IS ACADEMIC RESEARCH SUSTAINABLE?

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I am pleased to participate in my sixth Merrill Center summer meeting on research and graduate education policy. These meetings involve the university communities from the midwestern four-corner states of Kansas, Missouri, Iowa and Nebraska. Past keynote speakers have been Michael Crow, Luis Proenza, George Walker, Joan Lorden and Marty Apple, with Debra Stewart and Martha Crago this year.

As Debra Stewart said, graduate education is primarily funded via research, especially research grants and contracts. Thus, I shall focus on some national trends in research itself, which has the obvious application to the support of graduate education. Our two keynote speakers will focus on graduate education per se.

Debra Stewart mentioned the Roman god Janus. I will remind you about Athena, the Greek goddess of wisdom, skill and contemplation. Athena once assumed the form of Mentor, Odysseus' trusted counselor, in order to become the guardian and teacher of Odysseus' son, Telemachus. Athena's attributes of wisdom, skill and contemplation are required ingredients for research success. Mentoring, too, is essential for bringing along the next research generation.

I begin with several quotations to set the stage. Horace Walpole exhorts us to perform to the best of our ability and to help others do the same when he says:

> Men are often capable of greater things than they perform. They are sent into the world with bills of credit and seldom draw to their full extent.

Research success, at the faculty or institutional level, does not *just happen*. Participants at the AAAS Research Competitiveness Meeting in 1995 agreed on one thing: Institutional research competitiveness requires leadership at every level of the university.

Research leadership requires the enabling, the empowerment of the faculty and students. As an illustration of empowerment, Sir George Solti once said this about the people he led:

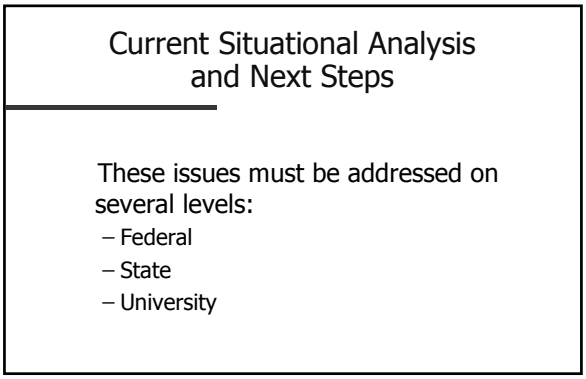
> When you go before an orchestra, you need to have a clear idea in your mind—a sound image—of what you are trying to achieve...If

your imagination is clear, then you will communicate with the orchestra even if your beat and technique are not first-rate...I learned that they generally played below the level they were capable of achieving, and that they were happier when I made them play at their highest level. A sense of accomplishment is the best gift that any conductor can bestow on an orchestra.

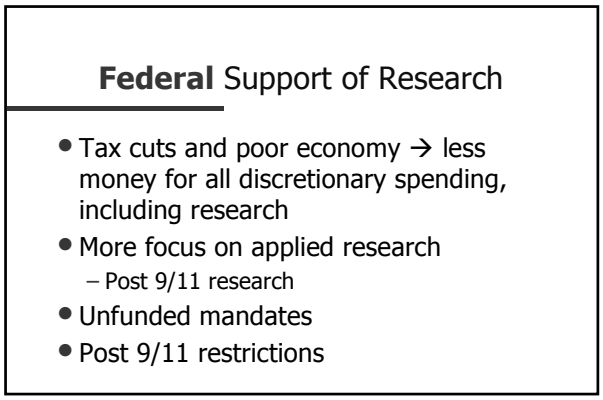
American academic research tends to percolate along in a sustaining or incremental way until some major external event occurs. Then, "disruptive" technologies, or processes, must be created. World War II and Sputnik were two such events.

Vannevar Bush made a valuable recommendation about federal support for research (found in *Science: The Endless Frontier)* and his criteria are still used today: health, wealth and defense. He also stressed producing a trained workforce and, as a co-founder of Raytheon, commercialization of university research.

It's helpful to look at the issues involved in sustaining academic research on three different levels—federal, state and university—including the current situation and, in each case, steps to take.



