputer has not been tested (since it could not be produced at the original price of $100), the demand gaps relating to content submit a persuasive argument of contextual mismatch between the device and the perceived information needs of the populations served.

## 4.2   Focus – user interface versus cost-saving

A fundamental distinction between the two projects is that CP focuses on creating a market through cost-saving by more cost-efficient existing hardware and software options, whereas the Simputer rejects existing solutions, and develops an entirely new product with a user-interface focus.

The distinction between India and Brazil is important here[46] – the CP was designed taking into account a large educated, linguistically uniform, urban population that did not have access to computing, but given the devices, could reasonably work out the functionalities of the interface. Given the complications of

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[45] There is also a prevalent notion that Linux is more difficult to learn than Windows

[46] However, this comparison also takes a very broad macro view, taking India and Brazil as two huge blocks. It is a reasonable assumption that a project similar to CP could have been perceived for urban centers in India, though in that case the cost savings due to Linux may not have been impressive since piracy of the Windows system is rampant among small computer manufacturers.

several different scripts, hundreds of mutually unintelligible dialects and very low literacy skills, the pressure on creating a friendly interface was more intuitive in India.

However, this brings up a critical theoretical question – how far should devices for underserved populations aim to assist within the parameters of limited skills? *Can technology enable greater information equity and yet continue to reinforce inequity on the technological skill itself*? Given that the paradigm of desktop computing (and arguably, MS Windows) has become a standard in the personal and professional spaces, and the most prevalent interface to the services available through the Internet, does the death of the digital divide coincide with the universal adoption of desktop computing? Should the focus then be on creating standardized solutions across the entire economic sphere and develop the supporting infrastructure to bring people up to speed, or are devices like the Simputer to provide a alternate user-interface?

If bringing technology *at the user level* to all Indians is a goal, then there is clearly a strong argument in favor of creating a device such as the Simputer. The challenges of bringing large adult populations in India from functional illiteracy to using a non-intuitive handheld screen with small characters, visualizations and a stylus interface are practically insurmountable. This is also true for populations in similar conditions in poor urban and rural areas in Brazil, as well as in most any developing country. But should succeeding generations be using friendly stepping-stone technologies? Or would enforcing English-language instruction and standardized computing curriculum in schools[47] across India be a preferable solution?[48]

There is little doubt that the Simputer's intended audience does exist, and is extremely difficult to design a useful system for, and as this segment of the population grows older, it will be plagued by an even greater gap than it faces today. It should also be recognized that with low high school enrolment rates, and poor basic infrastructure, succeeding generations will continue to have 'digital destitutes' who will continue to present a user-interface design question-mark for the economists, technologists, and policy makers who are concerned with issues of technological equity.

The Simputer project's eventual funding through the government may suggest an ominous lack of belief by private industry in investing research and development funds on a model of user interface design for low-income, low-attainment populations. Ironically, the CP, which did exactly the opposite, created an affordable computing solution at prevalent educational attainment rates, got no industry support either. This suggests that the design focus was just one among several reasons for the Industry's perceived poor free market viability of the two products.

## 4.3   General purpose versus market/need-specific product

The CP provides access to a general-purpose interface – the Web – to allow for applications to be deployed by independent providers. Given the connectivity model assumed, it is arguable that this may not have been the most optimal solution. The Simputer provides an environment for development of different applications that run locally, with a potentially consistent interface. The CP is a largely tried-and-tested product, with fairly consistent usage patterns across users, in comparison.

The Simputer's originally targeted population did not have any one or few specific needs that the device addressed. The Simputer wasn't a dairy application or an e-Governance data collection device. At the same time, the hardware/software combination wasn't economically optimized to serve as a general purpose PDA (which has definable standard functions) or a device with functions spanning across its target populations. So while the Simputer can use a range of applications do a number of things such as bill payment, information gathering – there weren't standard functions (like the calendar / organizer in the PDA, or the browser / word processor in the average computer) that all its users were expected to use regularly.

This lack of a general purpose usage model is likely to be a critical challenge for Simputer from this point on as it attempts to compete with the standard personal computer, which has fairly established basic usage patterns, with the key differences being at higher level specific applications.

