

INTERDISCIPLINARITY ACROSS SUBJECT PATHS & INSTITUTIONS:
LEADING TO NEW OUTCOMES -
THE CAL-IT2 PROJECT IN DETAIL

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Abstract:

Interdisciplinarity has been difficult to define for many reasons. The primary one is that it has emerged as a buzzword and catch phrase for new models of curriculum in higher education over the last forty years. However, the emphasis of this paper is to demonstrate how a university system responded to a statewide call for coordinated proposals to develop several institutes for Science and Innovation in California and the creative services and information delivery that is necessary to make it successful. Specifically, this paper and presentation examine how one such institute, the California Institute for Telecommunications and Information Technology, known as Cal-(IT)2 has emerged as the brainchild of two campuses of the University of California, at San Diego and Irvine, and has evolved from a proposal to a significant institute. The electrical engineering and computer science subject specialists at the two campuses are responding to the information needs of all project members and how this collaboration effort addresses interdisciplinarity has been the central focus of the library community. Whether this complex example of intercampus and interdisciplinary research will advance what we know about how we work in such settings is speculated upon as new methods of responding to such interdisciplinary inquiries is explored and described.

Background

This presentation is basically a case study about how the State of California hopes to stay competitive as a leader in research and to bolster its economy in the technology and related sectors. In late 2000, Governor Gray Davis created the California Institutes for Science and Innovation. One of the four funded institutes, the California Institute for Telecommunications and Information Technology, and known as Cal-(IT)2, is a collaboration between the University of California campuses at San Diego and Irvine with other partners, “designed to foster collaboration among government, industry and academe and expected to spur advances in information technology, biotechnology, nanotechnology and the Internet to help ensure California remains a high-tech powerhouse.”¹ (See Slide #1) The Institute is funded with \$25million for each of four years from the state. But that is the only the beginning of the financial picture – as each project will need to bring in twice what has been appropriated, thus the price tag is closer to \$400million. Even with the slowdown of the economy, and the \$100million seed money from the state, the project has attracted more than \$140million from 50

¹ Eric Pfeifer, “Planet Internet: Interview with Larry Smarr,” *Technology Review*, 105, #2: 82, March 2002.

corporations, \$30million from individuals and it is expected that more than \$100million from the federal government will go towards supporting the 220 faculty members currently associated with Cal-(IT)2 from the two UC campuses. One should not think that this is only a local or domestic project, because as of today, many exchange agreements have been signed between organizations in Malaysia, Hong Kong, Singapore, France, Italy, Sweden, and Germany to participate in the project and share product development. The entire project is best described by many of its websites at the major hub of <http://www.calit2.net/> Communication can be conducted via info@calit2.net and one can easily monitor what progress has been made in its short lifespan of eighteen months. Just three days ago on May 31, 2002, ground was broken at the San Diego campus for the new Cal-(IT)2 building.

The director of this enormous and most interdisciplinary project is technology visionary Lawrence (Larry) Smarr, basically the genius computer scientist, astrophysicist and entrepreneur who launched the National Center for Supercomputing Applications at the University of Illinois and mentored Mark Andreessen while he was a student there. Together they developed and commercialized the technology that became the Internet as the Mosaic Web browser was born, a predecessor of Netscape Navigator, and later launched open source server software as it came along. It appears Smarr is the right leader for this intense task by what has happened in just the first year, as he:

- “links all three sectors of government, local, state and federal
- oversees 220+ university faculty members from disciplines of computer science, medicine and life sciences, bioinformatics, biotechnology, transportation studies, civil and environmental engineering and the physical sciences and materials science
- and some of the major corporate players in cutting edge companies (at a time when the economy is hardly booming)
- while bringing along the community-at-large to explore how next-generation Internet technologies will transform transportation, medicine and the environment.”²

The goal according to Smarr, is “to weave together emerging technologies such as the wireless Internet, nanotechnology, chemical sensors and sensor nets and digitally enabled genomic medicine...into a living laboratory.”³ (See Slides 2) Smarr, quoted in a *New York Times* article at the onset 18 months ago, continues to explain as “he foresees the Internet evolving into a ‘emerging planetary supercomputer’ which will be capable of independent thought.”⁴

So what does this mean for interdisciplinarity in the applied sciences, for the campuses, for the profession, for commerce and for society? I don’t claim to have any answers except to say that working in this environment poses incredible challenges to the library community for services and for collection resources.

