Chapter 9

New Must Have Applications

> The Internet can become anything we can imagine and program it to be.
>
> - Vinton Cerf [1]

The global Internet technology creates a new economics of sharing. It was designed for collaboration;[2] and - with fresh and bold thinking - a universe of new projects can develop this dimension, accelerate progress, and benefit people in all countries.

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[1] Vinton G. Cerf, "Foreward," in *Internet Dreams: Archetypes, Myths, and Metaphors*, ed. Mark Stefik (Cambridge, MA: MIT Press, 1996), ix.

[2] For history: Timothy Berners-Lee, *Weaving the Web: The Original Design and Ultimate Destiny of the World Wide Web* (New York: Harperbusiness, 2000).
Eric S. Raymond, *The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*, Revised and expanded ed. (Sebastopol, CA: O'Reilly and Associates, 2001). Linus Torvalds, "The Linux Edge," in *Open Sources: Voices from the Open Source Revolution*, ed. Chris DiBona, Sam Ockman, and Mark Stone (Sebastopol, CA: O'Reilly and Associates, 1999). Christos J. P. Moschovitis et al., *History of the Internet: A Chronology, 1843 to the Present* (Santa Barbara, CA: ABC-CLIO, Inc,., 1999).
M. Mitchell Waldrop, *The Dream Machine: J. C. R. Licklider and the Revolution That Made Computing Personal* (New York: Viking, 2001).

Chapter 9

I. The New Economics of Global Sharing

Imagine that one thousand colleges and universities form a cooperative, a Higher Education Channel (using Internet technology and a Website archive) to which each contributes six hours/year of its best material - an audio/slide tour of a special exhibit at the college art museum; a distinguished lecture; a concert by the college orchestra; a special conference; etc. Each member uses its own speakers budget and pays the cost to prepare its material to professional standards and submits it in standard format . . . In return for these six hours each year, it receives 5,994 hours each year of the best material from the world s other leading colleges and universities. A good return on investment - and a good example of how the Internet introduces a new economics that makes it rational to share on a global scale. [3] [4] [5]

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[3] Costs will vary, but a one hour presentation, videotaped and then lightly edited and digitized, might require 3-4 man-hours of professional time at $60/hour. Although it would be possible to spend much more.

[4] The alumni of participating institutions also would be eligible to receive the Higher Education channel and access its archive (for video-on-demand viewing) via Internet broadband. In tape-slide format if they have only 56Kbps dial-up connections, in full version when they have home broadband.

[5] Each participating institution would also receive good global advertising for prospective students, conveying the intellectual vitality and ferment on campus. The number of participating institutions could expand: The U. S., alone has 2,300 accredited four-year institutions of higher education - 13,800 hours/year: John

By contrast, imagine that a commercial company tried to negotiate royalty agreements for their best material with 1,000 colleges and universities; and then to make a profit by selling subscriptions. It would be an impossible task, and the company would be quickly bankrupt. Historically, the competitive market was championed as a new mechanism that could miraculously (to ethicists) transform individual selfishness (profit-maximization) into a common blessing.[6] Today, the global Internet becomes a parallel mechanism for progress that makes sharing into rationally self-interested behavior; it multiplies the individual and common benefits of sharing anything that can be put into a digital form

Once upon a time, a book or CD or DVD or a videotaped lecture had to be in one physical location, and it could be used only by one person at a time. Yet put the same book, CD, DVD, or lecture online, and it can be distributed globally, inexpensively, and used (today) by 500+ million people, without any diminution of the earth s resources.[7] All of the important costs are fixed costs. As economists teach us, the best rule for efficiency is price = marginal cost and marginal cost= almost zero. As Cairncross has suggested, global

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W. Wright, ed., *The New York Times Almanac 2002* (New York: Penguin, 2001) 357.

[6] Albert O. Hirschman, *The Passions and the Interests: Political Arguments for Capitalism before Its Triumph*, 20th anniversary ed. (Princeton, NJ: Princeton University Press, 1997).

[7] See the discussion of nonrivalry, nonexcludability, positive externalities and related issues in: Debora L. Spar, "The Public Face of Cyberspace," in *Global Public Goods: International Cooperation in the 21st Century*, ed. Inge Kaul, Isabelle Grunberg, and Marc A. Stern (New York: Oxford University Press, 1999).

distribution will cost less than sending the bill.[8]

Consider another example of sharing by the Massachusetts Institute of Technology (Box 9-1). MIT will put the readings, lectures, and other material of 2,000 courses online for global access, without charge. They are sharing their resources for science education - for bright high school students and colleges in all countries, and for anyone else who is interested. The project embodies leadership to develop the spirit of sharing - an expectation that within ten years scientists and institutions in many parts of the world also will be putting their own resources on-line. The analogy is the magnificence of the Medieval Cathedral, created jointly for everyone, with each contributing an individual part.

In a quotation at the beginning of this book, I cited the forecast of the political scientist Ithiel de Sola Pool: *People who think about social change in traditional political terms cannot begin to imagine the changes that lie ahead.* He was right: Traditional political theorists will not know what categories to use for the MIT initiative. It is not an NGO - there is no name for a globe-spanning institution. It is not an international regime with rules or that seeks to limit or control behavior.[9] It is not Left or Right - pro-government or pro-

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[8] Frances Cairncross, *The Death of Distance: How the Communications Revolution Will Change Our Lives* (Boston, MA: Harvard Business School Press, 1997). For large-scale distributions, a hub-and-spoke design or regional caching/mirror sites can be used so that, for example, if the contents of a video file are intended for 5 million people in India, only one copy needs to sent from the US.

[9] Although what is shared may be similar - a spirit, vision, or

market. It is not clear that it is elitist or radically egalitarian, or serving the imperial interests of globalizing corporate capitalism or empowering individuals.[10] Those are old categories and lack a clean fit; the splendid MIT initiative is from a different dimension - what is gaining force in the world is a spirit of action, whose contribution is creative, and calling forth the same remarkable spirit of collaboration, contribution, and accomplishment.[11]

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conversation/discourse. See: Oran Young, "Global Governance: Toward a Theory of Decentralized World Order," in *Global Governance: Drawing Insights from the Environmental Experience*, ed. Oran R. Young (Cambridge, MA: MIT Press, 1997), 298.

[10] Michael Hardt and Antonio Negri, *Empire* (Cambridge, MA: Harvard University Press, 2001).

