DEVELOPMENT POWERED BY EDUCATION:

How Much Information Can You Hold in One Hand?

Matthew Herren and Maciej Sudra

Abstract (EN)

In the Kenyan village of Mbita, the sixty students and three teachers of class 5 had their textbooks replaced with an ICT platform for the distribution of curriculum content, called the EduVision E-Learning System. The students and teachers went about their normal curriculum much as any other primary school in Kenya, except in the place of textbooks they used handheld computers running a customized Linux operating system and EduVision's software. The software development continued throughout the project, taking into account feedback and suggestions from the teachers and students.
Using an inclusive, bottom-up approach to designing the overall project, EduVision has developed a functional implementation of its design. Taking the concept of bottom-up design further, we continued to solicit input on the system as it developed from the students
Keywords: Education, Pilot Project, User Interface, Textbooks, Development, Open Source,
PDA, Pocket PC

Zusammenfassung (DE)

Im kenianischen Dorf Mbita, am Ufer des Lake Victoria, haben sechzig Schüler und ihre 3 Lehrer die Schulbücher gegen das elektronische e-Learning-System von EduVision eingetauscht. Während der neunmonatigen Pilotphase des Projektes, haben die Schüler und Lehrer den normalen Lehrplan verfolgt. Mit der Ausnahme, dass Sie statt Bücher einen Pocket-PC zur Verfügung hatten, der mit einem vereinfachten Linux-Betriebssystem und der neuen Software von EduVision ausgerüstet wurde. Während der Pilotphase wurde diese Software schliesslich durch die Erfahrungen der Schüler und Lehrer laufend verbessert.

Die erste Phase der Entwicklung ist bereits erfolgreich abgeschlossen und man kann anhand der Resultate schon jetzt wegweisende Schlüsse für die Zukunft ziehen (eine umfassende Studie über den Effekt dieser neuen Technologie auf die Schüler und Lehrer war im Rahmen dieser ersten Projektphase leider nicht möglich). Der Vortrag beschreibt die von EduVision verwendeten Kriterien für
die Entwicklung einer erfolgreichen Technologie, den Entwicklungsprozess,
die Erfahrungen des Projektleiters und seiner Mitarbeiter sowie Testmethoden
und Resultate. Gegen Ende des Vortrages werden wir auf die Kriterien für die Entwicklung zurückkommen und beschreiben, wie wir aufgrund der gemachten Erfahrungen die nächsten Schritte planen, um das gesetzte Ziel zu erreichen: Eine nachhaltige Informations- und Kommunikationstechnologie, welche das oft
teure und qualitativ mangelhafte Lehrmaterial durch angepasste, womöglich mit lokalem Inhalt angereicherte Inhalte ersetzt. Diese lokalen Inhalte sollen an Ort und Stelle entwickelt und im Lehrplan integriert werden.
Schlusselworter:
Ausbildung, Entwicklung, Design, Schulbücher,

Resume (FR)

Dans le village kenyan de Mbita, sur le bord du lac Victoria, 60 écoliers de la cinquième classe ainsi que leur trois instituteurs ont échangé leurs livres pour un système de distribution du matériel pédagogique électronique "EduVision", une nouvelle plate-forme d'information et de communication électronique. Durant la phase expérimentale de neuf mois, les écoliers et instituteurs ont suivit le curriculum normal, excepté que leurs livres ont été remplacés par des pc de poche, fonctionnant avec un système d'exploitation Linux simplifié et un logiciel EduVision. Ce dernier a continué son développement durant la phase expérimentale, bénéficiant des suggestions des élèves et instituteurs.

Le cycle préliminaire de développement technologique touche à sa fin et les premiers résultats sont très encourageants et indiquent le chemin a suivre (les résultats sont indicatifs, étant donné que cette première phase expérimentale ne permettait pas de faire une étude très détaillée sur les effets de cette nouvelle technologie sur les écoliers et instituteurs). Cette présentation décrira les critères utilisés par EduVision pour la conception d'une technologie réussie, le procédé de la conception, notre expérience en développement, notre méthodologie pour tester les utilisateurs ainsi que les résultats de la phase expérimentale. Finalement, nous retournerons aux critères de conception pour identifier, sur la base de l'expérience acquise, dans quelle direction diriger les nouveaux efforts pour la réalisation des objectifs établis pour le projet. En particulier le remplacement des livres coûteux et de pauvre qualité par une solution basée sur un système informatique moderne, qui permet la création et l'échange de connaissances locales et leur intégration dans le curriculum traditionnel par l'utilisation du contenu du modèle EELS, une plate-forme ouverte dont la propriété et le contrôle reste avec les membres sa communauté de réalisateurs et d'utilisateurs.