First of all, just beginning to understand the relationships and who the players in this new paradigm are has been my goal this year. Understanding the different goals and values each constituency has is essential and as Smarr often indicates, a “new kind of

² Ibid.

³ Ibid.

⁴ John Markoff, “The Soul of the Ultimate Machine,” *New York Times*, December 10, 2000: BU1, 1.

culture,” in academe has been born to realize the project goals and reinforce the research process. Fortunately there have been an incredible number of papers describing Cal-(IT)2 by a variety of its participants so we continue to learn from them and observe how the partners and contributors are laying the foundations.

Smarr anticipates that 60% of his budget is for developments in the next two to five years. These developments can be described as primarily for optical networks and intelligent transportation; 30% for developments in the five to ten year span; and 10% is devoted to what may come along further than a decade out, or in the next horizon. My colleagues and I are really learning to live in the future, anticipating how life and science will meet with many new technologies and products.

What is Interdisciplinarity?

As disciplines grow, they also become more complex. As subject specializations become subspecialized and new ones result, a different sense of community emerges that sometimes estranges former colleagues and builds bridges with others. It is known to be easier to stay on the known trajectory and contribute to the mainstream disciplinary focus of computer science or molecular biology than try to forge the new hybrids of cross-disciplinary fertilization. “In the past when interdisciplinarity was criticized for not being “disciplined,” the charge was a resumed lack of rigorous thinking and methodology.”⁵ However, proponents of integration and interdisciplinarity projects and efforts have demonstrated that there has been a higher level of disciplinary integration than multidisciplinary projects,⁶ and that I think best describes Cal-(IT)2. Interdisciplinarity takes on many guises and we will see how Cal-(IT)2 responds to “expansions and contractions” in the specific disciplines, or as has been noted, survives as it is sometimes a “moving target.”⁷

Still it is useful to couch the concept of interdisciplinarity in a more global context. The Centre for Educational Research and Innovation under the auspices of OECD offers one of the earliest definitions and is among the broadest that I could find: “An adjective describing the interaction among two or more different disciplines. This interaction may range from simple communication of ideas to the mutual integration of organizing concepts, methodology, procedures, epistemology, terminology, data and organization of research and education in a fairly large field. An interdisciplinary group consists of persons trained in different fields of knowledge with different concepts, methods and data and terms organized into a common effort on a common problem with continuous intercommunication among the participants from the different disciplines.”⁸

The Cal-(IT)2 initiative may be a good example of what Thomas Kuhn conceptualized as the “cognitive framework of a discipline as consisting of three elements:

1. its underlying theory (or generalizations)

⁵ Lisa R. Lattuca, *Creating Interdisciplinarity: Interdisciplinary Research and Teaching Among College and University Faculty*. Nashville, TN: Vanderbilt University Press, 2001, 3.

⁶ Julie Thompson Klein, *Interdisciplinarity: History, Theory and Practice*. Detroit, MI: Wayne State University Press, 1990, 109.

⁷ Lattuca, 261.

⁸ Organization for Economic Cooperation and Development (OECD), *Interdisciplinarity: Problems of Teaching and Research in Universities*. Paris: 1972, 25-26.