[11] MIT will place the course materials (including lectures) on the Internet as resources, but will not teach courses on-line. Most experiments to teach college courses online for credit have not been profitable: Katie Hafner, "Lessons Learned at Dot-Com U.," *The New York Times*, May 2 2002. Especially if the problem of telepresence is solved, the use of the Internet to improve traditional distance learning probably will serve an important niche market.

Box 9-1

MIT plans on Wednesday to announce a 10-year initiative, apparently the biggest of its kind, that intends to create public Web sites for almost all of its 2,000 courses and to post materials like lecture notes, problem sets, syllabuses, exams, simulations, even video lectures. Professors' participation will be voluntary, but the university is committing itself to post sites for all its courses, at a cost of up to $100 million... .

[I]s the Institute worried that MIT students will balk at paying about $26,000 a year in tuition when they can get all their materials online? "Absolutely not," [President Charles] Vest said. "Our central value is people and the human experience of faculty working with students in classrooms and laboratories, and students learning from each other, and the kind of intensive environment we create in our residential university."

"I don't think we are giving away the direct value, by any means, that we give to students," he said. "But I think we will help other institutions around the world." . . .

"This is a natural fit to what the Web is really all about," Dr. Vest said. "We've learned this lesson over and over again. You can't have tight, closed-up systems. We've tried to open up software infrastructure in a variety of ways and that's what unleashed the creativity of software developers; I think the same thing can happen in education."

In fact, MIT is a hotbed of the "open source" software movement; and this new Internet initiative is based on a similar idea, said Hal Abelson, a professor of computer science and engineering who is involved in both.

"Fundamentally, they proceed from the same ethic, which has to do with sharing," Professor Abelson said. "In the Middle Ages people built cathedrals, where the whole town would get together and make a thing that's greater than any individual person could do and the society would kind of revel in that. We don't do that as much anymore, but in a sense this is kind of like building a cathedral." . . .

Over all, the vision for 10 years from now, Provost [Robert A.] Brown said, was "a world in which you'll find students able to search what will be huge repositories of content" and "they'll be able to use content from many places educationally, and we'll be using other people's as much as they'll be using ours."

- The New York Times (2001)[12]

[12] Carey Goldberg, "Auditing Classes at MIT, on the Web and Free," *The New York Times*, April 4 2001.

Such projects for sharing and collaboration can be created for every activity: This chapter provides examples that permits thousands or hundreds of millions of individuals and institutions to participate and benefit. (I will use the term must-have applications because, once they are created, I think everyone will want to have them.)

This chapter also discusses the new economic resources that can become available to support the new era of bold, global, and affordable projects. I will suggest several of these possible sources later in the chapter - but just to preview the new dynamic: a $60 million investment to create an online library of the best 40,000 books in 320 fields might be an attractive project, and a convenience, for Americans alone; it becomes an even more attractive (and compelling) project when the same philanthropic investment is multiplied by bringing the resources to (soon) several billion people, many of whom are literate (India is economically poor, but 2/3 of the adults in India are literate)[13] yet have no access to any libraries or income to purchase books.

[13] See www.britannicaindia.com/eb/demo.asp

Chapter 9

Table 9 -1

Examples of Must Have Projects

- Cultural Affairs Channel
    - New sources of financial support

- Global Tuesday brownbag (Inventions Wanted . . .)

- Visual Display Systems For Global Projects

- Global Virtual Library
    - Financing via a 1% startup tax, public library systems
    - Singapore model

- Stakeholder-supported CSPANS & Research Collaboration Systems
    - Renewable Energy Research
    - Global Grand Rounds & Biomedical Research
    - Education research (e.g., teaching foreign languages)
    - Spiritual growth
    - Conflict resolution and human rights

II. Examples of Must Have Applications

A.) Cultural Affairs Channel

Proposal: A Cultural Affairs Channel (and Website archive). A basic startup grant of $15,000 to one leading cultural institution (e.g., the national museum) in each of 189 countries. The

grants are used to digitize fifteen hours/year of current lectures, symposia, and exhibit tours concerning their national history, cultural heritage, their visual and performing arts, etc. Grants also can be used to develop a Web site and on-line ordering from the institution.

The Cultural Affairs Channel will be a global cooperative. The contributions from all countries can be accessed, via the Web site of their national participating institution, by citizens in every country.

With 189 countries and 15 hours from each country: there are 2,800 hours/year of high quality cultural programming from the full range of the world s cultures available worldwide without charge. The startup/authoring technology grants for the cooperative would be inexpensive: $15,000 for each participating country would be $2,800,000. A similar grant could be made each year, and as financial support for the global Cultural Affairs cooperative increased (see below) additional institutions and projects could be added in each country.

1.) Expansions

It would be easy to expand the programming, by the same logic of sharing. For example: The U.S. Department of Education provides competitive grants of about $21 million each year to underwrite 119 National Resource Centers in international studies (e.g., Africa, Middle East, East Asia, Europe) at American universities. The grants include money for public lectures and outreach programs.[14] It would

[14] There are National Resource Center grants for Africa (11), Asia (1), Canada (2), East Asia (15), Inner Asia (1),Latin America (19), Middle East (14), Pacific Islands (1), Russia/Europe (1), Russia/East Europe (15), South Asia (9), Southeast Asia (8), and Western Europe

be a simple step to ask each Center to expand its outreach program by sending the lectures, in standard format, to the Cultural Affairs Channel. Interested foundations could make $15,000 startup grants to counterpart academic Centers at institutions in other countries (so that, for example, the result is not simply American academics talking to American academics about Chinese history and culture - Chinese discussions of their history and culture can be included. And Americans can learn what Chinese scholars, lecturing about American history or politics, believe.)[15]

- Another step: an invitation to all US cultural institutions that receive public subsidies (e.g., museums, art galleries, professional theaters, symphonies, and dance companies) to contribute, in return, one selection each year from their best material for the public domain and the Channel. Invitations also might go to the State Councils supported by the National Endowment for the Humanities. (A recent list identifies 42 notable professional nonprofit theater companies in the US, 102 notable symphony orchestras, 101 dance companies, and 99 opera companies.)[16] [17]

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(5). In addition, 8 Centers receive broader federal grants for Centers for International Studies. Source: U. S. Department of Education. Center for International Education, *National Resource Centers (NRCs) and Foreign Language and Areas Studies Fellowships (FLAS) Program. FY 2000 - FY 2002* (Washington, DC: U. S. Department of Commerce, 2000).