Mots clés:

Education, Enseignement, PDA, Interface Utilisateur, Open Source, Projet Pilote

Introduction

Spanning the digital divide in Africa has been the focus of innumerable conferences, books and initiatives, with enough failed projects to populate a few land fills. In stark contrast, locating documentation and descriptions of the projects that have achieved a degree of success is not a trivial task. In this environment, innovative ideas for increasing the role of information communication technologies (ICTs) in development often cannot find the support they need to see the light of day. The potential for ICT to play a major role in the quest for development is significant, but only if applied to appropriate situations, in an appropriate manner. Too often, ICTs are presented as a

wonder-tool and solution to problems of all shapes and sizes. When these fail, precious resources are wasted, ICT and development critics are given more steam and for the situations where ICT could lead to changes for the better, the wait gets longer. Therefore we must wonder, how best can we learn from these previous attempts and begin to design projects that succeed.

In this paper, we propose that a flaw in the manner by which ICT projects are often conceived and designed seals the fate of many from the start. The paper will then look at the authors' current ICT implementation project, which is still on-going but has had notable successes over its short lifetime, to try and extrapolate a list of criteria for success, though far from comprehensive, can be used in the design other similar projects.

Design to Fail: The Top-Down Approach

In terms of divides, that which exists between a rural African village and California's silicon valley could scarcely be greater. ICT implementation projects often involve some form of interchange across this divide. For the most part this consists of taking a technology designed on one side and establishing it on the other. The advantages to this are obvious, chief among which is cost -- as any research and development expenditures are conveniently sidestepped. There is, however, one significant drawback: it is this approach to ICT promotion in developing countries that leads to failure after failure. While there are situations where a technology designed in the developed world may be equally suited to use in the developing one, these will be the exception rather than the norm.

Far more common a result of a project that focuses on how a technology can be molded to serve a role in a developing country is an inappropriate technology, that does not fully address the needs of its users to-be, and that these users do not have much enthusiasm for. Technology for the sake of technology serves little purpose, and it most certainly will not contribute the development of a country or region. These so called top-down approaches, a prime example being the Simputer Project in India result in tools, though at times novel, nonetheless lacking obvious uses. (Simputer was top-down in the sense that it was pioneered by technology enthusiasts, who imagined all sorts of uses for the technology but never consulted with those they imagined using it to find out what their needs and priorities were. Its only real use today is by a power company, to collect meter readings. It was novel in the sense that it was entirely conceived, designed and manufactured in India. However, this is part of problem it faced in meeting its target price: there simply was not the demand present to offset the development costs.)

Design to Succeed: The Bottom-Up Model

A more efficient method with higher success rates begins by identifying a situation where a technology-based system targeting an established need could yield tangible benefits to users. Once this has been established, restrictions on the proposed technology such as cost, available infrastructure and target user-base's exposure level to technology, need to be ascertained. Within such a framework, designs for information technology systems that are both appropriate and feasible can be explored. This process has to be inclusive and involve in a bi-directional dialog between users and technology design specialists. In addition to the benefits of painting the most comprehensive picture of the needs of users, and the environment the system will be operating in, this builds sense of cooperation and shared responsibility for the project. Projects conceptualized in this manner have the greatest chance of delivering real benefits to their targeted audience and thereby the highest potential to be readily taken up and used.

Designs that are derived from a real need, and involve the input of the intended users to take the focus away from merely the technology, and towards the system as a whole. A system-wide view starts with a situation where ICT can bring about benefits over existing systems and builds onto that the users, their environment and the information, as well as the interactions between them. Based on this background information, technology components that are appropriate can be designed and included into the system. Appropriate, therefore, being an all-important concept, yet one difficult to expand on in general terms by definition. To further explore what it means for a system to be appropriate requires us to get specific.

Education, ICT and Africa: Bottom's Up to EduVision

Throughout the developing world access to basic education is still far from universal. While commitments on the part of developing country governments and the donor community towards ensuring that every child receives at least primary level education are many (the most hyped of which are the Millennium Development Goals) comprehensive and feasible plans by which to do this are conspicuously absent. EduVision was borne of notion that perhaps ICT could be used to lower the cost of providing access to education throughout Africa, while substantially increasing its quality.

