One Laptop per Child: Taking the Next Step to Realizing Nicholas Negroponte’s Vision

by Mark Rennella, Tyler McNally, Ronald Jonash, and Hitendra Patel
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For Negroponte, improving and spreading education was the major goal; cheap laptops seemed to be the most efficient means to achieve the goal.

One Laptop per Child (OLPC) sprang from this experience into a program whose goal is to see that no children are left behind the digital divide in their education. Six years after that visit to Cambodia, Negroponte announced the existence of this new non-profit from the august halls of the 2005 World Economic Forum in Davos, Switzerland and introduced a prototype of that computer (which would be known as the “XO”). The XO was a rugged equivalent to the Toughbook but designed for kids offered at an almost unfathomably lower price: OLPC’s target price of $100 compared to typical small lightweight computers on the market for around $2,500. (At this time, small and lightweight laptops were more expensive than bulkier and heavier ones.)

OLPC’s eventual goal was to ensure that every child in the world had access to laptops in the classroom and in daily life. (This is often referred to as “1:1” computing programs.) (See Exhibit 1 for a full description of the XO’s functions.)

The world took notice. Less than two years after this announcement, OLPC (which is based in Cambridge, Massachusetts and closely associated with the MIT Media Lab that Negroponte helped to found in 1985) had garnered $29 million in funding from a wide range of high-profile tech companies, such as: Marvell, eBay, Brightstar, Quanta, Nortel, Chi Lin, News Corp, AMD, Google and Red Hat. On the other hand, many critics felt that the price was impossibly low. Computer manufacturers like Intel were threatened and its Chairman took an antagonistic stance, describing the computer as a “$100 Gadget.” Bill Gates thought the screen was too small. But comments by leaders of Microsoft and Intel were far from idle speculation. They were symptoms of the real threat posed by the XO to the laptop market as it existed. The threats included severely cutting the prices of laptop computers and weaving a new generation of computer users on open source operating systems. The scenario represented a truly disruptive innovation.

Exhibit 1: A Description of the XO’s Functionality

OLPC’s XO laptop offers a cohesive integrated software platform. The special features like a built-in video camera, high-resolution screen, long battery life, and pull-string charging makes it enjoyable and easy-to-use for children of all ages.

OLPC’s XO laptop includes a long-lasting nickel-metal hydride battery that allows the XO to operate between 6 and 20 hours depending on what features are in use. When power sockets aren’t available, users can recharge the battery with a built-in pull-string charge. The XO laptop also provides network access with a unique wireless mesh network technology and includes a built-in microphone and an integrated camera that can capture video at 30 frames per second with a resolution of 640x480. The laptop has a directional pad and game buttons integrated into the screen bezel in addition to a rubber-membrane keyboard and a touchpad that also supports stylus input.

The laptop-user interface, the software that children navigate to interact with the computer, is called Sugar. Based on the Linux operating system, Sugar is designed to encourage social interaction and collaboration and is currently offered in 25 languages. It starts with a range of activities, not programs, and promotes the sharing of these activities both online and through the physical interaction a child has with the computer. Nicholas Negroponte describes it as “active learning.” The system includes also a built-in chat system as well as a web browser based on Mozilla Firefox, providing opportunities for communication with and exposure to the global world.

The next step for OLPC’s XO is the XO-3 tablet, an affordable handheld media-center.

Sources
Success has been slow, but steady. When production of the computer finally started, the “$100 Laptop” actually sold for $188.5 (See Exhibit 2 for breakdown of costs of computer parts in 2007.)