[15] It may be easier to organize this as a separate project - for example, of specialty societies.

[16] William A. McGeveran Jr., ed., *World Almanac and Book of Facts 2002* (New York: World Almanac Books, 2002) 271-73. There are 74 notable museums. My list also excludes zoos, aquariums,

2.) New Sources of Support

The new economic truth - that any online resource is a global resource - opens a new dimension for support for a Cultural Affairs Channel and many other projects from the same mold.[18] At least a dozen global corporations have sales that exceed the GDPs of half

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arboretums and botanical gardens, and planetariums, who also might participate: it might be best for a national initiative, perhaps via Smithsonian Institution and/or PBS broadband.

[17] Their participation could help many institutions and lesser-known artists to become better-known and, as technologies evolve, they could operate Web sites and subscriptions series to their full season.

[18] To encourage philanthropy from the telecommunications industry, there also can be political requirements, especially for satellite owners who use such public resources as radio frequency spectrum and satellite parking orbits without charge. Our domestic CSPAN is an example: it is supported by annual voluntary donations from the cable industry, provided in lieu of regulatory requirements.

The US government and industry have a brilliant political record in promoting global deregulation of the communications industry, but the US government has remained silent at the International Telecommunications Union about global civic obligations of the new multibillion dollar global communications oligopolies. There has been a legitimate fear that any public discussion of international public service obligations would open the door to political abuse, as hundreds of local claimants step forward in almost 200 countries (including, in addition to legitimate causes, profit- seekers waving idealistic banners, suspect advocates of political fairness and other mischief from the earlier days of UNESCO's history, etc.) and threaten to reinstate government regulation.

the world s countries.[19]

Proposal: That globalizing companies voluntarily allocate 1% of their advertising budgets to Internet-based projects of their own choosing that benefit people in all countries.

Table 9-1 surveys the broader potential of advertising budgets: The 20 top advertisers in the US spend more than $37 billion annually. A 1% reallocation of their advertising budgets for Internet-based projects would yield $370 million/year. Our top three automobile advertisers (GM, Ford, Daimler-Chrysler) spend more than $7 billion, and 1 % would be $70 million. (For comparison, recall from chapter eight that the Annenberg Channel and Website to improve the quality of American teaching, K-12, costs only $15 million/year. And a Health Channel would be in the same range.) The Big Three and their stockholders could get a lot underway and still have funds remaining.[20]

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[19] Joseph Nye, *The Paradox of American Power: Why the World's Only Superpower Can't Go It Alone* (New York: Oxford University Press, 2002) 74.

[20] Advertising expenditures: Wright, ed., *The New York Times Almanac 2002* 354-55.

Table 9-1

Top 20 Domestic US Advertisers (2001)[21]

Rank	Company	Media Spending Inside US (millions)
1	General Motors	$3,935
2	Philip Morris Cos.	2,603
3	Procter & Gamble	2,364
4	Ford Motor	2,345
5	Pfizer	2,265
6	Pepsi	2,101
7	Daimler/Chrysler	1,964
8	AOL/Time-Warner	1,770
9	Walt Disney	1,758
10	Verizon	1,613
11	Johnson & Johnson	1,601
12	Sears, Roebuck	1,455
13	Unilever	1,454
14	ATT	1,416
15	General Electric	1,310
16	Toyota	1,274
17	McDonald s	1,274
18	US Government	1,246
19	Sprint	1,227
20	Viacom	1,221
	Total	$37,216

[21] Source: www.adage.com/datacenter.cms. Accessed March 31, 2002.

A substantial part of corporate advertising is image advertising. (Intel spends almost $1 billion/year on advertising but does not sell its chips directly to consumers.) New Internet-based opportunities to benefit people in all countries should be an attractive use for these advertising dollars, especially for cooperative projects like a Cultural Affairs Channel, where the project also conveys respect to the peoples in all countries in which the company does business.

Table 9-2 suggests an additional source of support by redirecting funds from a portion of the 30-second ads on American prime-time television shows. By now, does anyone truly remember who sponsored what show? Or a single ad from the barrage during the last season? Would not any leading company be better served (and feel proud) by having its name associated with a bold, exciting, initiative that benefits the entire world? With about eight minutes (sixteen 30-second ads) per weekly episode, the sponsors of one season s ER could pay for the startup of a domestic Health Channel (chapter eight) and make it available globally to an additional 100,000 health sites in the Third World to assure basic international availability. And there are likely to be other advertisers who will continue to sponsor the ER television show.[22]

Table 9-2

Price of 30-Second Ads
TV Network Prime-time (US), Fall 2001[23]

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[22] Louis Chunovic, "TV Clutter Reaches All-Time High," *Electronic Media*, March 11 2002.

[23] Source: Electronic Media, "Fall 2001 Network TV Price Estimates," *Electronic Media*, October 1 2001, 26.

Show	Cost of a 30-second spot ad ($)
Survivor	$445,000
ER	425,400
Who Wants to Be a Millionaire	115,600
Friends	353,600
Monday Night Football	330,200
Everybody Loves Raymond	305,600
Law and Order	116,800
The Practice	263,800

Table 9-3 shows the world s top 20 corporate advertisers outside the United States. They spend more than $20 billion/year (Procter & Gamble in 66 countries; Coca-Cola in 63; Nestle in 53; McDonalds in 48). If these companies see Internet-based global projects that they would like their companies to be associated with, the 1% annual shift of advertising budgets to these new options would provide $200 million/year. More than enough to enrich the lives of every-body in the world - a goal that starts to become realistic when combined with village-level linkups in the Third World secured at marginal cost by a purchasing cooperative (chapter six).[24]

[24] Extending the list to the top 50 companies for non-US international advertising gives a total of about $32 billion/year; 73 international companies spend more than $100 million/year on advertising outside the United States.

Table 9-3

Top 20 Global Advertisers -
Media Spending Outside the US (2000)[25]

Rank	Company	Media Spending Outside US (millions)
1	Unilever	$ 2,967
2	Proctor & Gamble	2,610
3	Nestle	1,560
4	Toyota	1,345
5	Volkswagen	1,290
6	Coca-Cola	1,176
7	Ford Motor	1,127
8	General Motors	1,028
9	PSA Peugeot Citroen	1,004
10	Fiat	988
11	Renault	914
12	L Oreal	913
13	Kao Corp.	715
14	McDonalds	694
15	Mars Inc.	692
16	Vodafone Group	673
17	Nissan	665
18	Henkel	654
19	Ferrero	633
20	Sony	556

[25] Source: www.adage.com/datacenter.cms. Accessed March 30, 2002.

