HISTORY OF INFORMATION TECHNOLOGY

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To understand the processes and impacts of a globalizing technology like the Internet, one must account for the historical development of that technology, the process of technology transfer in general, and the local cultural dynamics in unique regions. The Internet will diffuse differently in different regions and among different sectors within those regions. Chile, for historical and cultural factors, should demonstrate a different diffusion and use pattern than India or Kenya. This leads to different definitions of how Internet technologies are constructed within distinct regions and poses challenges for the development of a symmetrical global scientific community fueled by new ICTs. This last statement often weaves itself into the “taken for granted” rhetoric found in multi-lateral conferences like the World Summit on the Information Society (WSIS). It is simplistic to assume that the Internet will resolve inequities in social, political, economic and even scientific terms. It is a noble perspective, but the last 50 years of development failures based on other western technologies and protocols does not provide much optimism. The following session review highlights the complex factors involved in Internet diffusion, post war history, technological culture, case studies in the developing world, and innovations in technology research and development.

The session on History of Information Technology reflected many of the temporal, transnational and developmental dimensions of research in the information society. American scholars Martin Collins and Janet Abbate retraced the historical contexts of cellular and Internet technology research and development in the post war era. Collins discussed the ways Motorola’s transnational Iridium project was constructed by both Cold War political culture and post Cold War market culture notions of the global. Abbate reminded us that “Internet culture” finds its roots in the values of the research community that first conceived and then developed it. Brazilian scholar Celso Candido offered us an overview of the developmental constraints and potentials of Internet technology diffusion in his nation over the last quarter century. Brazil’s case mirrors many of the diffusion processes unfolding throughout the developing world. The session concluded with Swedish scholar, Mikael Snaprud’s overview of “open-source” platform support for collaboration in ICT training and research.

One World…One Telephone: The Iridium Satellite Venture and the Global Age[ii]

This paper explores the ways in which the boundaries among technology, politics, and concepts of the global were constituted through one of the grand business initiatives of the 1990s —the creation of a global, wireless telephone system via a network of 66 satellites in low-Earth orbit. This venture, initiated by Motorola in the late 1980s and developed through a start-up company called Iridium, represented the largest private capital investment initiative of the last several decades, as well as the largest private venture for a space technology project. The technical system's global scope was mirrored in its investment and business structure, as thirteen non-U.S. corporations and governments (including Cold War adversaries Russia and China) became partners in the project.

The Iridium case bridges two distinct technical and political cultures. Emerging at the end of the Cold War, Iridium had deep roots in that era's government-oriented approach to mega-technical projects—through strategies for managing big technology and through close connections to the US military. But as a privately financed and commercial venture, it exemplified the global market ethos that defined the 1990s. Through the development of a complicated, satellite-based telephony system and through the challenges of organizing an international business Iridium's history opens up the detailed ways in which market notions of the global were created and overlapped with Cold War conceptions of the global.

As a highly visible communications enterprise, Iridium became intimately linked with two ideological themes central to the period: The legitimization of national and transnational policies of deregulation and a belief in global communications technologies as bearers of liberal values and facilitators of individual autonomy. Motorola and Iridium used these technical-political resources to negotiate new sets of relations among their corporate partners, with national and international regulatory bodies, with U.S. agencies, with national governments, and other sites to shape an international framework favorable to their interests. Too, participating non-US investors and partners saw opportunity in Iridium to advance their own national and corporate agendas.

Iridium, thus, provides a telling window on how communications technology, markets, ideology, politics, and U.S. military interests mutually interacted over the 1990s to create particular concepts of the global. Moreover, this case suggests that the global as an intellectual construct and as a short hand for an international economic and political system needs to take into account discrete, purposive efforts to create the "global"—that this construct was not just a natural, 'ramped up' extension of pre-existing capitalism. Stated somewhat differently, the global as a construct is not monolithic, but is the product of multiple, specific undertakings. Viewed from this perspective the global is not (primarily) a problem in definition nor in its phenomenological effects in altering our perception of culture and the world, but a problem in history and politics: How did it happen and why?