Federal support of research is under pressure because of tax cuts, the poor economy, and more focus on post-9/11 issues. The latter affects both the dissemination of research findings and the list of people who are allowed to work on research projects. Since 9/11, some research topics are labeled "sensitive" and findings from such projects are subject to special restrictions. Some international students are barred from working in laboratories where certain topics are studied. In addition, the federal government's highest priority seems to be the creation of unfunded mandates, so no university recovers the actual cost of federally funded research.



My recommendation at the federal level is to develop a close collaboration between the institution and your federal delegation. Among the arguments for the support of research are its value to the national interest (cf. my quote in the *Kansas City Business Journal* March 24, 2003 issue), university graduates, economic development, and the overall prestige brought to the state.

Federal Support: Steps to Take

Work closely with your state's federal delegation to support the budgets of the NSF and NIH.

- National interest
- University graduates
- Economic development in your state
- Prestige of your state

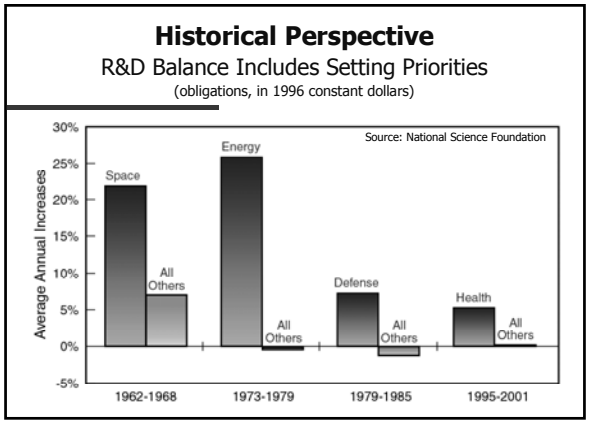
Leon Lederman, Nobel laureate, speaks highly of the social return on publicly funded research:

> Support of basic research offers a double-whammy of a solid payback to the Treasury of between 30% and 60% per year (after a waiting period of 5 and 10 years), as well as an array of new knowledge and technologies that create wealth, add to human health and longevity, and help fulfill human potential.
>
> The combination of education and research may be the most powerful capability the nation can nurture in times of stress and uncertainty.

MIT economics professor Lester Thurow cites rates of about 25% for industrial research and 66% for public research. Lederman also talks about the uniquely American synergistic combination of research and education.

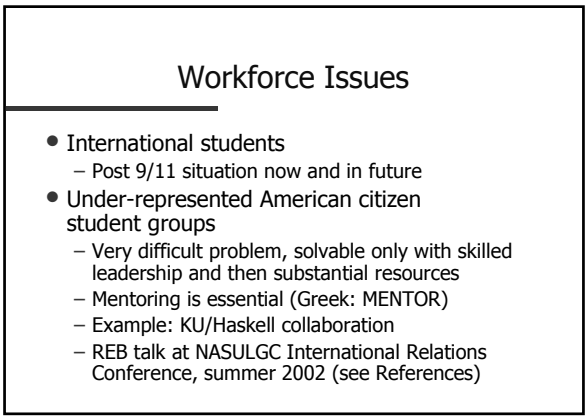
Kathie Olson, Associate Director of the OSTP, cites the Hart-Rudman Commission report on the national need to educate our citizens in mathematics, science and engineering. The commission warned that only weapons of mass destruction pose a greater threat to our national security than our inattention to investing in science and reforming curricula at all levels of our schools. Members of the commission unanimously concluded that the danger from under-investing in U.S. math and science education was greater than the danger from any conceivable conventional war. They stressed that this is important from K-12 schooling to undergraduate education, graduate and lifetime learning.

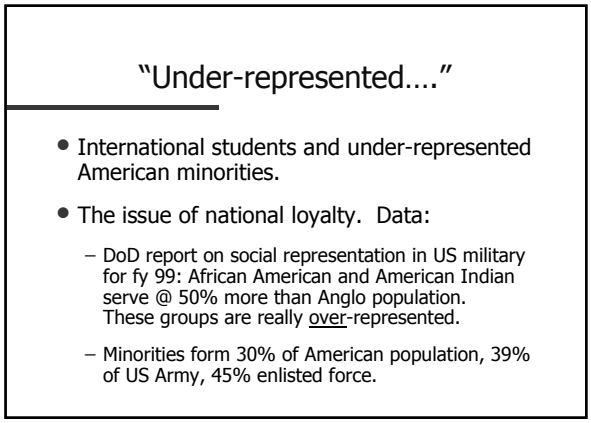
Federal support varies over time and so does what is supported. The following chart demonstrates the topics that have been of particular interest over the past 40 years: space, energy, defense and, currently, health.