TOTAL $22,204

- Many similar projects for sharing and collaboration can serve global niche markets and be attractive for support from corporate advertising budgets. Would it be a good idea to start a global virtual university for computer science? Intel (#40 for US domestic advertising), Microsoft (#34), and IBM (# 22) spend about $3 billion/year on advertising in the US: a 1% shift gives $30 million/year, more than enough for an Annenberg-level startup.[26] Today many students, in many countries, still must view the computer revolution from afar. An opportunity to listen-in, and participate - like the opportunity that two high school students, Steve Jobs and Steve Wozniak, had to sit-in and participate at meetings of the Home Brew Computer Club at Stanford - could be an opportunity to change lives and the future.

The opportunity to organize boldly, on a global scale, is relatively new and may require a psychological shift: Only yesterday, the ideas in this chapter might have seemed cosmic and too big to be realistic. Today, the leaders of many corporations think globally and there can be creativity and organizing from many new actors: The new world leaders may include creative employees of four global firms, Omnicom Group and Interpublic Group (New York), WPP Group (London), and Publicis (Paris) who control more than half of the world s $500 billion/year advertising industry.[27] Their ability to put

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[26] Grants for a cooperative CSPAN also could put state-of-the-art conferences and lectures from leading research centers (IBM-Yorktown, Xerox-PARC, MIT, Stanford, Carnegie-Mellon) on-line for everybody.

[27] Stuart Elliott, *Advertising's Big Four: It's Their World Now*

together visionary (global and niche) projects for their clients could change the future.

B.) A Tuesday Global Brownbag: "Inventions Wanted . . ."

> A natural resource . . . probably the most important one of all - our own ingenuity.
>
> - Willy Ley, Engineers Dreams[28]

> The economic payoff from more social investment in basic research is as clear as anything is ever going to be in economics.
>
> - Lester Thurow[29]

Historically, cross-breeding communication networks spark creativity and rapid-discovery science.[30] One of the most exciting

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(New York Times (online), March 31 2002 [cited March 31 2002]).

[28] Willy Ley, *Engineers' Dreams* (New York: Viking, 1954) 236.

[29] Lester C. Thurow, *Building Wealth: The New Rules for Individuals, Companies, and Nations in a Knowledge-Based Economy* (New York: HarperBusiness, 1999) 113.

[30] Donald T Campbell, ., "Blind Variation and Selective Retention in Creative Thought as in Other Knowledge Processes," *Psychological Review* 67 (1960).
Randall Collins, *The Sociology of Philosophies: A Global Theory of Intellectual Change* (Cambridge, MA: Harvard University/Belknap Press, 1998) 523-69.

uses of the Internet would be to build upon this lesson and experiment with large-scale (global) collaboration systems to accelerate the creative process.[31]

Proposal: A global colloquium series, a Tuesday brownbag: "Inventions Wanted . . ." Leading scientists, engineers, or mathematicians in a specific field will discuss the inventions or breakthroughs they are trying to achieve - and (especially) where they are stuck.

Topics will be chosen by five criteria:

- the potential of a breakthrough to contribute to a solution of an urgent global problem

- the availability of leading scientists, engineers, and mathematicians willing to be involved to develop a global briefing for other scientists.

- The potential benefits of fresh thinking and ideas drawn from across disciplinary boundaries and from outside already-established networks of communication.

- The potential benefits of enrolling new researchers and students to explore lines of investigation that exceed the manpower currently working on the problem.

- The existence of important theoretical issues or a class of

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[31] The tidal wave of information for scientists in the most advanced and well-funded countries quickly becomes a drought that limits accomplishments of scientists and students elsewhere.

important problems for which a breakthrough would have wide impact.

The Inventions Wanted . . . global brownbag could generate a degree of excitement (and opportunity to kibbitz) that no scientist would miss. Discussions of a malaria vaccine might suddenly engage a senior researcher in Kenya, a graduate student at Moscow University, a biochemist in southern China, an R&D startup in India, a geneticist at Berkeley, a mosquito specialist (innoculate the mosquitos) at NIH. With a written record of email discussions, scientific priority would be recognized by global networks who know that scientist x was the first to suggest a new line of thinking.

- For example, it would be attractive to gene-splice seaweed and cash crops, thereby being able to plant the deserts, irrigate with salt water, remove the salt biologically - and make the deserts bloom. A few people are trying to do this, but everything they have invented tastes terrible . . . and thereby begins a global process of scientific engagement and creative potential . . . Put it on the Internet, on the global Tuesday brownbag, and you may inspire a graduate student to do a thesis topic that solves the problem - or inspire a newly-retired Baby-Boomer scientist looking for an interesting and worthwhile project. Or discover that there is a unique species of seaweed, known only to specialists in a remote location of northern Japan, that would be an ideal candidate for experimentation . . .

The next week, a Tuesday session could focus on new ideas for a breakthrough in desalinization technology.

- Another example: the possibility of tapping zero-state energy in the universe (which nobody knows how to do).

- Another example: It is typical to discuss soil chemistry by reference to inorganic chemicals - e.g., this soil needs more nitrogen or phosphates - and to the application of chemical fertilizers to effect a change. However scientific analysis of highly fertile soils now shows that a wide range of microbes make a contribution. And one research project has recommended that a selection of 27 different microbes now might be packaged together in a nutrient solution, sprayed onto soil, multiply, enjoy a life in ecological balance, vastly enhance soil fertility, and reduce the need for commercial fertilizers to 1/3 or less.[32]

The special excitement of such a high-visibility global colloquium - as any scientist will recognize - is that the mixture, SC27, is only a *first draft* . . . and research scientists and undergraduates, backyard inventors and venture capitalists around the world can immediately begin to use SC27 as a jumping-off point, testing how it could be improved upon for different initial soil and climate conditions, crops, and other variables.

- There can be a long list of other topics. For example, the Seven Unknowns of chapter four suggest inquiries that could change the world - telepresence research, for example. Or holographics. Or new ideas for the nature of entertainment and accelerating the creative process in the humanities and performing arts.

It would be easy to organize support from governments, foundations, and R&D-oriented corporations for a series that nobody would miss.

C.) <u>Visual Display Systems for Global Projects</u>

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[32] Initial marketing by Martin Marietta Technologies.