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[47] Assuming that universal schooling and other support infrastructure such as electricity, permanent building etc. are possible.

[48] There are already persuasive arguments that the threshold of computing power in India rise proportional to English-language proficiency.

That being said, these usage patterns may tend to apply more to home users than to institutional buyers. Home PC buyers are a fraction of commercial and institutional buyers,[49] who sometimes run their own packages or platforms, the operators of the computing devices may have little or no exposure to systems outside of these applications.[50]

Market-specific products can thus be more tailored to the needs of a uniform group (thus institutions are a natural fit), whereas the world of IT for development deals with fairly complex, and diverse populations – thus a black-box solution for the technology needs of underserved populations is a complex, possibly unattainable product proposition. (see appendix on General Purpose/Specific Purpose differentiation)

## 4.4   Institutional versus consumer sale focus

There is a persuasive argument that reliance on institutions – both public and private, as production and sales partners, may have affected the programs. Both the projects saw an important role to be played by institutions as conduits of redistributing the technology products. In the case of the Simputer, despite the focus on the utilities to the retail user, there was a perceived role of governments or NGOs buying devices that would be used at the village level. The CP had two main variations: one for institutional use, and another for individual residential use. Even in the latter case, the Government had a fundamental role in facilitating loan schemes for individuals who wished to purchase the CP.

The need to address a product directly to a mass market of consumers adds a lot more pressure to the manner in which the business models are perceived. Creating a product that has a perceived need by the end user, and thus mass market potential, is key to making that a sustainable product. *Both the CP and the initial designs of the Simputer failed in reaching this mass market*,[51] either for being too expensive, too general purpose, or not competitive enough with existing technology. The CP was not perceived by the industry as a viable product for retail to individual consumers, and it is only its institutional version – that supposed to be used in multi-unit installations – which has enjoyed some acceptance by the industry. The Simputer also has not found its way into the hands of individual consumers: all significant uses of the Simputer that we are aware of are of institutional nature: schools, banks, government agencies, and the like.

## 4.5   Indigenous production versus speed to market

The focus on indigenous production of hardware is a point in which the two projects diverge: the Simputer focuses on indigenous hardware production,[52] while the CP focus was at getting economies of scale with commodity hardware. While scale of production is the foremost in increasing per-unit cost for the Simputer, it could be argued that the device would be marginally cheaper and better fabricated if put together abroad at centers of mass production of similar devices.[53]

There are competing factors that go into the discussion of what the right approach is. On the one hand, designing and integrating the hardware locally has the advantages of it being built according to the exact

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[49] Home users comprise about 15% of Indian computer buyers, Institutional buyers comprise four times that at about 60%. Source: Intecos-CIER, from India Stats (http://www.indiastat.com/)

[50] An example of this is the Indian Railways, which has its own systems with very limited functionalities for users outside of the commercial (often ticketing) functions.

[51] In fairness to the Simputer, the product is still at a nascent stage of development, and like other disruptive technologies, may take a while to get off the ground. As of February 2004, there is ongoing research on the Simputer project.

[52] It is currently not possible for some components not to be locally built such as the main processing units, memory chips, and perhaps display screens, because in these cases either is the fabricating plant too expensive, or have some regions become worldwide centers for their production, as is the case of Taiwan or South Korea.

[53] This of course dilutes some part of the "locally produced solution" notion that applies to the Simputer.

specifications needed by the project, allowing for optimization and customization. It also fosters the development of human capital in the country.

A fact supporting indigenous production is the great deficit brought by imports of computer and telecommunication products. For example, this added in Brazil to US$4 billion in 1998. Such production may require protectionist measures that may face great international opposition. Another important supporting factor is that by the establishment of a local industry capable of substituting some of the imports, the country is empowered to explore the export market. It would be in both countries, India's and Brazil's interests, to explore the so-called south-south markets.

A cautionary note is in place, though, against the local design and production of devices: delays in the time to market of the product caused by various factors, make the local product progressively in disadvantage with similar competing products. By Moore's law[54], which states that integrated circuits have an exponential progress in speed and density, if a device is delayed by 6 months, its competitors should already be 25% faster[55]. The Simputer had fairly unique capabilities at the time it was proposed and designed, and its speed to market may come as a potential hurdle: there are many devices available as of 2003 that have very similar capabilities, (including the capacity of doing text-to-speech), and similar or lower price.

