Report from a Symposium on Innovative Ways That Universities Do Research

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ABOUT CREATIVITY & COLLABORATION IN THE ACADEMY

Technology has enabled university research to become more rapid, more dynamic and more collaborative, but at the same time it has challenged – even upended – some academic traditions and practices.

- As information is retrieved, distributed and shared more easily, quickly and cheaply than ever before, how will peer-review evolve and keep pace with innovation?
- What is the role of departments and disciplines within research that increasingly requires networking and mobilizing multiple fields and institutions?
- As teamwork has become a hallmark of innovation, how should the appointment and promotion process be modernized to reward and motivate collaborative achievements?
- How do we balance technology’s ability to surmount distance, with the benefits of serendipitous personal encounters that occur on a bricks and mortar campus?

This conference – held December 3, 2010 with participants from across USC and beyond – spotlighted novel ways that research communities use technology and innovative practices to foster creativity and collaboration; it showcased some of the research products emerging from those communities; and addressed the tensions between traditional academic culture and cutting-edge methods to expand knowledge and benefit society. The Lear Center is producing an innovative online publication that captures the conversations that took place here, as well as a rich web resource that gathers together the best online materials (including articles, websites, videos and podcasts) about innovative practices in university research. Martin Kaplan and Johanna Blakley serve as project co-directors.

For more information on the initiative, visit www.usc.edu/creativity.

ABOUT DAVID BOLLIER

David Bollier is an author, activist, blogger and consultant who spends a lot of time exploring the commons as a new paradigm of economics, politics and culture. He co-founded the Commons Strategy Group, a consulting project that works to promote the commons internationally. His work on the commons takes many forms – as an author, conference organizer and frequent international speaker; as the host of an educational film, This Land Is Our Land: The Fight to Reclaim the Commons; as the Croxton Lecturer at Amherst College where he taught “The Rise of the Commons” in 2010; and as an expert witness for the “design commons” in a trademark lawsuit; among other initiatives. He was Founding Editor of Onthecommons.org and a Fellow of On the Commons from 2004 to 2010. He has written many books on the subject including Silent Theft: The Private Plunder of Our Commons Wealth (2002), Brand Name Bullies: The Quest to Own and Control Culture (2005), and Viral Spiral: How the Commoners Built a Digital Republic of Their Own (2009). While on the trail of the commons, he worked with American television writer/producer Norman Lear, since 1984, on a variety of non-television, public affairs projects. He is also Senior Fellow at the Norman Lear Center at the USC Annenberg School for Communication, and co-founder and board member (2001-2011) of Public Knowledge, a Washington policy advocacy organization dedicated to protecting the information commons. For more information, visit www.bollier.org.
ABOUT THE NORMAN LEAR CENTER

The Norman Lear Center is a nonpartisan research and public policy center that studies the social, political, economic and cultural impact of entertainment on the world. The Lear Center translates its findings into action through testimony, journalism, strategic research and innovative public outreach campaigns. On campus, from its base in the USC Annenberg School for Communication & Journalism, the Lear Center builds bridges between schools and disciplines whose faculty study aspects of entertainment, media and culture. Beyond campus, it bridges the gap between the entertainment industry and academia, and between them and the public. Through scholarship and research; through its conferences, public events and publications; and in its attempts to illuminate and repair the world, the Lear Center works to be at the forefront of discussion and practice in the field.

For more information, visit www.learcenter.org.

ABOUT USC OFFICE OF RESEARCH

The Office of Research is implementing the University of Southern California’s strategic plan by building interdisciplinary research collaborations that address societal needs and by increasing the impact and prominence of our research. The office invests in research initiatives, promotes our research among sponsors, and provides services that ensure that USC achieves the highest ethical standards in its research. The office is the university point of contact for these issues:

- Submission of research proposals
- Identifying sources of research funding, both inside and outside the university
- Participation in, and initiation of, major inter-disciplinary university research programs and formation of research units
- Education to prepare investigators for funding strategies and proposal preparation
- Clearance for research competitions that limit the number of proposals submitted by the University
- Financial disclosures or conflict of interest statements
- Complaints pertaining to research misconduct

For more information, visit www.usc.edu/research.
INTRODUCTION

How should universities, as premier research and teaching institutions, respond to the exciting, confusing and alarming changes being wrought by new digital technologies? This is an urgent question for academia as the information revolution continues its disruptive march through modern society. Technology is enabling university research to become more rapid, dynamic and collaborative – yet it is also challenging and even upending some academic traditions and practices.

To explore the challenges posed by new technologies, the USC Office of Research teamed up with the Norman Lear Center, a research and public policy center at the USC Annenberg School for Communication & Journalism, to host a one-day symposium on “innovative ways that universities do research.” The event convened a highly interdisciplinary set of participants and audience members both from within the USC community and from nationally renowned research projects and institutions. Notable researchers from the physical sciences, engineering, social sciences, medical fields and the humanities were represented.

For the Norman Lear Center, the symposium was part of its larger, ongoing exploration of the changing nature of creativity in various industries. Under a project known as Creativity, Commerce and Culture, the Lear Center has looked at the ways in which new technologies are transforming the music industry, newspapers, advertising and fashion, among other fields. In this context, Martin Kaplan, Director of the Norman Lear Center, saw the symposium as an inquiry into “the academy as a creative industry.”

The day’s discussions focused on how academia is being dramatically transformed by the Internet, new software applications, powerful search tools, new tools for multimedia authoring, social networking and much else. Randy Hall, Vice President of Research at USC, opened the day by noting that new technologies are changing research practices, academic traditions and the goals of university administration:

These tools have provided immediacy, sharing, visualization, search capabilities and communities that are changing the world of knowledge from products that are discrete, final and personal, to ones that are much more dynamic and collaborative. And this has created what I would call a “continuum of knowledge” rather than discrete knowledge, which does not have well-defined starts and finishes, transcends individuals, transcends places, and transcends time.
This initiative is about understanding how those changes will affect the future of university research, and the future of research at USC in particular. While universities are rooted in centuries-old traditions, we are also looked at as beacons of innovation. But do we have the institutions, the infrastructure, and the culture to be innovative in the decades ahead — not just in the research content but in the way that we do research? What will be the research products in the future? What will they look like? What forms will they take?

The symposium posed a variety of questions about academic practices that have no quick or easy answers. They included:

- As information is retrieved, distributed and shared more easily, quickly and cheaply than ever before, how will peer-review evolve and keep pace with innovation?

- What is the role of departments and disciplines within research that increasingly requires networking and mobilizing multiple fields and institutions?

- As teamwork has become a hallmark of innovation, how should the appointment and promotion process be modernized to reward and motivate collaborative achievements?

- How do we balance technology’s ability to surmount distance, with the benefits of serendipitous personal encounters that occur on a bricks and mortar campus?

This report is an interpretive synthesis of the discussions by rapporteur David Bollier, Senior Fellow at the Norman Lear Center and a frequent writer about digital commons and technology. Additional materials about the symposium and collaboration in the academy can be found at [www.usc.edu/creativity](http://www.usc.edu/creativity).
In preparation for the symposium, the Norman Lear Center attempted to learn more about actual academic practices through a series of five faculty workshops and an online survey. Faculty members were asked how USC could stay at the forefront of research, particularly in the use of new technology to enable collaborative research. Which innovative practices might enable faculty to work together, both within and across disciplines?

The workshops, held in the Spring of 2010, functioned much as focus groups, distilling basic insights from a diverse mix of participants. All told, the workshops engaged with fifty-five faculty members from thirty disciplines, who together represented thirteen schools and five research institutes at USC. The participants were asked three questions:

- What are the best practices in research collaboration that you know?
- What are the barriers to research collaboration at USC?
- And how can USC further develop a culture of innovation that supports creative ways to conduct and collaborate on research?

Johanna Blakley, Deputy Director of the Lear Center, reviewed some of the more salient findings of the workshops. In terms of best practices, faculty members cited a number of innovative programs for interdisciplinary research. They include the National Cancer Institute’s Specialized Program of Research Excellence (SPORE) and the NCI’s Transdisciplinary Research on Energetics and Cancer (TREC) Centers, a program that nurtures collaborative research and has helped launch successful academic careers.

USC faculty singled out two universities as leaders in using digital technologies to advance academic research, said Blakley – the University of Michigan, which has initiated a large cyber-infrastructure project and pioneered collaborative programs, and Syracuse University, which has a university-wide “Scholarship in Action” program, among other projects. Many of the most innovative institutional programs and practices, Blakley said, are focused on “taking the academy out of the academy” so that
they connect with the community.

There are many barriers to interdisciplinary research, the workshops revealed. First, different disciplines have different research priorities, expectations and ways of doing their work, and many scholars are skeptical of the value of interdisciplinary work in the first place. These issues can make it difficult to formulate projects that are mutually acceptable to participants.

Large, interdisciplinary, collaborative projects won’t work if its participants don’t have a sense of ownership and control over them. Yet this is difficult to establish if there are few convenient physical spaces in which to meet. “ USC faculty mentioned over and over again the physical distances that separate the two USC campuses as well as off-campus research centers,” said Blakley.

Another set of barriers to collaborative research projects involves tenure guidelines. Many workshop participants said that tenure guidelines do not reward collaboration or faculty members’ online activities. Graduate students, too, are reluctant to work outside their fields or share credit when they are poised to enter the academic job market; they fear that such scholarly work will not advance their careers.

Ironically enough, grant-funded collaborative projects are often not very collaborative, perhaps because each researcher is expected to use the money to accomplish his or her individual goals. Depending upon the project, the technical infrastructure needed to make data readable to diverse types of scholars with different research priorities, can be very expensive. “Perhaps the biggest problem is that collaborative research projects take more time than individual research projects,” said Blakley. “You just have a lot more variables in motion.”