The Iridium case focuses on elite rather than on "up from below" actions in constructing the global and highlights several connotations not emphasized in current literature. First, while the transition from Cold War to "post" at the end of the 1980s is an oft cited factor in shaping the global, its import is mischaracterized, giving preeminent emphasis to the erosion of nation state autonomy in face of transnational market forces. Yet Iridium fore grounded the persistence of a Cold War notion of the global, specifically of the US military's interest and actions in creating global technical capabilities—of which Iridium was one. Second, the global signified more than an abstract, amorphous transnational field of action. The global, for actors in the Iridium story, had a literal, concrete, ambitious meaning: creating and exerting control through technological means over the entire planet for military or markets ends. Third, implied in the preceding points, the global had two interconnected expressions, one rooted in military interests (primarily as represented by the US), another market-based, with the latter tending to obscure the former. Lastly, as an elite created instantiation of the global, the business venture fused together in pursuit of its goals a range of distinct instruments: technology, strategies of corporate organization, corporate lobbying (nationally and internationally), neo-liberal ideology, and adoption and use of academic concepts of culture—in short, its tools were heterogeneous and opportunistically applied.

Scientific Origins and Legacies of the Internet[iii]

Though the Internet today is a vehicle for commerce, entertainment, news, and personal communication, its origins lie in scientific endeavor, and it has been fundamentally shaped by scientific practices and values. The Internet was originally created to support scientists, and its technical design reflected the needs and abilities of this group. Many striking aspects of Internet culture, which have been celebrated as "virtual community," grew directly out of the scientific community's ideals of openness, collaboration, and sharing of data and resources. The composition of the early Internet community also mirrored the wider scientific community on which it was based: white, male, and somewhat elite, but also international in scope.

This paper outlines some problems and promises of the Internet's scientific legacy. While the Internet can no longer be managed as a scientific project, the scientific community offers expertise, values, and international networks that can contribute to solving to today’s policy dilemmas. At the same time, the experts who develop and promote information technology should be more diverse and inclusive than techno-scientific communities traditionally have been.

Scientific Origins, Design Choices, and Culture

The Internet's predecessor, the ARPANET, was built in the late 1960s by computer scientists funded by a US defense agency. The network had three goals: to save costs by allowing computers to be used more widely; to allow scientists to share resources such as specialized hardware, software, and data; and—most importantly—to strengthen the scientific community by making it easier for scientists to interact and collaborate. In the late 1980s the network was taken over by the civilian National Science Foundation and served scientists in a wide range of fields. While the original Internet was commercialized in the 1990s, next-generation projects such as Internet2 share a similar structure, funded by government (with private sector partners) and run by scientific and educational organizations.

As a scientific project, the Internet was conceived as an object of research as well as a tool for research, and was therefore designed to use cutting-edge experimental techniques and modes of analysis. To help explore the potential of this new technology, its creators made the Internet an open, modular, flexible, system that users could experiment with and modify. Its decentralized design contrasts sharply with most commercial products and systems, which tend to be closed and are designed to be “idiot-proof” rather than inviting users to modify them. The Internet’s creators assumed that users would be technically capable, creative, and trustworthy—in other words, scientists like themselves.

These design choices had important consequences. The long-term success of the Internet is largely due to its ability to grow and adapt to new infrastructure, such as Ethernet and wireless, and new applications, such as streaming video and peer-to-peer file sharing. The system’s openness to user experimentation encouraged grassroots innovations that became major applications, most notably the World Wide Web and more recently music-sharing, games, and blogs. On the other hand, the Internet's flexibility makes it unpredictable and hard to control. Its openness has made the Internet vulnerable to viruses and other attacks, spam, and fraud. Security measures have had to be retrofitted to reflect the reality that the Internet no longer serves just a community of colleagues but the entire world in all its diversity.

The culture of the Internet was also shaped by the scientific ideals, including openness, collaboration, and decision-making by consensus. This has led to an emphasis on nonproprietary technologies, applications for sharing information and collaborating, horizontal rather than hierarchical lines of communication, and a sense of “virtual community” online. The creators of the Internet also put in place a remarkable consensus process for technical decisions, which is still operative in bodies like the Internet Engineering Task Force. The IETF’s bottom-up, consensus-based style has worked remarkably well for developing effective technologies in a timely manner while avoiding control by a single company or country.

While the Internet began in the US, from early days the group that designed it reflected the global nature of the scientific community. Computer scientists from France, England, and Japan were involved in the design of the Internet protocols in the 1970s, and academic computer networks in Europe and Asia connected with the US Internet in the 1980s to provide international email networks well before the Internet itself had become global. Today’s next-generation Internet is also an international effort—though uneven levels of participation reflect the reality of unequal resources.

Conflicts and Policy Issues

The Internet's origins as a tool for scientists laid the groundwork for a flexible, expandable, robust system that has successfully served a much larger population. But policy issues arise from the conflicting needs and desires of the Internet's broader user base—including military, business, and ordinary users—and the need to expand and diversify participation.