Given the pressing need of extending the benefits of ICT to the low-income population at large, initial solutions may require the use of imported technology, but at a medium term, an imports substitution practice may prove beneficial, when it is possible.

Indigenous production of software is a common point in the two projects, to different extents and needs. There are similar advantages in the case of software as there are in the case of hardware, and the disadvantages outlined above are much more forgiving. Software production is largely dominated by human capital, as opposed to very high cost fabricating plants for hardware. This fact, in combination with a worldwide movement of open and free software, which lowers the entry barrier for indigenous software developers and contributors to the playfield, makes it highly recommendable for projects of this nature to focus on local software development. In the following subsection we detail more specifically the role that Free and Open Source Software plays in projects of this nature.

## 4.6   The role of free and open source software

The use of Free and Open Source is an important part of both projects, and these can be considered earlier manifestations of the interest that FOSS has been gaining in the developing world. Several projects are currently under way in developing countries using FOSS, and several governments are starting to pass laws to favor the use of open software in the administration[56]. As we mentioned previously, the advantages provided by the use of FOSS are the lack of cost, the freedom for indigenous development of software which is localized and customized to the needs of the project, and the possibility of building upon a large body of existing software which is readily available.

The first argument is the easiest to argue for, but also perhaps the easier to dismiss. Depending on the nature of the project, and on the interests of the multinational software corporations, licensing schemes can be created that greatly reduce the cost of the software[57]. The caveat of proprietary software, in this sense, is exactly this dependence on external interests, which is most certainly not directly aligned with the interest

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[54] The observation that the density of transistors in integrated circuits doubles every 18 months, originally made by Gordon Moore, Intel's co-founder, in 1965.

[55] It was a similar phenomenon that caused the demise of the super computers like the Cray by personal computers. The high level of customization in these machines meant that there was a delay between a new processor becoming available and a super computer using it reaching the market. Personal computers, on the other hand, could use the economies of scale to lower development cost and reach market much faster.

[56] See the "E-Commerce and Development Report 2003", by the United Nations Conference on Trade and Development (UNCTAD), chapter 4, for a discussion of the use and implications of FOSS in policy and development.

[57] There are also many examples of softwares that are *gratis*, but are not open source, such as Microsoft Internet Explorer.

of the poor population to be served by the project. The dependence is observed in the form of future support policies, and in the inclusion (or removal) of features to the software.

This is exactly the greatest strength of FOSS for development projects: its use gives the developers the opportunity to customize the software to their exact needs, and the freedom from external interests. The ability to leverage a large existing body of software makes this possible. Another advantage of using FOSS is that local human capital is formed and trained in designing software.

In the case of CP, the use of FOSS was detrimental in reducing the cost of the product. The developers were able to customize the GNU/Linux operating system, with some key applications, to be stored in 16Mb of Flash RAM, removing the need of a Hard Disk for the system software. They were also able to simplify the interface, removing unnecessary features. However, it is not clear that the market was ready to accept the GNU/Linux solution, as was evidenced by the aforementioned Request for Proposals of the Ministry of Education. Today, almost 4 years later, the environment in Brazil seems much more favorable to the use of FOSS, with successful examples of telecenters based on FOSS by some local governments.

In the case of the Simputer, while the Operating System is GNU/Linux, the browsing environment and software on top of it are free, but not open source. They are based, however, on open specifications, such as that of the IML (a markup language developed by the Simputer Trust). An interesting feature of the Simputer is that its hardware design is also released under an open license, that in theory gives any group the right to implement and or modify it.

The separation of the Simputer software from its hardware is an option for the future, and we see great value in the Indian language text-to-speech capabilities. However, if the software were unbundled and made open source, that would essentially take most of the value away from the Simputer, as other devices which cost less could provide the exact same functionality.

In the broader picture, it is important to see how projects that aim to assist underserved communities can have business models that enable their sustenance in the long run without being edged out by mass producers once the utility of their services is evident and accepted by the markets.