The first step towards this was a closer examination of education in Africa, so as to determine what role, if any, ICT could play. In discussions with government officials, NGOs active in education and schools themselves we established three broad categories of constraints to increasing access to education facing developing countries: (1) shortage of trained personnel, including teachers, or funds to train new ones, (2) infrastructure gaps, including lack of funds to build new

schools and (3) costs of educational materials such as textbooks. Of these, educational materials emerged as the area in which ICT could contribute the highest level of benefits if used. We identified three specific issues regarding educational materials that could be overcome using ICT. These are (1) distribution -- difficulties faced in getting materials to remote places at the right times, (2) cost -- the cost of the materials, whether borne by societies or individual families is prohibitively high and (3) quality -- the content is often out-of-date, poorly-written, seldom relevant to a student's immediate surroundings and with rare exception none of the content is translated into local languages. Based on this, we defined a role that ICT could play in education: as a replacement for sub-standard and expensive textbooks. We also knew that in order to be feasible, the ICT system would have to cost the same as, or preferably less than, the current textbook costs. In terms of the content provided via the system, we would either have to work with publishers, or publish our own content. But that, in either case, content would be available. Furthermore, it was around this time that Google announced its project with the universities of Oxford and Harvard to digitize their entire library collections, and offer access to all books whose copyright had expired. The potential to provide every school in Africa with access to most of information in these libraries made ICT all the more attractive.

For the most part, we had established a rough idea of what kind of system would be needed. Still missing, however, was a technology platform that could deliver content to students and teachers in schools anywhere in Africa at costs lower than textbooks. The first step towards a design for the platform involves dividing up the overall requirements into components. We ended up with three components: (1) a portable end-user terminal to access the content, which we have named an eSlate, (2) a content routing hub at each school that receives the content, stores and processes it, and then routes it to the end-user terminals called the BaseStation and (3) a command centre from where content is sent out to each school's routing hub called the Network Operations Centre (NOC). We called the platform as a whole the EduVision E-Learning System (EELS).

Then we began to evaluate hardware options for each of these individually, as well as a technology via which to create our network and connect all the routing hubs to the command centre. For the end-user terminal we selected handheld computers (also known as PDAs), based on wide-ranging criteria including durability, reliability and cost. For our content routing hubs, we decided to use an embedded system -- a bare-bones display-less computer, featuring networking support and that we could fit with a hard-disk that would store content. The system, however, became a real-possibility when we discovered a suitably cost-effective answer to our network's requirement of covering all of Africa: satellite radio.

Like the top-down approach our bottom-up one also led us to adopt technologies from developing countries, however, the difference is in our approach: sourcing technologies is only done after

designing the system, and is done with requirements and specifications of what we require in-hand. Moreover, we do not select these as ready-to-use technologies but has hardware platforms which will be heavily customized by our own software. EduVision now had a comprehensive design for its technology platform, all that remained was develop software to run it.

EduVision's Development Process: An Inclusive Model

EduVision was conceived with the requirement that its technology platform be equally at home in Africa's most remote villages as in Africa's largest cities. The former poses the greater challenge, both in terms of the physical environment and in terms of the end-users' exposure to technology. To ensure that our technology met this requirement from the outset we developed our system in one such village, and simultaneously tested it in a real classroom, making changes based on feedback from the students and teachers as well as our own observations.