What should USC do? Workshop participants offered a number of interesting suggestions. One of the most-cited solutions was more social time with colleagues, particularly those who work on distant parts of the campus. “Give us time for wine and cheese, and we promise we’ll come up with some cool research collaborations,” according to faculty, reported Blakley. Faculty also asked for collaborative work spaces.

Oddly enough, one of the biggest problems to collaborative research is simply identifying other faculty members.
who may share common research interests. A possible solution is to create a more sophisticated, searchable faculty research directory. It could include a social media application that resembles Match.com, Craigslist or Facebook. “Technical training is essential if we really want faculty to use these amazing new digital tools,” Blakley said citing comments from faculty. “A few people suggested that USC actually take the lead in developing new digital publishing tools as a university-wide effort.”

Bringing in more outside scholars to USC, from abroad and from across Los Angeles, would also be helpful. Their visits should be structured so that they would have time to network with USC faculty. USC might be able to attract more visiting scholars by sponsoring major international conferences and conferences on cross-cutting/interdisciplinary topics. USC may also want to try to recruit faculty who have a history of collaborative research success.

Interestingly, faculty members reported that many existing multi-disciplinary projects originate with students. So providing more incentives to undergraduates and graduates to do collaborative research could have valuable spillover effects on faculty as well. Administratively, it may also help if researchers had access to stop-gap funding to help their interdisciplinary projects bridge gaps in big grant cycles. It would help if the administration could assemble an inventory of best practices in collaborative research so that everyone could have a better sense of what works well and what doesn’t.

These were the more salient points elicited from the five workshops. (A memorandum itemizing the top suggestions from across the disciplines can be found in Appendix B.)

Survey Research

Everyone who attended the December 3, 2010, symposium was invited to respond to a short online survey. The results are not scientific by any means – a total of 35 people completed the survey, 62 partially completed it and 82 people only looked at it – but the responses do corroborate the workshop findings.

A full 100% of respondents said that tenure guidelines should be revised to reward creativity and encourage collaboration. Sixty percent said seed funding would be helpful, 40% urged more space for collaborative research, and 38% believe that a searchable faculty research directory would be helpful. Some 34% of respondents would find social spaces useful in stimulating collaborative research. The same percentage favored incentives for graduate students and for hiring faculty with a history of...
successful collaborative research.

In a section inviting open-ended comments, one respondent said: “The two obstacles [to collaborative research] are always the same – tenure risk for doing the work and social inertia at starting it.” Another wrote: “Trans-disciplinary faculty often have an office on one campus but meetings on another. We need offices as well as spaces for collaboration – a place to be.”
Creativity & Collaboration: INNOVATIVE RESEARCH

a graphic recording created by Lloyd Dangle
(View an interactive version of this recording on the Prezi website at http://j.mp/mSyrmF)
II. INNOVATIVE RESEARCH COMMUNITIES

Krisztina "Z." Holly, USC Vice Provost for Innovation and Executive Director of the USC Stevens Institute for Innovation, introduced the first panel as an attempt to define innovative research communities and identify best practices and opportunities. In the long history of human development, she said, the big leaps forward have come when ideas can flow more readily among people. That is how the first human tools were invented – in the first cities – and that is how double-entry bookkeeping became the great innovation of the Renaissance. People come together and share their different ideas. Innovation emerges.

“Today, technology enables us to collaborate in ways that we’ve never seen before,” Holly said. “That’s the good news. The bad news is, technology enables us to collaborate in ways that we’ve never seen before.” How should the academy respond?

Building A New Collaborative Infrastructure: The Case of the Large Hadron Collider

The first panelist, Carl Kesselman, a professor of Industrial and Systems Engineering and a Fellow in the Information Sciences Institute in the USC Viterbi School of Engineering, described his involvement with the Large Hadron Collider, or LHC – a massive scientific instrument built in “a very expensive hole in the ground” outside of Geneva, Switzerland. “There are three or four experiments running off the Collider,” said Kesselman, “and the problem they faced is that they were generating tremendous amounts of data. This required tremendous amounts of data analysis among a global community of scientists.”

To deal with this challenge, scientists ended up inventing a entirely new sort of global informatics infrastructure, “grid computing,” to manage the various scientific experiments, data-sharing and results-sharing among multiple scientific communities. The project was intended to create a “virtual organization” that was not just about building websites and sharing digital files, but about sharing some basic processes – computing, data management, services, the use of scientific instruments as well as the business rules, policies and provenance of the information.

The idea of creating new infrastructures for virtual organizations is gaining traction, especially as the National Science Foundation and Department of Energy fund such work, said Kesselman. The goal is to build “a persistent, reusable infrastructure that is
not domain- or community-specific, to support large types of collaborative research and scholarship,” said Kesselman. “You can’t build a one-off, integrated, one-size, sole-purpose system and expect it to support the diversity of scientific investigations that are needed. And so this infrastructure represents a really interesting new kind of creative, collaborative scholarship.”

**An Open Database on Alzheimer’s Disease to Spur Collaboration and Discovery**

A different sort of high-level scientific collaboration was described by Neil Buckholtz, Chief of the Dementias of Aging Branch, Division of Neuroscience at the National Institute of Aging at the National Institutes of Health. Buckholtz runs the Alzheimer’s Disease Neuroimaging Initiative, or ADNI, which is a revolutionary study in the clinical neurosciences for collaboration and data-sharing.

“ADNI was conceptualized in the early 2000s based upon discussions that I’d had with scientists in the pharmaceutical industry who were starting to develop drugs that would actually affect disease modification in Alzheimer's disease,” said Buckholtz. “But there are really no good ways of measuring that. The clinical and neuropsychological measures that were used really couldn’t differentiate between a disease-modifying effect and a symptomatic benefit.”

The idea behind ADNI is to collect data and samples to feed into a brain imaging, biomarkers and clinical database. It is hoped that the database will help scientists identify the best markers for following disease progression and monitoring treatment response. “There are 57 clinical sites in the United States and Canada collecting and sending data to various places to validate imaging and biomarker data by correlating them with the neuropsychological and clinical data,” said Buckholtz.

“There is a tremendous amount of data in the database,” said Buckholtz, “more data than any group by itself could really ever analyze.” He proceeded to explain the complex types of information being collected -- clinical and neuropsychological evaluations, magnetic resonance imaging scans of the brain, blood samples, a genetic analysis of each individual, cerebrospinal fluid from the brain, a measurement of glucose utilization in the brain to look at energy metabolism, and much else. The goal of the database, located at the University of California
Laboratory of Neuroimaging, is to amass a “pathophysiological signature of Alzheimer’s disease and follow it over time,” said Buckholtz.

What’s remarkable is that this entire database is in the public domain. It is available for free to all qualified investigators with no special access rights for anyone. “The threshold for getting a password to get into the data is very low,” said Buckholtz. “Essentially, anyone whose name is not Mickey Mouse or Donald Duck can get into the database, analyze all the data, write papers based on the data, and publish papers.” A person need only sign a data-use agreement that stipulates that any ADNI data used in publications must be acknowledged in a specified way. Everyone gets the data at exactly the same time, and the data input happens in real time.

A highly accessible database is seen as the best way to promote better collaboration and discovery about Alzheimer’s disease, said Buckholtz. He cited the vision of Art Toga, the head of the Informatics Corporation at the Laboratory of Neuroimaging, who hopes that ADNI will (in Buckholtz’s paraphrase) “let any scientist sitting at his or her computer anywhere in the world go into the ADNI database, day or night, and download any of the data, analyze the data however they want, with whatever novel methods or hypotheses they have, and then publish the data freely. This is really a tremendous advance for the whole neuroscience community.”

Shakespeare Quarterly Pioneers a Hybrid Editorial Review Process

A third presenter, Katherine Rowe, who teaches and writes about literature and media change at Bryn Mawr College, described how the editorial board of Shakespeare Quarterly (on which she sits) developed a hybrid editorial review process of open peer review.

Instead of relying upon the editor’s judgment and two selected, anonymous reviewers, the journal developed a new system that opened up the scholarly vetting of submitted articles to interested scholars from any field. It is a public process in which scholarly reviewers opt in to the process and are openly named, all in advance of the publication decision. (Shakespeare Quarterly’s collaborator in the project was Media Commons, and Rowe worked with Professor Kathleen Fitzpatrick of Pomona College in pulling the process together.)
The new process is a hybrid system because the journal’s editors continue to screen articles upfront, and they continue to make the final publication decision, as they always had. But the “middle process” of vetting submitted essays changed dramatically. The editor became less of an editor, said Rowe, and more of a “curator of the community.” “My central concern was how to keep the process respectful so that whatever the outcome, the participants felt as if it was both rigorous and respectful. That’s not a concern that an editor has to think about all that much.”

The open editorial review process was prompted in part by the journal’s subject, the interdisciplinary study of Shakespeare and new media. “As a field, Shakespeare studies doesn’t have a growing expertise in media history,” said Rowe. “The kind of questions that we’re grappling with require us to reach out into statistical analysis and social science practices that aren’t native to us and to our vetting processes. So we’re talking about arenas of knowledge that require expansive models of scholarly collaboration.”

One challenge in open vetting processes is attracting a sufficient number of scholarly participants. “It can be difficult to get enough scholars to step forward and speak frankly about a proposed essay, so that the editors can acquire enough information to decide whether to publish or not,” said Rowe. In this case, the journal attracted 41 participants. Scholars could comment at both the paragraph level and summary level – which is “the kind of commentary that a general editor wants to be able to see from an expert reviewer.” She noted that the process also yielded interesting “clustering of comments” that had the effect of giving “a peer-to-peer review of the reviewers” in substantive, direct terms.