## 4.7   Ubiquity of computing solutions v/s Region-specific solution differentiation

A crucial research question that must be addressed in projects such as the CP and the Simputer is the ability for a solution to be applied across the board to technology gaps in other underserved regions. The CP solution is typically one that is modular and scalable across regions with minimal effort. The Simputer, while designed specifically for Indian markets, has been done well enough with a text-to-speech capability scalable to several languages, though the user-interface itself needs significant reassessment for every new region.

# 5   Conclusions

In the next decades, new devices and technological solutions for the existing problems of underserved populations will continue to find their way to markets around the world. The Computador Popular and the Simputer are pioneering projects that will be pilot case studies for subsequent work in the area, as research in this now nascent field moves towards a more structured and investigative methodology. They offer valuable lessons in the study of initiatives in technological equity.

Decisive role of needs assessment and usability testing: We find that in an era of great enthusiasm for technology as a solution, there is limited research into the market's appreciations of these solutions. The Simputer case shows urgent need for studying and codifying low-attainment users' interactions with handheld screens. Contextual study to examine how people currently do tasks that technology plans to replace is vital in understanding peoples' relationships with the variables that new technology will affect.

**Greater focus on creating scalable general audience devices:** The scale of the Simputer's task may have been its greatest impairment – its aim to create a highly inclusive device by including audio capability drove up the cost to the point where it cannot compete effectively with other general audience devices in the market. An inexpensive low-power basic device upgradeable with external attachments for specific populations could have driven down the cost. Similarly, the creation of modular accessories could have enabled other products to gain from the same functionalities and facilitated greater market adoption.

**Free and Open Source Software will play a decisive role in development projects:** Underserved populations are dispersed and diverse, having needs that require significant improvisation and customization. The economic characteristic of FOSS is a benefit, but what is much more valuable is the application developer's freedom from the motivations of proprietary software producers whose willingness to invest in facilitating the advancement of new applications is directly proportional to tangible benefits.

**Government investment works better in infrastructure and scientific research:** Both projects relied on the government to for underwriting or purchase of systems. The availability of computing devices to consumers in India or Brazil is not yet at the point where it can be considered essential infrastructure. Since neither project was involved in fundamental scientific research, support from financial markets may have been more appropriate in ensuring that devices oriented to market needs were produced.

**Technologies must address existing pains:** It is important that advanced technology does not step in where it is not required. Both devices present better ways of doing things, but this may not always be obvious to their intended audiences, resulting in a lack of bottom-up demand. Evidence has shown that people with low literacy skills master relatively simple user interfaces, when they have a tangible context in which to use devices recurrently.

**Industry plays safe:** Creators of new technologies have to take into account the variables that would need to fall in place for them to succeed. Despite the promise of expanding markets to serve the economically marginalized, most of the initiatives to create products for the underserved have come from academia or non-profits. The cooperation of industry has been imperative, and as was seen in the case of the CP (and in the lukewarm VC response to Simputer), there is still lack of faith in the commercial viability of technology for development. The portentous conclusion here is that we may see succeeding generations of disempowerment until the underserved are naturally attractive to industry.

Given that current general purpose devices are too expensive for being directly used by the poorest (both devices we examined here failed to get the price below US$200 per unit), and that industry is risk averse to invest in the development of low cost, task specific devices, research universities have as a very important role to fill this gap.

**Technologies must be fun, schools and young people are critical test-beds:** As research into speech recognition breaks new ground, it is theoretically possible to test new technologies on all, even the least literate people. But it is much easier to get people with no preconceptions about a technology to become its adopters. School children have no proprietary software to unlearn, and no fears of technology to overcome. They are also more likely to find new devices fun to use and need not have a contextual practical benefit to become users of these devices. Children can take their knowledge of these technologies into the future as users of advanced computing devices, as well as into their homes, causing a "trickle-up" effect to their close relatives.

Any long-term change must be aimed at schools in developing regions. Many of these do not have basic infrastructure, but all have inquisitive children. Mobile devices can be easily incorporated into curricula, and inexpensive, low power versions of Simputers, for instance, can find their way into schools. Governments around the world are looking at policies such as India's IT for All to build their manpower

resources from the roots; basic handheld devices that circumvent power requirements present a viable solution for the future.

