Open Educational Resources: Opportunities and Challenges

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Although learning resources are often considered as key intellectual property in a competitive higher education world, more and more institutions and individuals are sharing their digital learning resources over the Internet openly and for free, as Open Educational Resources. The OECD's OER project asks why this is happening, who is involved and what the most important implications are of this development. In the following paper some preliminary findings are presented.

The OECD/CERI study on OER

There are many critical issues surrounding access, quality and costs of information and knowledge over the Internet as well as on provision of content and learning material. As it becomes clearer that the growth of Internet offers real opportunities for improving access and transfer of knowledge and information from universities and colleges to a wide range of users, there is an urgent need to clarify these issues with special focus on Open Educational Resources (OER) initiatives. There is also a need to define the technical and legal frameworks as well as business models to sustain these initiatives. That is the background to the OECD/CERI study which aim to map the scale and scope of Open Educational Resources initiatives in terms of their purpose, content, and funding and to clarify and analyse four main questions: How to develop sustainable costs/benefits models for OER initiatives? What are the intellectual property right issues linked to OER initiatives? What are the incentives and barriers for universities and faculty staff to deliver their material to OER initiatives? How to improve access and usefulness for the users of OER initiatives? (http://www.oecd.org/edu/oer)

What is OER? – a conceptual discussion

OER is a relatively new phenomenon which may be seen as a part of a larger trend towards openness in higher education including more well-known and established movements such as Open Source Software (OSS) and Open Access (OA). But what is meant by "open" and what are the arguments for striving for openness?

The two most important aspects of openness have to do with free availability over the Internet and as few restrictions as possible on the use of the resource. There should be no technical barriers (undisclosed source code), no price barriers (subscriptions, licensing fees, pay-per-view fees) and as few legal permission barriers as possible (copyright and licensing restrictions) for the end-user. The end-user should be able not only to use or read the resource but also to adapt it, build upon it and thereby reuse it, given that the original creator is attributed for her work. In broad terms this is what is meant with "open" in all three movements. It is also what is more or less covered in the definition used by The Open Knowledge Foundation when they say that knowledge should be legally, socially and technologically open. (http://www.okfn.org)

The term Open Educational Resources first came to use in 2002 at a conference hosted by UNESCO. Participants at that forum defined OER as: "The open provision of educational resources, enabled by information and communication technologies, for consultation, use and adaptation by a community of users for non-commercial purposes."

The currently most used definition of OER is: "Open Educational Resources are digitised materials offered freely and openly for educators, students and self-learners to use and re-use for teaching, learning and research." To further clarify this, OER is said to include:

- Learning Content: Full courses, courseware, content modules, learning objects, collections and journals.
- Tools: Software to support the development, use, re-use and delivery of learning content including searching and organization of content, content and learning management systems, content development tools, and on-line learning communities.
- Implementation Resources: Intellectual property licenses to promote open publishing of materials, design principles of best practice, and localization of content.

Although the most used, this definition needs further refinement. To start with it is not obvious what is meant by "open". Walker defines "open" as "convenient, effective, affordable, and sustainable and available to every learner and teacher worldwide" and Sir John Daniel speaks of "the 4 As: accessible, appropriate, accredited, affordable" (Downes, 2006). Downes argues that "the concept of 'open' entails, it seems, at a minimum, no cost to the consumer or user of the resource" and goes on:

> It is not clear that resources which require some sort of payment by the user – whether that payment be subscription fees, contribution in kind, or even something simple, such as user registration, ought to be called 'open'. Even when the cost is low – or 'affordable' – the payment represents some sort of opportunity cost on the part of the user, an exchange rather than sharing. (Downes, 2006)

He also argues that there is no consensus the term "open" should mean "without restrictions" as is apparent from the Creative Commons license, where authors may stipulate that use requires attribution, that it be non-commercial, or that the product be shared under the same license. So while "open" may on the one hand may mean "without cost", it does not follow that it also means "without conditions".

Furthermore the term "educational" is not unambiguous. Does it mean that only materials produced with the intention of being used within formal educational settings should be included? If so it would exclude resources produced outside schools or universities but used in formal courses, and materials produced inside such institutions but used for informal or non-formal learning outside. One alternative is to say that only materials actually used for teaching and learning should be considered. (OLCOS, 2006) The advantage with this option is that it avoids making an a priori stipulation that something is, or is not, an educational resource. The disadvantage would be the difficulty to know whether a resource is actually used for learning or not, be it formal or non-formal learning settings.

Finally it is also open to debate what the term "resources" should mean. It is possible to distinguish between the type and the media of the resource. Resource types might be courses, animations, simulations, games etc. and resource media might be web pages on the Internet, radio, television or paper. In this paper only digital resources will be considered although this limitation is not obvious in the general discussion on OER.

The ambiguous situation regarding the conceptual issues is probably due to the fact that OER as a concept is still in its infancy. Earlier on the OA and OSS movements have had the same kind of – often heated – discussions regarding conceptual issues. The conceptual discussion is an important part of the OECD/CERI study and by the end of the project we hope to be able to present a more clear-cut definition.

Mapping OER – who is the user and the producer?

It is still early days for the OER movement and at the moment it is not possible to give an accurate estimation of the number of on-going OER initiatives. All that can be said so far is that the number of projects and initiatives is growing fast. Side-by-side with a number of large institution-based or institution supported initiatives; there are numerous small scale activities. Building on Wiley (2006) the following brief overview can be given over the OER movement in post-secondary education:

- Over 150 universities in China participate in the China Open Resources for Education initiative, with over 450 courses online.
- 11 top universities in France have formed the ParisTech OCW project, which currently offers 150 courses.

- 9 of the most prestigious universities in Japan are engaged in the Japanese OCW Alliance that offers over 250 courses in Japanese and an additional 100 in English.
- 7 universities in the United States have large scale OER programmes (MIT, Rice, Johns Hopkins, Tufts, Carnegie Mellon, and Utah State University).
- Altogether there are over 2 000 freely available university courses currently online. And more OER projects are emerging at universities in Australia, Brazil, Canada, Hungary, India, Iran, Ireland, the Netherlands, Portugal, Russia, South Africa, Spain, Thailand, the UK, the US, and Vietnam.

There are also several translation efforts underway to broaden the impact of OER initiatives. These include Universia's Spanish and Portuguese translations and China Open Resource for Education's simplified Chinese translations and the traditional Chinese translations by OOPS. Universities in South Korea and Thailand are also considering launching additional translation projects.

The number of non-course OER available increases rapidly as well. Rice's Connexions project currently hosts over 2 800 open learning objects available for mixing and matching into study units or full courses. MERLOT offers almost 15 000 resources, European based ARIADNE offers links and federated searches in several networks and repositories. Textbook Revolution contains links to hundreds of freely available, copyright-clean textbooks. Freely accessible encyclopaedias like Wikipedia and Math World grow in size and quality. UNESCO/IIEP hosts a Wiki called "OER useful resources" listing several other portals, gateways and repositories. Even more difficult than to list the number initiatives would be to estimate the quantity of available resources, even with a narrow definition of OER. On top of resources accessible through initiatives like the ones listed above, it can be estimated to be far more resources available by way of search engines like Google or Yahoo!.

What can be offered is a draft of a typology of different repositories. As already mentioned, there are both large scale operations and small scale activities. It is also possible to distinguish between different providers – institution based programmes and more community based bottom-up initiated activities, which will be more discussed later in this paper. In both cases there are all kind of in-between-models forming a continuum which can be used to forms a diagram.

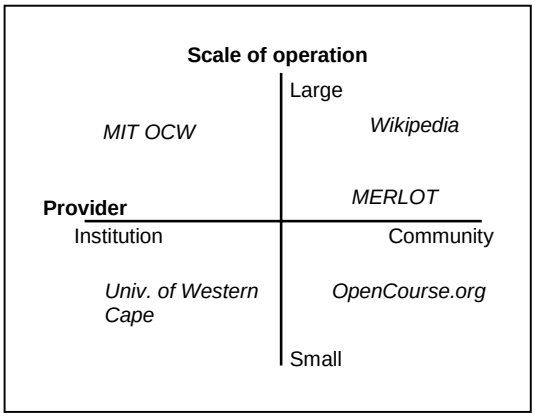

Diagram 1: Categories of OER providers

In the upper left corner of the diagram, large scale and institution based or supported initiatives would be found. A good example is the MIT OCW programme. It is large scale in the number of resources provided and regarding the number of people involved. It is totally institution based in the sense that all materials originate from MIT staff. Other initiatives like Connexions, run by Rice University, uses a mix of resources both from their own staff and from external people contributing materials. In the upper right corner, large scale operations without a base within an institution should be placed. The best example is probably Wikipedia – one of the Internet's real success stories and a good example of a large scale and

community based operation. Another example, although not as big as Wikipedia, is MERLOT. In the bottom left corner of the diagram, an example of a small scale but institution based initiative is listed. University of Western Cape, South Africa announced in October 2005 that they would launch a "free content and free open courseware strategy". Finally, in the bottom right corner there is one example of a small scale community based initiative. The OpenCourse is a "collaboration of teachers, researchers and students with the common purpose of developing open, reusable learning assets (e.g. animations, simulations, models, case studies, etc.)".

A third dimension to consider is whether the repository provides resources in a single discipline or if it is multidisciplinary. There are examples of single disciplinary programmes, like Stanford Encyclopedia of Philosophy and Planet Math, but the multidisciplinary approach seems to be more common at the moment.

Users and producers of OER

So far we do not know much about who is actually using and producing all the available OERs. Of course institutions based initiatives like the OCW programmes at different universities use their own staff to produce their material and some of them, like MIT try to continuously evaluate who their users are. But as a whole very little is known about whom the users and the producers are. To accommodate this deficiency the OECD project launched two web based surveys during spring 2006, one targeting institutions and one aimed at individual teachers and researchers. The first received only a very small number of answers although over 1 800 e-mails were sent to universities in the 30 OECD member countries. The e-mails were sent to the rector/vice chancellor's office and the poor result may be a sign that OER is still mostly a bottom-up phenomenon, where the managerial level of the institutions are not involved and not aware of the activities going on.

The survey for individuals was answered by 193 people from 49 different countries covering all parts of the world. The geographical spread is interesting although there is a clear bias towards teachers from English speaking countries, which may be due to the fact that the questionnaire was only available in English. The small number of replies also in this case calls for great caution in the interpretation of results. The majority of the respondents worked at institutions with 10 000 students or less and about one third worked at institutions with 11 000 – 50 000 students. More than half of the respondents worked in the area of education, and two out of three represent publicly funded institutions. A majority of the respondents said they were deeply involved in OER activities, mostly as users of open content and only slightly less as producers. About half of them said they experienced good support from the management in their use of open content, somewhat less support for producing content and using OSS. About one out of four felt good support from the management level in his/her production of OSS. The majority of the respondents said they were engaged in some sort of co-operation regarding production and exchange of resources, be it on regional, national or international level.

Other findings in this field results from individual programmes. According to Carson (2005) the traffic to the MIT OCW site is increasingly global but with a predominance of North American visitors. In the period from November 2003 to October 2004 36% of MIT OCW visitors came from North America; 16% each came from East Asia and Western Europe; 11% each from Latin America and Eastern Europe; and the remaining 9% from the Middle East, Africa, the Pacific, Central Asia and the Caribbean combined. Self learners, typically with a bachelor's or master's degree, seems to make up the bulk of traffic to MIT OCW (48%), followed by students (31%), and educators (15%). Tufts OCW reports that in their user survey half of the respondents identified themselves as self-learners, while 43% were faculty members or students at educational institutions. Over half have masters' degrees or higher. (Tufts 2006)

About two thirds of the respondents to the OECD questionnaire said they were involved in the production of open content, either to a large or a small extent. When asked to value nine possible barriers for involving other colleagues, the most significant barriers were said to be lack of time followed by the lack of a reward system to encourage staff members to devote time and energy to producing open content, and lack of skills. The lack of a business model for open content initiatives was also perceived as an

important factor with negative impact. The least significant barriers were said to be lack of access to computers and other kinds of hardware, and lack of software.

To sum up the typical OER user seem at the moment to be a single enthusiast – either a well educated self-learners, likely to live in North America, or a faculty members both using and producing learning resources with some support from the institution management and often involved in exchange of resources with other institutions.

WHY are individuals and institutions engaged in OER?

The first and most fundamental question anyone arguing for free and open sharing of software or content has to answer is – why? Why should anyone give away anything for free? What are the possible gains in doing that? Advocates of the OSS, OA and OER movements of course have arguments in favour of their specific cause. But there are also general arguments that apply to all three. These can be divided into pull arguments which lists the gains that can be reached by open sharing of software, scientific articles and educational materials, and push arguments that registers threats or negative effects that might appear if software developers, scientists and educationalists do not share their work openly.

Starting with the push side, it is sometimes argued that, if universities do not support the open sharing of research results and educational materials, traditional academic values will be increasingly marginalised by market forces. The risk of a software monopoly if everyone is using Microsoft programmes or a combination of a combined hardware and software monopoly by too many using Apple's iPod music players listening to iTunes, is often used to support the OSS movement. The same is true regarding the risk of monopoly ownership and control of scientific literature from opponents of the large scientific publishing houses. The possibility for researchers to keep a seat at the table in decisions about the disposition of research results in the future is sometimes said to be at risk. Increased costs and vulnerability, increased social inequality and slower technical and scientific development are other concerns.

On the other side, a number of possible positive effects from open sharing are put forward, such as that free sharing means broader and faster dissemination and thereby more people are involved in problem-solving which in turn means rapid quality improvement and faster technical and scientific development; decentralised development increases quality, stability and security; free sharing of software, scientific results and educational resources reinforces societal development and diminishes social inequality. From a more individual standpoint, open sharing is claimed to increase publicity, reputation and the pleasure of sharing with peers.

Arguments for institutional involvement in OER

From an institutional point of view there seems to be five main arguments to be engaged in OER projects. One is the altruistic argument that *sharing knowledge is a good thing to do and also in line with academic traditions*, as pointed out by the OA movement. Openness is the breath of life for education and research. Resources created by educators and researchers should subsequently be open for anyone to use and reuse. Ultimately this argument is supported by the United Nations Human Rights Declaration which states that "Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages." (Article 26)

A second argument is also close to what the OA movement claims – namely that *educational institutions should leverage on taxpayers' money by allowing free sharing and reuse of resources* developed by publicly funded institutions. To lock in learning resources behind passwords, means that people in other publicly funded institutions sometimes duplicate work and reinvent things instead of standing on the shoulders of their peers. It might be seen as a drawback for this argument that it does not distinguish between taxpayers in different countries – learning resources created in one country may be used in another country sparing taxpayers in the second country some money. But, as pointed out by Ng (2006), free-riding of this kind may not pose so much of a problem since the use of a learning resource in a foreign country does not hinder the use of the same resource by domestic teachers. Instead, he says "allowing free-riding may be necessary for the growth of a good community as they help draw new

members by words of mouth. Also, free-riders themselves may learn to value the community more over time, so much that some of them may share eventually."

A third argument is taken from the OSS movement: "What you give, you receive back improved". *By sharing and reusing, the costs for content development can be cut, thereby making better use of available resources.* Also the quality would improve compared to a situation where everyone starts from the beginning.

A fourth argument for institutions to be engaged in OER projects is that *it is good for public relations and can function as a show-window attracting new students*. Institutions like MIT receive a lot of positive attention for their decision to make their resources available for free. Other institutions could do the same.

A fifth argument is that many institutions feel a growing competition as a consequence of the increasing globalisation of higher education and a rising supply of free educational resources on the Internet. In this situation there is *a need to look for new business models, new ways of making revenue*, such as offering content for free both as advertisements and as a way of lowering the threshold for new students that still would need to pay for tutoring and accreditation.

To what extent the above incentives are the driving forces behind the initiatives taken by individual institutions is hard to say. It is also true that a combination of several of the motives listed here could be in play simultaneously, both altruistic motives and economic driven incentives.

Motives for individuals
The incentives for individual researchers, teachers and instructors to share learning resources are so far less mapped and well known compared to motives for OA publishing or participating in OSS projects. The motives to be engaged in OER are probably similarly complex. Findings from the OECD questionnaire to teachers and researchers involved in OER activities suggest that, when presented with a list of proposed goals or benefits with using OER in their own teaching, the most commonly reported motive was to gain access to the best possible resources and to have more flexible materials. More altruistic ambitions, such as assisting developing countries, outreach to disadvantage communities or bringing down costs for students seems somewhat less important. At the same time the least important factor was to personally be financially rewarded.

When asked about the most significant barriers among colleagues not using OER in their teaching, the respondents pointed out lack of time and skills together with the absences of a reward system. A perceived lack of interest for pedagogical innovation among colleagues is also mentioned. The barriers described correspond with lessons learned from an Australian evaluation of an institutional learning environment which included a learning resource catalogue (Koppi, 2003). The authors conclude that "[t]he issue of reward for publicising teaching and learning materials is of paramount importance to the success of a sustainable learning resource catalogue where the teaching staff themselves take ownership of the system". To establish a credible academic reward system that includes the production and use of OER might be the single most important policy issue for a large scale deployment of OER in teaching and learning.

Challenges to the Growing OER Movement

Although the idea of OER is thriving at the moment, it is important also to look at some challenges that might stifle the further growth of the movement. In this paper three challenges will be touched upon: the lack of awareness among academics regarding copyright issues; how to assure quality in open content; and how to sustain OER initiatives in the longer run.

Lack of awareness of copyright issues
While publication, consumption and distribution of texts were mediated through physical media, academics remained for the most part unaware of the licensing that underpinned the exploitation of copyright. Internet and other digital media have changed this. (McCracken, 2006) By having access to publishing and production tools, and by licensing access to a digital, ephemeral product rather than a physical object such as a book or print, researchers as well as teachers now interrelate with licensing as

never before. And for the most part they seem either unprepared or unwilling to engage with cumbersome licensing procedures.

Although many academics are willing to share their work, they are often hesitant as how to do this without losing all their rights. Although some people release work under the public domain, it is not unusual that authors would like to retain some rights over their work. The RoMEO project in UK made a survey in 2002-2003 among 542 researchers about what kind of rights they wanted to retain. (Gadd, 2003) A majority (over 60%), were happy for third parties to display, print, save, excerpt from and give away their papers, but wanted this to be on the condition that they were attributed as the authors and that all copies were done so verbatim. 55% wanted to limit the usage of their works to educational and non-commercial use. The RoMEO report concluded that the protection offered to research papers by copyright law is in excess of what is required by most academics.