“What was novel about our outcomes,” said Rowe, “was that the publication decisions were based on the push and pull among experts, rather than on the traditional two data points of anonymous, expert reviewers. There was a peer-to-peer effect in which the editors could begin to see where the field itself was grappling with problems that hadn’t yet been solved – as opposed to focusing on how a particular author might not be successfully grappling with a problem. That peer-to-peer effect among the reviewers and with the authors – as they responded to each other and grappled with particularly difficult issues – allowed us as editors to make decisions that were in a way accountable to the field as a whole, rather than to the two reviewers that we might traditionally be looking to.”

“For an interdisciplinary topic, that was crucial,” said Rowe. “We could not have made as successful an editorial decision without the wider net of participants that we were able to draw in to vet the four essays under consideration. And as editors,
we were able to gain some clarity about the significance of these essays. In particular, two of the essays brought significantly new methodologies to the field – methodologies new to the journal itself. Without a group vetting of this kind, I don’t think we could have seen the significance or challenge of those new methodologies.” Rowe believes that the new editorial review process is “less methodologically conservative” than the standard process of using selected expert-reviewers because it generated “so many data points to look at.”

Rowe noted that “naming reviewers was essential. We came to this conclusion after speaking with a number of junior scholars who noted that there are differential consequences for them in participating in an open review process. The junior scholars said that they could live with being publicly turned down, but they needed to be able to show, when they came up for re-appointment, that experts had reviewed their work. The naming of reviewers helped satisfy this need. As for the editors’ fears that the open peer review would attract trolls and other kinds of dysfunctional community behaviors, that simply did not happen. “When you carry your reputation with you wherever you go,” said Rowe, “you behave accordingly. And so, the result of [the open review process] was a tremendously respectful though critical set of exchanges.”

Professor Bruce Smith, also a member of the editorial board of Shakespeare Quarterly, confirmed Rowe’s point: “Before, an inhouse group of people at the Folger Shakespeare Library read the submissions and immediately eliminated about 90 percent of them. The 10 percent deemed possible were then sent out to two reviewers, and then the editor made the final decision. The new process acknowledged the possibility of a wide range of opinions, and was able to acknowledge internal contradictions about what is going on in the field. So even though the editors’ decisions were final, the decision-making was much better informed than if only two people had read the article.”

Some Implications of New Research Collaborations

Do scholars really want to collaborate? For certain scholars, particularly those involved in “big science,” collaboration is not really a choice, but a necessity. “There are classes of problems for which aggregation of information and collaboration is essential to making progress,” said Kesselman. “The ADNI database is an example. It’s only through the accumulation of enough data points that you can make scientific advances.
Collaboration is essential to making that happen.”

On the other hand, Rowe acknowledged that “in the humanities, many of us don’t want to collaborate. We love going into a quiet room and working with objects that stay the same from century to century. It’s a kind of contemplative, meditative coming to knowledge – a kind of sustained engagement that we deeply value, and that we usually do alone.” Certain disciplines “attract personalities who like solo work,” said Rowe, “which is why recognizing the need to collaborate is really as much an individual as well as an institutional struggle.”

But it is worth recognizing, also, that the situation is not bipolar – solo vs. collaborative. “Those are essentially the end-points in a collaboration spectrum,” said Kesselman. It’s not an either/or decision either in terms of anonymity versus non-anonymity, or openness of data versus control of data. It’s important to understand that this is a spectrum. There is a need to support a variety of social and collaborative processes, and to understand that a combination of both social and technical issues is involved.”

Kesselman also noted, “It’s not necessarily up to the system or the infrastructure to decide who is the expert and what is true and what’s not true. But the system must enable the individual to filter and apply the information that they view as meaningful – and also to support the traceability and repeatability of the information. That’s part of the scientific process.”

A spectrum of design principles also applies to social behaviors that span the “real world” and virtual spaces. At one end of the spectrum, open source software communities can develop some significant pieces of technology without its members ever meeting face to face. Yet at the other end of the spectrum, most scholars still benefit from getting together in person to talk with each other. The intermingling of virtual and physical behaviors is complicated. Some social protocols learned in face-to-face environments – such as how to behave on reviewing panels – are carried over into virtual environments, it was pointed out. Conversely, many behaviors learned in virtual environments – such as online dialogues that may disguise one’s credentials or personality – may be influencing how people behave in person.

How open vetting broadens the scholarly conversation. An audience member pointed out that altering the process of vetting to take advantage of the online environment helps open up a richer dialogue. In the conventional print environment, the editorial board serves as a proxy for the readers. But when any interested scholar or reader can participate, a wider array of concerns is likely to be raised.
As the audience member noted, “In the print world, you are forced to toss 90 percent of the submitted articles right off the top because you know you don’t have enough space to print them. What you do accept will be published within a year or two. But when you move to online publishing, you move away from the economy of scarcity. You don’t have a time lag, you can engage in ongoing scholarship in a much more interactive way, and you can experiment. Once you are no longer limited by a publisher dictating how many pages you have and the deadlines, you can host a variety of contributions and interactive, collaborative discussions. You can reach audiences around the world who never would have been likely to have access in the past, so the conversation can move in quite unpredictable ways.”

Professor Rowe pointed out that the open process did not, however, entice undergraduates and graduate students to comment on senior scholars’ work. By requiring commenters to be named, “very few junior scholars felt that could socially participate and comment on senior scholars’ work. We had fantasized there would be huge demographic shifts, but they didn’t occur.”

**Assigning credit in a collaborative environment.** Many scholarly disciplines are legitimately concerned about how to recognize the contributions of individuals in highly collaborative systems. Buckholtz conceded that this issue can pose problems for some people, especially young investigators who need credits to advance their careers. But papers developed under the Alzheimer’s Disease Neuroimaging Initiative are still authored by individuals, with full credit.

Rowe urged people to remember that “our traditional processes don’t manage to accredit labor that well, either.” She cited “peer reviewing itself, which happens nearly invisibly. Our scholarly communities depend on a kind of gift economy of significant labor – peer reviewing of other people’s work – and we don’t currently have a very robust way for crediting that labor. This is one of the places in which we as academics need to innovate.”

**New methodological challenges posed by academic collaboration.** Migrating to a more open, collaborative platform for scholarship introduces a number of new methodological challenges – as well as new opportunities...
for gaining insight into a problem. For example, the Alzheimer’s disease Neuroimaging Initiative, as a virtual organization, has a governance structure and highly prescriptive data quality control procedures that assure the data will be scientifically reliable. Kesselman pointed out, “By aggregating and distributing research money across multiple sites, we can get a larger, better-sized dataset. The reason is simple – not everyone with Alzheimer’s disease in various forms can come to the same lab.”

But new challenges arise as collaborators try to scale up the data-collection and analysis. “At the next level, where you’re not as centralized and you can’t be as prescriptive,” said Kesselman, “you’re going to get more data that’s messy and not clean and not collected consistently. So then, the interesting collaboration questions become, How do you deal with that noise and variability? How do you document the process enough to understand the mode that the data was generated in?”

New subsets of data may be generated that raise new questions: “How do we keep track of the fact that the new data is kind of the same as the old data, but it’s not? It’s a different resolution, using different acquisition protocols, and not going through the same quality control process. How do you then incorporate that data into the collaborative research activity and still have some kind of veracity for the results?”

While such questions may arise naturally in the physical sciences, the humanities often fail to grapple with these issues at all, said Katherine Rowe. “We don’t have good funding for that in the humanities,” she said. “In the humanities we don’t tend to think about the process itself as an artifact that should be subject to validation, testing and review. We have this infatuation with creating the new, and then we often forget the most important part, scaling it up and making a broader impact.”

An audience member, Dmitry Williams of the Annenberg School, pointed out that small research teams face some qualitatively different sets of challenges than big-science collaborators. “I run a relatively small research team of about twenty-five people,” he said, which consists of an interdisciplinary team of people at four universities, “at lots of different levels,” he said. Williams has found that his team’s needs are met fairly well through cheap and basic technologies – teleconference calls every two weeks and in-person meetings twice a year. He credits Google Docs with helping the group coalesce around the same documents with no one “owning them.” And simple screen-sharing technology that allows every collaborator to look at the same web screen during conference calls has doubled the team’s productivity.
The three presenters had succinct words of advice for anyone contemplating a move into innovative collaborations:

- “Don’t keep the data to yourself. Get it out there and let people analyze it. That’s what advances science and helps you as well.” (Neil Buckholtz)

- “Think about hybrid processes. When you experiment with some new tool, it doesn’t mean you’re abandoning the things you care about. It means that you are understanding better what it is that you care about.” (Katherine Rowe)

- “It’s important to think about your discipline as a mash-up culture, where your data gets mashed up with somebody else’s data, so that you can end up discovering something new that you had no idea you were going to discover. You need to think about that upfront.” (Carl Kesselman)
Creativity & Collaboration: **DIGITAL SCHOLARSHIP**

a graphic recording created by Lloyd Dangle

(View an interactive version of this recording on the Prezi website at [http://j.mp/jOhG7A](http://j.mp/jOhG7A))
III. DIGITAL SCHOLARSHIP

The second panel was introduced by a showing of a clever YouTube video animation1 that has served as a promotional trailer for a recent book written by Steven Johnson, *Where Good Ideas Come From: The Natural History of Innovation*. It is impossible to convey the ingenuity of the video here, but a portion of Johnson’s narration is worth quoting:

> ...The great driver of scientific innovation and technological innovation has been the historic increase in connectivity and our ability to reach out and exchange ideas with other people, and to borrow other people’s hunches and combine them with our hunches, and turn them into something new.....