# Appendix A – Simputer Device and User Interface Assessment

The Simputer looks like a large version of an existing handheld device. The software interface was optimized for a handheld screen, icons were somewhat intuitive. Despite not having a specific application to test, we felt the device would have a significant learning curve for semi-literate persons. The Simputer had good text-to-speech capabilities: although the speech is markedly synthesized, it is intelligible[58].

## A.1 Constraints

1. Power supply had reliability issues
2. There was no specific application to do a specific user interface study on
3. The analysis is based on testing by advanced users of handheld technology

## A.2 Functionalities

The Simputer argues being able to perform certain functions of low-income populations better. Several of these tasks are listed in its documentation (see Appendix B). There is clarity on the *better efficiency*[59] of automating some of these tasks, such as

- E-Governance
- long-distance personal communication
- remote price information relay
- data collection and storage (e.g. healthcare)

One some other tasks, the use of automation is *yet to be proven* as more efficient than existing techniques. These include

- literacy training
- livestock data
- restaurant orders

Other tasks, although proven efficient through automation for power users, are not yet optimized for rural populations

- banking
- online transactions

## A.3 Acceptability of service delivery

The Simputer is a fairly radical idea, because the acceptability of the handheld device as a solution to the perceived needs of the Simputer cannot be intuitively proven until the actual deployment of the devices

Assuming that the average user is a rural primary sector worker

- There is no cultural familiarity to handheld devices or small screens
- There is also a fear of computing devices, and this has been documented for information centers

Assuming that the average user is a data collection employee

- There is some familiarity with handheld devices, such workers are usually urban and have literacy skills

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[58] The goal in its design was to make it simple for the content author to phonetically specify text to be spoken, and for the system to be portable to other languages, rather that optimizing for perfect speech.

[59] Of course, the efficiency measure here is non-contextual, thus the better efficiency is non-contextual

There is some past evidence on the acceptability of solutions provided using shared kiosks (in India) to individuals with slightly higher attainment (e.g. Railways booths, Hole in the wall computers)

## A.4   User involvement in design, prototyping and evaluation method

- No ethnographic investigations were made at the design stage
    - No recorded interviews or surveys in the pre-design stage have been documented
- Interview evaluation methods were used on villagers in central India. Such evaluation was conducted by engineers (accompanied by social workers) who brought back information on user experiences to the Simputer research group in Bangalore.
- On the market side, investigators from the company found that there was significant difference in dialect across fairly small geographical areas, making the speech synthesis task difficult – however, there is some confidence that the speech software is ready to accommodate the dialects with reasonable ease
- No available information on testing of customers' existing technologies for tasks identified. No documentation on step-by-step process that low-income users currently used to complete the tasks that the Simputer could electronically perform for them, or the users' relationships with the other variables in such tasks (for instance, how does an semi-literate farmer in India conduct banking transactions, what kind of assurances does he/she need, what kind of questions are typically asked to bank tellers, how many documents are involved in a typical cash transfer, etc.)
- Data unavailable on number of design iterations
- For prototyping, a variant of the Wizard of Oz technique was used – a small model of the Simputer was taken through villages in Madhya Pradesh in central India, testing with low-attainment users, their reactions to the technology. The findings are not known to us.

## A.5   Casing / Hardware

- Simputer manufacturers have taken measures for ensuring that the device can sustain some of rugged use – there is a plastic casing for the device, and easily replaceable stylus.
- There are power problems in the Simputer that need to be resolved, especially if it is to appeal to rural markets

## A.6 Product Support

- Hardware and software support are likely to be a very major issue. Even if there is a critical mass of product sales, due to the unique nature of the product and the low technology exposure of users. Additionally, if the users are scattered geographically, there is an additional possibility of system failures.
- Currently, Simputers need to be delivered to Bangalore for rectifying any major failures. Online customer service was accessible and very prompt

# Appendix B – Software and Application Analysis: Malacca

The central component of the Simputer software development is the Malacca user interface. Malacca is technically a browser that displays content formatted according to the markup language IML. IML -- information markup language -- is a markup language developed specifically for the Simputer, which sits between the power, generality, and complication of HTML, and the limitations of WML.