Several open content licenses have been developed, like the Creative Commons and the GNU Free Documentation Licence, to accommodate this problem. Open licensing provides a way of controlled sharing with some rights reserved to the author. They have the benefit of introducing certainty and clarity into the process of obtaining permission to use the work of others. They also reduce the administrative burden of having to clear rights before use. This is particularly useful in the educational context where users have little or no inside knowledge of the mechanisms used by the media industries. Finally, open licenses establish a body of works licensed as “open content” that may be freely shared. However, it must also be recognised that they have some disadvantages. Rights holders must be prepared to grant and to live with exercising only a “broad-sweep” control over their works, replacing the case by case control with which they are familiar. Moral rights are waived under licences offering the right to make derivative works and different and often blurred and overlapping boundaries emerge between not-for-profit, educational and commercial exploitation or distribution. Despite some shortcomings, there seems to be a growing interest for open licenses, as shown by the increasing number of objects released under the Creative Commons license.

The RoMEO project also showed that 41% of authors “freely” assign copyright to publishers without fully understanding the consequences. Preliminary findings from the OECD survey on OER shows a low awareness regarding the importance of using open licenses among teachers and researchers producing learning resources, and few initiatives from institutions to accommodate this deficiency. Given that the scholars in the RoMEO survey and those responding the OECD questionnaire are more or less representative of academics from other countries, the conclusions seems to strengthen the assumption that raising the awareness on copyright and licenses is an important challenge for both the OER and OA movements. Maybe even easier ways of retaining only those rights that the individual author wants to retain are needed, together with active advice and support from higher educational institutions. A recent comparison of seven Australian universities underpins previous international research showing that relying solely on voluntary deposits by academics of research articles to OA archives will result in approximately 15% contribution. (Sale, 2006) Requirements to deposit research output in an open archive coupled with effective author support policy, results in much higher deposit rates.

Quality assurance

The overview of the current state of OER showed that a growing number of initiatives and digital resources are available. Teachers, students and self-learners looking for resources should not have difficulties finding resources, but still might have problems of judging their quality and relevance. The issue of the quality of resources is fundamental and can not be dealt with at depth in this paper. Instead a few different approaches to the issue of quality management will be listed.

Some institution-based providers use the brand or reputation of the institution to persuade the user that the materials on the website are of good quality. If not, the prestige of the institution is at risk. Most probably they use internal quality checks before the release of the courses, but these processes are not open in the sense that the user of the resource can follow them.

Another approach is to have the resources reviewed by peers. As described in the section on OA, the peer review process is one of the most used quality assurance processes in academia. As well as being a

well known and well understood routine, there are other arguments for using peer review schemes to guarantee the quality of resources in a repository. Taylor (2002) argues the process can be used to come to terms with the lack of a reward system by giving recognition and reward to the creator of a learning resource, as well as a dissemination method. Furthermore, there is a need for making the review decisions credible, and for that purpose an open peer review according to agreed criteria is well suited, Taylor claims.

A third quality management approach is not to have a centrally designed process, but rather let individual users decide on whatever ground they like whether a learning resource is of high quality, useful, or good in any other respect. This can be done by letting users rate or comment on the resource or describe how they have used it, or by showing the number of downloads for each resource on the website. This is a kind of low level or bottom-up approach often used on Internet based market places, music sites, etc. The argument for such an approach would be that quality is not an inherent part of a learning resource, but rather a contextual phenomenon. It is only in the specific learning situation that it can be decided whether a resource is useful or not, and therefore it is the user who should be the judge.

To sum up there are several alternative ways of approaching the quality management issues. As shown in Diagram 2, it can be done by a centrally designed process or in a decentralised manner, one might use open processes or more closed ones. Arguments can be made for all these approaches (maybe with the exception of the word-of-mouth method), much depending on which kind of OER initiative or programme one is considering. All sorts of combinations could also be used.

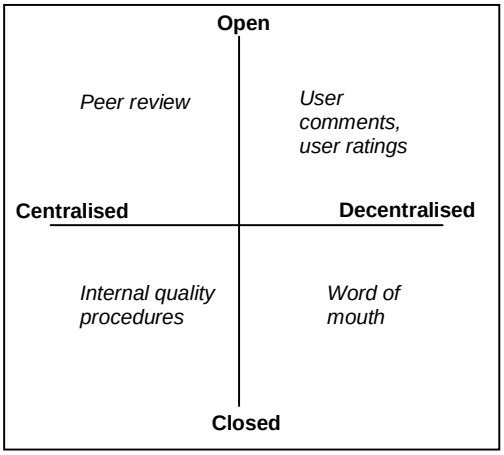

Diagram 2: Quality management processes for OER initiatives

Sustainability of OER initiatives

The fact that so many OER initiatives have started during the last years has created competition for funding. Although some projects have a strong institutional backing it is most probably start up funding that will cease after a few years. Therefore it is important to seriously consider how the initiatives can be sustained in the long run. There are many different kinds of OER providers and no single sustainability model will fit all. Instead there is a need to discover different approaches that might be useful in a local context. Two different approaches will be discussed here that might be looked upon as ideal types at each end of a continuum, where a lot of models could be invented in between. These two are the institutional model and the community model.

The growing competition among institution based OER initiatives calls for the development of a strong brand, user communities, increased site usability and improved quality of the resources offered. Community “marketing” is important for the institutional OER initiatives for several reasons:

- It enables users to form strong connections with the website;
- The institution can learn from the community about what works and what does not work on the website;

- It gives possibilities for rapid diffusion;
- Strong communities influence user behaviours – users come back to the repository.

Institutions launching OER programmes might also need to look into different revenue models for the long term stability and viability of their initiative. To this end some alternative models identified by Dholakia (2006) might be considered, such as:

- The *Replacement model*, where OER replaces other use and can benefit from the cost savings which is a result of the replacement. It was noted though that this model has a natural limit since it can only generate the same amount of resources as it replaces.
- The *Foundation, Donation* or *Endowment model*, where the funding for the operations are provided by an external actor such as foundations. This model was primarily seen as a start up model that will most probably not be viable in the long run. It might be transferred into a *Government support model*, which could be a long-term option in some (mostly European?) countries but not others.
- The *Segmentation model*, where the provider, simultaneously with resources for free, also provides "value-added" services to user segments and charges them for these services – such as sales of paper copies, training and user support, ask-an-expert services etc. This model, together with the conversion model, is among the most used in the education sector.
- The *Conversion model*, where "you give something away for free and then convert the consumer to a paying customer".
- The *Voluntary support model*, which is based on fund-raising campaigns. Another version of this model is the *Membership model* where a coalition of interested parties – organisations or individuals – is invited to contribute a certain sum as seed money or on an annual basis.
- The *Contributor-Pay model* where the contributors pay the cost of maintaining the contribution, which the provider makes available for free. This model is used to give OA to scientific publications and might work also for OER.

The alternative approach to building an OER programme with a strong institutional backing is the community model. This is more of a grass roots activity where individuals contribute with their time, knowledge and resources on a voluntary basis. In this model, production, use and distribution is decentralised, compared to the institutional model where at least production and distribution are centralised. From a community perspective, one might take an alternative view on the over-all concept of sustainability. From this standpoint, it is not enough to look at the advantages and disadvantages of different revenue or funding models – one should look not only at who pays for the resources but also who creates them, how they are distributed and how one can work with them. Some of the aspects to consider are:

- Technical considerations such as discoverability of the resources;
- The kind of openness and constraints on access and use that is given users;
- Different content models (the possibility to localise content) and issues of licensing;
- Different staffing models and incentives for people to contribute resources;
- Alternative workflows to the traditional design—use—evaluation model, to models without a clear distinction between production and use or between the user and the producer. The concept of co-production is important here.
- Maintenance and updating of resources.

Since the community model builds on voluntary work and enthusiasts, sustainability is not so much a matter of financial resources as of dismantling barriers that hinders the community to flourish and grow. Tentative actions could be to find alternatives to the existing IPR regime and changing the mind set of donators not only to include funding to institutional OER initiatives but also to loosely composed communities.

Concluding remarks

Although there are a growing number of OER initiatives a the moment, a lot of fundamental questions still remains to be answered such as who is involved, in what way are they involved and why? A wide variety of reasons seem to be at play for both institutions and individuals: some are altruistic and idealistic, others

are economic. The phenomenon – that individuals and institutions give away learning resources for free – which at first seems counter intuitive and difficult to explain within the old economic and educational context, might be better understood as a part of a new culture and an emerging economic reality with partly different characteristics. The apparently contradictory trends that were mentioned in the introduction to this paper – on the one hand a growing competition among universities and on the other that some do not protect their intellectual capital, but share it for free – might not be so contradictory after all. For some universities free sharing of learning resources might be a strategy to create a competitive advantage by using unorthodox methods. One can predict a growing debate within the OER movement concerning the role of commercial actors using open resources as part of their business model, as we have seen in the OSS and OA movements.

During the coming months the OECD study will concentrate on the issues of pedagogical, financial and other motivations, benefits and barriers for institutions to use and produce OER; usability issues together with management concerns around quality and validation; and finally policy implications on regional and national level of the OER movement. The final report will be published in early 2007.

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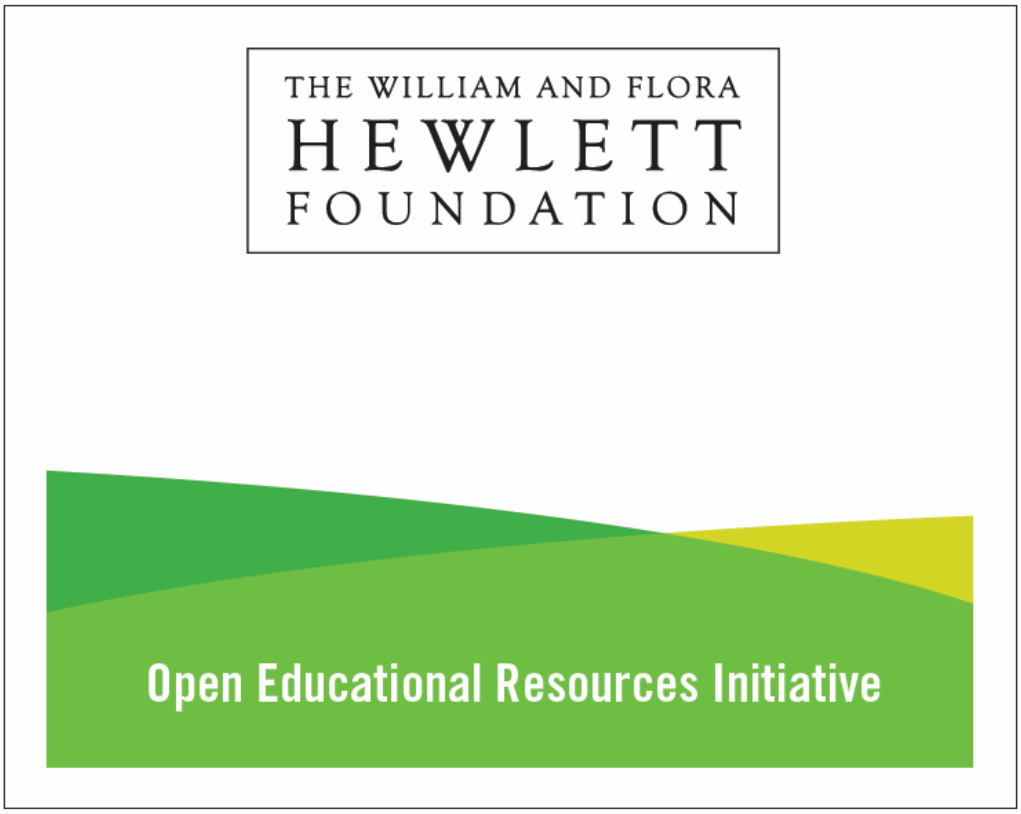
THE WILLIAM AND FLORA
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Open Educational Resources Initiative

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In a refugee settlement in northern Uganda, a humanitarian health worker hovers over her laptop, reviewing free, open coursework on international nutrition.

A physics instructor in a remote part of Guatemala is now able to supplement her lesson on particle wavelengths using an open online simulation and course materials translated into Spanish from MIT.

In a small town in rural Kentucky, a high school senior is taking an online Advanced Placement physics course not offered at her high school so she can prepare for the AP test on her own.

Innovate

For the past four years, the William and Flora Hewlett Foundation has been the leading grant-maker in the field of "open educational resources" — high-quality digitized educational materials offered freely and openly for anyone with access to the Internet. These materials are available for use as is, or for re-use as appropriate. Hewlett's commitment to advancing this exciting field is grounded in the belief that knowledge and education are common goods — and that limited resources and geography should not be barriers to an individual's passion to learn.

Invest

Since 2001, the Hewlett Foundation has made grants in excess of $40 million to support institutions and organizations that develop and provide online access to open educational content. For example, the Foundation is funding:

- MIT OpenCourseWare – to publish course materials from virtually all MIT courses
- Carnegie Mellon University's Open Learning Initiative – a portfolio of highly interactive multi-media courses
- African Virtual University – to provide free digital and printable materials to train teachers in Sub-Saharan Africa
- Creative Commons – to offer innovative copyright solutions that allow for more "open access" of creative work and scholarly materials online
- Widernet eGranary – to improve digital access in developing countries

Open Educational Resources Initiative: What's Our Goal?

The Foundation has funded over 50 OER initiatives with the goal of leveraging information technology to equalize educational opportunities across the world.

1. Sponsor High-Quality Open Academic Content

The Open Educational Resources movement began in 2001 when the Hewlett and the Andrew W. Mellon foundations jointly funded MIT OpenCourseWare (OCW), the first institution committed to making all of its course materials freely available.

Since then, more than 60 additional institutions have launched OpenCourseWare Web sites. In total, materials for more than 2,000 courses are now published openly, drawing almost a million visits per month. Hewlett also supports many other types of open education content including full courses, modules and library collections.

2. Break Down Barriers to Open Educational Content

Make it possible: Hewlett supports efforts to secure intellectual property rights for open content as well as open source learning management systems, content authoring tools, supportive learning environments and resource sharing.

Make it accessible: To make it easier for people to find Open Educational Resources online, the Foundation has funded the development of two searchable portals. Development Gateway is an online destination for people worldwide working on international development. The OER Exchange Portal, expected to launch in 2006, will provide users with tools that will help them search and evaluate the quality of existing open educational content. Both portals will regularly scour the Web to harvest high-quality OER and organize them in a central location.

3. Encourage People Worldwide to Use Open Educational Resources

Increase regional distribution: To broaden opportunities for people in developing nations who might make use of OER, Hewlett is forging partnerships with extensive networks and institutional partners in China, Africa and other targeted regions around the globe.

Strengthen partnerships: The Hewlett Foundation is developing relationships with the World Bank and other institutions, including UNESCO and the Commonwealth of Learning, to expand the opportunities for all people to use Open Education Resources. Hewlett is also exploring private sectors partnerships with Sun Microsystems, IBM and Google.

About the William and Flora Hewlett Foundation
The William and Flora Hewlett Foundation (www.hewlett.org) has been making grants since 1966 to help solve social and environmental problems at home and around the world. The Foundation concentrates its resources on activities in education, environment, global development, performing arts, philanthropy, population, and makes grants to support disadvantaged communities in the San Francisco Bay Area. A full list of all the Hewlett Foundation's grants can be found at www.hewlett.org/grants.

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Open Educational Resources - Sample Initiatives

Open Educational Resources – Sample Initiatives

First adopted at a meeting sponsored by the William and Flora Hewlett Foundation at UNESCO in 2002, the term "Open Educational Resources" refers to digitized materials offered freely and openly for educators, students and self-learners to use and re-use for teaching, learning and research. Open Educational Resources (OER) include:

- Learning Content: Full courses, courseware, content modules, learning objects, collections and journals.
- Tools: Software to support the development, use, re-use and delivery of learning content including searching and organization of content, content and learning management systems, content development tools, and online learning communities.
- Implementation Resources: Intellectual property licenses to promote open publishing of materials, design principles of best practice, and localization of content.

Below is a selection of Open Educational Resources offered freely on the Web for use by anyone, anywhere.

OPENCOURSEWARE (OCW) AND TRANSLATIONS

OCW sites present university course content on the Web, free for use and re-use. The content includes course descriptions and purpose, syllabi, problem exercises, calendars, tests, lecture notes and occasionally video lectures, simulations, and other materials.