Scientists’ desire to treat the Internet as an open experimental system has repeatedly clashed with the military interest in a stable and secure environment. In 1983, for example, the Defense Department split off the military users from the ARPANET to create a second network called MILNET, so that military users would not be disrupted by scientists’ experiments with the network. A more recent dispute has been over the use and export of encryption technology, which the US government has tried to restrict in the name of national security. Computer scientists have argued that such restrictions are futile (since strong encryption is already available outside the US) and have a chilling effect on scientific communication. There is also a gap in the US between the internationalism of the scientific community and the more narrowly nationalist outlook of the government. The US has been at odds with much of the world on issues such as technical standards, export restrictions for encryption, and the move to IPv6, which many countries see as necessary to create a sufficient supply of IP addresses (of which the US currently controls the lion’s share). Computer scientists have in some cases organized to insert the views of scientists into these political debates.

Habits of openness and sharing on the Internet also conflict with the desire of business interests for secrecy, closed proprietary interfaces, and tightly controlled dissemination of intellectual property. The 1970s saw debates over whether technical standards for networking should be proprietary or public, with the eventual triumph of the open TCP/IP standard thanks to US government backing. In the 1980s, tensions over business use of the taxpayer-funded Internet eventually led to its privatization and commercialization. More recent conflicts focus on intellectual property, such as the entertainment industry's push for harsh legal measures to restrict copying. Computer scientists have complained that these laws criminalize normal scholarly research and communication for scientists working in this area.

Finally, because the choice of Internet technology affects so many people, there is a need to make the communities that develop and standardize new Internet technology more diverse and inclusive than techno-scientific communities traditionally have been. The computer scientists who initially operated the network assumed that technical ability would provide the authority to make decisions about the development and administration of the system. This technocratic approach was not necessarily attuned to issues of democracy, justice, or the need to adjudicate between competing interests. To make the design process more democratic requires actively including voices who represent the wider community that will ultimately have to live with the technology. This should include ongoing efforts to get more underrepresented groups involved in science and to support participation by scientists who lack adequate infrastructure. In addition, governance mechanisms should recognize and accommodate political, not just technical, dimensions of design decisions.

Conclusions

One of the themes of the World Summit is that the Internet must be more inclusive. Without public debate on what the nature of the Internet should be, its future may be defined by the strongest actors, defaulting to a militarized, commercialized, and parochially nationalist space. The history of the Internet shows why scientists around the world must be included in the community actively shaping the future of the Info Society. It also suggests that a policy aimed at fostering the global Info Society should include measures to strengthen international scientific communication and to encourage local innovation with information technologies and services.

I suggest three ways in which scientists can positively shape the future of the Internet:

1. Design projects that focus on appropriate technology and include input from local user communities. One possible example is the Simputer, developed by the Indian Institute of Technology and private-sector partners, which provides a low-cost, low-energy Internet device that does not require literacy and can be easily shared by an entire village.

2. Build on existing professional networks. The scientific community has well-established international networks that can be channels for expanding Internet access and stimulating new types of services. Scientific groups have been the spearhead for many Internet projects in the developing world.

3. Participate in public debate on the future of the Internet. Scientists can bring a deeper understanding of the technical issues to public debate and can emphasize the value of open, international, non-commercial communication.

Brazil in the Information Society[iv]

The Information Society is an integrated and complex society. It is revolutionary compared to the industrial society because it brings about crucial changes concerning our ways of social communication and production, our ways of thinking and deciding. Information Society is situated in the post-industrial – maybe we could say post-capitalist - society context.

Brazil is the leader of one of the most important regions in the world. It is a very beautiful, wealthy and promising country, in spite of its enormous and dramatic socio-economical contradictions. Its wealth is based on the great intellectual, musical and physical creativity of the people, on its natural beauty and on the great power of the environment. It is also based on the power of its industry and agriculture, on its accelerated integration in the Information Society, and several other aspects. Because all of this, Brazil will surely play a capital role in the future of the planet.

Brazil occupies a very interesting and complex position in the Information Society. The information business in this county has developed productive forces in different areas, mainly in the industrial sector and in the service sector. In fact, Brazil has made a good jump into

Information Society in the last fifteen years, starting free and massive production and commercialization of personal computers from the late 80's and the World Wide Web in 1995.

No doubt, the increasing production and commercialization of PCs is to a great extent due to the expansion of Internet. But Brazil lived under a law of "protected market" for fourteen years, from 1977 to 1991. Nowadays, we can estimate that 30 million computers are installed in Brazil. However a considerable part of this development has happened or is still happening in the black market (about 65%). This digital cannibalism, strange though it seems, has helped the development of the main productive forces of the Information Society in Brazil.