## B.1  Design Goals

The main design goals for IML are:

- Simplicity
    - make the user interface usable by people who may not be literate
    - the model for interaction is to be by the use of simple icons for input, and text-to-speech for output
    - The user is not expected to be familiar with the currently widespread user interface paradigm (windows, slidebars and pull-down menus). The interface does not depend on the user keeping track of several windows for various applications
- Consistency
    - all applications in the platform should have a consistent interface
- Open standards
    - Simplicity of the browser software
- Ease of development
    - object oriented
    - facilitates code reuse
    - separates business logic from presentation from data
    - provides ready made widgets, allowing the developer to concentrate on the application, not on the front end
    - allows access to Simputer features: smart cart, text-to-speech

The development of applications should be similar to that of current Web based applications. One can design very flexible applications using Perl to represent the logic, with connections to MySQL for data persistency, communicating with the user through the IML presentation layer, via Malacca. For simpler applications, such as the provision of content for schools, for example, one can rely solely on IML `pages', which is naturally suited to represent hypertext.

The fact that specific tags are in the language to give access to Simputer specific functions, such as Text-to-Speech, and access to the SmartCard device, can make the full use of the device by more developers easier.

One component that would make significant difference is an authoring software package for desktop computers, or for the Simputer itself, which would allow for a more decentralized and scalable production of local content.

According to the PicoPeta web site, Malacca is being ported to other platforms, apart from the Simputer, such as competing PDAs running on Linux, and Pocket PC. It remains to be seen if this framework of integration works well with other platforms/usage patterns, which features continue to stand out, and which features become unimportant, if any. We also aim at developing simple applications for the Simputer, in order to test both the development process, and eventually the user interface possibilities with other less biased population.

Currently, Malacca is available for the Simputer and for GNU/Linux systems, the latter being mostly for development purposes. Ports for Microsoft Windows, Microsoft Pocket PC, and PalmOS are planned.

Below we list some features and applications that are envisioned for the Simputer/Malacca system.

## B.2 Features

- It can input and output text in Indian languages – currently supporting Hindi, Telugu and Kannada.
- Has a speech synthesis features built in, the Simputer's Text-to-speech engine can "read out" English sentences
- It is not clear if the exact same facility exists for supported Indian languages - Hindi, Telugu, Tamil and Kannada sentences. There are some "speak out
- It can read and write from the virtual SmartCard
- Use tables (the tag) for complete layout control over text and images
- Has the ability to create user forms
- Has the ability to annotate pages
- Executables can be inside the Malacca interface
- Perl / Tcl programs can be run inside the Malacca interface
- Can use client-side scripting for form validation etc.

## B.3 Applications

The applications of the Simputer can be broadly categorized into the general purpose uses that are applicable universally, and the customized uses

General purpose uses include:

- Word Processor
- Internet Browser
- Spreadsheet
- Scientific Calculator
- PDF Viewer
- Address Book
- Image Viewer
- MP3 Player
- Games

According to the creators of the Simputer system, the benefits of the device lie in custom-made applications in a series of Remote Communication and mobile device applications that require collection and transmission of data from hard to reach places. Some potential uses for the Simputer in this space include:

- E-governance
    - Smart Card enabled citizen services( Voter IDs, driving license, ration card, etc. )
    - Data collection and processing
    - Land and revenue records
    - e-mail device
- Microbanking
    - A Smart Card pass book
    - Online synchronizing of transactional details
    - Interactive multi-lingual transaction log book
- Education

- o Interactive text book with large data storage (extensible using smart cards)
  - o Universal interface for education in any language at any level
  - o Automatic adjustment of content based on progress.
  - o Regular download of new educational data without reliance on infrastructure or additional expense
- Communication
  - o Kiosk device with Data and voice transmission
  - o Preferences of each user stored on a Smart Card
  - o Removes barriers of language and literacy
  - o Universality of data transmission achieved through use of icons and text-to-speech
- Market pricing and agriculture
  - o Both market and weather forecasting data instantaneously distributed
  - o Online cash transaction capability
  - o Digitization of the barter system via organization of secure transactions using smart cards
- Health
  - o Interactive data collection device for a health worker, especially for remote rural access
  - o Preliminary diagnosis of common ailments via an expert system
  - o Health schedules, data storage, advice on livestock
  - o Telemedicine: remote health care advice
- Technology in everyday life
  - o Usage in restaurants for orders
  - o Personal Digital Assistant and diary options for personal home use
- Distribution network organization; Simputers carried by delivery agents
  - o Inventory management made easy
  - o Integration with Global Positioning Systems for directions and way-finding
  - o Voice transmission over standard telephone lines in emergency situations