Massachusetts Institute of Technology (MIT) OpenCourseWare*
Provides free, searchable access to MIT's course materials for educators, students, and self-learners around the world.
http://ocw.mit.edu/index.html

China Quality OpenCourseWare
Promotes closer interaction and open sharing of educational resources between Chinese and international universities.
http://www.core.org.cn/cn/jpkc/index_en.html

Foothill-De Anza Community College District, Sharing Of Free Intellectual Assets (Sofia)*
Publishes community college-level course content and makes it freely accessible on the Web to support teaching and learning.
http://sofia.fhda.edu/

Japan OpenCourseWare Alliance
Provides a wide range of free and open educational resources via the Internet to any individual interested in higher education.
http://www.jocw.jp/

Johns Hopkins Bloomberg School of Public Health (JHSPH) OpenCourseWare*
Provides free, searchable, access to JHSPH's course materials for educators, students, and self-learners around the world.
http://ocw.jhsph.edu/

Tufts University OpenCourseWare*
Supports and advances education by making high-quality content freely available on the Web for learners and faculty across the nation and the world.
http://ocw.tufts.edu/

Utah State University OpenCourseWare*
A free and open educational resource for faculty, students, and self-learners throughout Utah and around the world.
http://ocw.usu.edu/Index/ECIndex_view

Translations:

Chinese Open Resources for Education*
Translations from English to Chinese and Chinese to English.
http://www.core.org.cn/

Opensource OpenCourseWare Prototype System
Translates MIT OCW into traditional Chinese.
http://www.twocw.net
Translates MIT OCW into simplified Chinese.
http://www.cocw.net

Universia
English to Spanish and English to Portuguese translations.
http://www.universia.net/

OPENCOURSEWARE SETUP TOOLS

MIT OpenCourseWare How-To Site*
Helps institutions interested in creating their own OpenCourseWare initiatives get started. Also offers implementation tools, including resources and materials from MIT's experience.
http://ocw.mit.edu/OcwWeb/HowTo/index.htm

*** Project or initiative funded by the William and Flora Hewlett Foundation (updated as of November 1, 2005).**

eduCommons*
A project of the Center for Open and Sustainable Learning. Its open source software allows institutions to easily publish OCW content via a ready-made platform designed for efficient production of course materials.
http://cosl.usu.edu/projects/educommons

COURSES & LEARNING OBJECTS

Carnegie Mellon University, Open Learning Initiative (OLI)*
A collection of "cognitively informed," openly available and free online courses and course materials that enact instruction for an entire course in an online format.
http://www.cmu.edu/oli/

Monterey Institute for Technology, Online Advanced Placement (AP) courses*
Allows high school students to learn AP course content even if their school doesn't offer AP classes.
http://www.archive.org/details/ap_courses

Rice University, Connexions*
A space for collaboratively developing, freely sharing, and rapidly publishing scholarly content on the Web to provide educational materials for everyone — from children to college students to professionals.
http://cnx.rice.edu/

DISCIPLINE-SPECIFIC COLLECTIONS

- **History:**

Library of Congress, American Memory
http://lcweb2.loc.gov/amhome.html

Digital History: American History
http://www.digitalhistory.uh.edu

Harvard University Library Open Collections Program*
http://ocp.hul.harvard.edu/

History Matters*
http://www.historymatters.gmu.edu

Internet Modern History Sourcebook
http://www.fordham.edu/halsall/mod/modsbook.html

University of California, American West Collection*
http://www.cdlib.org/inside/projects/amwest/

World History Sources
http://chnm.gmu.edu/whm/whmfinding.php

- **Health:**

Johns Hopkins Center for Public Health Preparedness
http://www.jhsph.edu/preparedness/index.html

- **Math:**

Drexel University, Math Forum
http://mathforum.org/

Eisenhower National Clearinghouse
http://web.archive.org/web/20041013043116/www.enc.org/?ls=bc

- **Philosophy:**

Stanford University, Encyclopedia of Philosophy*
http://plato.stanford.edu

- **Science:**

Access Excellence
http://www.accessexcellence.org/AE/

Carnegie Mellon University, Chemistry Collective
http://www.chemcollective.org/

University of Washington, High School Human Genome Program
http://hshgp.genome.washington.edu/

National Human Genome Research Institute
http://www.genome.gov/Education/

National Science Digital Library
http://www.nsdl.org

University of Colorado, Physics Education Technology *
http://www.colorado.edu/physics/phet/

National Science Teachers Association, Science Teachers' Grab Bag
http://www.nsta.org/resourcesgrabbag

ARCHIVES & ENCYCLOPEDIA

Internet Archive*
An 'Internet library,' that offers permanent access for researchers, historians, and scholars to historical collections that exist in digital format.
http://www.archive.org/

Wikipedia
Free online encyclopedia to which anyone can make edits or additions.
http://www.wikipedia.org/

*** Project or initiative funded by the William and Flora Hewlett Foundation (updated as of November 1, 2005).**

COUNTRY OR REGION-SPECIFIC INITIATIVES

This is a short list of other institutions and projects around the world that are working on making high-quality education content available for free on the Web.

African Virtual University*
Works with over 57 learning centers in 27 African countries to support economic development by leveraging the power of modern telecommunications technology.
http://www.avu.org/

Commonwealth of Learning, Learning Object Repository (Worldwide)
An online database of learning content compiled by searching across a number of open content repositories.
http://www.col.org/lor

Discovery Channel, Global Education Partnership (Sub-Saharan Africa & Latin America)
Brings the world into under-resourced classrooms and communities with the help of television, video, satellite and cable technology.
http://www.discoveryglobaled.org/

European Union, EducaNext
Provides a place to exchange learning resources and distribute educational activities and content.
http://www.educanext.org

National Institute for Multimedia Education (NIME) (Japan)
Manages higher educational information portals, develops and distributes educational contents, and operates educational networks.
http://www.nime.ac.jp/

New Partnership for Africa's Development (NEPAD) eSchools (Africa)
Aims to provide every African school leaver with the basic technological skills required to function in an information society, to make learners health literate and to bridge the 'digital divide' within the next 10 to15 years.
http://www.schoolnetafrica.net/index.php?id=864

OPEN REPOSITORIES & PORTALS

BBC
Provides a variety of education materials in many disciplines.
http://www.bbc.co.uk/

Commonwealth of Learning's Knowledge Finder
Indexes nearly 1 million documents from around the world on education and development from selected Web sites.
http://www.colfinder.org/public/index.jsp

Development Gateway Foundation, OER Topic Page*
Helps improve people's lives in developing countries by building partnerships and information systems that provide access to shared knowledge.
http://www.developmentgateway.org

Discovery Channel, Global Education Partnership
Provides tools and training necessary to extend the power of technology and information to under-resourced communities around the world.
http://www.discoveryglobaled.org/index.html

DSpace
A digital repository system that captures, stores, indexes, preserves and redistributes an organization's research material in digital formats.
http://www.dspace.org/

Gateway to Educational Materials
Provides educators with quick and easy access to thousands of educational resources found on various federal, state, university, nonprofit, and commercial Internet sites.
http://thegateway.org/

Sun Microsystems, Global Education Learning Community (GELC)
Empowers teachers, students and parent with self-paced, web-based, free and open content (curriculum resources, assessment) combined with best practices for advancing student achievement.
https://edu-gelc.dev.java.net/nonav/index.html

Internet Archive, Education*
Provides a variety of content including materials on education and a Web search tool as it existed at different times over the past decade.
http://www.archive.org/details/education

Smithsonian Institute
Allows users to take advantage of its extensive collection of learning and teaching materials.
http://www.si.edu/

OPEN JOURNALS & BOOKS

Boston College, Third World Law Journal
http://www.bc.edu/schools/law/lawreviews/thirdworld/

University of Chicago at Illinois Library, First Monday
http://www.firstmonday.org

Project Gutenberg
http://www.gutenberg.org

*** Project or initiative funded by the William and Flora Hewlett Foundation (as of November 1, 2005).**

University of Michigan School of Information, Internet Public Library
http://www.ipl.org

University of Michigan and Cornell University, Making of America
http://www.hti.umich.edu/m/moagrp/

Public Library of Science
http://www.plos.org

Tufts University, The Perseus Digital Library
http://www.perseus.tufts.edu/

INTELLECTUAL PROPERTY

BBC Creative Archive License Group
Makes moving images, audio and stills available for download under the terms of a single, shared user license scheme.
http://creativearchive.bbc.co.uk/

Creative Commons*
Offers creators a best-of-both-worlds way to protect their works while building a layer of reasonable, flexible copyright in the face of increasingly restrictive default rules.
http://www.creativecommons.org/

Creative Commons, Science Commons*
Encourages stakeholders to create areas of free access and inquiry using standardized licenses and other means: a 'Science Commons' built out of voluntary private agreements.
http://science.creativecommons.org/

Harvard Law School, Berkman Center for Internet & Society
A research program founded to explore cyberspace, share in its study, and help pioneer its development.
http://cyber.law.harvard.edu/home/

CONSORTIA AND VIRTUAL COMMUNITIES

Digital Library Federation
A consortium of libraries and related agencies that are pioneering the use of electronic information technologies to extend collections and services.
http://www.diglib.org/

International Network for the Availability of Scientific Publications
Works with partners and networks around the world to encourage the creation and production of information, to promote sustainable and equitable access to information, to foster collaboration and networking, and to strengthen local capacities to manage and use information and knowledge.
http://www.inasp.info/

OpenCourse
A free collaboration platform that hosts virtual communities developing, evaluating and using open, non-proprietary learning objects in their discipline.
http://www.opencourse.org/

Open Learning Support*
An open source software designed to integrate with collections of open access educational materials and provide educational support services.
http://ols.usu.edu

UNESCO, International Institute for Educational Planning*
Works to strengthen the capacity of countries to plan and manage their education systems through training planners and managers, supporting institutions and fostering an enabling environment through policy forums, international cooperation and networking.
http://www.unesco.org/iiep

INNOVATIVE OPEN BUSINESS MODELS

OpenBusiness (UK)
A platform for sharing innovative entrepreneurial ideas which are built around openness, free services and free access.
http://openbusiness.cc/?n=OpenBusiness.Home

ENABLING SOFTWARE & APPLICATIONS

Commonwealth of Learning, Learning Objects Repository Software
http://www.col.org/lor

Center for History and New Media, ECHO Tools Center
http://echo.gmu.edu/toolcenter-wiki/index.php

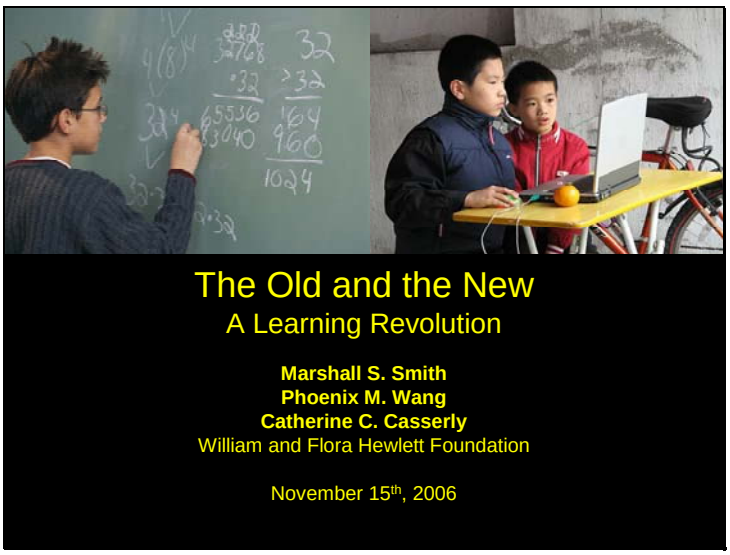
ETUDES-NG Alliance, Learning Management System*
http://foothillglobalaccess.org/etudes2/

Moodle, Course Management System
http://moodle.org/

Sakai Project, Learning Management System*
http://www.sakaiproject.org/

University of Iowa, WiderNet Project*
http://www.widernet.org/

*** Project or initiative funded by the William and Flora Hewlett Foundation (updated as of November 1, 2005).**

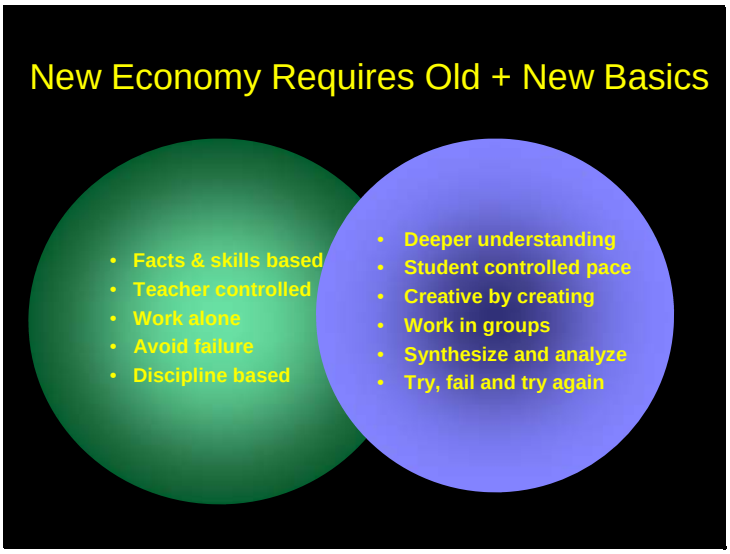


Thank you. It is a pleasure to speak with you about the future of learning. We at the William and Flora Hewlett Foundation focus on issues of Open Education Resources and the improvement of opportunities to learn. Our primary goal is to help create powerful, lasting improvements in learning opportunities for all students, all over the world. I will not discuss marginal changes in the education system and schools that appear to have only a small impact on learning. For example, we know from studies that conventional distance learning using practically any medium for transmission is as effective as conventional teaching. Distance learning should be part of the future, but we believe that there are ways of increasing the effectiveness and efficiency of distance learning by magnitudes of two or three times. That is an example of powerful improvement.

My focus will be on ways of using technology to create powerful improvements in learning. We cannot continue to think of schooling and learning as bounded by what we call our education systems -- four walls, traditional text books, teachers standing in the front of classrooms, grades, exams, all carried out within highly scheduled fixed amounts of time. We have tried improving almost every aspect of the current education system – better, required curricula, more exams, more accountability, more professional development, better alignment of resources – yet we have made only incremental improvements on learning outcomes.

One thing I hope you will take a way from this talk is that for us to expect significant improvements, we need to consider breaking down the constraints of our current education system. Powerful improvement sometimes requires disruptive change in the conventional order. Just as with the experience of other institutions that have used technology to improve productivity, we find that the gains from creating efficiencies in the old processes is only marginal -- to dramatically improve productivity we need to change the processes and practices. Some societies and education systems will be more open than others to such change. We suspect that those societies and education systems will succeed, with the important caveat that they change in the right direction, while the others will fail.


Marginal variation will not do the job.
We need significant changes.



My discussion builds on the morning talks. We believe that the new economy brought on by the information age requires us to strive to educate all of our children, to make education universal. Our children will need more than reading, writing and arithmetic. Every nation will need far more workers who are able to take responsibility, work cooperatively, grapple with uncertainty, behave creatively. Many jobs, engineering, the sciences, management, investment, politics, the arts, require the capacity to try, to fail, to try again, often many times over. Creativity thrives in environments that support second chances – think of the CEOs in Silicon Valley (Jim Clark – Netscape and Silicon Graphics, Steve Jobs – Apple)

Advocates of the old basics argue that teachers should be in control, students should work alone, and that problems with a right answer are still important and must be practiced in schools. We agree, though, we argue, they must only be part of the picture.

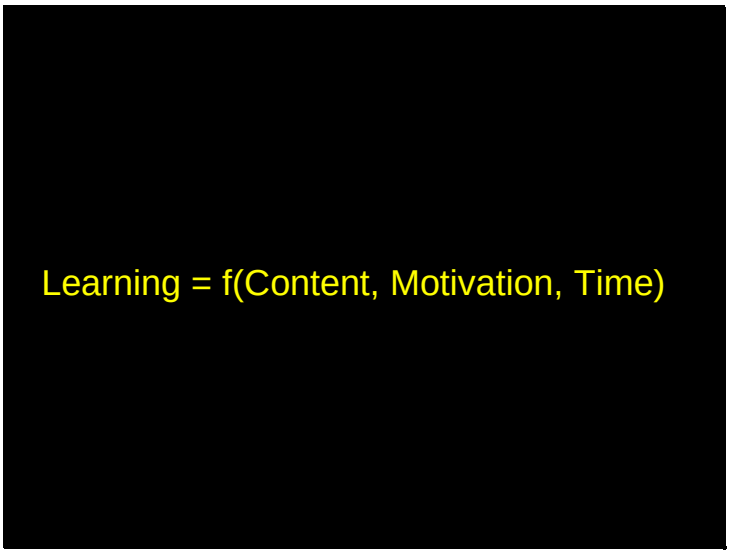
The new basics -- a combination of gaining a deeper understanding of academic content, and a set of strategies to enable students to "learn to learn," to be creative, and to control their own environment must also become part of the curriculum.

How do we teach both the old and the new basics in the same amount of time that it takes us to teach the old basics? I will suggest some approaches in a moment.

But part of the answer is simple to say and hard to do -- we need to become more student centered and less adult centered. What does student centered mean? -- it means giving students

some control over their learning and going to the students rather than forcing them to learn in the modern world the way that they learned in the 1920s.

Specifically, we need to use time in school much more effectively and we need to go where the learners are out of school. Only 20% of a child's waking hours between the ages of 5 and 18 are spent in school, and even then they are half asleep -- we need to use at least part of the 80% of the time students are outside of the school for educational purposes.



Put in note “apologies to Professor John B. Carroll”

Before we consider the potential uses of technology for learning let’s look at a way of thinking about the general conditions that make learning possible. I find the equation Learning is a function of Content, motivation and time is a useful oversimplification of the factors that go into learning.

School learning a function of: L=f(Content, Motivation, Time)

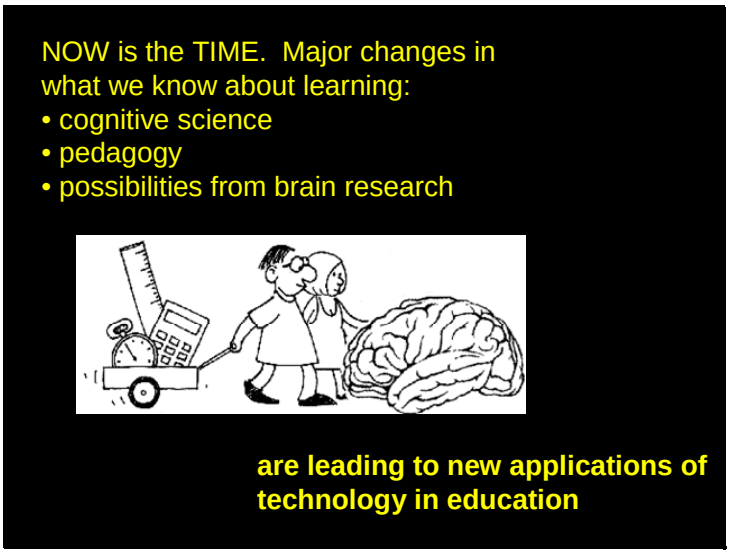
Content includes teachers (knowledge, energy), curriculum (content and skills), pedagogy Motivation has a variety of components including student readiness (health, self-confidence, level of attention, sense of control over learning), cultural and social incentives and disincentives. Time refers to the length of time it takes a particular student to learn particular content. Time varies depending primarily on prior knowledge, the knowledge and skills in the area that the student brings to the learning situation.

We have emphasized that we need to change the Content dramatically to include the new basics. And, we have suggested that the Time need not be a fixed dimension in schools anymore – in the future the student can carry the school along with her.

Motivation is a critical issue in the United States, though we pay little attention to it. I don’t know how much of an issue there is about the need for greater student motivation in the Asian nations. But, I suspect that the increase in interesting out of school activities such as computer games and

chat rooms poses a threat to student motivation even in Asia. There is a lot of research evidence that student motivation is absolutely critical -- that positive reinforcement, a sense of control over environment and social support are critical. The technology approaches we suggest for learning some of the new basics have student motivation front and center -- they are designed to capture and engage students that have other choices.