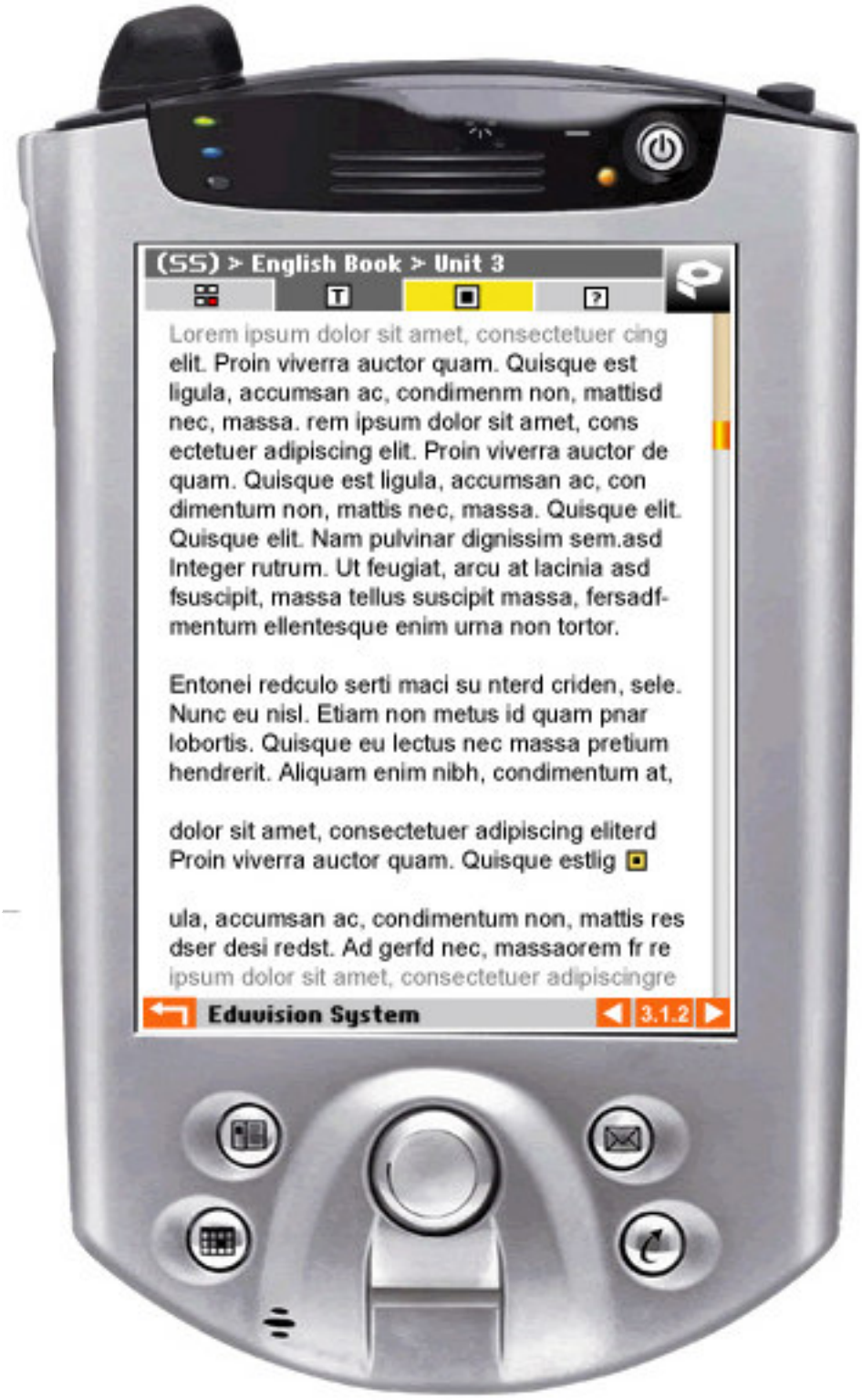
This is most applicable to our user interface. While the conceptual framework remained the same (the ability to scroll different types of cross-referencing data independently of each other), the adaptations made to the interface, based on user feedback, were critical to the success of the project. Basic graphical and text layout changes, the scroll-bar's history trail feature, the ability to change the text highlight colour, the text scrolling speed as well as the actions of hardware buttons, were largely defined by the users. A "final" application does not exist, and the eSlate reader is no exception. Software is never finished, technology and the needs of users are constantly evolving, and only if we measure all of these voices can we create powerful and user-friendly software.

The majority of the EduVision network runs in the background, invisible to the user. The students are unaware of all the wireless transmissions going on around them, seeing only the content displayed on their eSlates. As a result, it is equally important, if not more so, that the front-end of EELS follows the same bottom-up approach discussed above. No matter how efficient the back-end network is, if the users are confused and frustrated when accessing the content, the project fails. It is the user interface that ultimately determines with what ease users adopt new technologies and how they benefit from them. Keeping in mind the constraints of the hardware, the interface should focus on the needs of the students, teachers and the material they are receiving. Most of the students taking part in the pilot project have no electricity at home, and before the pilot, had never used a computer, let alone accessed the Internet. A simple user-friendly interface was essential to avoid the frustration and intimidation users might experience with the new technology.