Taxes, for example, are mostly organized via the Internet (about 95%). All large enterprises are being interconnected through the Internet and intra and extranet. The voting process in Brazil is totally computerized. With a population of about 200 million people and about 120 million electors, Brazil uses "voting machines" to define its executive and legislative government and carry out plebiscites. In a recent plebiscite, last October, for example, there were over 300 thousand (exactly 325.458) "electronic ballot boxes".

Scientific research in Brazil is also greatly computerized. All researchers have their electronic Curriculum on the Web, in a database of the National Center of Research (CNPq). All proceedings for budget to research happen on line, too. But, surely, CNPq doesn't have money for all the demands of the academic community. Brazil applied only about 1% of its Gross Domestic Product to research last year. Academic researchers have an online public database for publication and access to doctoral thesis and master dissertations at the Digital Library of Thesis and Dissertations (BDTD) of the Brazilian Institute of Information in Science and Technology (IBICT) that assembles about 30 universities and research institutions.

Remarkably, in January 1996, Brazil had about two hundred thousand people connected to the Internet. In 2000, they were about ten million. Nowadays, Brazil has about thirty million people connected to the Internet. All of the states in the federation are connected through a backbone with a speed that ranges from 4 Mbps to 622 Mbps. Young people account for an expressive appropriation of the Web in Brazil. About 37% of them are between 18 and 34 years old. This generation has a great participation in virtual communities like Orkut, instant messaging, sent/received e-mail and chat-rooms. They participate intensely in the creation of blogs, web sites, and so on. In June 2005, Brazil was first list of countries when people spend most time on residential navigation (about 17 hours). In the first quarter of 2005, 20% of residential navigation was related to virtual communities; 10% to e-mail use. Nowadays the Internet users have broadband connection. But, publicity investments in the Internet are still very low, corresponding to only about 2% of all publicity in the media in Brazil in April 2005. So, although much of the population is excluded, the most important social sectors are entering or are already in the Information Society.

No doubt, in Brazil the ways we do things are being changed quickly. But, as in other countries, it brings about dramatic and difficult situations of social and cultural marginalization. In Brazil the digital divide is enormous. On the one hand, this is due to our immense social divide: Brazil has high social exclusion and high concentration of wealth. On the other hand, though some political decisions have been made towards favoring "digital inclusion"[v], like "PC connected", "Free Software", "Telecenters", through the "Electronic Government project"[vi], they have not been effective in narrowing the digital divide.

Brazil has a good chance to integrate the Information Society and narrow the digital divide. To do this, we need, first of all, a public and private policy of high investment in research and education. But we also need some more general political decisions without which digital inclusion in Brazil is impossible. This is necessary in order to fight unemployment and poverty. We need to fight social misery and marginalization with a serious policy of *minimum income* and so reach a greater social harmony. Finally, knowledge became the infrastructural base of production, on which the main productive forces of contemporary society are developing. Information Society is very rich, because knowledge is its core commodity and knowledge is a very powerful good. It is a source of wealth that can be shared and is not used up. Thus, research became a strategic "tool" for production and digital knowledge engineering became a crucial question for contemporary society.

Therefore, we need a model for the formal and informal research and for education adapted to the *digital noolithic*, to the new digital economy and new digital culture. We need a global education for creativity, complexity and the essential knowledge focused on the great questions of human life. It means an ethics of social and environmental respect and responsibility. It must be the *ethics of research and digital knowledge engineering*. This is an Ethics to affirm life, justice, and beauty.

Open Source: Synergies in ICT Education and Research[vii]

Open Source Software already has a wide use in ICT education and research. In this paper we outline the current use and further synergies to be drawn from a tight integration of university level ICT courses with scientific research projects based on Open Source software and collaboration with the Open Source community. At Agder University College (AUC), we are not only using Open Source software and methods, we strive to achieve a close integration between our FOSS research and teaching activities - following the so-called research-based-education model.

The FOSS research at AUC is primarily dealing with meta-modelling and with access to Internet content for people with disabilities. Our main research project is the European Internet Accessibility Observatory[viii] (EIAO). The project both uses and produces Open Source software to develop machinery for web accessibility benchmarking. Based on the EIAO project we have defined a course called Webmining and Data Analysis.[ix] The course teaches the students basic skills in webmining techniques and Python programming which are used in the course to carry out software development projects. HarvestMan[x] is the Open Source web crawler used in the course. The same webmining techniques, Python programming and crawler are actively used in the EIAO project, which allows us to increase consistency and synergies among our teaching and research activities.