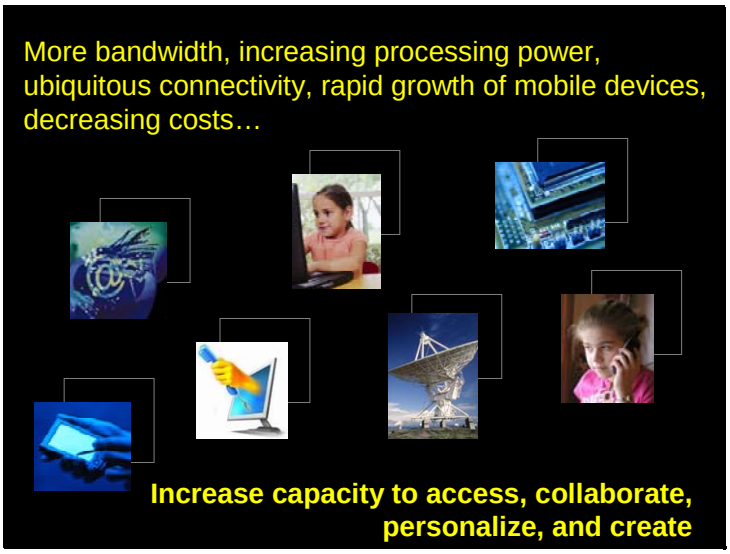
Our bottom line is that we need to substantially alter all three components, content, motivation and time.



Educational efforts by many governments in the last decade have focused primarily on increasing access to technology. Hardware and pipeline issues have dominated. Very little interesting has occurred in the area of technology applications for teaching and learning. In the US, one reason this has happened is that we have left the development of content primarily to the private sector, which, in the US, is slow to change because it is protecting its core business in textbooks and other materials. The result is that technology has had only a small effect on education. But it is possible that we have not been ready.

We believe that we are now ready for a revolution. One reason is the giant strides in understanding learning and teaching that we have made from recent research on cognitive science, in pedagogy and, for future applications, in research on the brain.

This research base is one key ingredient.



The second key ingredient is the new technology itself and the use of it by young people all over the world.

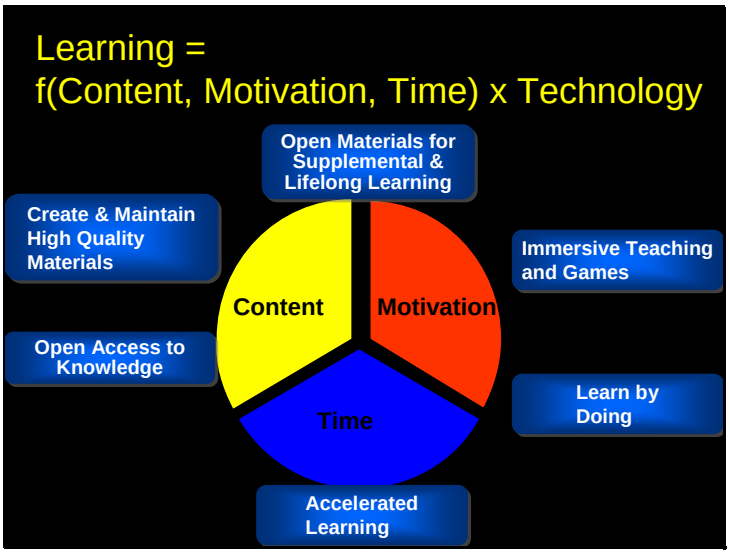
We now have huge amounts of bandwidth and computers and handheld devices are ubiquitous. Connectivity is everywhere, and capacity and processing power double every 12 to 18 months.

Moreover, given the opportunity, our youth engage in using technology -- they use computers more fluidly and creatively than we do and the handheld device of my grandaughter has greater computing power than the desktops of the late 1990s.

The ubiquity of technology means that formal, structured, engaging open educational materials could be available all of the time (24/7) to everyone. What we learn in school could be reinforced and expanded by high quality digital experiences outside of school. The content that we teach in our schools, language, mathematics, science, art, music, history, philosophy, engineering, public health, and on could be immediately available to anyone, anywhere, anytime.

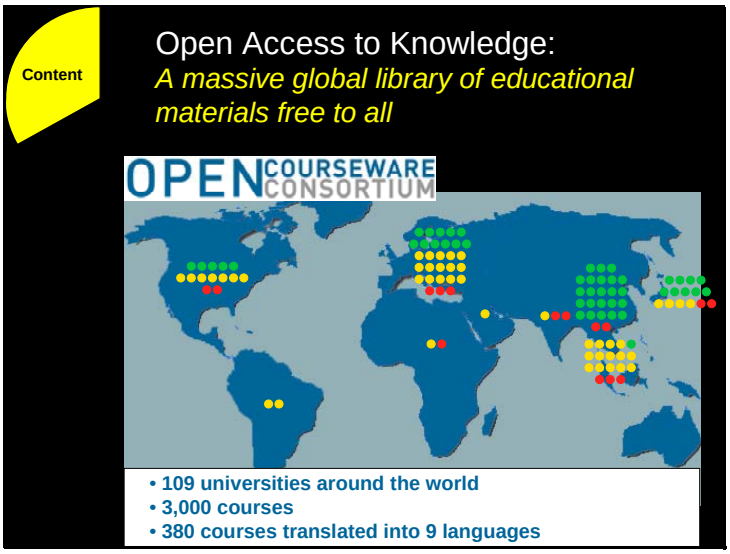
One major contribution of technology that will significantly change the way we approach education is that it allows us the opportunity to teach and learn anytime, anywhere, and on any device.

This is the second ingredient. We are ready to bake a cake.



We will look at six different applications of technology that can help us change all three dimensions that make learning possible. Each of these applications addresses one or more dimensions -- time, content, and motivation.

- Open access to knowledge of the world – Open educational resources, such as Library Collections, Books, Video, encyclopedias, data, journals, art, and translators, together enable huge amounts of high quality content available to all, especially those who typically lacked access.
- Creating and Maintaining High Quality open materials: technology enables us to create fast feedback loops to improve the quality of textbooks, lesson plans, or other instructional material, in timeframes much shorter than what exists today.
- Powerful resources for 24/7, open supplemental and lifelong learning: The expansive proliferation of educational materials in open archives of books and journals, allows us to rethink schools as 24/7, anytime and anywhere.
- Accelerated Learning: Why not increase the rate of learning by 2 – 3 – 4 times. Cognitive tutors enable us to shorten the time or the other way to think about it, enable student to double the learning but in the same amount of time.
- Learning by doing: If we want our students to think and act like a scientist, architect, historian, computer programmer, electrician, then we should consider using technologies that can help us create environments in which students can think and act like scientists.
- Immersive teaching environments and powerful educational games: millions of students spend hours playing games. What if we can harness the essence of gaming environments and apply them to formal education. I think we have early examples and are on our way.



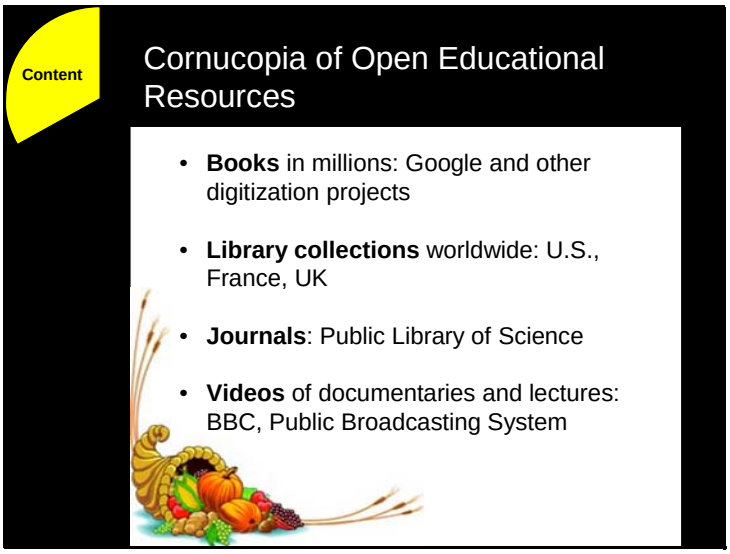
Open access to knowledge of the world: The big idea here is to bring the knowledge of the world to the smallest villages in Western China, the slums in Nairobi, the barrios of Los Angeles -- to everyone in the world.

One of the best known examples is Open CourseWare, which was started by MIT and has since spread across the world. Open CourseWare is a large-scale initiative to provide free, searchable, access to course materials for educators, students, and self-learners around the world. (www.ocw.mit.edu) MIT is putting the course materials for all of its more than 1500 courses on the web for free.

Over 100 universities around the world have joined with MIT in an OCW consortium in placing their learning materials openly on the web. This includes the premier universities in China and Japan, the Paris Technological Institutes, as well as many others. Altogether 3000 courses are published and this number is rapidly increasing. (www.ocwconsortium.org)

The combined websites receives over 1.5 million users a month. The users include faculty, students, and independent learners. China, Japan, India, and Canada are in the top five nations in terms of use.

For the first time some of the worlds greatest Universities are opening the doors for everyone to the content that had hitherto been reserved only for their students. Six years ago who would have believed this could happen?

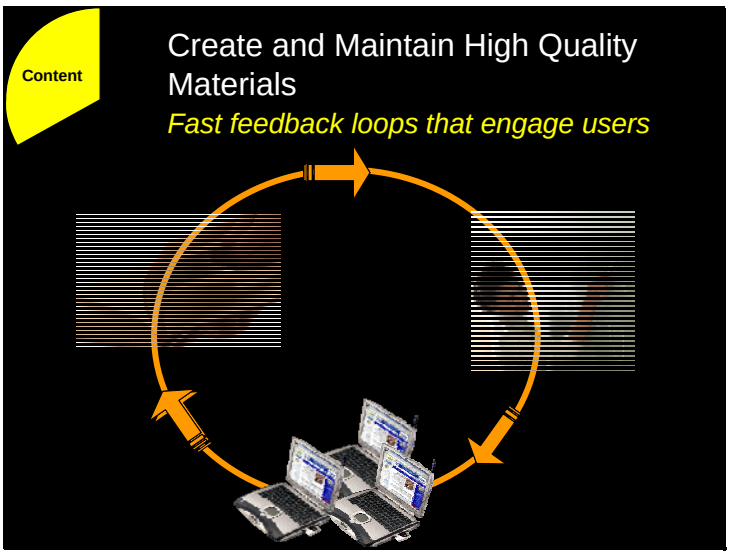


OpenCourseWare is only one of many different types of high quality education materials that are being placed on the web for free. Open Educational Resources include Library Collections, Books, Video, encyclopedias, data, journals, art, and translation and communication tools.

All over the world universities, libraries, public television, museums, government agencies, profession organizations and other entities and individuals are placing high quality education content on the web for open use and reuse. The materials are available to everyone in the world via computer and an internet connection. They carry a license that allows open use. In the US institutions that are part of this include Harvard, Yale, Rice, the Smithsonian and the Library of Congress – in England the BBC and the Open University of the United Kingdom. Even private sector organizations are giving educational materials away for free. GOOGLE expect to shortly be providing access to well in excess of a million open books.

In British Columbia, Canada their premier university is building a web site of open materials for their teachers and students. The World Bank has a web site pointing to open materials across the web. The National Science Digital Library supported by the US National Science Foundation is a huge repository of open materials supporting the teaching of science in the pre-collegiate years. The National Institute for Multi-Media Education in Japan has put together a repository of mostly open digital objects supporting teaching and learning. Australia and England and many others have similar sites.

These are the beginnings of a universal world library of high quality education materials of extraordinary size and scope, a library that will be available to every child in Kenya or the Philippines that has access to a handheld connected to the world wide web. This establishes the real possibility for all of learning on demand, whatever you need to learn at a given time.



This category includes textbooks; lesson plans; examples of best practice on video; assessments and lots of other things. You may ask why am I talking about such a dull topic?

The fact is that the tools of teaching and learning in schools all too often are created by people outside of the classroom and almost never rigorously tested in the classroom. Almost every K-12 student in the world has a text book, most teachers use lesson plans, almost every nation has high stakes assessments -- what do we know about the quality of the textbooks? the effectiveness of the lesson plans? the validity of the assessments? The fact is we know almost nothing of use about all of these areas.

A glaring exception to my generalization is a practice used in Japan (and other nations) of taking teacher built lesson plans and having other teachers try them and critique them and improve them. The process of lesson study is a process of continuous improvement, a practice made popular on the manufacturing lines of Japanese industry.

This form of continuous improvement cycle can be widely, cheaply, and powerfully accelerated by modern technology!! It can be applied to textbooks, lesson plans, workbooks, professional development, assessments of various forms and other types of teaching materials.

The big idea here is to use the web to create fast feedback loops to dramatically improve the quality and usefulness of the materials by engaging teachers and students who are users of the materials!!!!

This category could be populated by open resources or by proprietary materials. However, improving the materials dramatically will require opening it on the material to use and reuse by teachers and students and independent learners.

Imagine a text book for teaching eighth grade students biology is on the web and used by a large number of teachers in the country. The textbook has the conventional pages and figures – it also may have embedded laboratories, interactive simulations, video and other supporting material. One powerful component of putting a textbook on the web is that it could be continuously updated for new knowledge from, in this case, the field of biology. A version of the textbook could be usable on a handheld device. The textbook could be printed though it would lose the interactive characteristics but they still are as useful as current text books.

Imagine now that teachers are asked to react to the textbook, to feed back information to the authors or publishers about the usefulness of lessons, end of chapter assessments, and to highlight places and concepts where the presentation is not clear and their students did not understand the materials. Perhaps even the students will feed back information.

The publisher would gather the information --when it was clear from strong data that some area was problematic the publisher would change the textbook to meet the concerns. Perhaps the change would only be appropriate for students who did not have prior knowledge of certain principles of science -- in that instance a second, modified and augmented text could be placed on the web, with an annotation indicating that it is appropriate for certain kinds of students. This is an important step in personalizing materials. Unlike the past the ideas for change would come directly and in real time from the users. This would create a strong and rapid feedback loop to create a cycle of continuous improvement.

In another application of fast feedback loops, imagine that 20 second grade elite math teachers were selected to place on the web their lesson plans for the 20 most troublesome areas for the students in 2nd grad math. Other teachers would then be asked to try the lessons and to judge them or even modify them to make them work better in their classroom and to post the modifications on the web, along with their reasons for altering the original More teachers would then try either the modified or the original lessons, and possibly make modifications and post them. The result is jet propelled lesson study where fast feed back loops are created to continuously improve the lesson plans so that they work well within the particular contexts of the teachers.

The take away is that in many countries there is no method of validating or ensuring the effectiveness of teaching materials. This simple process would dramatically change that. In a short period of time the quality would rise, the relevance to teachers would rise, and the pride among teachers of their having contributed would rise. And, I suspect, the achievement of students would increase.

As a by product, this might also allow us to make radical strides in a real theory of learning.

Many college and secondary school students stay up late at night and wake up groggy in the morning. It is in their genes. Yet our libraries, lectures, and professors are available in the morning and not in the middle of the night. Middle aged people who work during the day cannot attend college during conventional hours. Or maybe they don't want to go back to school – rather they want to sit in their home and bone up on algebra and biology so they can do a better job in their current occupation.

The big idea here is that we need to build a virtual world comprised of a large number of structured learning materials. The world would open to all on the web for use by anyone, anytime, anywhere. The materials that would comprise such a world is rapidly growing but as of yet they are scattered throughout the web.

These materials include stand alone multi-media and lecture courses with fully developed content and instructional capacity; modules for home study, homework helpers and other supports, and language learning tools (CHENGO). Over 100 such courses are already available for free in English and some are being translated into Spanish and Chinese. They cover such areas as calculus, algebra, world history, biology, chemistry, programming in C++ and others. In a short time we expect 200-300 such courses to be available along with many thousands of other useful digital objects. Homework helpers provide support for all learners by bringing specific knowledge to bear to help students learn a concept.

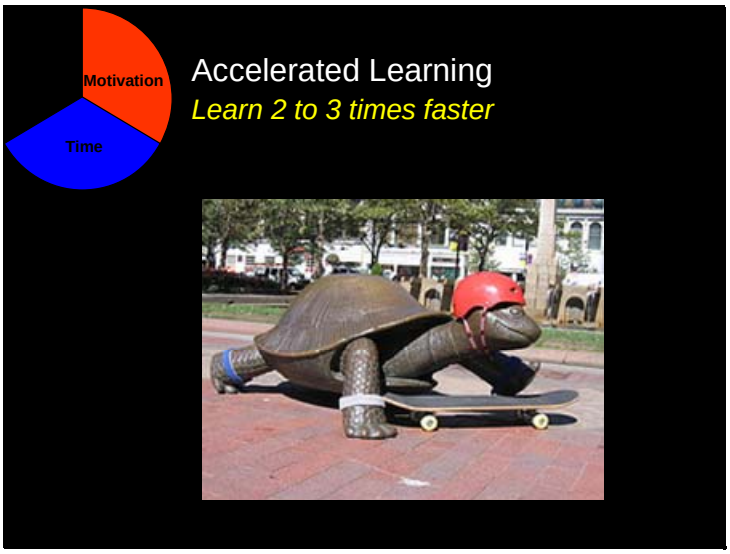
"So far the site is helpful. I have worked through sample questions and used it yesterday to study for my chapter test in algebra. I will use if for other subjects as well. Sorry it has taken so long to get back to you but I have been very busy."

A variety of models are springing up. In the Netherlands the Open University is placing some courses open on the web for use by anyone, anytime with the aim of attracting students to take officially take courses in a degree program. The effort is being supported by the government in the hopes of stimulating an increase in the overall college population.

One particularly interesting example of a lifelong learning resource is in the area of language learning. The technology of voice recognition, language translation and machine language production has improved dramatically. With a language training program a student has the chance to practice and learn on her own, fail and then receive feedback and support, practice and repetition in an immersive language environment.

The Chinese and US governments signed an agreement some time ago to create programs to teach Chinese to English speaking students and English to Chinese native language students. CHENGO, or Chinese and English on the Go, is a highly innovative R&D project that uses online technology to deliver foreign language instruction, 24/7, open, and accessible from anywhere. The system is designed to deliver 35, one-hour English language lessons by integrating the technologies of gaming, animation, and voice recognition via the Internet with a structured immersion pedagogy.

Chengo creates an environment where learner can learn at his or her own pace and practice as long and as often as necessary.