# Appendix C – Specific versus General Project and Audience

In this section we draw a first attempt in characterizing technology solutions to developing countries along two important dimensions: whether the solution has a general or specific purpose, and whether its audience is a specific group or a more general group within society. These dimensions are detrimental in determining the viability of the development and marketing of a solution: they affect the *scale* to which a solution can be applied, and the *complexity* of the design process and fabrication, which have antagonistic effect in the economics of a product. In the following matrices we try to make these effects more clear.

## C.1 Description and project types

<table>
<tr><td colspan="2" rowspan="2"></td><th colspan="2">Purpose</th></tr>
<tr><th>Specific</th><th>General</th></tr>
<tr><th rowspan="2">Audience</th><td>Specific</td><td>Projects that complete specific functions and are designed for use by specific audiences.<br><br>**E.g. Milk fat testers, Heavy Engineering Devices**</td><td>Projects that have complete general functions, but are designed for specific audiences.<br><br>**E.g. Simputer**</td></tr>
<tr><td>General</td><td>Projects that have specific functions, and are designed optimally for use by broad audiences.<br><br>**E.g. Remote Controls, Calculators, Insulin Tester**</td><td>Projects that general and varying functions, and are designed for use by all audiences.<br><br>**E.g. Personal Computers, Computador Popular[60]**</td></tr>
</table>

## C.2 Complexity: Technology and UI Features

<table>
<tr><td colspan="2" rowspan="2"></td><th colspan="2">Purpose</th></tr>
<tr><th>Specific</th><th>General</th></tr>
<tr><th rowspan="2">Audience</th><td>Specific</td><td><ul><li>Varying production complexity</li><li>Varying production cost</li><li>High technological barriers to entry</li><li>Varying learning curve</li><li>Very standard usage patterns</li></ul></td><td><ul><li>Moderate production complexity</li><li>High production cost</li><li>Moderate technological barriers to entry</li><li>Moderate learning curve</li><li>Varying usage patterns</li></ul></td></tr>
<tr><td>General</td><td><ul><li>Low production complexity</li><li>High production cost</li><li>Low technological barriers to entry</li><li>Short learning curve</li><li>Very standard usage patterns</li></ul></td><td><ul><li>Very high production complexity</li><li>High production cost</li><li>Highest technological barriers to entry</li><li>Moderate learning curve</li><li>Varying usage patterns</li></ul></td></tr>
</table>

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[60] The CP is most likely intended for a general audience, although it can be argued that it should be at an intermediary point in this scale, as it was targeted to lower purchasing power consumers.

## C.3 Business Features

| Purpose | | |
|---|---|---|
| | Specific | General |
| **Audience** Specific | • Highly Market Driven<br>• Low unit sales<br>• Institutional buyer oriented<br>**Stable market: Niche market, possibly oligopolistic, low competition, high entry barrier** | • Technology Driven<br>• Lower unit sales than general audience devices<br>• Mixed buyer orientation, (more institutional)<br>**Uncertain market: Risky, pioneer market, low competition** |
| **Audience** General | • Highly Market Driven<br>• Very High unit sales<br>• Consumer purchase oriented<br>**Highly developed, Competitive market** | • Highly Market Driven<br>• Very High unit sales<br>• Mixed buyer orientation, (more consumer)<br>**Highly developed, Competitive market** |

## C.4 Directions for the future

| Purpose | | |
|---|---|---|
| | Specific | General |
| **Audience** Specific | Option 1. Refocus on creating inexpensive devices with one or very few functions | **Simputer Today** |
| **Audience** General | Option 2. Create cheaper general PDA-type devices with more focused functions, possibly upgradeable | **Computador Popular** |