Debra Stewart discussed the difficulties of international students coming to this country due to our post-9/11 rules and regulations. She also mentioned the importance of educating our own citizens. This problem is ongoing because, first, it is very difficult and, second, because it was easier to import the best students from the rest of the world.

Leadership at every level is essential to educate our own citizens. And those leaders need appropriate levels of resources. We have a good example of the extreme difficulty of such an improvement program in our KU/Haskell Indian Nations University partnership. The NIH has provided over $11 million to bring more American Indians into mathematics, science and engineering. Good will on the part of the faculty is there; over 60 faculty at the University of Kansas (KU) opened their labs to participation by American Indian students. But this is still a very difficult problem, requiring both leadership and resources.





The same minorities that are under-represented in science and engineering fields are vastly over-represented in our country's military branches. A fiscal year 1999 Department of Defense report on social representation in U.S. military forces reveals that African Americans provided 20% of our active duty personnel while they make up only 14% of the civilian population; the group labeled "Others," including American Indians, were 7% and 5%, respectively. Hispanics were 11% and

15%; hence, Anglos were 62% and 66%. What more loyal pool of untapped talent could be found than those minorities, those American citizens, who are currently under-represented in our science and engineering programs?

Of course, this is not a "quick fix" answer to the looming question of who will fill the ranks in our science and engineering programs, but it *is* one that every state and local school district can begin addressing immediately. Curriculum experts in our Schools of Education should collaborate with scientists and engineers, and with social scientists who understand minority cultures, to develop programmatic content and appropriate teaching techniques for our K-12 schools. Science and engineering faculty in the academy might also benefit from some teaching tips. If our minority students have a firm foundation in the sciences, along with a love for learning, they will be more likely to enter undergraduate and graduate programs in science and engineering.

I often like to quote John F. Kennedy when I say that a rising tide raises all boats. An additional positive point to improving American science and math curricula is that our majority white students will also benefit. Over time, newer educational programs will also encourage their participation in science and engineering programs.

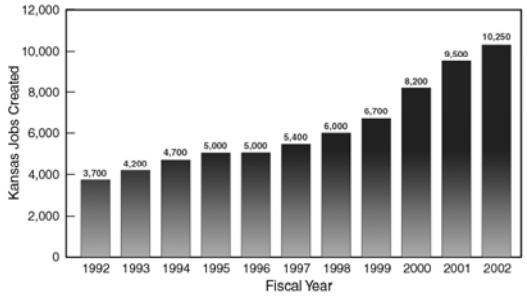
State Support of Research

- State support of public universities is decreasing and will not proportionally increase after and if the economy improves.
- Universities can and should control what they can earn and be freed from state regulations.
- Universities should properly portray their contributions to state economic development.
  - Graduates are the best form of "tech transfer"

State support of public universities is declining and will not proportionally increase after and if the economy improves. Along with this declining support should come declining control by the states.

Universities can make a good case for support in terms of state economic development. Note that the arts and humanities contribute to economic development (cf., for example, Richard Florida's recent book, *The Rise of the Creative Class).*

Kansas Jobs Created by KU Research



Using U.S. Department of Commerce indicators, the AAU estimates the number of jobs caused by the ripple effect of university research and development throughout the local economy. For Kansas, this number is approximately 42 jobs per $1 million of university R&D; thus KU's research produced over 10,000 jobs in fiscal year 2002.

Although state legislatures are not enthusiastic about supporting higher education, they do support research. Last year in Kansas, the state legislature provided bonds for university research at the same time that state budgets per se were being cut.

State Support: Steps to Take

- Targeted requests for major research facilities and personnel
  - Example: Kansas bond issue
- Economic development for
  - The state
  - The university community

Modern, big-time research occurs in interdisciplinary teams. Since these teams are difficult to arrange within departments, their development can be fostered by research centers. Regarding the former, see the article I wrote with Marigold Linton about department-focused research.