Proposal: New online visual display systems for global projects.

For example, Table 9-4 lists the Millennium Development Goals adopted by 189 members of the United Nations General Assembly in September 2000.

Table 9-4
UN Development Goals for 2015[33]

1. Eradicate extreme poverty and hunger

" " Halve the proportion of people with less than one dollar a day.

" " Halve the proportion of people who suffer from hunger.

2. Achieve universal primary education

" " Ensure that boys and girls alike complete primary schooling.

3. Promote gender equality and empower women

" " Eliminate gender disparity at all levels of education.

4. Reduce child mortality

" " Reduce by two thirds the under-five mortality rate.

5. Improve maternal health

" " Reduce by three quarters the maternal mortality ratio.

6. Combat HIV/AIDS, malaria and other diseases

" " Reverse the spread of HIV/AIDS.

7. Ensure environmental sustainability

" " Integrate sustainable development into country policies and reverse loss of environmental resources.

" " Halve the proportion of people without access to potable water.

" " Significantly improve the lives of at least 100 million slum dwellers.

8. Develop a global partnership for development

" " Raise official development assistance.

" " Expand market access.

" " Encourage debt sustainability

[33] Source: www.worldbank.org.

These global projects can be quantified and the progress can be monitored on visual displays.

For example, 20% of the world s population (45% in sub-Saharan Africa) still lacks clean drinking water. Online maps could display, in red, each village in every country where the problem remains unsolved.[34] Then the colors of villages, and eventually entire geographic regions, could change as the problem is solved. The online War Room display systems also can provide links to information about each village, the name of any NGO that has identified a way to solve the problem of that village, and the resources that it needs - for example x hundred dollars to dig a deep well; or for a solar-powered filtration device for drinking water.

Thus, every individual and organization who wants to help with the UN Millennium projects can do so. Every Monday morning, the first thing they can see when they turn on their computer is a pop-up display of the rate of progress (or lack of it). Soon, I think we will find that the official goals that governments ratified through the United Nations and World Bank are more modest than they should be: We probably underestimate how much capability we have, once democratic power can be brought online.

D.) Global Virtual Library

Proposal: A Global Virtual Library, beginning with the best 40,000 books in 320 fields and expanding to include all media. Access to the GVL would be free to any individual with a public library card: payment of royalties will be organized through public library systems.

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[34] See www.worldbank.org

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A Global Virtual Library is an obvious step: a capacity to send all of the world s printed material everywhere in a few minutes is useless if there is nothing online to send.[35] The project is feasible with current technology, although broadband will make it possible to download books more quickly.

The project can be based on the encyclopedic Reader s Catalog, co-founded by an editor of the New York Review of Books, which recommends the 40,000 best books in 320 categories, selected by academics, critics, and writers.[36] (The Gutenberg Project and other initiatives already have almost 2,300 classics online and available without charge.)[37]

Run the numbers: At $1,500/volume, the cost to digitize the best 40,000 will be $60 million.[38] About what each major corporation

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[35] The Coalition for Networked Information, www.cni.org, is a leading clearinghouse for discussions of these and related topics.

[36] Geoffrey O'Brien, ed., *The Reader's Catalog: An Annotated Selection of More Than 40,000 of the Best Books in Print in over 300 Categories*, Second ed. (New York: RC Publications, 1997).

[37] See one listing of such resources by the Hart Library at www.worldwideschool.org

[38] Such an investment, alongside a royalty arrangement for use of copyrighted material in advanced countries, could include an agreement that libraries and schools in the world s poorest 117 countries will have free access until they pass a specified GDP/capita. So far as I am aware, no major publisher expects to make any significant profit from sales to these countries, so the actual cost of this agreement is zero.

spends to be one of the sponsors of an Olympics game. Such a donation to get a global virtual library underway would be an historic contribution to the world, and long remembered.[39]

1.) How Will Royalties Be Paid?

Royalties for copyrighted work can be collectively negotiated and paid by subscription through public libraries in advanced GDP nations, who will vastly expand the services available to their users. (In the United States there are about 9,800 public libraries (main + branches = 16,180) spending about $7 billion/year).[40] Users would access the global virtual library via the Web page of their local library. Each library would handle record-keeping and would forward aggregate information to a central office for annual payments of royalties. (Such payment systems are straightforward. Royalties are paid for music broadcast over radio, with logistics handled through a central clearinghouse.)

Current sales of the 40,000 books can be established, and fees can be paid to compensate the publishers for any significant decline in their hard-copy sales. They (and the original authors) also will receive a new and continuing royalty income from the library-based uses of the digitized versions (i.e., that will have been produced without additional cost to the publisher.) It is not clear that the individual royalty payments need to be large for most individual

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[39] Richard Sandomir, "Sports Desk: Olympics: Salt Lake Games End; Marketing Games Begin," *The New York Times*, February 27 2002. US sponsors included AT&T, Bank of America, Anheuser-Busch, Delta Air Lines, and Home Depot.

[40] U. S. Census Bureau, *Statistical Abstract of the United States: 2001*, 121 ed. (Austin, TX: Hoover's Business Press, 2002) 718.

items. In practice, it seems possible that, once readers have evaluated the convenient online versions, the actual annual sales of hard-copies of most of the books are likely to increase - the global virtual library could include One-Click ordering accounts. If so, safety net payments would be unnecessary.[41]

2.) How About Other Books?

OCLC, the world s largest library consortium serving 82 countries, has about 46 million unique bibliographic records in 400 languages.[42] Assume $100/item for high-speed scanning: $4.6 billion will achieve the goal. (This provides a page-image format, which requires much more storage but it will be more cost-effective for most of these items, that will have limited use. High-use items can be retyped or converted to text after scanning - perhaps at $1,500/volume including proofreading, the high-end estimate for the initial 40,000 (above); the text-based format will be more effi-

[41] Given changes in printing methods, many of the volumes already may be available in electronic form in standard formats.

[42] www.oclc.org

cient to store and transmit.)[43] [44]

3,) Is This Feasible? Will Publishers Agree?

Publishers (and authors) should be delighted, especially if there is a no-loss guarantee. A model already is operating in Singapore. There , registered library users can read any of 10,000 reference books on-line and 13,000 magazine titles without charge. (As the Director of Development said, If you don t go to the library, it now comes to you.) Downloading copies of magazines and journals will cost from $1.40 - $2.80. The library also will permit users to create a personalized virtual reference shelf, to make it easy to use their frequently consulted sources. It is building new educational capabilities - e.g., a video-on-demand capacity to transmit 900 educational video and 700 CD-ROM titles, such as Discovery Channel programs, to users PCs through broadband connections.