> What has happened that is really miraculous and marvelous over the last fifteen years is that we have so many new ways to connect, and so many new ways to reach out and find other people who have that missing piece that will complete the idea that we’re working on, or to stumble serendipitously across some amazing new piece of information that we can use to build and improve our own ideas. That’s the real lesson of where good ideas come from – that chance favors the connected mind.

Re-inventing the Forms of Scholarly Work

The Digital Scholarship panel showcased a number of cutting-edge projects that use new digital technologies to create new sorts of “living” scholarly genres and knowledge, usually in a multimedia context. The first presenter (and moderator as well) was Tara McPherson, who teaches courses in digital media, television and popular culture at the USC School of Cinematic Arts. McPherson is one of the few scholars who has managed to bridge the deep divide between technologists and the humanities, a frontier that deserves much more exploration.

McPherson noted that the “vernacular archives” of popular culture – or what scientists might call “datasets” – are expanding at a phenomenal rate. YouTube now hosts more than 150 million videos, with thirteen hours of content uploaded every minute.

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1 [www.youtube.com/watch?v=NugRZGDbPFU](https://www.youtube.com/watch?v=NugRZGDbPFU)
Flickr surpassed five billion photographs in September 2010, and Facebook claims that 2.5 billion photos are uploaded to its site every month.

Scholarly “datasets” of text, video and images used in the humanities are “none too shabby either,” said McPherson, citing the USC Shoah Foundation Institute for Visual History and Education. With a collection of nearly 52,000 video testimonies in 32 languages and from 56 countries, the archive is the largest visual history archive in the world. McPherson also noted the National Science Foundation-funded cyber-infrastructure DataOne (Data Observation Network for Earth), a versatile, distributed framework for observational data about the earth. The platform is designed to be “open, persistent, robust and secure,” and will “ensure preservation and access to multi-scale, multi-discipline and multi-national science data.” Digital Sky Survey is another example of very large dataset.

The rise of these and other vast datasets is prompting many scholars like McPherson to suggest that the very forms of scholarly production are begging to be re-invented: “Can we have the communal nature of a blog or the multimedia capacity of YouTube incorporated into our scholarly practices? Can these vast archives change not only how we do our research, but how we share and publish it, producing new scholarly outcomes? Can our analyses live with our data? What would it mean if the interpretations we are producing actually lived side-by-side with our evidence? I think it would make us more accountable because we couldn’t make wild claims. But it would also mean our interpretations could be layered.”

The character of scholarly data is changing in many ways. For one thing, data is now gathered by amateurs as well as experts. The website ebird (www.ebird.org) collects information on avian species from thousands of amateur birders, who submitted most of the bird-impact data collected about the 2010 Gulf Coast oil spill. The graphic representation of data is also undergoing huge changes. McPherson cited Google Maps as well as TextMap (www.textmap.com), a search engine for “news entities” – people, places, and things in the news – that analyzes both the temporal and geographical distribution of them.

To explore some of the ways in which “born digital” objects might be managed in a more coherent way, the Alliance for Networking Visual Culture was recently founded. The Alliance links five universities (NYU,
USC, UCSD, Brown and Rochester) into a two-year prototype project for networking visual culture via the creation of a video annotation tool; digital publications with MIT, Duke and California university presses; conferences at Brown and at the Clark Art Institute; as well as other projects.

McPherson also presented a few innovative humanities projects. One is an early prototype of a “video-book,” Learning From YouTube, by Pomona scholar Alexandra Juhasz that exists online, on YouTube. It’s a non-linear book (and designed by USC’s Craig Dietrich) that MIT Press also published as an e-book in February 2011.

Another fascinating experiment is Scalar, a publishing platform for scholars that integrates video, audio, animation, graphic and interaction design, and databases. The goal of the project is to create a standardized interface for reading and writing visual works, and so to spread the practices more widely across scholarly presses and scholarly societies.

As we re-think how to integrate scholarly practice with “big data” and “big archives,” McPherson urged the designers not to assume the ways in which data and information will be used. Instead, she said, honor openness as a value. Users/readers should be regarded as co-creators. To enhance that potential, it is important that systems have “open APIs” (application protocol interfaces) and the capacity for users to gain “deep access” to data so that they can curate their own pathways into the data. There should also be multiple types of front-ends to access information, she urged, “from the transparent to the opaque, and from the text-based to the visual.”

The Shoah Foundation’s Vast Video Archive

Sam Gustman, the Chief Technology Officer of the USC Shoah Foundation Institute, demonstrated the astonishing types of information-retrieval and analysis that are possible using the Institute’s vast video archive of testimony by Holocaust survivors. The eight-petabyte collection includes 52,000 interviews and 105,000 hours of video. All of the interviews, in thirty-two languages, have been transcribed and synced with the video, enabling scholars quickly to locate testimonies on very specific topics and even single words.

To illustrate the possibilities, Gustman typed in the keywords “food” and “hiding” and “Auschwitz.” Up came three entries, 

2 www.youtube.com/watch?v=apZ2EBat6Y
3 mitpress.mit.edu/catalog/item/default.asp?type=2&tid=12596
one of which was at 1:78 minutes into the testimony, as a person talked about forced marches and food. “We have keywords, people’s names, latitude and longitudes, time and places, and various other ways of looking through the interviews,” said Gustman. The Foundation is exploring other ways to index the testimonies, including by images. A mashup of the testimonies using Google Map is in a prototype phase. This will enable scholars to type in a place like Radom, Poland, and discover interviews that mention that place.

Some twenty-six universities around the world now subscribe to the Shoah Foundation’s archives, said Gustman. The next challenge is to meet the community content protocols of various K-12 school systems so that the materials can be made accessible there as well. A specific challenge facing the Foundation is preservation of the archives. “Everything rots,” said Gustman. “Film can last fifty years, conservatively; videotape, twenty years, hard drives, five years; data tape, three years; and DVDs, as little as two years in some cases.” The newer the technology, the more rapid its deterioration, he said -- so affirmative steps need to be taken to ensure the longevity of the information.

McPherson noted that while most of the scholars who use the Shoah archives “typically go back to their ivory tower next door to write an article or book about the material,” the future may well see a massing of scholarship in the same spaces as the archive datasets. “We should start to imagine a future in which scholars embed their interpretations more closely with the data itself – the evidence. Then you could start to connect the threads of analysis. You could start to accumulate knowledge in different patterns and probe different possibilities, rather than having the lone humanities scholar put out his or her work alone. In the networked environment, we can begin to aggregate things in really rich ways that are greater than the sum of any individual scholar.”

The idea of multiple, open-ended uses of databases puts enormous new pressures on the task of metatagging of data, however. How should this be done?

While it is possible that some of it could be automated or facilitated by machines, many panelists agreed that there is great pedagogical value in having it done manually by students. “When you go into an [electronic] archive and you begin to see what it means to tag something,” said Katherine Rowe, “you understand how a database delimits or enables modes of inquiry.” For example, some metatagging may have embedded
ideological biases. Other metatagging may ignore things that may not be obvious, such as instances of weeping or pausing in the Shoah video testimonies.

As databases become more important to research, more students and scholars find that they need to learn more about multimedia literacy and research methodologies. Fortunately, USC offers a number of courses in this regard, but it is not always easy for doctoral students to figure out which schools are offering such courses.

**Interdisciplinarity as a Generator of New Knowledge**

A second presentation, by Anne Balsamo, who teaches in the USC School of Cinematic Arts and the Annenberg School, writes frequently about the intersection of culture and technology. Balsamo, a former “Chief Humanist” at Xerox PARC and cofounder of Anime Labs in Silicon Valley, is deeply committed to interdisciplinarity and transmedia scholarship. Indeed, it was a mission statement in USC’s strategic plan in 2002 that attracted her to teach at USC.

Interdisciplinarity is important, said Balsamo, because it helps create new knowledge and identify the horizons of new research: “It engages multiple intelligences and creates ‘deep knowledge’ (to know something is to ‘know it’ from multiple perspectives).” But pursuing interdisciplinarity requires both an institutional culture that supports it as well as an ethical framework. The “rules of engagement for interdisciplinary collaboration” include “intellectual generosity, flexibility, reliability, humility and confidence,” said Balsamo.

Balsamo’s latest work of transmedia scholarship is a project called *Designing Culture: The Technological Imagination at Work*. It consists of a print book that will be published by Duke University Press in the spring of 2011 along with a DVD containing an interactive documentary. The project also includes a website, a blog and repository of Balsamo’s digital portfolio.

One focus of Balsamo’s work is to explore new sorts of “peer to peer learning experiences” that allow students, faculty, researchers and others to collaborate on trans-domain projects. “One of the consequences of these engagements,” she said, “is that we are getting the insights to develop new research questions, build transformative projects and do technology prototyping.”

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4 That statement reads: “Since social problems rarely fall within the domain of a single discipline or school, collaboration that brings together different perspectives and skills may be the best means of addressing such problems. Existing disciplinary and school boundaries, however, often impede effective collaboration. We must create mechanisms that remove structural disincentives to such collective efforts on problems of major significance.”
One example, said Tara McPherson, is “experimental forms of writing that might feel like a video game, in which an argument is made through immersion and play.” The beauty of big data is that so many novel points of access to the same information can be made through different types of interfaces and metadata. One could imagine drawing upon a database by using a Google Map mashup, a search field with text or a remixed video, she said. A problem that arises in some quarters, Anne Balsamo said, is that many people “don’t know how to read these dynamic documents. The literacies for apprehending them are not very widespread.”