The initial interface design issues included: optimizing the interface and content for the small screen size, integrating the graphics and the text based content in a fluid manner, finding an innate relationship between the hardware and software button functions, separating static textual and visual content from interactive content and that which required text input, and finally making sure the user does not get lost within the book and/or the application. Further challenges arose in designing the interface of the teacher's eSlate as it would ideally include extra features the students could do without. Essentially, we wanted to not only access technology and information, but also to be able to use the technology to gain a deeper understanding of the information.

Many e-readers are already on the market, and many of them run on PDA's. However, the existing e-readers usually only handle text and if they accept images they embed them within the text which becomes very inefficient on a small screen. In addition to textual and visual information, the eSlate reader has to handle questions requiring text input, as well as editing features such as note taking, bookmarks, and text highlighting. Furthermore, the application should allow for easy switching and cross-referencing between different types of educational content. While the interface should not be limiting to the user, features such as drop down menus, pop-up windows and the like would be too confusing to these novice users.

EduVision has come up with a powerful user-centered interface optimized for the eSlates' small screens (fig 2). The interface is divided into four main sections; a text section containing all the student's reading material, an image section containing visual data such as photographs, charts, video clips and animations, a question section containing exercises, problem-sets and questions requiring text input, and an overview section containing the currently displayed content file's table of contents and any bookmarks made by the user. In addition there is a toolbox containing user-specific features, such as text highlighting, increasing/decreasing text size, and adding booknotes.



Tabs separate the four sections, allowing easy switching between the different types of content. All the sections are cross-referenced and can be browsed independently of each other. If content in one section relates to content in another section, relevant tabs light up, giving the user the

choice between viewing the related content or to continue scrolling within the current section. One of the students Fred Odhiambo explains, “they [eSlates] allow me to find information better. If I remember a picture I can find the text that that goes with the picture, without having to flip through the whole book.” A dynamic scroll-bar containing a “history trail” lets the user know if the text or text associated with an image or question is new, or if it has already been viewed. The application makes use of many powerful options and features that are possible with digital media, while simultaneously maintaining a consistent structure ensuring that users don’t get lost while navigating.

EduVision Mbita Pilot 2005: From the drawing board to the chalk board

The Mbita Pilot Project’s primary objective was to test the feasibility of the EduVision E-Learning System, both in terms of the technology and the willingness and ability of users to adopt it. Class five, comprising of sixty students aged between eleven and twelve and three teachers took part in project. The school, Mbita Point Primary School, is a public school, in Western Kenya located on the shores of Lake Victoria. It has an enrollment of roughly 320 pupils who are taught by 9 teachers. The target student body comes from a poor rural background, the majority of whom have had little or no exposure to modern ICT tools. The village of Mbita was only recently connected to the national power grid, and in our experience, power cuts occur upwards of 30 per cent of the time.

During the first month of the pilot project, as the EELS technology was being finalized, members of the EduVision team trained teachers the operation of EELS and eSlates as well as the methodology for training students to use eSlates. Teachers then trained the students, with EduVision staff standing by to monitor and offer any necessary aid. Interestingly, it took the teachers longer than the students to learn the software, our team noting several instances where after training the students, the teachers would end up asking students to remind them how a certain feature func-

tioned. Following the initial training phase, we came up with an EELS Training Curriculum, created specifically for the classroom.

Once trained, the teachers and students began using the eSlates, which contained all the textbooks required by the curriculum, as well as a calculator, a dictionary, and other supplementary reading materials. As James Okoth, a class five pupil put it, “eSlates are like one textbook that carries all my textbooks and more”. At first the eSlates were used in conjunction with the textbooks, but as
teachers and students became more comfortable with them, the textbooks tended to remain on the shelf. James continues, “At first my parents were confused. They thought it [the eSlate] would affect my studying. But when they saw how I was using them, they wanted to use them”. Teachers were encouraged to use eSlates as much as possible, but ultimately the decision whether or not to use them and to what extent, was up to them. While the students enthusiastically embraced the new technology, the teachers were more skeptical. They had grown up up using textbooks, textbooks were used when they trained to become teachers, and up to this point, all class five students had used textbooks, and now they were expected to teach lessons using small handheld computers. In the hopes of quelling their fears, we allowed the teachers to take the eSlates home with them. Having the time and space to explore the technology lessened most of their initial fears. Encouragingly, all three teachers became avid fans of the technology and nearing the end of the project, eSlates were fully integrated into the class curriculum.