As of the end of 2009, OLPC has manufactured 1,284,000 computers to 20 countries.6 Principally targeting the government ministries in charge of education, OLPC has generally depended on computers being bought in large quantities and distributed through large government programs.7 It has encountered the most success in South America, particularly Uruguay and Peru. In 2009, Uruguay that country signed up for 435,000 400,000 XO’s and was the first large-scale government agency that committed (and succeeded) to reach 1:1 saturation in all public school systems. Peru has embarked on a similar objective but will take longer as there far more primary school children in Peru.8

The questions facing OLPC today need to be answered quickly if Negroponte’s 1999 vision is to be realized. Those questions are as daunting as they were in 2005: How does OLPC arrive at the tipping point to drive scale and make OLPC-style computers the twenty-first century equivalent of chalk and board, or pen and paper? How does the XO become the minimum standard for high-quality education for children around the world? In the words of a current Board Member and Former President Charles Kane, OLPC will succeed when “it creates a design that others will build.”9 Additional pressure to find the right business has emerged with the recent economic crisis. With the foundation that funds OLPC suffering, pressure has been building for OLPC to be run more on a “for-profit” business basis as a means to ensure sustainability of its mission.

A more detailed look into the history – successes and surprises – of the XO will offer some insights into potential new options available in the future.

The Challenges of Creating the $100 Laptop

When Negroponte announced OLPC in 2005, one goal of the organization was to enable more people to have access to XO-style computers by driving down the cost of manufacturing.

OLPC aimed to cut costs wherever it could in the supply chain. The most impressive achievement in this area was their innovations in computer screen production. OLPC’s former Chief Technology Officer Mary Lou Jepsen, (who had directed the technology development at Intel’s Display Division) made an LCD screen that used 80% less power than conventional screens and cost only $40.10 The display is made so it can be easily seen in both indoor and outdoor environments. And even though it runs on low power, the visual quality of the display is very high. As important, the screen had a sun sensor that would automatically adjust the content to black and white in sunshine. This was critical for classrooms without a roof. It’s also field repairable—all a user needs is to undo a few screws to get access to the system internals. Finall, adding to its “green” credentials, the display employs no mercury.11

OLPC was a start-up of sorts, establishing a manufacturing arm to put these innovative parts together would take too much time and be too costly. In 2007, OLPC turned to Quanta Computer Inc., a Taiwan-based company with an impressive track-record: it was responsible for about 33% of global laptop production with clients including companies such as Dell, Lenovo, and Hewlett Packard.12

Another task was creating the software to run the computer. In 2007, Red Hat contributed a compact version of its Linux-based Fedora operating system which was used to build the Graphical User Interface (GUI) called Sugar. Red Hat and OLPC software engineers, together with help from the open source community, developed and continue to enhance this software. Sugar required only 130 megabytes of memory (compared to Windows XP, which required 1.65 gigabytes). The XO GUI was designed to be intuitive to children. Rather than the typical subject/ folder organization of Windows OS, the XO GUI as chronologically organized like a journal, where you can easily find the work you’ve done on Monday or Wednesday, for example.13 Soon afterwards in May of 2008, Microsoft agreed to license its XP system to OLPC at the rate of $3 per computer.14 Microsoft may have been motivated by the fear of missing out on a huge portion of the world’s next generation of computer users if the XO took off. OLPC also experimented with innovative marketing. One of these efforts was the “Give One Get One” campaign, which ran from November 12 through December 31, 2007 in the US and Canada. For $399 a consumer would buy two computers: one to own and one to give to a child in a developing nation. In total, the campaign raised $35 million and a total of more than 100,000 XO laptops were distributed to children in Afghanistan, Cambodia, Ethiopia, Haiti, Mongolia and Rwanda.15

In its first two years, OLPC did not make a profit and was funded principally by its foundation and corporate donations. OLPC first aimed to start production only when 5 million machines had been ordered, but this scenario had not been realized by 2007. It seemed that, at least for the time being, the $100 price goal would not be feasible.16

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2. Interview with OLPC staff, March 1, 2010.
3. Interview with Charles Kane, January 7, 2010.
4. Interview with OLPC staff, March 1, 2010.
5. Interview with Charles Kane, January 7, 2010.
7. Interview with OLPC staff, March 10, 2010.
12. Interview with Charles Kane, January 7, 2010.
With this purchase, Uruguay has given every child in public education between 1\(^{st}\) and 6\(^{th}\) grade, as well as all of their teachers, one XO laptop.