The webmining course illustrates how research activities can be used as a starting point for development of ICT courses. On the other hand, however, teaching activities might also be used as precursors for larger research efforts. A Master level project, recently initiated at AUC by Bruce Perens, on software defined radio based on GNU Radio[xi] may be given as a good example. The project attempts to build better user interfaces to the software defined radio components. As such, it develops the basics necessary for the development of more specific research activities concerning how measurement instruments, communication protocols, antennas, etc. may be implemented using Open Source software and Open Source hardware, providing a lower cost and skills threshold to fascinating experiments and research on wireless communications.

The benefits from using Open Source in education seem obvious for ICT courses where the students are allowed to gain a deeper understanding by viewing what is going on under the hood. In several courses we already see that Open Source enables a continuity of student projects and facilitates the collaboration with enterprises and authorities. Still, one semester is often too short to gain the thorough understanding needed to really do useful work in a project.

In our opinion it is important to stimulate involvement of the Open Source community in the research-based-education model. Such involvement may be stimulated by: definition of research proposals based on an Open Source policy (e.g., the EIAO project employs the Open

Source policy that allows for reuse of code and collaboration with the FOSS community), organization of workshops with a clear focus on Open Source (at AUC in the summer of 2006 we will have a conference focusing on Open Source in Education), close cooperation with external companies that use Open Source for their business to define student projects (many of the student projects at AUC are carried out as part of collaboration with local SMEs or larger FOSS community projects like Skolelinu[xii]), improvement of student project- documentation (at AUC we have developed a student report template to improve the quality and consistency of the documentation produced by the students).

It is important to note that the proposed research-based-education approach requires tools that would effectively support distributed collaboration in a similar way like Open Source development. One of our current research activities aims at developing such a tool that would enable effective use of collaborative annotation, a code version server, and trackers to support the development both of code and of teaching content. To support this development we have already migrated some existing courses to Open Source software such as Plone. We also plan to extend Plone for collaborative development of research projects and Open Content teaching material. All of the tools and templates used for teaching and for research are included in a continuous development cycle that is increasingly linked with external Open Source projects. The research-based-ed*ucation* approach can potentially release synergies among Open Source projects scientific research and university level ICT education.[xiii]

Conclusion

The session on History of Information Technology suggested that ICT histories, case studies of ICT adoption within developing nations, and studies on ICT innovations like "open source" contribute to an organic understanding of the Internet's potential and constraints as a developmental agent. Collin's portrait of the process of control that framed the Iridium project might be applied to the ways the Internet has been constructed as a global agent of power. This may explain why its diffusion has been much more tentative than global cellular penetration. Abbate adds to this the historical conflict in openness between scientific and political cultures. This may also explain the inertial experience of Internet global diffusion. Candido suggests that in unique settings like Brazil, the imperative of creating local capacity in Internet technology is sometimes a process of technological "cannibalism". But successful efforts in reducing digital divides do not always reduce social divides in class-conscience societies like Brazil. Open source initiatives such as those of Snaprud and his colleagues, maintain an optimism that the historical patterns illustrated by earlier speakers may be circumvented. Given access, traditional obstacles may melt as online research communities fulfill the legacy of diversity and inclusion described by Abbate.

Notes

[i] Authors in order of the section they contributed. The chapter was compiled and edited by Rick Duque.

[ii] This paper was presented by Martin Collins. For an extended version of the argument see Martin Collins, "One World… One Telephone: One Look at the Making of the Global Age, "History and Technology 21 (2005): 301-324.

[iii] Presented by Janet Abbate.

[iv] Presented by Celso Candido Azambuja.

[v] http://www.idbrasil.gov.br/

[vi] http://www.governoeletronico.gov.br/governoeletronico/publicacao/noticia.wsp?tmp.noticia=212&tmp.area=25&wi.redirect=MBDMQSUYMK

[vii] This paper was co-authored by Mikael Snaprud, A. Sawicka, A.B. Pillai, N. Olsen, M.G. Olsen, V. Laupsa, and T. Gjøsæter.

[viii] http://www.eiao.net, partially funded by the European Commission contract number 004526

[ix] http://www.eiao.net/webmining

[x] http://harvestman.freezope.org

[xi] http://www.gnu.org/software/gnuradio/

[xii] http://www.skolelinux.org/portal/

[xiii] We refer the reader to the Open Source research community (http://opensource.mit.edu/), and Open Course Ware, MIT (http://ocw.mit.edu/index.html). See also Derek Keats' article on "Collaborative development of open content," First Monday, Volume 8, Number 2 (3 February 2003), (http://www.firstmonday.org/issues/issue8_2/keats/) and the interview with Bruce Perens (14.august 2005) http://madpenguin.org/cms/?m=show&id=4921&page=2.