Accelerate learning. The title of this presentation in the agenda is "Can we Learn 2 to 3 times faster". We believe that the answer to that question is yes in many subjects.
The big idea here is that interactive on-line courses, developed by content experts who are informed by recent knowledge from cognitive science, can enable students to learn faster than they learn from regular, high quality lectures delivered in our world's greatest universities. Our preliminary hypothesis is that students can learn twice to three times as fast using the on-line courses.
Carnegie-Mellon University is developing such a set of college level courses for delivery on the web. The courses are based on current theories and data from cognitive sciences and the course content in each is exactly the content of a corresponding lecture course in the university. The University course takes one traditional semester of lectures. Carnegie – Mellon calls their technology courses Cognitive Tutors. They provide all of the content necessary to successfully complete the course. They are 24/7 cognitive tutors that are capable through effective use of feedback loops to create personalized experiences. 24/7 personalized cognitive tutors – this is going to the student with highly motivating material under their control and reactive to their needs. Who can ask for anything more?

Carnegie Mellon is embarking on a set of experiments to determine whether the 24/7 cognitive tutors can accelerate learning. They already know from other studies that the cognitive tutors work as well as the lecture approach when both groups are given a full semester to learn the material.

In the new experiments the 24/7 cognitive tutor students will only have one-half the semester to take the course before the end of course examination while the lecture class students will have the full semester. The scores of the students in the two groups on the common end of course exam will be compared. Our money is riding on the 24/7 cognitive tutor students.

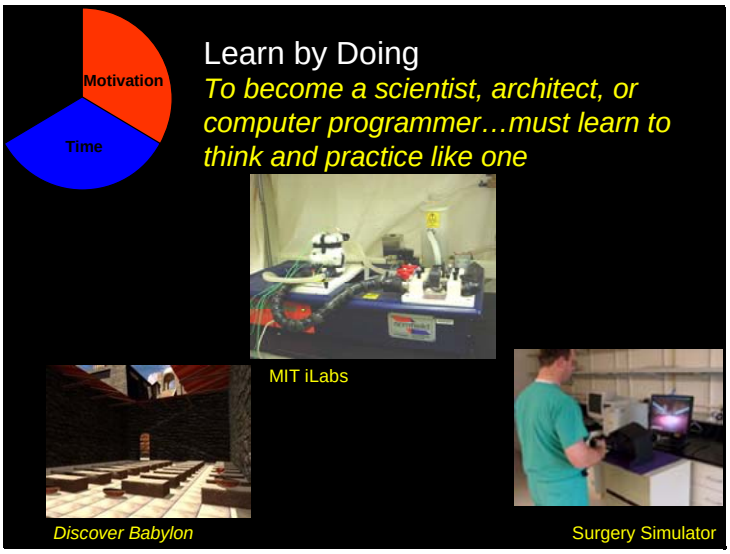
Accelerate Learning Slide: CMU's Static Tutor

The OLI MiniTutors are grounded in studies that have attributed the sizeable learning gains that students achieve with human tutors to the feedback the tutor gives in the problem solving context.

This tutor is in a section of the Statics Course on Effects of Multiple Forces and helps students learn how to calculate moments using components. It is intended to be an opportunity for students to do a "self-check" to make sure they understand the concept. However, if the student is unsure of the procedure for solving the problem, the first hint provides a link which, when clicked, expands the tutor into the various steps needed to solve the problem.
The tutor provides scaffolding to support the student to learn the steps of the procedure when needed.

The hints and feedback change depending on which part of the exercise the student is attempting. Notice that the hints are given in three levels with the first level of hint orienting the student in general terms, the second level of hint restating the rules, strategies or equations that the student should apply in solving the problem, and the final level of hint, or "bottom out hint" gives the student the solution for that step in the process. The student's answers are green when they are correct and red when they are incorrect. This demonstrates the methodology of a cognitive tutor: making comments when the student errs, answering questions about what to do next, and maintaining a low profile when the student is performing well.

The tutor recognizes when a student has used the scaffolding and hints and when the student gives the correct answer after having used the scaffolding and hints; the tutor suggests that the student try another problem without scaffolding and hints. The graph, the problem statement, hints, feedback and answers are dynamically-generated. The student can work through the tutor multiple times, receiving a different problem each time, until the student is confident that he or she understands the concept. This provides the student with virtually unlimited opportunities for supported practice.



If we want our future workforce to be have the skills and knowledge to adapt to the rapidly changes brought on by globalization, then what better way to learn than to simulate the kinds of challenges that one might encounter? Rather than memorizing facts, why not start early and help students practice doing what a scientist, architect, doctor, dentist, historian, computer programmer, or electrician does? Technology has made it easier to create simulations for job-training, and, some instances, to give students the chance to actually carry out real work.

Some examples:
iLab at MIT supports a network of users who from a distance can manipulate high-end laboratory equipment to teach science. This is not virtual laboratory -- it is the real thing. The lab names are
Dynamic signal analyzer
Shake table for Civil Engineering
Polymer crystallization for Chemical Engineering
Microelectronics device characterization for Electrical Engineering
Heat exchanger for chemical engineering

In Australia an observatory has opened windows of its time to students and amateur astronomers who wish to explore and solve the kinds of problems that professional astronomers think about. Students create hypotheses, for example, predicting where a black hole might be, reserve the right time for the telescope to be focused on a particular part of the universe, and then analyze the results of their investigation. And, all of the images are open source, allowing anyone else to examine and study their importance.

Discover Babylon teaches a user to be an archeologist with accurate historical and scientific information in 3D photorealistic simulations that allow the user open-ended exploration and discovery.

Surgery Simulator shown here is a high-fidelity laparoscopic surgery simulator that enables surgeons to practice complex operative tasks before entering the operating room. The device emulates, with a high degree of accuracy, the anatomy of organs and tissues.

Where do many of our children and young people spend their extra time? Games!! And coming on strong are non-gaming immersive environments!! On the computer, on the handheld device, at home, on the playground, on airplanes, autos, wherever they are kids 5 to 30 there are games. The games and immersive environments may have one or two or three or up to many thousands of participants. Something on the order of 25 million people play World of Warcraft and there are over 1 million inhabitants of Second Life. The gaming industry is larger than the movie industry. Parents all over the world worry that their children (and sometimes their spouses) are spending too much time playing these games. Yet there are very few powerful games designed for education purposes available for our schools and colleges.

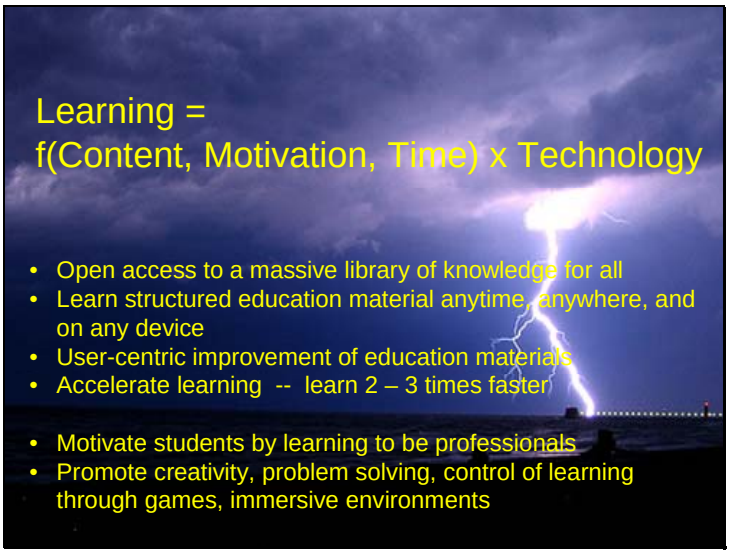
The irony here is that the Defense Department in the US and, I am sure other countries, already employ games and immersive environments for learning and training activities, as do multiple large private corporations around the world. What do they know that we do not know?

They know that these environments foster learning to be take control of your learning, be creative, solve problems, and manage complexity, through competition, collaboration, engagement in games and virtual worlds.
The big idea here is that personalized, engaging, challenging game activities provide an extraordinary opportunity to teach both the old and new Basics.

Some games for social and educational purposes are already in circulation.

Games exist for science, defense, health, conflict resolution, and social change. Their sophistication, target audience, and message vary. The Federation for the Advancement of Science developed *Immune Attack* to allow high school students to experience the challenge of defending the human body against invading antigens; *PeaceMaker*, a game created by students at Carnegie Mellon University, lets Palestinians and Israelis switch roles to better understand each other's plight (I will add image of this); and the U.N. World Food Program's *Food Force* teaches kids about the difficulties of delivering aid to the developing world. Food Force had had 4 million downloads in 15 months (Time Magazine, August 2006).

(Demo Food Force Trailer) Each player is a member of a rookie team sent to complete six missions. Each mission represents a part of the process of delivering food aid to an area in crisis. The final mission shows you how food aid can help people rebuild their lives in the years following a disaster.



What does this sample of opportunities created by technology offer us?

Open access to a massive library of knowledge for all

Learn structured education material anytime, anywhere, and on any device

User-centric improvement of education materials

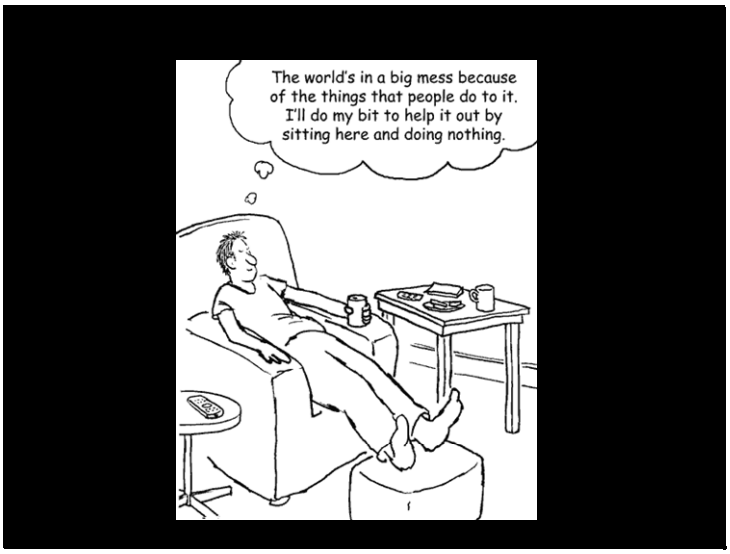
Accelerate learning -- learn 2 – 3 times faster

Motivate students by learning to be professionals

Promote creativity, problem solving, control of learning through games, immersive environments

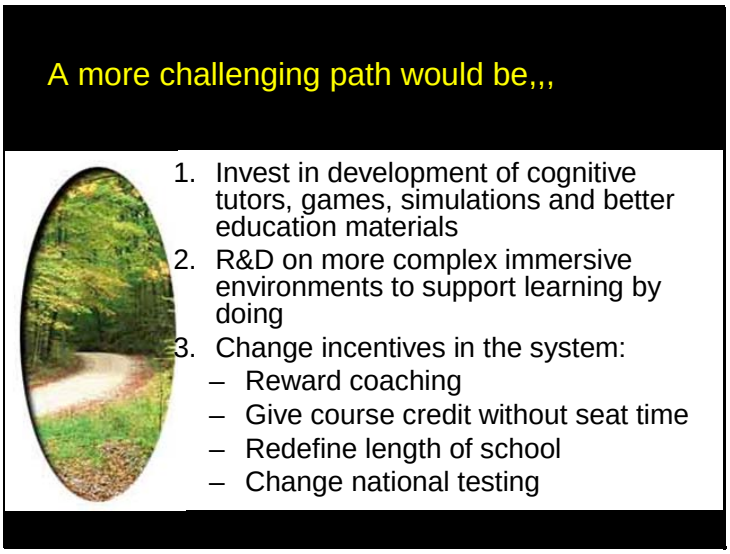
And these are only examples of categories of opportunities.

What might be done to make these opportunities real?



What are our options for governments and other funding agencies? The obvious one is to do nothing special. Continue to dabble on the edges of the education system. Don't alienate adults and special interests that are embedded in the education system.

What would happen? I believe that the open education resources movement has enough impetus and support around the world to continue growing though special interests will create barriers and slow the movement down. The well to do will still have access to it as well as to material that has a price. The losers, of course, will be those who cannot pay and fight back. Maybe the private sector would step up but their materials would be closed to all who cannot pay -- again the losers are not in this room.



Invest now in what we know how to do – develop 24/7 cognitive tutors in twenty key areas, build a new generation of textbooks that achieve validity though user feedback, create a library of open games, simulations and better education materials. The cost of a government funding this would be an astonishingly small fraction of the overall cost of the schooling in their government. Suppose, for example, that using US prices for labor it cost 1 billion dollars -- that would be 2% of one year's cost of California's K-12 education system. The savings could be massive.

How about embedding the entire curriculum of secondary schools with these extraordinary tools? How about a massive site with multi-player games, simulations, data collection and analysis tools in multiple languages for middle school students all over the world in the area of global warming? How about? -- you fill in the blanks.

For the long run we need R&D on more complex immersive environments to support creativity and deep problem solving. And we need to change incentives in the system: For example.

- To cede more control to students and to support the use of technology reward coaching as a model of teaching rather than the "sage on the stage" model.
- Give course credit without seat-time to those who learn on their own.
- Reduce length of school for those who can accelerate through the system.
- Change national testing and college entrance requirements to include measures of creativity, deep problem solving, and experience with problems that do not have a "right" answer.

There are real impediments and considerable costs to changing the status quo. In this case, we believe that the costs of not changing are far greater.

Curriki - Global Education & Learning Community
Bringing Curricula into the Participation Age

By Dr. Barbara (Bobbi) Kurshan
Executive Director
Curriki - Global Education & Learning Community

When assessing the quality of life of an individual, or the economic condition of a nation, one fact stands out – education makes a measurable and positive difference. Quality learning requires access to quality curricula that include defined learning objectives, scope and sequence for instruction, lesson plans, instructional materials, teacher training and student assessment.

Unfortunately, quality learning and the infrastructure to support it are not universally accessible. Typically, the affluent of the world have access to high quality education and a corresponding high standard of living. However, a far larger number of people who live in rural or impoverished areas have little or no education available to them.

Thus, an unacceptable gap in learning opportunities exists, and viewed from an international perspective, this "Education Divide" looks as vast as the Grand Canyon. Globally, the numbers are staggering. Around the world, more than 100 million children do not have access to a primary school education.

Even in the inner cities and rural areas of the United States, the lack of qualified instructors and sufficient instructional materials, such as a textbook for each student, has a profound negative impact on graduation rates, health and crime. Almost 40 percent of students in the lowest socioeconomic quartile drop out of school, and the costs to the individual and society are monumental. An estimated 67 percent of prison inmates nationwide are high school dropouts.

In developing its "Millennium Goals," the United Nations recognized the global necessity of education, and the socioeconomic cost of the lack of it. The UN urged people around the world to ensure that, by 2015, every child is able to complete a full course of primary schooling. Improving educational opportunities directly improves a country's economy and the lives of its people. The challenge is making quality education universally available to all.

Quality learning requires access to quality curricula that include defined learning objectives, scope and sequence for instruction, lesson plans, instructional materials, teacher training and student assessment. Today, textbooks are the primary form of instructional materials used in a curriculum. The U.S. spends about $5 billion on textbooks each year, up from about $2 billion in 1991. These costs are continuing to rise, not only in the U.S., but all over the world.

With the advent of the Internet, we now have a unique opportunity to change the curricula paradigm, and thereby to dramatically expand access to quality learning while reducing the cost.

The Internet has proven to be the great world equalizer. It has eliminated a number of economic and structural barriers to both the free exchange of knowledge and access on a global scale. First e-mail, then web publishing and more recently hosted applications and web-based "Marketplaces," "Groupware" and "Social Networks" have provided never-before-seen opportunities to collaborate on the development and delivery of intellectual assets on a global scale. The relationship between authors and publishers is changing, as the Internet democratizes who can share his or her work. Now a publisher is anyone with access to the network and not exclusively those with access to the capital intensive means of print publication.

Open Source and the Participation Age

A major driver in lowering barriers is "open source." Free/Open Source Software (FOSS), for instance, has transformed the software industry. The basic idea behind open source software is simple: when developers can read, redistribute, and modify the source code for a piece of software, the software evolves. For example, the Gnu/Linux operating system, the Apache Web server and the OpenOffice desktop application have all proven to be world-class software.

These examples have also provided a successful model for how online communities can organize and govern themselves, evaluate and improve their products, and grow in size and influence. A community of people can fix, improve or adapt something at a speed that, compared with the pace of conventional development, can be astonishing.

Virtually every successful open source project has several common elements:

- An infrastructure and process that enable disparate individuals to collaborate on development.
- A community that is energized and motivated to complete, publish and support the work.
- A critical mass of content that can be used to create an enhanced or customized version suited to the specific needs of a specific community member or locale.

The open source model directly correlates to the need in education for a common infrastructure to link students and the teaching community with best materials for and practices in instruction. More recently, the potential to apply this community development approach to educational content has been demonstrated by Wikipedia, a free and open source encyclopedia.

The open source framework is especially conducive to the way people interact online today in the new "Participation Age." The Participation Age is the successor to the Information Age, where economic value was generated by controlling the creation, distribution and use of proprietary information. In the Information Age, the proprietary nature of the intellectual property required users to purchase restrictive use rights or "reinvent the wheel" for unrestricted use. The Internet has enabled the Participation Age and has seriously challenged this proprietary control. The Participation Age is about access and sharing, where networks of human beings interact to solve problems, creating meaningful content, connections and relationships never possible before.

To this end, a growing number of education organizations and foundations are finding that an open source approach can fill the education content gap. Many are leading and supporting the development of Open Educational Resources (OER) that further provide stimulus to building network access.

To date, these efforts have developed educational resources that provide a specific or point solution. For example, Wikipedia provides a free and open source encyclopedia. Its sister site, Wikibooks, is developing open source textbooks. However, Wikibooks is not focused on K-12 and does not address the full complement of curriculum resources. Both are valuable educational resources, but do not provide a complete curricular solution.

Good examples of Open Source Curricula exist at the local level. Because these isolated instances are not well publicized or disseminated globally, their excellence is not leveraged, and many hours of development time on nearly-identical projects are wasted by "re-inventing the wheel." Many OERs exist in silos of expertise and are difficult to find or use. Educational organizations that have created OER sites tend to be at the university level or regional level, and are limited to specific subject areas or restrict access to specific audiences.

For example, California Open Source Textbook Project (COSTP) is developing a World History textbook in conjunction with Wikibooks. This OER will be aligned to California standards of learning and will be available only to teachers in California after it has been approved for California public school adoption. COSTP plans to use content that has some IP rights reserved (is not truly open) and to charge a fee to users outside of California.