**Business Models used by OLPC**

In growing demand to date, OLPC mainly targeted governments. OLPC worked with often big and cumbersome government bureaucracies to make the case for the potential benefit of the XO and to overcome concerns about the substantial outlay of funds required of tens or hundreds of thousands of XOs.

The examples of illustrate OLPC’s experience selling directly to Ministries of Education (or equivalents) in large quantities. This model depends on personal relationships with influential government officials.

**Uruguay**

Uruguay represented the first large-scale governmental buy-in to reach 1:1. It was called the “Plan Ceibal” – “Ceibal” being the national flower of Uruguay as well an acronym for the project. President Tabaré Vázquez was very enthusiastic about the XO’s potential role in the education of Uruguay’s citizens and publicly announced the plan in December of 2006. With about 400,000 units included, this plan represented the largest purchase by a single country of the XO laptops.\(^{15}\) With this purchase, Uruguay has given every child in public education between 1\(^{st}\) and 6\(^{th}\) grade, as well as all of their teachers, one XO laptop.

By 2009, around 70% of the XO model laptops were given to children who did not have computers at home. The director of the Plan Ceibal, Miguel Brechner, described the goals of the program: “This is not simply the handing out of laptops or an education program. It is a program which seeks to reduce the gap between the digital world and the world of knowledge.”\(^{16}\) In one of many encouraging signs about the Plan Ceibal, the government reported in 2009 that close to 80% of economically disadvantaged children said that using the XOs made classroom assignments more enjoyable.\(^{17}\) Success in Uruguay is also making neighboring states, such as Argentina, more enthusiastic about OLPC’s mission. Like Rwanda in Africa, Uruguay’s OLPC efforts have encouraged neighboring Argentina to look into OLPC – the La Rioja Province recently purchased 60,000 XO laptops.\(^{18}\)

**Rwanda**

As part of Rwanda’s Vision 2020 campaign, the country has begun embracing information technology as their main strategy for economic and social development. This is the long-term country development plan that aims to transform the country into a medium-level income country by 2020. Even before OLPC started their project in the country in January of 2007, bringing computer literacy to primary school students was an important part of Vision 2020.

President Paul Kagame has committed to deploying 120,000 laptops across the country. This is partly supported by collaboration between the wealthier city schools and the poorer rural schools. OLPC has also set up a major learning center in Rwanda, the Center for Laptops and Learning, which aims to serve the educational and learning needs of countries across Africa.\(^{19}\) Success and experience in Rwanda is encouraging other African countries to follow suit, such as Mali.

Both the Rwandan and the Uruguayan experiences illustrate another key success factor for OLPC: creating successful relationships with lead customers in Global regions. By demonstrating success in Uruguay, for example, Argentina is encouraged to give the XO a try. Likewise success in Mali, Cameroon Burundi and other African countries using financing with third parties is fostering experimentation in Nigeria. This model builds on large regional successes – their experiences and publicity – to grow the XO distribution in nearby regions.

The case of Sri Lanka demonstrates another successful business model: setting up a high profile pilot that demonstrates success on a small scale and creates the possibility for expansion on a broader scale within the country.

**Sri Lanka**

The small island country, just off the southeast of India, has been struggling with internal strife for years, and is still recovering from the devastation of the 2004 tsunami. One of the main goals of its Ministry of Education has been to provide the younger generation with skills in Information Technology and the English language. This was one of the key drivers for the collaboration with OLPC and launch of the program that was planned to bring 1,250 new laptops to students in thirteen separate schools around Sri Lanka as a pilot project. This pilot program has received a strong support by the World Bank.

In early 2008 a non-profit foundation called Lanka OLPC Foundation was established. The Sri Lanka Ministry of Education (MOE) piloted the One Laptop per Child (OLPC) program by purchasing laptops from the OLPC Foundation, with funding from the World Bank, and distributing them to students in selected primary schools throughout the country.