4.) What About Periodicals and Scientific Journals?

Scientific and professional journals should be available online

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[43] A typical journal page, scanned at 600 dpi and compressed in Group 4 Fax/TIFF format takes up about 100KB (kilobytes), and storing and downloading a 10 page article in image format would involve 1 MB, about 8 Mb (megabits): John Chung-I Chuang and Marvin Sirbu, "Network Delivery of Information Goods: Optimal Pricing of Articles and Subscriptions," in *Internet Publishing and Beyond: The Economics of Digital Information and Intellectual Property*, ed. Brian Kahin and Hal R. Varian (Cambridge, MA: MIT Press, 2000), 158.

[44] We may not want 46 million items online. It can work better for a scholar to travel to a special collection, meet with librarians, browse through dust-covered boxes, etc.

without charge: Almost all of the reported research is paid by the governments, and the journal publishers are already making a profit through subscriptions - i.e., they have a strong case for a stop-loss system that prevents them from losing money, but a much weaker case to make additional profit.[45]

A reasonable formula, adopted by the magazine Science (American Association for the Advancement of Science), helps to preserve subscription and advertising revenue: It requires a journal subscription for online access to current issues (first year) and then makes all issues publicly available online without charge. For Third World students and research scientists, the flood of journals in the United States is a drought - and the online version is the only version they can read, and there is unlikely to be any significant loss of revenue by permitting their libraries to offer access to online versions free, without delay.

The same formula probably would work for all periodicals: Users could read current issues online if (like using a physical copy) they are the only online user; if they wish immediate access and/or to download a copy, there will be an added fee. Older issues can be searched and read online without charge to the individual.

5.) Should There Be Changes in Copyright Laws?

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[45] For overviews of these issues: Jeffrey K. MacKie-Mason and Juan F. Riveros, "Economics and Electronic Access to Scholarly Information," in *Internet Publishing and Beyond: The Economics of Digital Information and Intellectual Property*, ed. Brian Kahin and Hal R. Varian (Cambridge, MA: MIT Press, 2000). Chuang and Sirbu, "Network Delivery of Information Goods: Optimal Pricing of Articles and Subscriptions,".

It will be helpful for every nation to change its copyright laws to require that all publishers above a certain size also submit a copy of a work to be copyrighted in a standard digital format. This already-digital version will automatically enter the public domain when a copyright expires - thus (albeit with a substantial lag) putting a cap on the long-term expenditures for digitizing library material.

The new copyright requirements also will give all publishers the necessary nudge to create such digital versions - and incentives to explore how they can receive income from these digital versions while they hold the copyright.

6.) Are There Additional Sources of Financial Support?

Aside from philanthropy, and current operating budgets of the world s public libraries, earmarked taxes could be used to get the GVL underway, and for related projects. Americans have been willing to pay earmarked taxes - for example, gasoline taxes, which go to the Highway Trust Fund to support the Interstate Highway System.

Proposal: A 1% tax on monthly Internet payments, for the next five years, to build a global virtual library and other on-line resources.

Today. the typical online American household pays $264 for Internet service.[46] At 50 million households, a 1% earmarked tax would secure (50 million x $2.64) about $130 million/year in America alone. It is more than enough to pay the investment cost of a global virtual library, even in the first six months. Run the tax for

[46] Robert J. Samuelson, "Telecom's Disconnect," *The Washington Post*, February 27 2002.

five years and assign a working group of leading public cultural institutions (e.g., Library of Congress, Smithsonian Institution, National Endowment for the Arts) to decide how (as an investment and/or for experiments) to spend the Trust Fund. Worldwide, ask each country for collaboration and reciprocity, to place a 1% tax on its own Internet users, with the funds used to place its own national resources online.

E.) Stakeholder-Supported R&D Channels

Proposal: Stakeholder financing of global online CSPANs and research collaboration systems, to accelerate research in every field where we want rapid progress,

Stakeholder-supported R&D Channels, similar to our domestic CSPAN, could accelerate global innovation in almost any field. Here are five examples, to illustrate the range of topics and financial support.

1.) Renewable Energy Channel

For example, a Renewable Energy Channel could be financed as a stakeholder cooperative (like the Cultural Affairs Channel). Each leading university or specialty society - for example - could spend $5,000/year from its own speakers budget to put its 10 best lectures on the Channel. It could be an honor to have a presentation or conference deemed worthy of international attention.[47] Each university and scientific society would receive many times its own investment - and everyone else also could benefit.

[47] A 56K dialup connection can receive a tape-slide format.

One of the many incentives of the Renewable Energy Research Channel and similar projects also will be the enhanced ability of labs and researchers to advertise, de facto, worldwide and at low cost for research collaborators, financial support, and consultantships - to build wider relationships of support.[48] [49]

a.) Are there additional sources of revenue for science innovation channels?

Yes. Once underway, additional funds might be secured from a wider universe of stakeholders, on the model of the Industrial Liaison Program at MIT.[50]

Under MIT's program, corporate sponsors make annual donations and receive, in return, access to preprints and briefings of state-of-the-art research, 1-2 years before print publication. Revenue is shared and, in return for their participation, individual lecturers and research centers receive financial credits. While these cannot be

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[48] There may be highly proprietary areas where the Channels will not work (e.g., companies nearing a breakthrough in applications of genome mapping).

[49] In supporting such channels to accelerate scientific innovation, corporate sponsors will be agreeing to compete based on their ability to recognize and use good ideas, the efficiency of capital markets, the alertness of management, etc. - rather than on proprietary and exclusive access to information. However, American companies can receive their share of the benefits, competing on this basis. And it will make for exciting viewing, and create an incentive for many companies to become partners and receive the channel.

[50] For a nonprofit prototype by the University of Washington, across many fields: www.researchchannel.com

taken as personal income, they can be used to pay for professional travel, to purchase books and additional equipment, and other research expenses.

Corporate support for the Channel could provide revenue to each participating research institution. And R&D-oriented industries could be invited to identify areas where early access to the world-wide creative process, 1-2 years before print publication, would be valuable, and where accelerating creativity by developing the Channel would benefit their industry. For example, the international automobile industry might identify key technologies related to environmentally sustainable development where they would be interested to support an acceleration of global research: photovoltaics, battery design, efficient manufacturing, plastics, and synthetic fuels, etc. And from this list, the programming and financial support could flow.

b.) Could a Channel accept advertising?