Roger Ghanem, a professor at the USC Viterbi School of Engineering, advanced the discussion about digital scholarship by talking about the need to transform traditional publishing formats. “Over the past 350 years, the functionality of the publication has not evolved. With the Internet, we have started to imagine an evolution not only in the manner in which we disseminate knowledge and discoveries, but also in the functionality of that knowledge, and the manner in which we interact with it. We are perhaps at a point now where the ontology and semantics of knowledge can start to converge.”

Instead of publications being static summaries of research, said Ghanem, they could become live, dynamic objects that can interact with others. Instead of using the Web as a medium for storage of information, the Semantic Web and metadata protocols could be used to make knowledge more easily discoverable and useable. For example, if an engineer or homeowner wanted to use the latest technologies for building a house, they might be able to use new types of digital formats and markup language on the Semantic Web “to automatically find a useful paper, connect to it, upload any requirements for [the house that would be built], and retrieve specifications consistent with the scholar’s most recent scientific discoveries.” Tara McPherson suggested that scholars in the future will not just write an article or a book, but instead contribute to “product spaces where knowledge lives in a kind of collaboratively extended network.”
Creativity & Collaboration: **NETWORKED RESEARCH**

a graphic recording created by Lloyd Dangle

(View an interactive version of this recording on the Prezi website at [http://j.mp/jh9RQk](http://j.mp/jh9RQk))
III. NETWORKED RESEARCH IN BIG SCIENCE

From 2004 to 2010, Dr. Arden Bement served as the 12th Director of the National Science Foundation, which funds research and education in all fields of science and engineering. Its $6 billion budget supports hundreds of programs and approximately 200,000 scientists, engineers, educators and students. During his tenure at NSF, Dr. Bement took on the issue of how to do collaborative research in “big science” and build cyber-infrastructures that link disciplines, universities and different types of institutions.

Dr. Bement gave a formal address, “Network Science: Using Information to Enable Collaborative Research,” which is excerpted here:

*I’m going to talk about the information revolution to start with. During this revolution, which continues to build momentum, there are a number of changes in the international scene that have driven enormous changes in how science is being done and how scientists engage with other scientists to do science.*

*First of all, the tempo has increased through the increases in scientific productivity. This is driven in part by international competition. Most economists today will agree that economic growth in today’s information revolution is substantially linked to investments in education, research, and infrastructure, primarily cyber infrastructure. This has naturally led to heightened investments in these areas resulting in greater worldwide leveling in research intensity relative to GDP. Many nations now aspire to get the 3 percent and the U.S. hasn’t been at 3 percent yet.*

*In addition to increased competition in the conduct of science there’s a greater imperative among governments to measure the returns from scientific discovery in terms of new job creation and innovative activity. I learned in Washington that members of Congress didn’t know exactly what the National Science Foundation did, but they trusted us. And I thought that was a lot better than the other way around.*

*There has also been a movement among U.S. universities to become international universities through heightened...*
international enrollment, student exchanges, research collaborations, and the establishment of campuses abroad. Purdue University is an example. It ranks now among the top four universities in international enrollment, but they’re three places behind USC, who ranks number one in international enrollment. And Purdue ranks prominently in emphasizing global engagement and leadership in its strategic planning. The establishment of the Global Policy Research Institute, which I have the honor to lead, is one example among many of Purdue’s global leadership.

In addition, international networking has expanded substantially in just the past five years. The latest example is the Taj network which now links Singapore with Delhi, with Cairo, and then on up to Amsterdam. And that’s in addition to GLORIAD, which takes care of the northern flank, which ranges from Korea to China to Russia and to Scandinavia. While there’s still some dark spots, mostly in Sub-Saharan Africa, most of the major academic, industrial, and government research centers in the world now are connected. And I expect that even the dark spots will soon be connected.

Because of these developments, the world continues to shrink at an accelerating rate and a much faster rate than even global travel brought about. There’s a growing imperative to collaborate in order to compete. To do frontier research it is first necessary for the scientist to know where the frontier is, where the next salient of the frontier is likely to occur, and what grand challenge need to be addressed. Because of the increased intensity of global research, insights into finding answers to these questions might be quite different in different parts of the world. Hence, it’s important for scientists to network globally to keep from becoming blindsided.

To guard against this, many scientists are now connecting more extensively with virtual international research groups, and many are becoming peripatetic, having research groups in different parts of the world. While such global outreach among scientists is not new, the accelerating volumes of data and information flows, and the complexity of modern day scientific problems makes global engagement today much more sporty than in the past.
Among the factors at play is the growing attention being given to interdisciplinary research involving research groups and centers, using computer modeling and simulation and data sharing in synthesis. I believe that these trends are driven by a faculty interest and doing research systemically to tackle the complexities inherent in global grand challenge problems by using the advanced computational tools now at their disposal.

Finally, pressures for high-end research instrumentation and facilities with embedded cyber tools and networks continue to skyrocket. NSF is under increasing pressure to increase this cap on major research instrumentation to as much as $100 million. Furthermore, the pressures to build new national research facilities costing from $500 million to above $1 billion are likewise increasing not just in the United States, but through the world. This trend raises the question, should we not be building more kinds of facilities rather than more facilities of one kind. It was the pondering of this question that led to the development and commissioning of the National Earthquake Engineering System, or NEES, connected by a common backbone network and now managed by Purdue.

USC is one of the 14 NEES system members. The NEES network has been a resounding success, not only in providing the means for free online data sharing, but also enabling coupled systems testing on virtually connected structure. Now, think about that. Think about a bridge where the superstructure is at one university, the abutment is at another university, and some other part of the bridge is at another university and testing concurrently with the same simulated earthquake.

Having demonstrated the benefits of such a virtual test network at a national scale, it was natural to propose that such a network could and should be extended internationally among seismically active nations. I was delighted in 2005 to sign an MOU between NSF and MEXT to connect Japan’s e-Defense “shake table,” the largest and most complex test facility of its type, to the NEES network. I might say parenthetically MEXT is Japan’s all-inclusive ministry of education, culture, sports, science, and technology. Hopefully other countries will join the NEES network in the near future. There are several opportunities that are budding.

One can cite other examples of virtual networks. We heard about the Large Hadron Collider this morning. Examples would include the autonomous virtual operating scheduling and sharing of data from major telescopes, such as the Gemini telescopes in Chile and Hawaii and the 10-meter telescope at the South Pole. Observational virtual scientific
networks funded by the NSF that are connected by a common network and data repository include the Incorporated Research Institutes for Seismology, or IRIS, the Earth Observing Network, or EarthScope, the Ocean Observing Initiative, OOI, the National Ecological Observing Network, NEON, and the Arctic Observing Network, AON. Such virtual facilities will be major contributors to the burgeoning volume of data and information flows that are already saturating our networks, storage facilities, and capabilities to curate and evaluate data.

In the remainder of my remarks in order to provide some examples, I would like to outline some of Purdue’s contributions to facilitating virtual communities through the open sharing of data, metadata, and publications. And I hope that from what I heard this morning we’ll find some natural linkages for collaboration. It should be stressed at the outset the problems in open sharing among these three categories are not just problems of scale, but also of scope concerning scientists, such as trust, reliability, security, provenance, precedence and authenticity. These items were mentioned this morning.

The growth in high performance computing occurring not only at Purdue University, but also throughout the U.S., is both driving and responding to the rapid acceleration in data generation. Purdue employs community clusters, which tap the operational availability of campus computers broadly in the interest of reducing cost and power consumption while improving versatility. Since 2006, research-computing power at Purdue has increased by more than ten times. But since 2000, it has increased 200 times. That’s an increase of two orders of magnitude in one decade. To meet this demand, Purdue built in 2008, 2009, and 2010 three super computers worth more than 130 teraflops of collective capacity. And that’s in addition to the capacity that already existed.

These three supercomputers are named the Steele, Coates, and Rossmann, respectively, after three campus-computing pioneers. The Coates and the Rossmann supercomputers were ranked respectively at the 2010 Supercomputing Conference as the 147th and 126th among the world’s 500 most powerful known computing systems.
In addition to these three supercomputers, Purdue has developed a TeraGrid resource called Wispy, a cloud computing system that allows researchers to package self-contained programs or virtual machines to run remotely on a specifically configured clustered supercomputer. Up to 128 virtual machines can run on a Wispy cluster at one time and address a variety of computing environments. Since the Wispy cluster is readily scalable, this capability can greatly extend computational capacity over time at low cost.

Perhaps the innovation Purdue is most noted for in support of virtual communities is the development of HUBzero, which is the open source foundation for the development of a growing number of hubs, one of the most notable being the nanoHUB. HUBzero has been termed a Facebook supercharged with steroids for scientists. For those of you who may be unfamiliar with the hub, it’s a web-based collaborative environment with such features as how-to videos, interactive simulation tools, online presentations, mechanisms for upgrading new resources, a tool development area, and areas for rating citations and content tagging. It’s a sharing, learning, exploring, discovering, and virtual people connecting environment. For example, the NEES hub has been developed to access NEES projects, run earthquake simulations, facilitate the analysis of structural responses to displacement reversals, support learning with data and simulations, and share resource results and publications.

[Open sources] to access data and information flows are essential for scientists in general and virtual communities in particular. Data mining in astronomy and astrophysics data sources, for example, such as the National Virtual Observatory, NASA’s Astrophysics Data System, and international astronomical and astrophysics surveys, such as the Sloan Digital Sky Survey, have enabled even young amateur astronomers to discover exo-planets, galactic degeneracies, and binary stars.