The Ministry of Education has chosen 9 primary schools around Sri Lanka for the pilot project and is working in cooperation with a coalition of corporate donors (such as the Chart Foundation, Hatton National Bank and mobile provider Tigo) to get the project up and running. On December 10, 2009, Sri Lankan President Mahinda Rajapaksa and Education Minister Premajayantha presented the first 400 laptops at a public ceremony announcing the pilot program.\(^{22}\)


\(^{19}\) Interview with OLPC staff, March 1, 2010.

While conventional laptops require up to 20-40 watts of power, the XO was designed to run on an average of two watts. At these levels, the XO can be used with sources like solar power, human generated power and others.

Another business model with which OLPC has been experimenting is local development partnerships. In Brazil, for example, OLPC works in partnership with a Brazilian manufacturer to assemble parts for the XO for Brazilian distribution. This is an example of a win-win partnership. Currently, OLPC has submitted a bid to sell 1 million XOs. If OLPC wins this bid, the funding for purchasing the laptops will be provided by the country’s National Development Bank (BNDB).

This bid has been preceded by many positive interactions between OLPC and Brazil. Building on very good relationships with government officials, OLPC has already begun pilot projects in Porto Alegre. Swift has donated 3,000 XOs that are now being distributed by the government. Also, following a bid won in 2008, 250,000 classmates will be delivered during 2010 in 500 schools worldwide.

While the overall progress of OLPC’s global vision has been steady and promising, the program has yet to really catch fire with many groups of stakeholders globally: teachers, parents, and government officials.

Overcoming Significant Barriers to Adoption

With Negroponte’s great vision to make the XO the global standard for laptops in the classroom came many other obstacles to success. In experiences from all over the world, OLPC found ways to overcome many of these obstacles and concentrate efforts in arenas that had the most promise.

Red Tape and Bureaucratic Inertia

OLPC’s goals (either to lower the price of XO-style laptops or to increase the numbers of XOs adopted) have typically entailed targeting large public and private entities. A typical barrier in many of the developing countries where OLPC hopes to make an impact is bureaucratic inertia. They have overcome this by building close relationships with major players in the government who understand how to champion OLPC’s offering through the government bureaucracy. Because many of these governments are relatively centralized, getting buy-in from a high placed government official is a very helpful first step. In the United States, in contrast, education is often run at a local level, so scaling efforts in the U.S., even though there is more money available, is much more difficult.

Another barrier in dealing with governments is the high cost of buying hundreds or thousands of laptops at one time. More fundamentally, some critics contend that laptops are very low on the priority list of many developing countries. However, OLPC and its supporters make the case that childhood education – that is efficiently and effectively supported and enabled using technology – is critically important for children in developing markets. 

Cost

While OLPC has not yet produced a laptop that costs $100, the XO 1.0’s $180 and the XO 1.5’s approximately $200 (depending on quantity) price tags represent an amazing achievement in cost reduction. Nevertheless, many countries still feel that the cost is above their ability to pay. One way countries may calculate their return on investment is to factor in the durability of the laptops (averaging at five years), which offers another large benefit for the large cash outlays for the XOs.

Teachers and Technology

Beyond introducing these devices to children (many of whom have had little or no experience with computers), many teachers also had to be persuaded to bring it into the classroom. Even when XOs get into the classroom, their acceptance still depends upon such key variables as: the capacity of teachers, the methods of ‘introduction’ (e.g. if XOs are requested vs. mandated from higher institutions like a Ministry of Education), and others.

While the XO appealed to forward-thinking government officials as well as to students who were very curious about the new technology, teachers sometimes represented an unanticipated obstacle to adoption. Many of them were also unfamiliar with computers and had never integrated them into their work efforts. Suddenly, there were pressures from above and below for the laptop. From above, authorities like governments had or were interested in investing in the XOs as a silver bullet. And from below, children almost always react positively to the XO and nearly always learn quicker than the teacher. This adds a new dimension to the classroom: children are in a way undermining the teacher’s authority if they know more about a particular technology than the teacher. Indeed, part of the educational outcome of the XO was to help foster independent learning. OLPC reacted by being more careful and deliberate about building the capacity and capability of teachers to use the XO in the classroom.