Once a Channel was underway, the participants might decide to form a limited partnership and/or seek additional revenue. For example, advertising can be an intrusion on entertainment television. But for global Internet channels to interested, niche audiences, it also could be scheduled into specific time slots and perform a useful and valued purpose. Advertising to recruit employees (world-wide) could begin with 5-minute video clips scheduled during an hour of prime-time Webcasting to interested members of a global audience.[51] As additional income is secured by the partnership, it

[51] TV Guide secures $700 million/year in advertising revenue (www.adage.com). Scientists are an attractive demographic group for many advertisers and even ads in program guides for scientific audiences can secure income. See early estimates by Gary Welz for

could be used to build science education resources in the field; and also provide distributed compensation (on the MIT model) to participating institutions and labs to support professional work.

2.) Global Grand Rounds Channel

Proposal: A Global Grand Rounds Channel that would receive digitized lectures at the world s leading medical schools and biomedical research centers and organize them for shared access online by researchers, physicians and health professionals, and students worldwide.

It would be an honor for an institution to be invited, by a distinguished committee of the World Health Organization, to take responsibility for two years for global Grand Rounds in its field (for example breast cancer treatment and research.) And the cost to record and digitize the lectures for Internet availability is minimal.

a.) Are there working examples of this kind of sharing?

Yes. The National Institutes of Health (US) has taken a step in this direction (http://videocast.nih.gov). Leading scientists from the US and other countries visit NIH to provide lectures and participate in state-of-the-art conferences. Topics include basic research, new research to improve clinical practice, and issues of interest to the public (e.g., women s health, environmental health).

NIH is using the intellectual life at its Bethesda campus as a capture-point (now, with hundreds of hours online) so that the best and latest ideas, from all countries, can begin to be shared widely.

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the SETN project, supported by the Sloan Foundation, online at www.policyscience.net.

Its Director s Series is climbing the charts in the biomedical world. (It also is enriching - free - the curriculum of every four-year college and university in the country and the world. And providing a service to companies and to individuals with a science background and interest in the topics.)

With breakthroughs in genome-mapping, we are headed into a new era of accelerated potential in biomedical research and health. A Global Grand Rounds Channel is one of the most important steps. And, beyond information transmission per se, it will help to build relationships and organize research partners who want to develop a good idea, or help to test it. We probably are vastly under-using the world s science-trained resources in many countries, including the former Soviet Union, Eastern Europe, China, India, parts of Africa and Latin America. If we heed McLuhan s caution (pp. ~xx) and move beyond seeing the Internet as a (first generation) library, or even a global television channel, and see it as a tool to establish relationships and new patterns of daily cooperation, we will begin to realize a new level of its potential: Biomedical research and health are fields that can help to lead the way.

Global, stakeholder-supported, projects need not be limited to the physical and biomedical sciences. For example:

3.) Education Research Channel

A decade ago, when I served as Director of Graduate Studies for International Relations at Yale, one of my responsibilities was to certify that graduate students had met the foreign language requirement. At the time, I recall asking a member of our French Department whether two years of college French, at different undergraduate colleges, was essentially the same. The answer was Yes, but it struck me that our entire educational system might be essentially

stagnant. I.e., two years of college French always requires two years. . . . And the same is true of every school subject: we have a global system of bureaucratic institutions geared to an expected pace of learning, and methods, that may not have improved for many years.

An example on this lock-in is the work of Alfred Binet, the early French inventor of the IQ test. Binet was not interested to measure an inherited trait. Rather, he was concerned that the French educational system used methods that worked well for one type of student, but poorly for others. He wanted to use his measure of intellectual attainment to begin a program of research and innovations in teaching methods that could support rapid learning by all students. His dream is still awaiting its realization.

Thus, one of the most interesting projects for a global Internet is a large-scale collaboration system among public school teachers to share curriculum ideas, resources, and methods. And to linkup with research projects that can use computers and other technologies to explore options for improving the educational process. (An impressive initial step has been taken by the Annenberg Foundation, in its www.learner.org project and Channel.)

An attractive prototype would be the teaching of foreign languages, a good and shared topic for our emerging future. A large-scale collaboration system might begin with seven languages - including English as a foreign language. There could be a global colloquium series drawing upon lectures at MIT (a leader in this research, with crossroads lectures similar to the NIH startup, discussed earlier) and leading research centers on other continents. [52]

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[52] I am endebted to Dr. Steven Lerman for a discussion of this

4.) Spiritual Growth Research Channel

> My doubt has to do with how optimistic to be that improved communication among individuals will change the nature of government for the good. I guess I see the source of human suffering more in our individual personas than in the social structures we create.. . Perhaps we have evolved to a point in our technological advance where we face the real test - what will we use this capacity for? What do we as persons want? What percentage of us will do this, and whether this is enough?
>
> - Rev. Stan Jones[53]

Proposal: A global R&D Channel and large-scale collaboration system to explore the possibility of belief-independ-

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idea.

The best and latest ideas could be transmitted at soon as possible to the desktops of researchers and teachers in all countries. Next, educational resources from all countries could be pooled and available to everybody in the world with a mouse click. Experimental materials - that now are almost impossible to evaluate with a large N of users - could be posted for use by, and feedback from, interested teachers worldwide. For the first time, it may be possible to test the intuition that different students learn best by different methods - and to have first-rate materials for each method available. Much of the best age-graded educational material in each culture (e.g., Sesame Street) could be on-line to teach the same vocabulary and reading skills to foreign beginners

[53] Rev. Stan Jones (personal communications)

ent spiritual growth.

To suggest an example along a different dimension: By now, psychologists have used scientific methods to identify invariant stages of mental growth (e.g., Piaget.)[54] In light of the classic tripartite conception of human nature (body, mind, spirit) is there a comparable process for *spiritual* growth? I.e., that is universal and does not depend upon or require specific beliefs of different religions?