Scientists who made discoveries by data synthesis rather than by original research – note the language – were not highly regarded in the past. However, this has changed with open data and information sharing and the availability of computational tools that enable data mining, synthesizing, modeling, simulating, and discovery. So now it is original research. Data storage, archiving, safeguarding, and making accessible data, papers, and publications have brought university libraries even closer to scientists as full partners in their discovery of publication endeavors.

Supercomputers and object based storage systems are now common tools for libraries. Furthermore, libraries are now becoming much more involved in ontology, semantics, and database development.
University libraries collaborate actively in establishing innovative means to perform these roles. For example, many new light archives have been established to circulate e-publication [and v-publications] and digitized archives broadly as compared with archives where they may never see the light of day.

Purdue Library is especially active in performing these many roles and among their active projects are the following, as illustrated in this slide (see right hand column, first image). First, archiving, safeguarding, and making accessible to Indiana state residents U.S. federal documents, probably not as good as Twitter these days; establishing an enterprise business information network called e-BIN, aimed at reaching out to entrepreneurs in 14 countries during the pilot phase; building a distributed data curation center called D2C2 – sounds like Star Wars – to help scientists determine how to best archive and preserve their data. This center, facilitated by 30 terabytes of data storage provided by Sun Microsystems, is being developed in partnership with the University of Illinois at Urbana-Champaign and will provide data curation profiles across multiple research disciplines and will address the question which researchers are willing to share data, when, with whom, and under what circumstances.

The libraries are building Purdue e-Scholar, which is a distributed institutional repository containing collections of digital documents, such as doctoral dissertations, faculty authored journal articles, conference proceedings, and technical reports, provided by a system called Purdue e-Pubs. Also, digitized archival collections were provided by Purdue e-Archives, and research datasets were provided by Purdue e-Data.

Next, using the content and the open access repositories or openDOAR to harvest, characterize, test, and measure, or randomly select a set of 100 metadata records to establish criteria for establishing collections of such records, and finally, engaging with the CIC Google Book Digitization Project to scan as many as 500,000 to 750,000 volumes from Purdue’s Library--Purdue Library signature collection. This partnership marks the first time that a consortium of independent institutions,
namely the CIC, which is the big 10 universities plus the University of Chicago, has joined in a collective scanning of print materials being provided by Google, with the potential of digitizing up to 10 million volumes.

Most of the developments outlined above in computation, hub development, and open data and information sharing also benefit education. The open courseware movement initiated in 1999 by the University of Tubingen was soon followed in 2002 with the launch of the MIT open courseware and subsequently joined by several of the universities. This movement is providing enormous benefits to science, technology, engineering, and mathematics education internationally, and especially for developing countries with sparsely populated regions of the world.

I know from my work in Pakistan that most universities in Pakistan now use MIT science and engineering courseware in almost all of their major universities. Furthermore, since they have their own communication satellite system, they also broadcast that content throughout the Middle East. Advanced information and communication technologies are now commonly deployed in learning laboratories at most U.S. universities.

Looking to the future, one can expect additional revolutionary developments in how research and education are conducted. For example, the evolution of a semantic web – the dream of Tim Berners-Lee, to make available machine-readable metadata that can facilitate machines talking with machines – will be advanced by the new scientific understandings of how the human brain stores and transfers data. The size of the neuroscience community has increased dramatically in recent years due to interdisciplinary couplings with other disciplines. The potential for increasing exchanges of insights should bring about major advances in understanding the functionality of the human brain in greater scientific detail.

Such advances in knowledge should advance prospects of developing natural bridges between human intelligence and machine intelligence, enabling greater synergies between what the human can do best and what the machine can do best. This will in turn lead to new advances in how scientists do science and how virtual communities of scientists collaborate. These advances will also lead to further improvements in the efficiency of manufacturing and operating systems, such as a smart grid, through the use of both central and network distributed controllers that have embedded anticipatory and smart agent functions.
A blue ribbon advisory panel of the National Science Foundation in their 2003 report, Revolutionizing Science and Engineering Through Cyber Infrastructure, expressed this vision. A new age has dawned in scientific and engineering research, pushed by continuing progress in computing information and communication technology, and pulled by the expanding complexity, scope, and scale of today’s challenges. The emerging vision is to use cyber infrastructure to build more ubiquitous, comprehensive, digital environments that can serve individuals, teams, and organizations in ways that revolutionize what they do, how they do it, and who participates.

This vision provides hope that, as the world continues to shrink and virtual engagement is further facilitated, scientists collaboratively will more readily find solutions to the dawning global challenges facing the world today and pave the way to an improved quality of life for humanity.

In the limited time for questions after his remarks, Dr. Bement addressed the tepid political support in the U.S. Congress for science and technology funding. He said the three key questions that Members of Congress ask him are, How much funding is enough? What are the important scientific discoveries that we should be investing in? And how many jobs and how much economic development will occur if the NSF budget is boosted by, say, $100 or $200 million? Dr. Bement said that these questions “express the leanings and attitudes” of many members of Congress.

But for those who are concerned about America’s commitment to science and technology education and research, Dr. Bement is convinced “we have everything going for us. If we lose out in this [global] competition, it’s only going to be through complacency.” From his international travels, Dr. Bement believes that the U.S. has three significant advantages over other nations: an open society, the cultural permission to fail, and a culture that supports competitiveness. He also cited the integration of science research with education, and the close ties between university researchers and the marketplace.

The U.S. has three significant advantages over other nations: an open society, the cultural permission to fail, and a culture that supports competitiveness.
Creativity & Collaboration: NEW METHODS FOR EVALUATING SCHOLARS

a graphic recording created by Lloyd Dangle
(View an interactive version of this recording on the Prezi website at http://j.mp/kPRAnM)
III. NEW METHODS FOR EVALUATING SCHOLARS & THEIR RESEARCH

The final session of the symposium focused on the special challenges that collaborative research poses for evaluating the quality of a scholar’s work, especially as it plays into the appointment, promotion and tenure process. Evaluation of scholarship embedded in new digital media and new collaborative forms can be exceedingly difficult precisely because consensus standards of high-quality scholarship do not yet exist; the technologies are too new.

To judge from several reports on collaborative research by respected academic bodies, this challenge is not being met well. The American Council of Learned Societies issued a task force report on collaborative research in which it declared: “In the most elite universities, traditional scholarly work in the form of a single authored printed book or article published by a university press or scholarly society, is the currency of tenure or promotion. Work online or in new media, especially work involving collaboration, is not encouraged.”

An empirical survey of educational institutions conducted by the Modern Language Association advised its readers: “Asked about inexperience in evaluating scholarly monographs in electronic formats. Two thirds of doctoral-granting departments report that they have no experience.” Finally, at a workshop hosted by the Institute of Medicine called “Extending the Spectrum of Pre-Competitive Collaboration in Oncology Research,” the Vice Dean of the medical school at UC San Francisco said: “The merit, tenure and promotion processes in the University undermine everything we are trying to accomplish here.” (These quotations were culled by Martin Kaplan of the Norman Lear Center.)

Genevieve Giuliano, Senior Associate Dean for Research and Technology at the USC School of Policy, Planning & Development, framed the problem facing universities well: “How do you assign value to something you haven’t figured out before? And how can you do that in a way that assures that you are minimizing the university’s risks [in making an “incorrect” decision]?

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How to Evaluate Collaborative Research?

Assessing the merits of an individual’s role in collaborative research is difficult for a number of reasons. First, as Terence Sanger of the USC Viterbi School of Engineering put it, “A lot of the fundamental problems in collaboration are due to the lack of respect across fields…. This lack of respect for different types of research comes from a lack of understanding.”

Sanger told the story of a collaboration between an engineering and medical school in which a senior professor at the medical school remarked that the engineers were obviously not going to be able to contribute much because the medical students were so smart and would quickly master the straightforward facts about engineering. Meanwhile, a senior electrical engineer at the same university touted the brilliance and intellectual rigor of his engineering students, and expressed doubts that the medical students would offer much in the collaboration.

“The way that you can tell that you have moved from one discipline to a neighboring discipline, said Martin Levine, USC Vice Provost for Faculty Affairs, “is when people start saying, ‘That’s not research!’ Or you hear things like this from a music school: ‘Well, I play violin and she plays viola. How could I possibly evaluate the quality of her work?’”

These problems get amplified when trying to assess quality in scholarly fields whose very parameters of inquiry and methodologies are still emerging. “The problem is when you’re on the boundary between two fields, you have no peers,” said Terence Sanger. “Yet we count on peer review in order to make accurate assessments. If you are trying to create a new collaborative effort or do something that is really on a boundary – a place where there isn’t really anybody else who has done that before – the very existence of a peer group would lessen the status of that person….. The problem is not so much the knowledge base that exists between two disciplines. It’s the way in which knowledge is created and the way in which that knowledge is assessed.”

A good example is interactive, online games. When that genre was raised, Martin Levine replied that “games are like movies and other works of art. You evaluate it like any other work of art.” But Kathrine Rowe of Bryn Mawr College disagreed, noting, “Games might actually be a form of argument, not just a form of...
entertainment. A film might be a form of an essay – not a pure creative act in the mode that we’ve been thinking about visual art for so long.”

The fluidity of genres may have important consequences for the protocols of reviewing and evaluating scholarly work, said Rowe. Perhaps peer reviewers should be asked the question, “What is the appropriate mode of comparison for thinking about this new genre? Can you make the case that a game ought to be thought of as equivalent to an essay rather than to a film? Should the design of digital tools be compared to the design of new scientific processes?” There is a risk in making facile comparisons to existing media, said Rowe, “because one may be tempted to look narrowly at one’s own, familiar genres rather than across disciplines and their genres.”