2. idealized models and analogies (fabricated examples that are abstracted from real cases to ideally describe phenomena)
3. exemplars (which are specific instances of generalizations and models.”⁹

When we think of what constitutes the framework of interdisciplinarity we often resort to labels as a means of defining the contribution – meaning that they came from this or that subject area. According to many people who have studied the value of interdisciplinary relationships, the kind of “ist” someone is may obscure important differences among the faculty and lead to a false sense of how a specialist thinks or what they know. Indeed this is more about what the boundaries are which define the scholarship of that discipline.¹⁰ Today they are expanding and overlapping at incredible rates and that is clear with the more specialization that takes place – one is not just an engineer nor only a mechanical engineer but instead one that only works with microelectromagnetic sensors (MEMS) in a specific application. Lisa Lattuca created a grid that categorizes interdisciplinary scholarship as follows and again this is relevant to the case of Cal-(IT)2 in several ways that should become clear upon more description.

<u>Types of Scholarship</u>	<u>Teaching</u>	<u>Research</u>
Informed Disciplinarity	Disciplinary courses informed by other disciplines	Disciplinary questions requiring outreach to other disciplines
Synthetic Disciplinarity	Courses that link other disciplines	Questions that link disciplines
Transdisciplinarity	Courses that cross disciplines	Questions that cross disciplines
Conceptual Interdisciplinarity	Courses without a compelling disciplinary basis	Questions without a compelling disciplinary basis ¹¹

We may wonder what the scholarly outcomes are of such interdisciplinary activity, especially when it is not easy to engage in the activity with so many academic barriers potentially complicating and impeding the scholar’s work. The reward structure is not always institutionally in place, while the personal rewards and satisfaction are usually far greater and outweigh the hassles of explaining and documenting the process for research and tenure reviews. It is usually sought out by extremely creative scholars who have a more aggressive thirst for trailblazing in their professions and are risk takers with unlimited imagination. Science seems to be more receptive to interdisciplinarity, yet the cultural and area studies programs are excellent examples of how universities are now shaping humanities and social science curricula. Interestingly, one can note the universal trend of how critical neurosciences has become and how those who only

⁹ Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2d ed. Chicago, IL: University of Chicago Press, 1970, 194.

¹⁰ Lattuca, 71.

¹¹ Lattuca, 81.

studied the impact of whatever on rats are now more seriously studying human anatomy for the analogy of behavior or outcomes in human trials. They tend to be people who are confident in their pursuits, value exploration, conversation and networking as much as the collaboration process itself, and want to contribute to cutting edge work on a very fast paced track. They are able to share attribution and rewards more than people who want to take full credit for smaller or personal outcomes where they are solely responsible. The expansion of that intellectual universe that usually accompanies and is a byproduct of interdisciplinary work can take significant time and may require relearning basic skills in math, statistics, or theory that is not part of the everyday life of a scientist when one is focused on more subject-based work.

Calls for sponsored federal research support now indicate an increasingly strong orientation for interdisciplinary collaboration. This is clear in the United States with the National Library of Medicine, National Institutes of Health and Mental Health, National Science Foundation, and the National Endowments for Arts and Humanities as well as in the qualifying criteria from state governments, international bodies and private foundations. It is also clear that recent nominees to the National Academies of Sciences and Engineering and new Fellows of the AAAS are being recognized from a wider range of disciplines and institutional affiliations.

Some researchers of interdisciplinary work suggest that there may be two types of “interest theory” that sustain one’s drive in collaborating with colleagues and seeking out such activities. They may be “individual or situational.”¹² The first describes the personal or individual efforts and can be linked to increased knowledge while the latter interest is more shared among a cohort group and is environmentally-based.

Now what does this mean for this initiative I have built up and which promises to change some of the fundamental things that we currently know? There are incredible leadership roles for Cal-(IT)2 with enormous potential for new partnerships with industry, specifically with the telecommunications, computer and software firms and other related industries committed to developing a higher quality of life and a series of innovative products to make that happen. In relationships with industry, academic partners probably have the most to offer because industry has to overcome some of the following assumptions that may have initially been perceived as barriers in some partnerships:

- Open dissemination – free and open results; optimal sharing
- Freely distributed for instruction & future research
- Has to have benefit for public good or the society at large
- Informed participation contracts are the norm where there is shared royalties from the intellectual property
- New physical space may be required in which to conduct and accommodate this work
- Fair economic values or compensation for the product development.