Since the Dalai Lama began to travel in the West, there has been growing recognition that the best Buddhist teachers (for example) use what they call skillful means. Like professors in a classroom, they provide assignments that respond to their students current level of growth and an intuition about next steps. And, among leading practitioners, they have a twinkle in the eye test to distinguish genuine spiritual teaching from televangelists.[55]

Across independent religious traditions, spiritual growth may be encouraged by what psychologists call pattern interrupts that engage identity, socialization, and non-conscious habits of body and mind. Thus, if a student is into the pursuit of wealth, he/she gets the vow of poverty. If there is a commitment to figure-out the right answer and to rationality, the student gets what is the sound of one hand clapping? If talking, then the vow of silence. If sexual plea-

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[54] Other writers and theorists include Kohlberg, Gilligan, Loevinger and, while less rigorous, Maslow.

[55] Ken Wilber, *The Marriage of Sense and Soul: Integrating Science and Religion* (New York, NY: Random House, 1998) 171-73 et passim.

sure, then chastity. If physical activity, then sitting-still and following one s breathing. But these are teaching strategies, like problem sets, and not (by good teachers) presented for purposes of conformity.

Why bother? In part because genuine spiritual leaders appear to have had extraordinary powers to inspire people, and to promote ethical sensibilities for government and throughout society. And - politically - there may be a vital core in the resonance of fundamentalist religion (Christian, Islamic, and other) that is independent of beliefs and structure: even the Pope has objections to the modern secular world. Before the world starts to polarize for political battles, it may be helpful to explore if human beings have a spiritual nature in common, that is nurtured in similar ways. Progressive politics may grow with unexpected allies.

5.) Conflict resolution and human rights education.

A similar large- scale collaboration system could support curriculum development for human rights and conflict resolution in public schools worldwide, especially with a psychological component.

To engage young people and to create the empathy for conflict resolution and principled settlements, the language of psychology can be more helpful than the traditional language of law. Social science research also has started to illuminate how much of the world's violence, in teenage gangs, tribal and ethnic violence, and armies, (including suicide bombing) involves recruiting young people (especially males) with a wide range of appeals to discipline, self-sacrifice for a group, ideals of honor and loyalty, strategic calculation, and other traits. Considering the extraordinarily youthful age structures in the developing world - especially in areas that may be at risk for ethnic and tribal violence - it would be timely to

use new Internet technologies to get there first.

III. A Review of Must-Have Applications

The second part of this book has outlined a range of new Internet-based opportunities for international cooperation that can change the world and that would have seemed miracles to statesmen at any early stage of history. And the first-generation Internet can get us started - even audio and slide technology can work, while the final build-out of broadband brings desktop television routinely available to home or village users in all countries. And if (chapter eight) a PBS-II Channel is created, selections from all of these projects can be available on home television even before broadband arrives.

Each of the chapters in part II describes a must have applications - resources that, once created, everybody will want to have. A high-visibility Global Affairs Channel will be monitored in every Foreign Ministry. A global purchasing cooperative will be attractive for every Third World country and NGO project. A new system for citizen question-posing, if it works to re-engage capable people in a civic role and to improve government, is an idea that could spread quickly across democracies. A Health Channel could become national - and then (with appropriate adaptations) global, with the kind of health information that people search for, in other countries, as seriously as they search in America. Numerous large-scale collaboration systems, along the lines discussed in this chapter, are capable of supporting almost everybody in anything that interests them - a Cultural Affairs cooperative with supported contributions from every country; visual display systems for large-scale coordination that speed the achievement of humanitarian goals; global Tuesday

brownbags for scientific innovation; a global virtual library (beginning with 40,000 volumes in English, of the best books in 320 fields); mini-CSPANS and other online collaboration technologies (to be invented) supported by stakeholders in any field.

In Table 9-2 I have given a brief summary, by values, of the types of global benefits that we can get underway. And with a new technology whose use does not diminish the earth s resources and that, for the first time, leaves-out nobody.

Table 9-2
Examples of Internet-Based Acceleration
and Must Have Applications , By Value

Power - Convening and linkup functions to build a new dimension of global power. Little effect on distribution and quantities of hard power, but may carry the world further. Uses an open architecture Internet technology and invests resources in civic life in a way that is a political argument for freedom and democracy. Links up agenda-building institutions and processes in all countries to accelerate global agenda-building; provides expanded due process, participation, and global audiences to more groups and individuals interested in international cooperation. Visual display systems to help organize and motivate bold humanitarian achievement. Prototype systems for citizen question-posing to improve public policy.

Enlightenment - Startup package with the best curriculum materials, worldwide, available to teachers in every school (including the Third World); added resources for science education in the Third World. Initial distributions of 2,000 courses from MIT and crossroads biomedical lectures from NIH; Cultural Affairs channel supports a (non-credit) virtual global university in the humanities. Global virtual library with 40,000 best books in 320 fields, and all scientific and technical journals after one year. Growing video-on-demand capabilities. Large-scale collaboration systems for research to improve education (beginning with learning of foreign languages.)

Wealth - Global CSPANs in every field to accelerate scientific innovation and provide the best and latest ideas, as quickly as possi-

ble, to researchers, students, and corporations in all countries. Begins with high-priority areas for sustainable development (e.g. renewable energy). Global Inventions Wanted . . brown-bags to accelerate breakthroughs and the creative process in high priority areas. Education, health, and usable information (World Bank) startup package for the Third World. A global purchasing cooperative for the Third World to reduce costs for communications technology and other fundamental public investments, including the costs of NGOs and other development-related institutions.

Well-Being - Health Channel initiative and Website in US, available globally. Reliable and full access to health-related information by consumers, including those with handicaps and preference for oral communication in a range of languages. Customization systems for patients and physicians. Basic Internet access for health information via clinics and villages worldwide.

Affection - Village level startup package for the Third World supports email and limited voicemail, expanded contacts with friends and relatives.

Rectitude - Support for human rights activist linkups; public commitments to a world commonwealth of human dignity via commitments to health, resources for self-help organizing. Creates opportunities for civic and ethical leadership by large globalizing corporations. Global colloquium series explores belief-independent spiritual growth and nurturing an ethical spirit.

Respect - High priority commitment to resources for participation by people in all countries; open architecture systems, widely affordable for basic services; initial support to make knowl-

edge of their past and current culture and traditions available worldwide. Global collaboration system to develop a new human rights and conflict resolution curriculum with an empathetic/psychological foundation.

The key ingredients to these, and many other projects, as we have seen, will be visionaries and good ideas. And they also will need ability, perseverance (the S curve starts slowly and there is much inertia and many obstacles, and work to do), collaborators, luck - and financial support. Many people and institutions can participate. And - with the infrastructure that is already available, and the improving technology that will become available - wherever people can begin to bring these elements together, they can change the world.

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