Though it will require a sustained and persistent effort, the time is now to begin building a community among those who can contribute or teach and those who want to learn, to freely share and support universal access to quality curricula. Development of an extensive repository of Open Source Curriculum is the key to eliminating the Education Divide and providing universal, equal educational opportunities.

Bringing it All Together: Curriki - Global Education & Learning Community

Curriki - Global Education & Learning Community is the first all-embracing Internet site instituted to develop, aggregate, evaluate and support the best of Open Source Curriculum. Curriki is the only site to develop this complete Open Source Curriculum solution based on a comprehensive curricular framework that includes defined learning objectives, scope and sequence for instruction, lesson plans, student activities, instructional materials, teacher training and student assessment of mastery.

Curriki's mission is to empower people worldwide through Open Source Curriculum and to eliminate the Education Divide by moving learning into the Participation Age.

Curriki was founded by Sun Microsystems in March 2004 as the Global Education & Learning Network. In 2006, Sun created an independent 501(c)(3) organization to accelerate and focus the Open Source Curriculum repository development effort. Curriki was initiated as a result of the stated need of over 20 Ministers of Education around the world for cost-effective, online curricula and is supported by educational luminaries who believe in universal access to education.

Curriki provides an online repository where anyone, anywhere, students or teacher, can contribute to and/or access quality learning materials. The initial focus is on K-12 curricula in the areas of mathematics, science, technology, reading and language arts, and languages. This interactive and open repository empowers and enables people everywhere to learn and teach.

To foster global educational opportunities, Curriki believes the optimum solution is to become the best source for world-class learning – quality curricula, just a click away. Curriki's approach represents a paradigm shift in curriculum development, distribution and evaluation that is represented by its 3-D model:

- Develop curriculum through community contributors
- Deliver the curriculum globally
- Determine the impact by project and by individual

Develop Curriculum through Community Contributors

Curriki is a pioneer in applying an open source approach to curriculum development. Only a few governments and decision-makers have thus far embraced the open source approach to curricula, although many have expressed support for open standards. Many existing sites that are exploring this model include proprietary content and restrict access to a select group.

Through its open source community, Curriki will support, aggregate and leverage the work of other organizations and individual developers. Curriki will promote the opportunity to collaborate online in developing curriculum and will provide unique online tools to streamline and support the development process. Curriki will also provide hosting and support for development and localization efforts including the support of curricula in multiple languages.

Deliver the Curriculum Globally

Delivery also poses distinct challenges for Open Source Curriculum. The same dynamic that has local school officials continually recreating content applies here. Finding trusted resources on the Internet is difficult.

Curriki intends to meet this challenge by being a "one stop shop," a single repository of validated curricula and learning objects. The organization will support, aggregate and leverage the work of other organizations and individual developers. Subject matter experts will review and comment on the curricula with local education administration support, and the curricula will all be freely accessible through a single, well-publicized website.

Determine the Impact

What determines the success of Open Source Curriculum? How is quality controlled? These are important considerations around the world as Open Source Curriculum advances education.

Curriki is developing a research-driven model that applies metrics to quantify what improvements in individual and group learning outcomes are necessary for success. By researching "what makes the best curricula and why," and disseminating that information widely, Open Source Curriculum effectiveness will be continuously improved.

Curriki's Strategy

Curriki will build and support a community of contributing educators, students and developers to create an Open Source Curriculum repository. The community forum will evolve and foster the exchange of ideas among students, parents, developers and educators from all parts of the globe. Assessment will be available to students and parents to monitor progress and performance. Curriculum developers will be able to get the community's feedback and evaluation of their work, as well as ensure that the content meets accreditation standards for the relevant regions.

There are four elements to Curriki's strategy:

- Create a website repository
- Build a community of educators
- Build a repository of Open Source Curricula
- Engage a global community

Create a Website Repository

Curriki's interface, with its many constituencies, will be through a website, based on a robust, open technology infrastructure that will enable and support community, foster collaboration, and adhere to open standards. The website will support community content creation by providing the following: curricula guidelines, publishing tools to simplify creating content and inserting metatags, assessment, and support for alignment

to curriculum frameworks or standards. Other technologies such as bulletin boards, blogs and podcasts will be used to foster collaboration between contributors and users of the content to improve the curricula. The Curriki curricula can also be used as the basis for creating localized versions.

Build a Community of Educators

Curriki has a two-pronged approach for building a community of educators by 1) providing unique, time-saving online curriculum development tools as well as validation research and user feedback, and 2) obtaining localization and implementation agreements from departments and ministries of education, as well as policy makers to ensure the sustainability of the program.

First, Curriki will attract educators who want to contribute Open Source Curriculum by providing unique online tools that streamline the curriculum development process, by promoting the use of each curriculum project, by making research available to validate a curriculum project, and by offering a multi-step feedback loop: (1) Define objectives; (2) Define pedagogy; (3) Define components to be in the course; (4) Search repository for content (viewable or editable); (5) View, create, edit; (6) Community review; (7) Publish/Collaborate; (8) Test effectiveness; (9) Continuous loop back to step one, to monitor the impact of their work on student learning.

One such online tool is the Textbook Builder, which will enable a new paradigm for textbook development. This Textbook Builder will be focused on the group collaborative development of textbook assets. It will have features to allow a group of teachers or professors to take a curriculum framework and use the embedded features to create and edit a book map, sections and pages of an instructional textbook using online, real-time editing tools. Version control and editorial workflows will be used to manage the collective effort of the community and to control editorial intent, process and schedules. This robust tool will accelerate the population of the repository and will make Curriki the site of choice for Open Source Curriculum development.

A second set of development tools, the Currikulum Builder, will complete the community support system for curriculum creation and will include publishing tools, curricula guidelines, support for alignment to standards of learning and curricula frameworks, and learning and content management systems. The Currikulum Builder will enable developers and users to share and create lesson plans, course syllabi, learning activities, scope and sequence hierarchies, and to align and compile assets into collections, courses and learning objects. In addition, it will have features for facilitating group activities, discussions, processes and workflows related to the instructional design process.

For example, a sophisticated instructional design process might go as follows: a group of department or Ministry of Education officials in a particular locale develops their curriculum guidelines using Curriki tools. It does this using a local community of teachers to collaborate on the development of the list of skills to be taught and performance expectations to be measured and met. It then creates or selects and revises source materials into a course collection of learning objects aligned to its

curriculum framework or standards. This “Package” is pilot tested in two schools as a controlled study, and improvements are made online. The improved curriculum is re-released, and this process continues until all of the schools have migrated to using the new and now continuously improving curriculum.

Educational research will be supported by Curriki to evaluate and certify what works based on global, regional and local outcomes. Editorial comments will be developed by Curriki’s Chief Academic Officer along with community educator members to guide students, teachers and parents in the best application of a given curriculum or resource. Organizations providing teacher professional development will be provided with resources for teacher training on how to use a curriculum. Teachers and parents independently seeking guidance will also have browser-based access to these professional development resources.

Assessment and accreditation tools and learning and content management systems will be developed or contributed to the repository by community partners. Bulletin boards, blogs and podcasts will be used to foster collaboration among and between contributors and users of the content. Ultimately, the community will drive the process of accrediting all content at all levels.

The second prong of the approach to attract educators to the community is to work with Ministries of Education (MOE), policy makers, state departments of education, large retired teacher organizations and school districts to secure implementation commitment agreements with Curriki. An implementation commitment would include an agreement from the agency to localize the content to its area and to validate the accreditation of all material for its locale, as well as the alignment to the curriculum or standards of learning for the area. Implementation commitments will include teacher professional development and ongoing teacher and student mentoring.

Build a Repository of Open Source Curricula

Curriki’s website will support curricula covering a range of subject areas, initially for K-12 in areas such as mathematics, science, technology, reading, language arts and language. It will initiate and develop collaboration with universities and organizations that address curriculum development, evaluation and open source technology. All educational content meeting Curriki’s criteria will be cataloged and included in the repository.

Curriki intends to be the “one-click stop” for the best world-class learning. Building on the infrastructure of the Java.net community, Curriki community projects and registered developers, teachers and other users are growing exponentially. Some of the projects are developing free and open source tools for teachers, including grade books, embedded learning objects and assessment tools.

Since the textbook is the most common and easily understood method for presenting instructional materials, Curriki will provide an online format for curricula development that is textbook-centric. Curriki’s repository will offer easy access to online materials that can be localized by ministries or departments of education. As every education

agency, even in the more rural and impoverished areas, has a printer and paper for reproducing and distributing the materials, online access at the student's desk will not be necessary. Therefore, only the bare minimum technology requirement is needed to benefit from Curriki's repository.

Anyone throughout the world with access to the Internet will be able to guide themselves or others through a logical progression of modularized learning to master a discipline, such as algebra, reading readiness, physics, or English grammar. Users will be able to access curriculum online, print it, and/or save it to a CD. The repository will be designed to allow a user to access either the entire curriculum or a specific learning object within a curriculum, such as an assessment or a chapter in a book.

To expand its repository, Curriki will identify, aggregate and support existing sources of open resources. Curriki will be responsible for evaluating curricula, content, assessment and tools. There will be three levels of curricula. The highest level of curricula will be that which independent researchers or government ministries have previously evaluated and found that it meets the standards or national requirements. The second level will be a curriculum that has received some evaluation and feedback by Curriki community or by the education community. The last level will be a repository for all content which may not be evaluated or initially approved by the community. Here, contributors can seek feedback or assistance in meta-tagging their content. Where voids in the curricula exist, community contributors will be encouraged to fill the gaps.

Engage a Global Community

Curriki's website will foster the exchange of ideas among students, parents, curriculum developers and educators in a global, interactive community. The website will provide guidance to teachers, students, and parents on the appropriateness and the best application of a given curriculum or resource. Assessment tools will be available to students and their parents to monitor progress and performance.

Building on the efforts of others in Open Source Curriculum, Curriki is becoming a community of communities. Curriki will increase awareness of its resources through the following marketing strategies:

- Focus public relations activities on publications that speak to each audience – internationally, regionally and locally.
- Participate in high-profile global events that establish thought leadership and raise awareness of Curriki in the Open Source Curricula arena.
- Partner with key governmental agencies and educational organizations that bring educators to Curriki.
- Sponsor low-key, local user group meetings that leverage and connect grassroots evangelists to build loyalty and enthusiasm.
- Develop and aggregate easy-to-use community resources including development tools, online forums and discussion groups.
- Support highly branded curricula projects that drive usage and awareness.
- Increase end user reach through robust Internet placement with search engines.

Viral growth in education takes time and nurturing – there is no spontaneous combustion. It will take sustained dedication to build a repository of world-class curricula. It takes time for a curriculum to be tested and improved by early adopters. It takes time for the early majority to witness and comprehend the value of a new curriculum. Word of mouth spreads in annual increments, as student progress is substantiated by research and word of mouth.

The business model of the Participation Age—that is, one built around collaborative development, open source, open architecture and creative commons—is already proving to be sustainable. This model offers significant advantages over other existing content creation and distribution methods, as it has no profit motive, and can change and adapt quickly – for the benefit of all involved.

Conclusion

Delivering open content in a cost effective and sustainable fashion is critical to success in eliminating the Education Divide. By engaging students, parents, developers and educators in this global, interactive community, Curriki is a focal point for the "open sourcing" of education. Developing effective partnerships with Ministries of Education, policy makers, content developers, and content providers, Curriki is building a learning community of student users, parents, educators, and contributors, both inside and outside the classroom.

It is clear that open source methodologies have been essential to the Internet revolution and to the explosion in technological advancement. Curriki will build on these two fundamental and growing forces. It will augment the value of all the work done earlier by others by providing a curricular framework and context for open education resources and aggregating and creating Open Source Curricula and development tools.

Curriki will be a digital crossroads for those who want to teach and those who want to learn. Together we can eliminate the Education Divide. Freely sharing through community is the right thing to do for educating an increasingly interdependent global population in the Participation Age.

# # #

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Curriki offers new world of course content

New online community promotes free and open collaboration among educators

By Corey Murray, Senior Editor, eSchool News
January 5, 2007

Imagine a world where science teachers in India could swap lesson plans with their counterparts in California, or where students in a rural high school in Nebraska could try their hand at mathematics problems written for an audience halfway across the globe--in China, or Germany, or Italy, for example.

Ten years ago, such academic collaborations would have seemed ridiculous to most classroom educators, many of whom hardly have enough time during a typical day to network with co-workers in their own school buildings, much less cultivate relationships with colleagues hundreds and even thousands of miles away.

Thanks to the internet and the evolution of web-based software programs in schools, however, many of those geographic barriers no longer exist. Now, a new online community has emerged that promises to democratize the process of curriculum development, giving educators the ability to tailor instructional content to the needs of their students, wherever they are, free of charge.

Dubbed the "Wikipedia of curriculum" by its creators, the online community known as Curriki--accessible at www.curriki.org--aims to provide a place online where educators from anywhere in the world can post curricula and lesson plans for review and use by fellow classroom teachers.

Like Wikipedia, the organic online encyclopedia that lets its users edit and update existing entries, Curriki employs a philosophy of open access, encouraging its members not only to use the content available on the site, but also to upgrade it, modify it, and tag it to suit the needs of their students, wherever they are.

The brainchild of Sun Microsystems CEO Scott McNealy, Curriki was founded as a way to provide disadvantaged teachers and students around the globe with open and unfettered access to high-quality educational content.

So enamored was McNealy with his vision that he decided to spin the company off from Sun into its own freestanding nonprofit organization. Based in Washington, D.C., the group is led by longtime educational software designer Bobbi Kurshan. In an interview with *eSchool News*, Kurshan, whose resume includes work with industry heavyweights Microsoft Corp. and Apple Computer, talked about the challenges associated with turning McNealy's vision into a reality, and particularly with applying the controversial notion of social networking to open curriculum.

In conversations about the project, Kurshan calls Curikki "a dangerous and exciting proposition" for education; exciting, she says, for its ability to revolutionize how educators approach and integrate new learning resources in

their classrooms--and dangerous for its potential to shake up the current market for traditional, standards-based curricula in schools.

Because Curriki is a free resource based on an open platform, Kurshan says, the learning materials posted by members of the community to the web site will be accessible to educators anywhere in the world, regardless of their computer's operating system, as long as they have an internet connection.

That means educators in Germany or England, for example, will be able to post and share resources with the same freedom and ease as teachers in the U.S. or India, wherever they are.

For schools, Kurshan says, the benefits of such a resource are obvious. For one, it gives educators across the globe a chance to review and integrate learning resources beyond those immediately available to them in their own schools or districts; second, she says, Curriki's open architecture lets participating educators tailor the content to meet the needs of their students; and third, because the resource is free, it gives teachers and students--especially those who hail from rural and disadvantaged communities--access to high-quality educational content at no cost.

At a time when schools everywhere are charged with preparing their students to succeed in an increasingly competitive global economy, Kurshan said, the hope is that Curriki will empower "the haves to help the have-nots."

But Curriki isn't simply about giving teachers access to more resources--it's bigger than that, says Kurshan, who believes the site also will help start "a wave of conversations in schools about what it means to be open."

Open technologies have been widely adopted by colleges and universities for years, she says, but K-12 schools have been slow to catch on. The hope is that open solutions such as Curriki--which makes its source code available for educators to view (though not to edit) online--will help move that trend forward.

Early indications are that, so far, the approach is working.

After celebrating its official launch in October, organizers report that as of press time membership in the online community had ballooned to more than 15,000 registered users, with more educators coming online daily.

Like Wikipedia--currently one of the ten most visited sites on the internet--the reach of an always-on, constantly evolving online community has the power to spread quickly, Kurshan says, adding: "It's viral."

Already, parents and teachers have written in to offer their endorsements. William Kaufmann, a parent who has used the site to find learning materials for his two girls, said the site is perfect for parents who want to find additional resources for use at home with their children.

"I could go on and on," wrote Kaufmann in a letter to the organization. "I am very enthusiastic about this site and its potential." But success rarely comes without its share of challenges and, as Kurshan tells it, Curriki--despite its potential--is no exception.

For one, she said, educators and others who use its resources must be willing to accept the fact that Curriki, by its very nature, represents "a work in progress."

Unlike traditional classroom resources, many of which come store-bought in

boxes, packaged with certificates detailing their effectiveness based on results culled from carefully constructed focus groups and control-based research studies, the free-flowing resources featured on Curriki boast no such guarantees.

But that's precisely the point, says Kurshan. With Curriki, educators can customize the resources featured on the site to fit their needs and those of their students. The real benefit comes in the ability to expose educators to resources they otherwise would never have access to.

Getting educators to buy into the philosophy of open curricula won't be easy.

For one thing, Kurshan said, educators, especially in U.S. schools, are so bound by state and local standards that integrating any resource into the classroom without prior approval constitutes a risk some might not be willing to take.

Translation also might be a problem. Because the materials submitted to the site can come from educators anywhere in the world, Kurshan said, it's not unlikely that some resources will include grammatical errors and other mistakes that are the result of language gaps or other cultural misinterpretations.

Rather than shrug those materials off as ineffective or inaccurate, Kurshan said, the community enables its members to weigh the program based on its educational merits and potential. If an instructor finds the pedagogy to be sound, he or she has the ability to update the lesson and modify it to make it work within any given educational system.

To help educators navigate the community, organizers are training a group of current and former educators to serve as mentors, whose jobs it will be to help teachers learn to use the resource effectively.

Curriki also is taking steps to make the resources more user-friendly, Kurshan said. As the project evolves, featured curricula will be displayed in a three-tiered system.

The first tier will consist of fresh resources not yet reviewed or edited by Curriki curriculum experts. These resources will feature a disclaimer that warns educators to use them at their own peril, said Kurshan.

The second tier will feature only submissions that have been reviewed by Curriki's curriculum team. In many cases, she said, Curriki reviewers will contact contributors with suggestions about how to tweak and improve their lessons before approving them for use on the site.

The third and highest tier will feature so-called "premiere" curriculum resources that have been validated by the Curriki team after careful consultation with the author.

Like Wikipedia, Kurshan said, Curriki is an evolving online medium, which means that the strength of it resources is dependent upon its ability to cultivate and sustain participation among its users.

As the online community grows, she said, so, too, will the resources featured on Curriki. The more educators who review the materials, the more detailed and effective each resource will become.

"Users have to understand that they are part of a process," said Kurshan.