The obvious mutual concerns of such programs may include:

- Management of any financial conflicts of interest that may evolve.

¹² A. Krapp, et al, “Interest, Learning and Development,” in Renninger, K.A., et al, eds., *The Role of Interest in Learning and Development*. Hillsdale, NJ: Lawrence Erlbaum, 1992: 3.

In reality, what is Cal-(IT)2?

Simply stated, Cal-(IT)2 was conceived to study the emerging world of the wireless Internet and to envision its evolution. (See Slide 3,4) According to Smarr, “billions of Internet-connected cell phones, embedded processors, hand-held devices, sensors and actuators will lead to radical new applications in biomedicine, transportation, environmental monitoring and interpersonal communication and collaboration.”¹³ The emphasis on wireless instruments, including phones, satellites and how the Federal Communications Commission (FCC) unlicensed wireless band is spreading coverage around the world enabling both the scientific communities and emergency preparedness to use a wide variety of sensornets is the primary task at hand, and obviously not an easy one. (See slide 5) And there are probably applications we have yet to consider or discover.

Thus, there is much work underway on the creation of a variety of prototypes of early warning systems coupled to a disaster-response and telecommunication system, that shapes one of the first priorities of Cal-(IT)2. The system will be based on a net of wirelessly enabled sensing devices in the field that provides information in real time to a connected set of analysis and decision support and crisis management response centers. These facilities will be equipped with new computer models, enormous data storage and visualization capabilities and will allow the teams of respondents located throughout the world to collaborate on assessing natural disasters and human-error catastrophes as they occur and information about them unfolds (See Slide 6). How this translates into practicality is anyone’s imagination, but Smarr’s approach is to create teams to work on critical sub-systems that can be expanded by certain magnitudes to accomplish this most ambitious task. (See Slide 7) Examples that are underway include:

- mobile software that account for security and privacy concerns;
- data management and data-mining;
- linking crisis management operations with optical fiber and geographic information systems (GIS) so that they can be integrated with videoconferencing technologies and input from remote sensors to share information on an immediacy basis;
- new applications for nanotechnology where experimentation at the molecular and atomic scales will be able to advance developments in biomedical applications utilizing smart sensors and sensor nets, again building on wireless transitions.

This last application most vividly reinforces the interdisciplinary concept. Specifically, because smart sensors apply to the integration of biological, chemical and physical sensors with computing and telecommunications capabilities to create an intelligent system on a given chip, capable of generating a wide variety of data flows from many physical environments and transportation methods and products.

Challenge for Library Support

You probably now know more about the Cal-(IT)2 project than you did a quarter of an hour ago and have also had a chance to ponder the concept of interdisciplinarity and how this project will develop over the next three years and whether its goals will be achieved or if they are just “pie in the sky” and the artistry of dreamers. But what does it

¹³ Larry Smarr, “Extending the Internet with Sensornets: Supporting Science and Emergency Preparedness,” Plenary Lecture delivered at the annual meeting of the American Association for the Advancement of Science (AAAS) Boston, MA, February 12, 2002.

mean for those of us practicing librarians? I have had to engage in the following in recent months:

- Fill in the knowledge gaps I have had in several subject and technical areas, such as brain imaging, business and marketing data, etc
- Begin to live in the future by about a decade and take to heart content on “Mastering New Forms of Intelligence” and other approaches explored by anthropologist, Jennifer James¹⁴
- Imagine what the university and higher education around the globe will be like in the future¹⁵
- Learn about knowledge emergence, technological innovation and economic performance¹⁶
- Become acquainted with all the players and relationships between teams
- Participate in the public forums and attend campus activities that track the research progress – i.e. Short Courses, and programs like “Internet Pianos” – the first networked musical performance in both places at the same time where the performance of each pianist will be heard on the pianos in both locations due to dueling disklaviers
- Realize that no one person has the answer to any question I may get from a researcher or may have myself, and I must filter the responses I get from several sources
- Learn to be more media savvy – the media is crazed by the excitement this project has created and is very visible on the campuses when press announcements or made or when they want to stir up a good story – journalists often seek out the library and need help in getting facts substantiated and put into context while not always practicing healthy scholarly communication habits
- Understand that the campus needs to document the historical chronology of each facet of this project, made complicated by its sheer size, administrative overhead and occasional incompatibilities of technology documenting the work – thus requiring collaboration with campus archivists and those sensitive to digital records management. This latter piece is a new orientation on my campus and not well articulated nor yet understood and obviously not well handled at this important first stage
- Many people associated with the project are extremely ambitious, feeling overextended and can be demanding and difficult to work with often causing