Technical and Infrastructure Concerns

Inadequate or intermittent power and communications can be a problem in the developing world, especially in remote areas. While conventional laptops require up to 20 – 40 watts of power, the XO was designed to run on an average of two watts. At these levels, the XO can be used with sources like solar power, human generated power and others. This very low use of energy put less stress on existing infrastructure.

In Peru, for example, some effective responses to infrastructure concerns were relatively inexpensive. In some remote villages in mountainous areas of Peru, for example, a satellite dish could make acquiring conventional telephone wires unnecessary. Also, solar panels could be installed at the schools to provide the power necessary to run the XOs in remote locations.


Interview with Charles Kane, March 10, 2010.

Interview with Charles Kane, January 7, 2010.


Existing and Potential Competitors

While smaller and cheaper than laptops, most netbooks are unable to stand the physical abuse they would receive from pupils and the generally harsh environments in developing country classrooms; therefore, they have not emerged as true competitors.

But there are some direct competitors. One important one came from Intel, which had its own alternative to the XO, the Intel Classmate, launched in May 2006. [See Exhibits 3a and 3b for comparisons of the XO and Classmate.]

Exhibit 3a: XO and the Classmate – Sales and Distribution

XO
By the end of 2009, small XO deployments have been made to between 20 and 30 countries; large orders have come from only Uruguay, Rwanda, and Peru. About 1.1 million have been sold, with a backlog of around 500,000.

Price: around $200.

Classmate
Classmates PCs are available worldwide, but have been adopted most in the Europe and Latin America, particularly in Portugal and Venezuela. There are about 2 million Classmates that are in circulation worldwide.

Price: around $400.

Exhibit 3b: Comparison of Some Features – XO and Classmate 2009

Comparison between Classmate PC by Intel and OLPC XO 1.5

<table>
<thead>
<tr>
<th>Feature</th>
<th>XO</th>
<th>Classmate PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>VIA C7-M (1 GHz) ULV CPU</td>
<td>Intel® Atom® Processor N270 at 1.6GHz</td>
</tr>
<tr>
<td>Display</td>
<td>8.9” 1024 x 600 touch-screen, Convertible or touch-optimized tablet mode</td>
<td>7.7-inch dual-mode LCD, supporting a resolution of 1280x800 in monochrome mode and 800x600 in color mode</td>
</tr>
<tr>
<td>Memory</td>
<td>1 GB / 512MB DDR2 2GB RAM or 1 GB DDR2 512MB SO-DIMM</td>
<td>1GB DDR2 SDRAM system memory</td>
</tr>
<tr>
<td>Storage</td>
<td>16GB/32GB Flash or 1.8” HDD</td>
<td>4GB of NAND Flash memory on motherboard, 1 MB of serial Flash memory provided separately for firmware Expandable through a single externally accessible SD/MMC memory card socket</td>
</tr>
<tr>
<td>Operating System</td>
<td>Windows or Linux</td>
<td>Linux, Windows, Sugar interface</td>
</tr>
<tr>
<td>Weight</td>
<td>1.25 - 1.4 kg</td>
<td>1.45 - 1.5 kg</td>
</tr>
<tr>
<td>Battery</td>
<td>Nickel-metal hydride, supporting between 6 and 20 hours operating</td>
<td>64-hour battery, supporting between 6 and 20 hours operating</td>
</tr>
<tr>
<td>Camera</td>
<td>Integrated color video camera, Full frame rate (30fps)</td>
<td>Integrated color video camera, Full frame rate (30fps)</td>
</tr>
<tr>
<td>Network</td>
<td>10/100M Ethernet, WLAN 802.11b/g/n WLAN, with antenna, 0.8m support (Linux only), Security: WPA, WPA-PSK, WPA2, WPA2-PSK</td>
<td>Integrated IEEE 802.11b/g (2.4 GHz) wireless networking interface, Ad-hoc and AP mode networking supported, Capability of network operation when CPU is powered down</td>
</tr>
<tr>
<td>Keyboard</td>
<td>Water resistant, Touch pad (integrated vertical scrolling)</td>
<td>Water and dust proof 80+ key rubber keyboard, with 1mm stroke Capacitive touchpad used for pointing device</td>
</tr>
<tr>
<td>Other features</td>
<td>Built-in water resistant keyboard, speakers and microphone, an optional wireless pen device</td>
<td>Directional pad, games buttons integrated into the screen bezel, rubber-membrane keyboard, touchpad supporting stylus input</td>
</tr>
<tr>
<td>Battery</td>
<td>6-cell battery (6 hours) or 4-cell battery (4 hours), based on 8.9” LCD and defined brightness, Wi-Fi off, and camera disabled</td>
<td>Nickel metal hydride, supporting between 6 and 20 hours operating</td>
</tr>
</tbody>
</table>