After Mbita: The Future of EduVision

The Mbita phase will end in September 2005, and with core technologies developed and potential proven, we will start work on the remaining two (of three) aspects, that when attained signify the transition from adolescent technology in need of continued development and proving to a mature platform ready to released to the world. It is of vital importance not to lose site of the crucial role of content in the development of the system. A system akin to EELS that distributes tailored, relevant and useful local content can have an enormous impact on the lives of people in the developing world. Google is digitizing the world’s greatest libraries, MIT has opened up its coursework, free educational web resources are multiplying on a daily basis, and all of this is making knowledge free and there for the taking. However, as Wendy Lazarus, founder of the Children's Partnership puts it, "There's been so much focus on the boxes and wires to connect to the Internet that we almost forgot to ask what people are getting once they connect. We found a strong desire among people for practical, local information that seems to fly in the face of the way the Internet is moving” (Lazarus 2000). Recognizing this, EduVision is in the process of developing a radically different approach to content, that hopefully will form the bulk of the content transmitted through EELS in the future. Our intent is to make trivial the task of users creating content themselves,

holding discussions on whatever topic they please, peer-rating systems to filter content among other similar technologies and methods by which we can spurn a new movement to create indigenous content material. We hope, in large part, to replicate the success of projects such as the Wikipedia to the remote Africa village. Eventually, our vision would be that educational material in use today, which can trace its roots back to the colonial era, will be replaced with completely homegrown knowledge and curriculums. We do not expect this vision to be attained any time in the near future, if at all, but we would still like to see a greater amount of African content available and accessible to people throughout Africa. Like our EELS hardware, the content model is built entirely on open technologies that are commonplace today, but connected and used in ways that serve African user-base requirements, and where within users will form a community that will own and manage the space, and the content shared in it, for the benefit of all.

The last piece of the puzzle needed to convince skeptics that we are not “a novel idea, ahead of our time” is to devise an implementation model for EduVision that is self-funding. EduVision believes that real development is not driven by donors, but by entrepreneurs, as it is they who remain in place when the donors pack up and go home. We believe that the only way for EduVision, and other projects like it, to have a lasting impact on the digital divide is for technology to pay for itself, which undoubtedly must be possible. Following the end of Mbita project, this will become the prime focus at EduVision.

Conclusion

In countries where classrooms commonly lack the most basic needs, such as a roof, much less electricity, where illiteracy is widespread, and where people struggle to provide their families with enough food, many may question diverting money to ICT tools. How can the illiterate, and the computer-illiterate, benefit from the network society? These are, without doubt, fundamental questions that societies must answer for themselves. However, if these tools are able to bring about higher-quality education at lower costs, thereby, among other things combating illiteracy, then perhaps they justify the diversion of money. In our opinion they do. Educating the youth of today is a sure-fire why to bringing more widespread development tomorrow. Education is the key out of cycle of poverty, by enabling communities to develop their own solutions to the problems they face day in and day out. And, in general, homegrown solutions to homegrown problems are much more effective, because they understand better than anyone the situation, the problem, and how much potential any solution has to succeed. They are the purest form of bottom-up approach that could exist.

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Author Biographies

Matthew Herren: Swiss and American, Matt grew up in Nigeria, Benin and Kenya. He is half of a father-son team that conceived of EduVision, and is responsible for the design of the EELS technology platform. He is currently leading EduVision on hiatus from pursuing a B.A. in legal studies at Hampshire College in Amherst, MA. His interests broadly stretch from constitutional jurisprudence, to public policy, to African development and, of course, to technology. During his second, and last, year with EduVision he hopes to see it transition into a private company before handing it off to someone more capable.

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Maciej Sudra: This Swiss/Polish Graphic Designer is currently working with the EduVision project in Western Kenya. He is in charge of designing and implementing the eSlate user interface, user testing the system and making changes accordingly.

Born in 1983 in Guadalajara, Mexico, Maciej spent most of his life in Nairobi, Kenya before attending studies in Boston, Massachusetts. He holds a BA in Graphic Design from the Massachusetts College of Art, specializing in New and Dynamic Media. Maciej also co-founded Ambient Interactive, an award winning Boston based design agency.

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