¹⁴ Jennifer James, *Thinking in the Future Tense: Leadership Skills for a New Age*. NY: Simon & Schuster, 1996:179-204.

¹⁵ See Frank Rhodes, *The Creation of the Future: The Role of the American University*. Ithaca, NY: Cornell University Press, 2001.

¹⁶ See Ikujiro Nonaka and Toshihiro Nishiguchi, eds., *Knowledge Emergence: Social, Technical and Evolutionary Dimensions of Knowledge Creation*. Oxford: Oxford University Press, 2001; and Benn Steil, et al, eds., *Technological Innovation and Economic Performance*. Princeton, NJ: Princeton University Press, 2001; Michael A. Hitt, et al, eds., *Creating Value: Winners in the New Business Environment*. Oxford: Blackwell Publishers, 2000; Lawrence Lessig, *The Future of Ideas: The Fate of the Commons in a Connected World*. NY: Random House, 2001; Alex Lightman, *Brave New Unwired World: The Digital Big Bang and the Infinite Internet*. NY: Wiley, 2002.

some frictions so it is essential to be eager to serve, patient and politically aware while remembering what “Best Practices” means in all these contexts

- Must think out of the box and collaborate increasingly with librarians at sister campuses and with subject librarians outside of engineering, specifically those working in biological or life sciences, medicine, physical sciences.
- Anticipate global information needs and conclude that most of it will not come from traditional standard sources, but will be from the Grey Literature, increasingly challenging to identify, locate and cite on demand
- Services to this project community are more analogous to a special library function than the typical academic research situation due to intense research consultation and off-the desk and behind the scenes information gathering and the need for quick turn around.

Conclusions

There is an obvious level of excitement, urgency and accomplishment that already surrounds Cal-(IT)2. Success is easy to feel as the research community is so inclusive of many partners at other institutions, with influential government and powerful industrial partners. Everything we know about traditional experiences in interdisciplinarity has been confirmed as taking place:

- Answering more complex questions
- Addressing broader issues
- Exploring disciplinary and professional relations
- Solving problems that are beyond the scope of any one discipline
- Achieving unity of knowledge, whether on a limited or grand scale.¹⁷

We are confident that Larry Smarr has assembled one incredibly talented team to proceed and that the notion and potential of wireless is still not fully grasped. The wireless environment on both the UC San Diego and Irvine campuses will grow exponentially, and the new Cal-(IT)2 building at Irvine will unify the projects on that campus. The following projects at Irvine:

- Networked Infrastructure
- Crisis Management
- Embedded Systems
- Interfaces and Software Systems
- Security & Privacy
- Reconciling with Personalization
- and ideas like Disease Diagnosis by Applying Machine Learning Methods to Gene Expression Data,

all point to Smarr’s projection that, "The growth of the wireless Internet will lead to radical change," prompting sensors embedded in bridges, cars and even people that may someday transmit information to a computer miles away that can assess problems such as stresses during an earthquake or wear-and-tear on vehicle's brakes. "Wouldn't it be nice if you got a call on your cell phone that said, "Hello, we thought you'd like to know that

¹⁷ Klein, 11.

your right front brake will fail in about 100 miles."¹⁸ Thus, that is the tone of the long-term concept for Cal-(IT)2- doing well for society in the realm of telecommunications and information technology. I am glad that being a liaison to Cal-(IT)2 is part of my work and I look forward to the next few years.

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¹⁸ Pfeifer.