Links:

Curriki
http://www.curriki.org

Sun Microsystems Inc.
http://www.sun.com

www.eschoolnews.com
info@eschoolnews.com
7920 Norfolk Ave., Suite 900
Bethesda, MD 20814
(800) 394-0115 - Fax (301) 913-0119

Former Sun CEO hopes the world is his classroom

McNealy says nonprofit Curriki Web site encourages learning

By Benjamin Pimentel
CHRONICLE STAFF WRITER

Scott McNealy likes to say that he stepped up, not down, from his former post as CEO of Sun Microsystems, the Silicon Valley giant he co-founded 25 years ago.

"I have more time now to focus on things that I think really matter," he said in an interview last week during a Sun conference on education in San Francisco.

Although McNealy handed over his job to Jonathan Schwartz last year, he remains chairman of the Santa Clara company whose technology helped build the online world.

Today, McNealy is focused on a rapidly changing part of the online world: K-12 education.

McNealy has spent most of the past year as the leading pitchman for Curriki, a nonprofit group that's trying to build a mega-Web site of educational materials that teachers, students and parents anywhere in the world can use, modify, critique and expand on. And they can do all that for free.

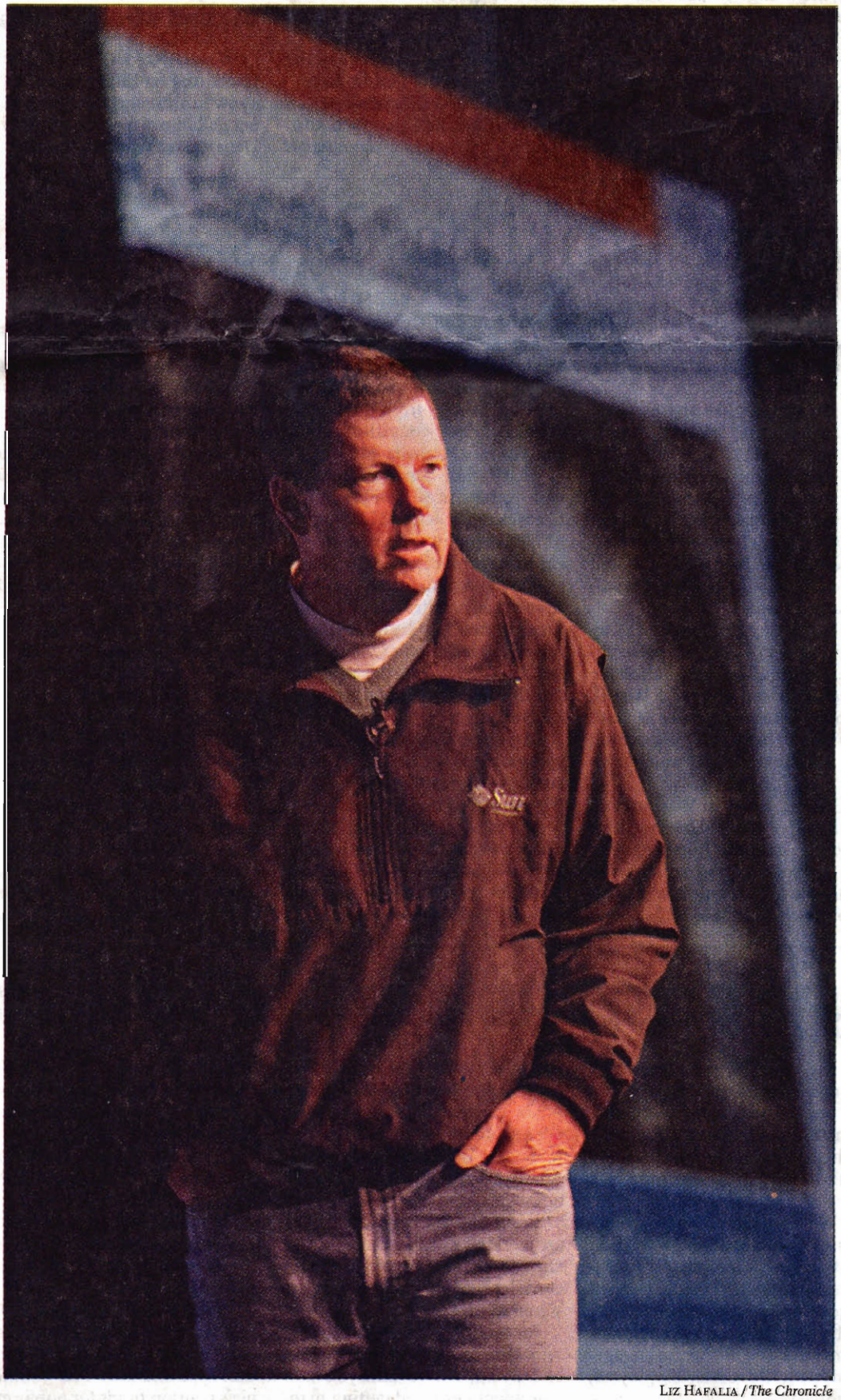
As the chief executive officer of Sun, McNealy often pointed to education as an arena where network computing can make a major difference. He routinely cites the tech giant's origins as a startup formed by a group of Stanford and UC Berkeley students who early on had to decide what to call their company.

"The big decision was to call it Stanford University Network or Berkeley University Network, and 'Sun' won over 'Bun,'" he quipped. "We've always been looking to pay back, share back, if you will."

That led him to Curriki, whose name comes from "curriculum" and "wiki," a collaborative Web site that can be edited or expanded by users.

Think Wikipedia for educators, schoolchildren and their parents. McNealy calls it "open-source curricula."

The concept for Curriki, which began as part of Sun's global education program before being spun off as a nonprofit organization, is not new, as other Web sites offer free educational resources.



LIZ HAFALIA / *The Chronicle*

McNealy says Curriki has 3 R's — and lessons for the world

▶ **WIKI**
From Page C1

For example, the Multimedia Educational Resource for Learning and Online Teaching, or Merlot, which began as a project of the California State University system, contains projects, papers and activities that can be used by college students. The site includes a section where educators can offer comments or suggestions.

Another site, Connexions, affiliated with Rice University, has been offering free-access educational materials to colleges and K-12 students. Users also are able to revise and update the materials.

Curriki offers educational materials for K-12 students. Like Merlot and Connexions, its materials are reviewed and vetted by experts, and can be modified by users depending on the needs of a school, teacher or student.

A mathematics lesson can be changed to adjust to the learning speed and abilities of a student. Or a social studies lesson plan can be changed for political, religious or cultural reasons.

"If you don't like any mention of creationism, take that out," McNealy said. "If you don't like any mention of Darwinism, take that out. We're not going to tell you what to teach. We're just going to provide you with a reference that has been looked at and vetted. Take it or leave it. It's voluntary. It's open."

On Curriki, a course on D-Day features a PowerPoint presentation outlining the Allied offensive toward the end of World War II. Another features a series of flash animation cartoons illustrating the transformation of water from ice to liquid to gas.

Curriki, based in Washington, has a staff of four led by Executive Director Barbara Kurshan, who had helped develop educational materials for Microsoft and book publisher McGraw-Hill.

Kurshan said Curriki, which is still in the early stages of building a database, already has 25,000 registered users and about 100,000 monthly visitors from the United States and other countries, including Australia, Canada and India.

That's still small compared with other sites. For example, Connexions has 320,000 to 613,000 monthly visitors, said project manager Katherine Fletcher.

Curriki has not disclosed how much money it has raised, but the organization has said it hopes to raise $100 million to $200 million by 2010. "We're in the millions, not the tens of millions yet," said McNealy.

McNealy, known for being outspoken in taking on bigger rivals such as Microsoft and IBM, has high goals for his venture.

Noting how California spends about $400 million a year on educational materials, including textbooks, he said, "There is no reason why in California (we) need to spend $400 million a year on textbooks when we can open-source. . . . If we had half of the annual California textbook budget — and we just need it one time — we think we can become self-funding."

Tom Adams, curriculum frameworks director at the California Department of Education, said though it's hard to evaluate Curriki, which has just started, its goal is laudable because technology and the Web have helped educators become more creative.

"The more (material) that's out there only makes it better," he said. "And it comes with the right price — it's not going to cost you anything."

Tim Magner, director of the Office of Educational Technology at the U.S. Department of Education, noted that schools around the country "are looking to develop their own content or take advantage of content that's available online."

Kim Jones, Sun's vice president of global education, said this trend and the emergence of Web sites like Curriki have made textbook publishers "nervous with the idea that people will no longer be buying textbooks."

But Jay Diskey, executive director of the school division of the Association of American Publishers, downplayed that concern.

While Curriki and other sites may serve a purpose in education, he said, textbook publishers put out materials that are based on established education standards.

"At this point, a Curriki or anything like it can provide dribs and drabs of information," he said. "It can provide resources, some supplemental materials. . . . It's hard to argue with anything that is provided for free, but people should not be under the impression that Curriki is providing curriculum."

Still, Jim Daly, editor in chief of Edutopia, a magazine published by the George Lucas Educational Foundation, said Web sites like Curriki highlight the dissatisfaction of many educators with what might be in a textbook, which he said is "often myopic, outdated and doesn't reflect diverse opinions."

"If you start allowing curricula to be posted online and to be massaged and extended and expanded, this provides a huge benefit," he said.

Added Joel Thierstein, executive director of Connexions: "We got to the point where education is open and free and mandatory, but the information is not. So we're here to help the information flow along."

McNealy is thinking of a global free flow of information as he described the Curriki database.

"This will be a fairly large grid," he said. "How many people are there involved in K-12 education worldwide — parents, teachers and children? It's kind of like most of the planet."

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CHAPTER 1

Property and the Problem of Software

This is a book about property and how it underpins the social organization of cooperation and production in a digital era. I mean "property" in a broad sense—not only who owns what, but what it means to own something, what rights and responsibilities property confers, and where those ideas come from and how they spread. It is a story of how social organization can change the meaning of property, and conversely, how shifting notions of property can alter the possibilities of social organization.

I explain the creation of a particular kind of software—open source software—as an experiment in social organization around a distinctive notion of property. The conventional notion of property is, of course, the right to exclude you from using something that belongs to me. Property in open source is configured fundamentally around the right to distribute, not the right to exclude. If that sentence feels awkward on first reading, that is a testimony to just how deeply embedded in our intuitions and institutions the exclusion view of property really is.

Open source is an experiment in building a political economy—that is, a system of sustainable value creation and a set of governance mechanisms. In this case it is a governance system that holds together a community of producers around this counterintuitive notion of property rights as distribution. It is also a political economy that taps into a broad range of human motivations and relies on a creative and evolving set of organizational structures to coordinate behavior. What would a broader version of this political economy really look like? This

book uses the open source story as a vehicle for proposing a set of preliminary answers to that very large question.

The way in is to answer two more immediate questions about open source. How is it that groups of computer programmers (sometimes very large groups) made up of individuals separated by geography, corporate boundaries, culture, language, and other characteristics, and connected mainly via telecommunications bandwidth, manage to work together over time and build complex, sophisticated software systems outside the boundaries of a corporate structure and for no direct monetary compensation? And why does the answer to that question matter to anyone who is not a computer programmer?

Let me restate these questions as an observation and two general propositions that together provoked me to write this book. The observation is that collaborative open source software projects such as Linux and Apache have demonstrated that a large and complex system of software code can be built, maintained, developed, and extended in a nonproprietary setting in which many developers work in a highly parallel, relatively unstructured way. The first proposition is that this is an important puzzle for social scientists worrying about problems of both small- and large-scale cooperation (which is just about every social scientist, in one way or another). It is also an important puzzle for anyone who struggles, in theory or in practice, with the limits to very complex divisions of labor and the management of knowledge in that setting.

The second proposition is that the open source software process is a real-world, researchable example of a community and a knowledge production process that has been fundamentally changed, or created in significant ways, by Internet technology. Understanding the open source process can generate new perspectives on very old and essential problems of social cooperation. And it can provide an early perspective on some of the institutional, political, and economic consequences for human societies of the telecommunications and Internet revolutions.

This book explains how the open source software process works. It is broadly a book about technology and society, in the sense that changes in technology uncover hidden assumptions of inevitability in production systems and the social arrangements that accompany them. It is also about computers and software, because the success of open

source rests ultimately on computer code, code that people often find more functional, reliable, and faster to evolve than most proprietary software built inside a conventional corporate organization. It is a business and legal story as well. Open source code does not obliterate profit, capitalism, or intellectual property rights. Companies and individuals are creating intellectual products and making money from open source software code, while inventing new business models and notions about property along the way.

Ultimately the success of open source is a political story. The open source software process is not a chaotic free-for-all in which everyone has equal power and influence. And it is certainly not an idyllic community of like-minded friends in which consensus reigns and agreement is easy. In fact, conflict is not unusual in this community; it's endemic and inherent to the open source process. The management of conflict is politics and indeed there is a political organization at work here, with the standard accoutrements of power, interests, rules, behavioral norms, decision-making procedures, and sanctioning mechanisms. But it is not a political organization that looks familiar to the logic of an industrial-era political economy.

The Analytic Problem of Open Source

Think of a body of software code as a set of instructions for a computer—an artifact, a "thing" in and of itself. In that context, what is open source software and how is it different from the proprietary software products that companies like Microsoft and Oracle build and sell?

Consider a simple analogy to Coca-Cola.[1] Coca-Cola sells bottles of soda to consumers. Consumers use (that is, drink) the soda. Some consumers read the list of ingredients on the bottle, but that list of ingredients is surprisingly generic. Coca-Cola has a proprietary formula that it will not divulge, on the bottle or anywhere else. This formula is the knowledge that makes it possible for Coke to combine sugar, water, and a few other readily available ingredients in particular proportions with a secret flavoring mix and produce something of great value. The point is that the bubbly liquid in your glass cannot be reverse-engineered into its constituent parts. You can buy Coke and you can drink it, but you can't *understand* it in a way that would let you reproduce the

drink, or improve upon it and distribute your cola drink to the rest of the world.

Standard economics of intellectual property rights provides a straightforward account of why the Coca-Cola production regime is organized this way. The core problem of intellectual property is supposed to be about creating incentives for innovators. Patents, copyrights, licensing schemes, and other means of "protecting" knowledge ensure that economic rents are created and that some proportion of those rents can be appropriated by the innovator. If that were not the case, a new and improved formula would be immediately available in full and for free to anyone who chose to look at it. The person who invented the formula would have no special and defensible economic claim on a share of the profits that might be made by selling drinks engineered from the innovation. And so the system unravels, because that person no longer has any rational incentive to innovate in the first place.

The production of computer software is typically organized under a similar regime, with a parallel argument behind it. You can buy Microsoft Windows and you can use it on your computer, but you cannot reproduce it, modify it, improve it, and redistribute your own version of Windows to others. Copyright, licenses, patents, and other legal structures provide a layer of legal protection to this regime, but there is an even more fundamental mechanism that stops you from doing any of these things. Just as Coca-Cola does not release its formula, Microsoft and other proprietary software makers do not release their source code.

Source code is a list of instructions that make up the "recipe" for a software package. Software engineers write source code in a programming language (like C++ or FORTRAN) that a human can read and understand, as well as fix and modify. Most commercial software is released in machine language or what are called "binaries"—a long string of ones and zeros that a computer can read and execute, but a human cannot read.[2] The source code is basically the recipe for the binaries; and if you have the source code, you can understand what the author was trying to accomplish when she wrote the program—which means you can modify it. If you have just the binaries, you typically cannot either understand or modify them. Therefore, shipping binary code is a very effective way for proprietary software companies to control what you can do with the software you buy.

Proprietary source code is the touchstone of the conventional intellectual property regime for computer software. Proprietary source code is supposed to be the fundamental reason why Microsoft can sell Windows for around $100 (or why Oracle can sell its sophisticated data management software for many thousands of dollars) and distribute some of that money to programmers who write the code—and thus provide incentives for them to innovate.

Open source software simply inverts this logic. The essence of open source software is that source code is free. That is, the source code for open source software is released along with the software to anyone and everyone who chooses to use it. "Free" in this context means freedom (not necessarily zero price). Free source code is open, public, and nonproprietary. As Richard Stallman puts it, freedom includes the right to run the program for any purpose, to study how it works and adapt it to your own needs, to redistribute copies to others, and to improve the program and share your improvements with the community so that all benefit.[3] Programmers often explain it with simple shorthand: when you hear the term free software, think "free speech" not "free beer." Or, in pseudo-French, software libre not software gratis.

The core of this new model is captured in three essential features of the semiofficial "Open Source Definition":

- Source code must be distributed with the software or otherwise made available for no more than the cost of distribution.
- Anyone may redistribute the software for free, without royalties or licensing fees to the author.
- Anyone may modify the software or derive other software from it, and then distribute the modified software under the same terms.[4]

If you array these terms against the conventional intellectual property story for software, open source software really should not exist. Or at best it should be confined to small niches outside the mainstream information technology economy, perhaps among a tightly bound group of enthusiastic hobbyists who create and share source code for the love of the challenge.

Here's the empirical problem: Open source software is a real, not marginal, phenomenon. It is already a major part of the mainstream information technology economy, and it increasingly dominates aspects of that economy that will probably be the leading edge (in technological and market terms) over the next decade. There exist thou-

sands of open source projects, ranging from small utilities and device drivers to office suites like OpenOffice, database systems like MySQL, and operating systems like Linux and BSD derivatives.[5] Linux and Apache attract the most public attention. Apache simply dominates the web server market—over 65 percent of all active web sites use Apache.[6] Nearly 40 percent of large American companies use Linux in some form; Linux is the operating system for more than a third of active web servers and holds almost 14 percent of the large server market overall.[7]

Sendmail is an open source email transfer and management program that powers about 80 percent of the world's mail servers. BIND is an open source program that acts as the major addressing system for the Internet. If you use Google to search the web, you use a cluster of 10,000 computers running Linux. Yahoo! runs its directory services on FreeBSD, another open source operating system. If you saw the movies *Titanic* or *Lord of the Rings,* you were watching special effects rendered on Linux machines that are running at companies like Disney, DreamWorks, and Pixar. Increasingly, open source software is running major enterprise applications for large and small corporations alike. Amazon, E*Trade, Reuters, and Merrill Lynch are examples of companies that have recently switched backend computer systems to Linux. Large parts of the U.S. government, including the Defense Department, the Department of Energy, and the National Security Agency, work with open source software. National, state, and municipal governments from Germany to Peru to China are considering and in some cases mandating the use of open source software for e-government applications. IBM is now a major champion of open source after publicly declaring in 2001 a $1 billion commitment to developing technology and recasting central parts of its business models around Linux and other open source programs. Hewlett-Packard, Motorola, Dell, Oracle, Intel, and Sun Microsystems have all made serious (if less radical) commitments to open source software.