Yet another problem is assessing the contribution of an individual in a collaborative process, especially one that has dozens or even hundreds of collaborators. There may be huge numbers of people contributing to online repositories, digital tools that other scholars use, new software infrastructures and metatagging systems. How does one isolate the individual scholar’s intellectual leadership, rigor or brilliance?

“How does one isolate the individual scholar’s intellectual leadership, rigor or brilliance?”

“Suppose I take it upon myself to document a database in a way that everybody else can now use,” Genevieve Giuliano said.

Although the new genres of scholarly work are in fairly rudimentary stages of development, their academic importance is generally recognized. What is unresolved and problematic is how to make intelligent assessments of scholarship in particular cases. Whom does one consult for independent assessments? What standards does one apply? How can a contextual judgment be made?

“Suppose I take it upon myself to document a database in a way that everybody else can now use,” Genevieve Giuliano said.
“That’s a great altruistic thing for me to do. But unless I have created some intellectually creative form of documentation [or metadata], it really isn’t much of an intellectual contribution. It may be that some of the rules of the game [from conventional scholarship] translate here, even though they are in new media that we don’t know very much about at this point in time.”

The phrase “at this point in time” may be a critical one. “Our judgment of what’s critical or not – what’s a tool and what’s the content – are always bound by our blinders that we have at the moment,” noted Anne Balsamo of the USC School of Cinematic Arts. She cited the “very old story of women in the production of knowledge.” Women are often seen as doing the “scut work that doesn’t count” – yet later feminist historians of science and technology have revealed that “scut work” to constitute significant scholarly advances.

A number of speakers emphasized that impact is what matters. “How much has a scholar impacted the field and broadly, other fields?” asked Shrikanth Narayanan of the USC Viterbi School of Engineering. “If we can measure that, then that makes a case.” Tom Jordan of the USC College of Letters, Arts and Sciences, agreed: “This question of impact is the real nexus of the problem. We have to admit that in collaborative structures this issue is a layered problem.” That is one reason that USC is currently re-drafting language in its faculty handbook (available online at http://policies.usc.edu/facultyhandbook/facultyhandbook2010.pdf) to take account of collaborative research, he said. (This issue is taken up in the next section).

To ascertain an individual’s contribution, “you have to go to the opinion-brokers within the collaboration,” said Jordan. “You have to go to people embedded within the collaboration.” But at the end of the day, he said, the assessment is “going to depend on the absolute impact of the collaboration as well as on the relative contributions of the individual within it.” He cited as an example the Intergovernmental Panel on Climate Change, a prominent, well-regarded body whose work is regarded as the authoritative scientific judgment on changes in the Earth’s atmosphere. The number of scientists involved in the first IPCC assessment was about 250; the fourth assessment had 600; and now there are over 1,300 scientists involved.

“It’s clear that the IPCC is an important collaboration,” said Jordan. “Its impact is very high. And if somebody is making an important contribution within that collaboration, it can be assessed and assigned, I think, a suitably high value.” Jordan stressed that a university must be “especially diligent not only in evaluating relative
contributions but also the absolute impact of collaborative research. We can’t presume that it has high impact.”

Part of the problem in honoring collaborative work, suggested Philip Ethington, a professor of history and political science at the USC Dornsife College of Letters, Arts and Sciences, is our deeply rooted ideas about individual genius and originality, a notion that began in the Romantic era. By locating “originality” in individuals (and then assigning property rights in the results), we tend to neglect the actual importance of everyday collaborations and co-production.

“The irony,” said Ethington, “is that for years librarians have been producing really valuable repositories, and struggling to be recognized as scholars or faculty. Now that scholars are becoming more involved in creating these databases, we have to reassess the difference between an archive and something that is a work of scholarship. I think that originality and creativity in the production of it are probably key criteria.”

**How Can Promotion and Tenure Decisions Take Account of Collaborative Scholarship?**

The quandary facing higher education, as it comes to terms with digital technologies and the collaborations that ensue, is how to recognize individual accomplishments that are embedded in a collaborative context. If a university remains focused on conventional metrics of scholarly achievement, academia will overlook – and fail to reward – the significant innovations and new knowledge being generated through new technologies.

Yet the pragmatics of this challenge are difficult. Or as Shrikanth Narayanan put it, “It’s a very simple principle: credit follows effort. But operationalizing this principle is very hard because the nature of collaboration across disciples is very heterogeneous.”

Tom Jordan recapitulated why tenure reviews operate the way they do: “The reason why we have a rigorous tenure process is because the University is making a very big bet on a person. We’re trying to avoid two types of errors. A Type One error is a false positive, in which we incorrectly identify a scholar of great merit. A Type Two error occurs when we do not properly identify that person.”

“You want to avoid a Type One error,” said Jordan, “because you’re putting something like a $5 million bet on the career of this faulty member. To evaluate that person and his future is a tricky business, one that is intrinsically subjective. What we want to do...
is assess a scholar's impact at the time of tenure, with the notion of the potential for future impact. I think the mechanisms for doing this are being perturbed by the development of large-scale collaborations.”

One reason that tenure decisions tend to err on the side of conservative judgments, said Genevieve Giuliano, “is because you’re not just betting on the person, you’re betting on the university’s reputation. And in a university that wishes to go up in the rankings, the peer groups are the people at the top – and the people at the top may be extremely conservative. That is to say, the disciplines rule and sole-authorship rules. If you make too many Type One errors, the university is not going to move up.”

This system has a self-reinforcing conservatism, said Giuliano, because it is very difficult to change the rules. “Who, then, can be the innovators?” she asked. “In my view, it is the few universities at the top – because they’re now good enough to be able to break the rules and get away with it. And so I would expect to see real changes coming from the very top universities. It’s no surprise to me that it was MIT that developed Open CourseWare first. That’s a risky maneuver that other universities wouldn’t take. So I would encourage us to think about how USC could be more risk-taking and less risk-averse.”

Tenure also serves to provide scholars with a guarantee of academic freedom, noted Philip Ethington. “That’s why academic tenure was instituted at the beginning of the 20th century, after several major scholars were fired for taking controversial stances on economic questions, in particular, advocating socialism…..” One of the unfortunate, paradoxical things about tenure, said Ethington, “is that until you get it, there is a lot of pressure not to take risks. That is one of the questions that we’re going to have to manage. We want our young scholars to be risk-takers, and we don’t want them to be timid and worried about stepping out of their disciplinary boundaries, in ways that won’t be rewarded, by undertaking digital collaborations.”

USC has already taken some steps to address these issues, Ethington noted. The University’s Research Committee has been considering how to promote both interdisciplinarity and collaboration in the UCAPT manual – the guidelines for tenure and promotion – and the faculty handbook. Both documents contained language that some might perceive as discouraging interdisciplinarity and collaboration.

For example, the UCAPT manual until recently stated: “Fundamentally, we want to know whether the candidate
[for tenure] has made an impact or shows high likelihood of impact on the field and demonstrates focus and independence.” The word independence was seen as a yellow flag because it might be perceived as discouraging interdisciplinary collaborations. It was decided to replace the word “independence” with “originality.”

Another problematic passage, said Ethington, is in the faculty handbook, under the section called “The Dossier.” It reads: “Although some of the reviewers may be selected from a list of names provided by the candidate, most should neither be from that list nor have a close personal or professional relation with the candidate.”

This language was seen as problematic because, for scholars who must collaborate with others, it would seem to exclude many potentially knowledgeable recommenders. This passage in the faculty handbook now reads: “Although some of the reviewers may be selected from a list of names provided by the candidate, most should not be from that list. Care should be taken to avoid soliciting letters from scholars whose close personal or professional relation with the candidate may predictably bias the scholar’s evaluation.”

For tenure candidates who are involved in collaborative projects, the University now seeks out letters from collaborators and spells out the process clearly. The candidate is invited to explain in detail what he or she has contributed to joint projects. The academic department is also reminded to seek out letters from collaborators to address these questions. For a number of years, there has been a special letter sent to a tenure candidate’s collaborators, and the departmental committee is explicitly asked to gather evidence of an individual’s collaborative work.

These procedures are intended to improve the rigor of tenure reviews and properly take account of collaborative academic scholarship. The USC Research Committee has identified this as a priority. Its number one recommendation reads:

To reflect the value that USC places on collaborative research, the evaluative committees in schools and units will need to develop fair and consistent standards for assessing the quality, volume, extent and impact of the collaborative activity of a faculty member.

The enduring problem, as Terence Sanger noted, is, “You’re always being evaluated [in tenure reviews] by people from different fields, cultural backgrounds, races and genders. The problems that can result are very, very relevant and may be amplified when you are looking at collaborative group efforts.” Certainly these issues will benefit from continued, close attention in the future.
The problem of evaluating an individual’s scholarly performance, it was pointed out, is akin to asking, How do you assign credit to jokes? It sounds like a frivolous question, but in fact, the analogy is worth examining. A landmark 1981 article on the public domain by Professor David Lange explored this very issue as it pertained to vaudeville humorists. Groucho Marx once explained that the use of material from other comedy acts, burlesque shows, beer gardens, and comic magazines was entirely routine, adding: “In time, if [the comic] was any good, he would emerge from the routine character he had started with and evolve into a distinct personality of his own. This has been my experience and also that of my [Marx] brothers, and I believe this has been true of most of the other comedians.”

“What Groucho is saying in this passage,” said Professor Lange, “is that although he and his brothers began as borrowers they ended as inventors….It is a central failing in the contemporary intellectual property literature and case law that that lesson, so widely acknowledged, is so imperfectly understood.”