Recent Developments

[See Exhibit 4 for XOs Deployed up to 2009]

In 2009, OLPC split its operations to achieve more efficiency. While advocacy and engineering would remain in Cambridge, Massachusetts, much of the operations and overseeing of manufacturing as well as the implementation of programs would be done in Miami. Miami was also much closer to much of the most promising OLPC activity that was taking place in Latin America: Peru, Uruguay, and Argentina. The two offices seem to have achieved a better focus on their respective responsibilities in accomplishing OLPC’s mission. The addition of Charles Kane as president in May of 2008, who boasts a series of high-level positions in the tech industry, adds more expertise in running OLPC as a business. As Kane put it, “Profit and high ideals are not a contradiction: we use the profit for good ends, but we need a sustainable business.” 19

To open 2010, OLPC partnered with General Mills in a “Win One Give One” campaign. Using codes printed on boxes of Betty Crocker fruit flavored snacks, kids can enter a daily drawing to win an XO, with another given away that day to a student in Africa. The campaign will last 240 days. 20

There are hopeful signs of growing demand now in Brazil. Preceding 2010, the government of Brazil has looked into buying large amounts of XO-style laptops. A new approach that has appealed to the Brazilian government recently is to ship the XO’s parts that are made in assembled them in Brazil. This can create jobs for Brazilians while simultaneously helping to achieve OLPC’s mission: a win-win partnership.

(For an overall view of the deployment of XOs around the world up to 2009, please see Exhibits 4a and 4b.)

Exhibit 4 for XOs Deployed up to 2009

Geographic Distribution

Numerical Distribution

Number of XOs Deployed up to 2009


19 Interview with Charles Kane, January 7, 2010.
20 Interview with OLPC staff, March 1, 2010. See also the Win One Give One web site: http://winonegiveone.com/#, accessed March 4, 2010.
AUTHORS

Dr. Hitendra Patel  
Hult Professor of Innovation and Growth; Managing Director, IXL Center  
At IXL Center, Hitendra works with firms and their executives to develop the institutional capabilities and culture that foster growth through innovation. He is also a lead instructor and facilitator for IXL Center’s innovation management certification programs. At Hult, Hitendra teaches innovation and growth courses and is the founder of the school’s Innovation Olympics program.

Ronald Jonash  
Partner, IXL Center  
Ron’s specialties are the strategic management of innovation, technology, and R&D to create and capture maximum value. In addition, Ron is on the faculty of the Hult International Business School, and on the advisory board of Arthur D. Little, Inc.

Tyler McNally  
Partner, IXL Center  
Tyler works closely with IXL Center’s clients to design and deliver innovation management capabilities, building programs that combine blended learning instruction, workshops, coaching, and mentoring for executives and teams.

Mark Rennella  
Principal  
Mark leads a number of IXL Center’s major research and writing efforts. Prior to IXL Center, Mark was as a Research Associate at Harvard Business School and taught at Harvard’s History and Literature Program from 1997 and 2003. He has a Ph.D. in American history and has researched and published extensively on the cultural and business implications of international travel.

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