The fact that Linux is probably not running your desktop computer today does not diminish the significance of what is happening with open source. That is partly because more PCs and computing appliances will run Linux and open source programs in the next few years.[8] But Windows on your desktop is not important for a more fundamental reason, and that is because your PC desktop is becoming much less

important. Even Microsoft knows and acknowledges this—that recognition is at the heart of the company's move toward web services and the "dot-net" architecture. Sun Microsystems claimed a long time ago that "the network is the computer" and the technology is upholding that claim. Your desktop is like the steering wheel to your car—important, but not nearly as important as the engine. The engine is the Internet, and it is increasingly built on open source software.

Computer scientists and software engineers value Linux and other open source software packages primarily for their technical characteristics. But as open source has begun over the last several years to attract more public attention, it has taken on a peculiar mantle and become a kind of Internet era Rorschach test. People often see in the open source software movement the politics that they would like to see—a libertarian reverie, a perfect meritocracy, a utopian gift culture that celebrates an economics of abundance instead of scarcity, a virtual or electronic existence proof of communitarian ideals, a political movement aimed at replacing obsolete nineteenth-century capitalist structures with new "relations of production" more suited to the Information Age.

It is almost too easy to criticize some of the more lavish claims. Like many things about the Internet era, open source software is an odd mix of overblown hype and profound innovation. The hype should be at least partly forgiven. The open source phenomenon is in some ways the first and certainly one of the most prominent indigenous political statements of the digital world. Unlike the shooting star that was Napster, the roots of open source go back to the beginning of modern computing; it is a productive movement intimately linked to the mainstream economy; and it is developing and growing an increasingly self-conscious identification as a community that specifies its own norms and values.

Some of those values sound extraordinarily compelling, particularly when compared to darkly dystopic visions of the Internet-enabled society as one in which computer code leads to a radically privatized, perfectly regulated, tightly controlled world in which technology enforces upon the many the shape of a market that is preferred by and benefits the few. In the widely read book *Code and Other Laws of Cyberspace,* Lawrence Lessig repeatedly invokes the idea of open source as a major challenge and counterpoint to the possibilities for government and

corporate control of the architecture that will help shape the e-society. He implies that this is part of an almost epochal battle over who will control what in the midst of a technological revolution, and that open source is on the right side of that battle.[9] Lessig is hardly alone in this view.[10] And it is an important point to make, although I will show that the situation is considerably more complicated than "open=good, closed=bad."[11] To get to a more nuanced understanding of what is at stake, we first should confront in detail the problem of how open source comes to be, what its boundaries and constraints are, what makes it work as a social and economic system, and what that system in turn makes possible elsewhere. That is the purpose of this book.

The Political Economy of Open Source

My starting point for explaining the open source process is the lens of political economy. I will situate the puzzle to start in modern concepts from political economy and then say more precisely why open source challenges some conventional theories about the organization of production, and how it affects and is affected by society. This lens represents a choice: There are other starting points you could choose; and the choice does matter in terms of where you come out as well as where you start. One of the strengths of the political economy perspective in fact is that it can naturally open up to a much broader set of discussions, and I will do so particularly in the conclusion to the book. The point is to take the political economy perspective as a useful focusing device for a discussion of a very complex set of human and social behaviors.

One of the foundational problems of political economy is collective action. People do not easily work together in large groups toward a joint goal. There are many reasons for this: People have different preferences around the goal, they have different tolerances for costs and effort, they find it difficult to evaluate the importance of others' and their own contributions, and in many cases they would come out better if they were able to sit back and allow somebody else to contribute in their place. The classic modern statement of the problem is Mancur Olson's book *The Logic of Collective Action.* Olson's arguments have been refined over time, but the core logic has become almost the

equivalent of an instinct for people who think about politics and organization. And thus the natural attraction of the open source process to this conceptual frame: Intuition tells us that thousands of volunteers are unlikely to come together to collaborate on a complex economic project, sustain that collaboration over time, and build something that they give away freely, particularly something that can beat some of the largest and richest business enterprises in the world at their own game.

Marc Smith and Peter Kollock took that intuition a step further when they wrote about Linux as "the impossible public good."[12] Linux is nonrival and nonexcludable. Anyone can download a copy of Linux along with its source code for free, which means it is truly nonexcludable. And because it is a digital product that can be replicated infinitely at zero cost, it is truly nonrival. For well-known reasons that track with the intellectual property rationale, public goods tend to be underprovided in social settings. In other words, it is hard for a community of human beings to organize and sustain organization for the production and maintenance of public goods. The situation with Linux ought to be at the worse end of the spectrum of public goods because it is subject additionally to "collective provision." In other words, the production of this particular good depends on contributions from a large number of developers. Stark economic logic seems to undermine the foundations for Linux and thus make it impossible.

The elementary political economy question about open source software is simple. Why would any person choose to contribute—voluntarily—to a public good that she can partake of, unchecked, as a free rider on the effort of others? Because every individual can see that not only her own incentives but the incentives of other individuals are thus aligned, the system ought to unravel backward so no one makes substantial contributions, and the good never comes to be in the first place.

But Linux is also an impossibly complex good. An operating system is a huge, complicated, intricate piece of code that controls the basic, critical functions of a computer. Everything depends on it. It is the platform on which applications—be they word processors, spreadsheets, databases, or anything else—sit and run. To design a robust operating system and to implement that design in software code is a gargantuan task. Testing, debugging, maintaining, and evolving the system over time are even harder. Computer users will run an operat-

ing system in a nearly infinite number of settings, with functionally infinite permutations of behavior, leading to infinite possible paths through the lines of code. Complex software is not like a book, even the longest and most complex book ever written. It is more like a living organism that must continually adapt and adjust to the different environments and tasks that the world puts in front of it.

There was a time when a single determined individual could write the core of a simple operating system for a primitive computer. But given the demands of computer applications and the capabilities of hardware technology at present, that is no longer conceivable. The task needs to be divided somehow. This immediately raises a second core political economy question, about coordination of a division of labor. The standard answer to this question has been to organize labor within a centralized, hierarchical structure—that is, a firm. Within the firm an authority can make decisions about the division of labor and set up systems that transfer needed information back and forth between the individuals or teams that are working on particular chunks of the project. The boundaries of the firm are determined by make-or-buy decisions that follow from the logic of transaction cost economics. The system manages complexity through formal organization and explicit authority to make decisions within the firm as well as price coordination within markets between firms.[13]

Even this caricatured model of industrial-era organization for production is hardly perfect. It is expensive and sometimes awkward to move information and knowledge around, to monitor the actions of labor, and to enforce decisions on individuals. No one says that hierarchical coordination in a complex production task like software development is efficient, only that it is less inefficient than the alternatives. And it does seem to work at some level. Within companies, the job gets done and complex software—imperfect, buggy, and expensive, but functional—does get produced. And thus a third core political economy question arises: Is this an inevitable way of organizing the production process for software (and, perhaps by implication, other complex knowledge goods)? Is it the best way?

Eric Raymond, computer hacker turned unofficial ethnographer of the open source movement, draws a contrast between cathedrals and bazaars as icons of organizational structure. Cathedrals are designed from the top down, then built by coordinated teams who are tasked by

and answer to a central authority that implements a master plan. The open source process seems to confound this hierarchical model. Raymond sees instead a "great babbling bazaar of different agendas and approaches."[14] Yet this bazaar has produced software packages that develop "from strength to strength at a speed barely imaginable to cathedral builders."[15]

There is some hyperbole here, and the imagery of chaos and invisible hands in the bazaar misleads by distracting attention from what are the real organizational structures within open source. But focus for the moment on Raymond's core observation. Many computer programmers believe that Linux and other open source software packages have evolved into code that is superior to what hierarchical organizations can produce. The quality of software is to some degree a subjective judgment; and like "good art," a lot depends on what you want to do with the software and in what setting. But the technical opinions are serious ones. Ultimately, so are the opinions expressed in market share, and particularly in the success of open source software in taking away market share from proprietary alternatives.

To summarize and set the problem, open source poses three interesting questions for political economy:

- *Motivation of individuals:* The microfoundations of the open source process depend on individual behavior that is at first glance surprising, even startling. Public goods theory predicts that nonrival and nonexcludable goods ought to encourage free riding. Particularly if the good is subject to collective provision, and many people must contribute together to get something of value, the system should unravel backward toward underprovision. Why, then, do highly talented programmers choose voluntarily to allocate some or a substantial portion of their time and mind space to a joint project for which they will not be compensated?
- *Coordination:* How and why do these individuals coordinate their contributions on a single focal point? The political economy of any production process depends on pulling together individual efforts in a way that they add up to a functioning product. Authority within a firm and the price mechanism across firms are standard means of coordinating specialized knowledge in a

highly differentiated division of labor, but neither is operative in open source. Instead, individuals choose for themselves what they want to work on. Money is not a central part of the equation. And any individual can freely modify source code and then redistribute modified versions to others. A simple analogy to ecology suggests what might happen over time as modifications accumulate along different branching chains. Speciation—what computer scientists call code-forking—seems likely. In effect the system evolves into incompatible versions. Synergies in development are lost. And any particular developer has to choose one or another version as the basis for his future work. This is essentially what happened to another major operating system, Unix, in the 1980s. How does the open source process sustain coordinated cooperation among a large number of contributors, outside the bounds of hierarchical or market mechanisms?

- *Complexity:* Software is an extraordinarily complex technical artifact. In *The Mythical Man-Month,* a classic study of the social organization of computer programming, Frederick Brooks noted that when large organizations add manpower to a software project that is behind schedule, the project typically falls even further behind schedule.[16] He explained this with an argument that is now known as Brooks's Law. As you raise the number of programmers on a project, the work that gets done scales linearly, while complexity and vulnerability to mistakes scales geometrically. This is supposed to be inherent in the logic of the division of labor—the geometric progression represents the scaling of the number of possible communication paths and interfaces between pieces of code written by individual developers. Chapter 3 considers in detail the deeper line of reasoning behind this argument, which is an incredibly interesting statement about the relationship between complex systems of meaning and the imperfections of human communication. Recognize for the moment the challenge it poses to organization. What is the nature of governance within the open source process that enables this community to manage the implications of Brooks's Law and perform successfully with such complex systems?

The book answers these questions by developing a multilayered explanatory model of the open source process. Throughout the book,

including the analytic history and descriptions in Chapters 2, 3, and 4, I portray open source as a social phenomenon, like any difficult collaborative project. It is also a political phenomenon because collaboration is governed by formal and informal institutions, norms, and conflict-management procedures. And it is self-evidently an economic phenomenon as well, in both the micro and the macro sense. At the center of the process are individuals who engage in some kind of cost-benefit analyses according to some kind of utility function. And open source has real implications for the organization of production, for corporate structures, and possibly for the economy as a whole.

All models simplify reality, and all analytic perspectives have baselines, be they implicit or explicit. My goal here is to take the political economy perspective seriously, but not too seriously, as a baseline. It would be taking it too seriously to posit that the lack of money is the big puzzle to be explained (although it is certainly part of the puzzle). It would be taking it too seriously to doubt or ignore what are obvious truths about people: Human beings often have a passionate relationship to their creative endeavors and their work; they wish to share their creativity with others; and value inheres in things other than monetizable rewards. Each of these attitudes exists within the open source community. But none of them is unique to that community or distinctive to the Information Age.[17] Human motivation and behavior is always and everywhere an elaborate mix of factors. An analytic perspective grounded in economic assumptions is a useful heuristic that helps to start structuring a story that explains that behavior. But a starting point is all it is.

The Bigger Picture

The other purpose of a heuristic is to open up discussion toward much broader questions that surround and embed the open source process. I will do that throughout this book in at least four general areas.

The first is simply the context of the Internet revolution. The collapse of the dot-com stock market extravaganza can lead to unadulterated pessimism that is just as intellectually diverting as was the irrational exuberance of the 1990s boom. Open source too has ridden some of the waves of public interest and hype over the last few years, with particular attention focused on Linux. Recognize right now that the future of the open source process is a bigger question than the future

of Linux. Linux will not last forever. Someone will break Linux up and use pieces of it as a tool kit to build another major operating system or something else. Remember what is potentially durable and possibly deserving of the term "revolutionary"—not a particular manifestation of a process but the process itself. After all, the logistics revolution was not any single container ship or a company building tractor-trailer trucks; it was a new way of moving goods around the world.

The rapid introduction into human affairs of extensive telecommunications bandwidth, configured as a neutral network, does not change everything.[18] But it does change some very important things about the constraints and opportunities that face individuals and organizations in the new economy. The open source story opens up a significant set of questions about the economics and sociology of network organization, not just network economics. And it demonstrates the viability of a massively distributed innovation system that stretches the boundaries of conventional notions about limits to the division of labor.[19]

There is a subtle but important point that will emerge here, overlapping with Lessig's case that in a computational environment, software code plays a structuring role much like law does in conventional social space. The open source process is a bet on the idea that just as important as the code itself and probably more fundamental is the *process* by which the code is built. Consider a slightly different analogy, to physical architecture, not law (after all, if Lessig had been an architect and not a lawyer, he would have probably emphasized physical structures and his book might have been titled "Code and Other *Buildings* in Cyberspace"). Stewart Brand wrote that "all buildings are predictions. And all predictions are wrong." His point is that some buildings are designed to "learn" from their users over time and others are not, and that matters much more in the long run than what the building looks like on the day it opens.[20] Human-computer interface designers are deeply aware of the fact that what they build embodies decisions about policy, and underlying that rights, values, and even basic philosophical views on human action in the world.[21] But they have paid less attention to the process by which those decisions about design are made. Open source is one sign that the information politics discussion is growing up and taking itself seriously enough to confront those tricky questions. Some of these questions and their evolving answers will have significant and long-lasting consequences beyond the lifespan of Linux or any other open source software program.

The second broad area is the evolving relationship between communities, culture, and commerce. The open source "community" (as it calls itself) is indeed marking out a set of organizing principles. These include criteria for entering (and leaving), leadership roles, power relations, distributional issues, education and socialization paths, and all the other characteristics that describe a nascent culture and community structure. At the same time the community is figuring out how it relates to commerce and the capitalist economy that embeds it. These characteristics are evolving and are not always transparent. And the technology that lies at the heart of the community sometimes distracts attention from what may become really important changes in the way people relate to each other around creativity and economic production.

Peter Drucker argues consistently that technology may change the costs of doing things but that is ultimately a marginal adjustment in political-economic behavior. What make a significant difference in human life are the ideas, theories, and institutions that are themselves a product of experimentation and imagination, of a different sort. The steam engine was the metal behind the first industrial revolution; but the revolution was a set of ideas about organizing factories, limited liability corporations, trade unions, and daily newspapers. The second industrial revolution was a story about the publicly traded corporation, the commercial bank, business schools, the professionalization of women, and so on. None of these is a technology, and neither is the open source process. They are ideas—ideas that create institutions and ways of organizing that were nearly unimaginable beforehand and nearly unrecognizable when they first emerged.

My point is that during the early stages of economic and social change, analysts often pay more attention to what is going away than what is struggling to be born. To use Schumpeter's phrasing, it is easier to see precisely the destructive side of creative destruction, than it is to see the creative side.[22] We know how the old and familiar institutions function and we know when they are being challenged. The significance and meaning of a new way of doing things is unfamiliar. That new way may not be a functional replacement for institutions that are being destroyed.[23] And there is always a great deal of noise that accom-

panies any signal. That counsels caution, but it also recommends an open attitude toward unfamiliar possibilities that demonstrate themselves even within relatively specific economic and social conditions.

The third general area is the nature of collaboration and production in knowledge-intensive economic processes. The software world is almost a limiting case for the study of knowledge economies, in the sense that it is made up of digitally encoded knowledge all the way through from top to bottom.[24] Production processes that evolve in this space are not a hard test of limits but rather a leading indicator of change and a place where experiments can be seen at a relatively early stage.

Open source is an experiment in social organization for production around a distinctive notion of property. The narrow problem in thinking about property is simply who owns what. Broader theories of property differentiate among bundles of rights—rights to access, rights to extract, rights to sell or lease other rights, and so on—that can be combined in different ways. While these differentiating arguments remain important, the open source process is experimenting with some of the most fundamental aspects of property. That is, what does it mean to "own" something? What rights does ownership confer upon whom and for what purpose?

The intuition around "real" property is that to own something is to be able to exclude nonowners from it. In practical implementations, of course, property often carries with it expectations and obligations as well as rights. But the right of exclusion is essential because it brings with it opportunities to sell access or transfer the right of exclusion to someone else, under terms that the owner can set. Free riding is an unfortunate imperfection that governance systems try to minimize. For intellectual property, copyright and particularly the fair use provision is a pragmatic compromise between the interest of the owner-creator in having exclusive rights and the aggregate interests of society in gaining access to ideas. This argument sounds intuitive, but it is not encoded in the facts of nature.

Open source radically inverts the idea of exclusion as a basis of thinking about property. *Property in open source is configured fundamentally around the right to distribute, not the right to exclude.* This places the open source process a step beyond standard norms of sharing in a conventional scientific research community. The entire research product

and the process of generating the product is made open; copying is allowed and encouraged; and under the most commonly used open source licenses, modifications and improvements of any sort must be given back to the community fully and without any restriction. It is almost as if the concept of fair use were extended without boundaries, along with a guarantee that no individual's fair use will be permitted to constrain subsequent fair use by any other individual, and for any purpose. What does "ownership" then mean, and what is the significance of free riding in this context? Ultimately the open source process poses a simple but provocative challenge: Is it possible to build a working economic system around the core notion of property rights as distribution? What kinds of characteristics would that system take on?

The fourth broad area is probably the most obvious. How big a phenomenon is this, and how broad is its scope? I argue in this book for the demonstrated importance of the minimum case. Even if open source were just a story about software, it would still be an interesting problem for social scientists thinking about large-scale cooperation. And it would still have significant implications for economic growth and development.

At the same time I build the contours of a more ambitious case: The open source process has generalizable characteristics, it is a generic production process, and it can and will spread to other kinds of production. The question becomes, are there knowledge domains that are structured similarly to the software problem? If we take the structure of the knowledge domain and the nature of demand that people have to solve particular kinds of problems in that domain as independent variables, then allow organization in the broadest sense (how people organize themselves to solve the problem) to be the dependent variable, can we sketch out some of the boundaries within which an open source–type process might work? In addition to the practical implications, this is a reasonably good test of how well we understand what makes the open source process succeed.