One might argue that the academy is trying to come to terms with a similar dynamic in scholarship – navigating the blurry line between “borrowing” and original invention in its highest forms. What’s different in scholarship in the digital age is that “individual achievement” may no longer be seen as an isolated fact and developmental end-point. Perhaps “originality” will increasingly be embedded in collective contexts, or at least our cultural lens will perceive it that way. In any case, the steady advance of digital technologies is making interdisciplinary collaborations a structural feature of contemporary scholarship, and a highly important one at that. These novel circumstances call upon the academy to realign its most venerated traditions to the exigencies of the time. New systems may be needed to recognize and reward individual scholarly achievement in a collegial context.

One way to contextualize the current dilemmas faced by universities is to recognize that we are living in an interregnum between different modes of scholarship. We are moving from scholarship in which the primary publishing media have been based on a regime of economic scarcity – whereas the new modes afford much greater abundance and versatility. Managing abundance

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8 An illuminating recent critique of creativity as the product of the cultural commons, as affirmed by the American Founders, as can be found in Lewis Hyde, Common as Air: Revolution, Art and Ownership (Farrar Strauss, 2010).
is quite different from managing scarcity; there are different warranting structures and processes for determining what is trustworthy, rigorous and valuable. The new digital tools for research and scholarship are sometimes radically different from conventional ones.

And yet, while there are certainly many technical, legal and institutional issues that are implicated, at bottom the issues are mostly professional, social and cultural. Traditional academic practices are being re-contextualized in a new digital, networked environment – and this is understandably disrupting some deeply rooted norms. As it tries to figure out how to reinterpret its foundational principles in a new context, the academy may wish to ask some of the following operational questions:

- Who will be the primary agents of change in stimulating collaborative research in the academy?
- How can fledgling collaborative projects and ideas be supported, scaled and sustained?
- What principles should guide the redesign of scholarly infrastructure and its institutional support?
- How can the academy embrace professional roles and identities that embrace collaborative practices rather than marginalize them?

In concluding the symposium, Randy Hall, Vice President of Research, said: “Universities face challenges from the outside. We are not the only institutions that do research and create innovation. And while we do things pretty well, it is not necessarily the case that we will always be the leaders in innovation…. Much of what we do is text-based, but in the future it may be datasets, multimedia and other models. One thing that is clear is that the boundaries [among scholarly genres] are not so clear as they were in the past. And because those boundaries are not so clear, it’s that much harder to evaluate what we’re doing.”

“Our own conservatism, based on the past, does not drive our future. We have to go back to the basic principle that, as a university, we are all about creating and disseminating knowledge. The issue is, How do we do that best and stay at the top of that game?”
APPENDIX A: LIST OF PARTICIPANTS

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BEST PRACTICES: Examples of Programs and Projects that are developing active research collaborations across disciplines

Institutional Programs & Practices Beyond USC

- The Radcliffe Institute for Advanced Study sponsors groups of ten researchers to gather for a few days to discuss a topic in an Exploratory Seminar.
- The Los Angeles Basin Clinical Translational Science Institute (LAB CTSI) provides a network for prospective collaborators.
- The National Cancer Institute’s Specialized Program of Research Excellence (SPORE).
- MIT has chalkboards all over the hallways so that people can have spontaneous meetings and conversations in public spaces.
- NCI’s Transdisciplinary Research on Energetics and Cancer (TREC) Centers: This program nurtures collaborative research and has helped launch successful academic careers.
- At Stanford, any faculty can be in charge of any dissertation in any program.
- UCLA holds seminars where students have to work with two different investigators in two different departments.
- The Modern Languages Association (MLA) has launched a national wiki for rethinking standards for promotion.
- HASTAC (Humanities, Arts, Science and Technology Advanced Collaboratory) is a consortium that supports collaborative, networked research across traditional disciplines.
- The University of Virginia (with the help of the Mellon Foundation) has taken the lead in addressing the future of scholarly publication.
- JISC is a UK foundation that supports UK schools at all levels, putting “technology and information management at the heart of research and education.”
- “What’s Cool Open Mic:” At Fox Mobile, employees at all levels – from receptionists to executives – were invited to take the floor and talk about something innovative and new.
- Look at University of Michigan for a model for collaborative research.
- Climate Science: vast amounts of data are publicly available now, which has generated better science and a lot more public engagement.
- China’s investment in hosting major international conferences.
- Scholarship in Action: The president of Syracuse University is creating a model we should follow, which stresses collective work and
reaching outside the university for partnerships.

- **RAND** has the right idea: put together great people from different disciplines into a confined space and they’ll do great work.
- **Center for Advanced Study in the Behavioral Sciences** at Stanford University (CASBS) is an excellent program, bringing people together for lunch for one year.
- The **Fulbright program** is an excellent model: post-doctoral programs encourage collaborative research.
- The **Department of Defense** has an excellent communication model across locations.
- The “Research on Research” program at **Ohio State** allowed undergraduates to get directly involved in faculty research.

**Publishing**

- **Analytical Chemistry** has an innovative new feature: they choose their favorite article of the issue and do a video abstract and an entertaining interview with the authors.
- **Music Theory Online** is a peer reviewed, online only journal that encourages multimedia publications.
- The open review process is becoming standard in **biology journals**.
- **Engineering journals** are very open to publishing collaborative work.
- **G3, Geochemistry, Geophysics, Geosystems: An Electronic Journal of the Earth Sciences** produces highly vetted research because of the vibrant exchange of comments about articles on the site.
- Economists have embraced the “working paper” model, where papers are posted and reviewed by anyone interested. **Economics journals** do not discriminate against papers that have gone through this public review process.

**Technologies**

- The engineers said that the main technologies they use for collaboration are teleconferencing, email, wikis, WebEx and **Skype**.
- **Academia.edu** is a new social networking site for academics.
- Technologies like **Pathable** allow researchers to informally connect before, during and after conferences/gatherings/events.
**USC Programs & People**

- **Steven Moldin**, Executive Director of the USC Washington, DC Office of Research Advancement
- USC’s seminar series “**Engineering, Neuroscience, and Health**” brings outside speakers to campus each month for a full day.
- There is less of a silo mentality at the **Health Sciences Campus** because of the arrangement of departments and divisions – many disciplines are clustered in the same physical location.
- **Health, Sciences & Technology** (HST@USC) aims to create an “innovation environment.”
- “**Critical Code Studies Working Group**” used Twitter and Ning to bring together more than 100 scholars for an online conference/workshop that lasted six weeks.
- “**The Night Journey**” is a unique USC Game Lab Research Project that brings together video artist Bill Viola with students and faculty.
- The **professional schools** at USC are deeply collaborative.
- USC’s **Psychology Department** is well-known for being highly collaborative
- The **Leonard Schaeffer Center for Health Policy and Economics** is an innovative center at USC.
- The most successful interdisciplinary research at USC tends to be at its **centers**.

**Main Barriers**

- To interdisciplinary research
  - Different disciplines have different research priorities.
  - Many scholars are skeptical about the value of working outside of one’s discipline.
- Physical distance limits contact among University Park Campus, Health Sciences Campus and off-campus research units and centers.
- Scholars are confused about intellectual property rules at the university.
- Especially in the humanities, collaboration isn’t part of the culture.
- Tenure guidelines do not reward collaboration or faculty activities online.
- Grant-funded collaborative projects are often not very collaborative (each researcher uses the money to accomplish their own individual goals).
- There are few incentives for collaboration among grad students, and students planning to go on the academic job market are justifiably nervous about sharing credit or working on anything outside of their field.
- There are not enough collaborative workspace areas nor enough opportunities to mingle with faculty from other departments.
It's very hard to share datasets.
Putting together a good team and a good research topic takes a lot of time.

What Should USC Do?

- Create a more sophisticated searchable faculty research directory
  - May include creating a social media application – a match.com, Craigslist or a Facebook for research
  - May be built upon faculty productivity reports, the experts directory or the Baxter database in Faculty Affairs
- Dedicate more space to collaborative research
  - Create a skunkworks with seed funding
- Create social spaces for casual interactions among scholars from different disciplines
  - Create services/spaces for visiting faculty/researchers
- Revise tenure guidelines to encourage collaboration
  - Develop a system to determine credit in multi-author work
  - Give credit for online faculty research activities
- Provide technical training for faculty
  - Develop mentor programs
  - Train them to teach in more interactive learning environments
- Train translators and generalists who can speak the languages of multiple disciplines
- Video conference calling: technically proficient faculty really like Skype – train other faculty to use it as well
  - Offer better tech support for video conferencing
- Structure collaborative grants so that they cover costs for initial in-person meetings
- Create innovative new online publishing models
  - Develop mark-up languages
  - Create alternate models for scholarly publication (archives, games, databases, etc.)
- Bring more outside scholars to USC (from abroad and from across LA) and structure their visits so that USC faculty have time to network with them
  - Sponsor major international conferences
  - Sponsor conferences on cross-cutting/interdisciplinary topics
• Provide incentives for graduate students to work on interdisciplinary projects
  o Encourage them to work with faculty from multiple departments
  o Explore whether Stanford’s model might work at USC
  o Prepare students for non-academic careers, which often require collaboration skills
  o Encourage students to develop technical skills (especially students in the humanities)
  o Create an interdisciplinary postdoctoral program
  o Provide students with space/tools for online collaboration
• Conduct research on the effectiveness of interdisciplinary and collaborative research
  o Conduct case studies
  o Ascertain best practices for collaborative research in the professional schools at USC
• Assist faculty in the pursuit of large interdisciplinary grants
• Provide a variety of funding (seed funding, stop-gap funding, mini-grants) for collaborative research
• Hire faculty with a history of collaborative research success
• Develop new criteria for recruiting students that emphasizes creativity
• Take the lead in changing the rules for academic scholarship