The American system combines education and research. I regard research as the education of all participants. The management of research is intertwined with academic affairs. If the local retention, promotion and tenure committee does not reward interdisciplinary research, then such a university will not do as well nationally as it could.

University Support: Steps to Take

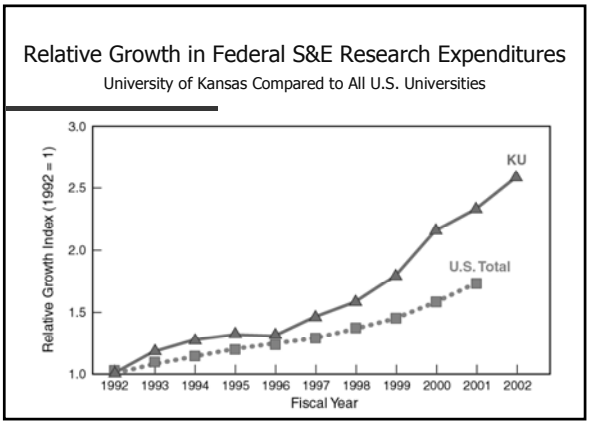
- Team-oriented, interdisciplinary research as the norm.
- How to organize?
  - Research centers, not departments
  - Research/education: a false dichotomy?
    - Implications for Academic Affairs/Research
    - The current tenure system
  - Example: KU Centers (next slides)

On the Lawrence campus of the University of Kansas, we have a vibrant research center structure. Our six "designated" centers are: The Schiefelbusch Institute for Life Span Studies, the Biodiversity Research Center, the Center for Research on Learning, the Higuchi Biosciences Center, the Hall Center for the Humanities, and the Information and Telecommunication Technology Center. Note that they cover a wide range of interdisciplinary research and education areas. The largest, the Schiefelbusch Institute for Life Span Studies, includes the Merrill Center for Advanced Studies, the host of this conference.

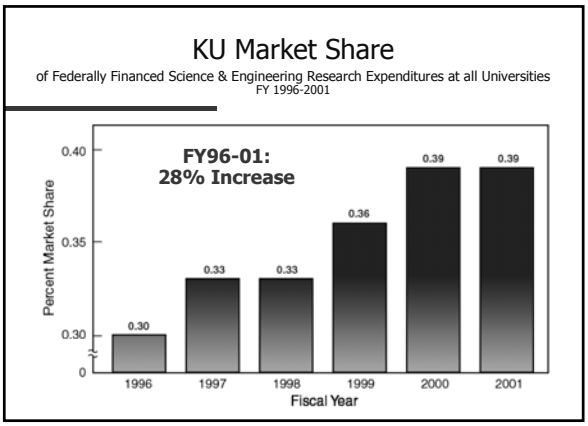
Designated Center Criteria

- Interdisciplinary research focus
- World class
  - Invited to all the right meetings
  - $5 million funding/year ($10 million as a near term target) or equivalent stature in field
  - Prestige (publications, presentations, etc.)
  - "You know you are in a center"
- Significant return on investment
- Ties to academic units
- Benefit to researchers

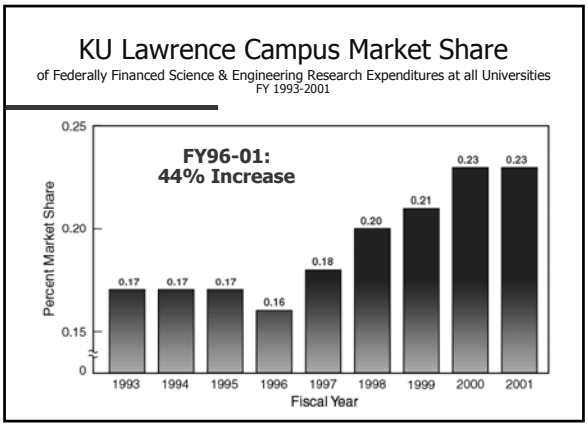
Our criteria for designated center status are listed here. They should be interdisciplinary and "world class" which means that every significant international meeting in a subject must include someone from that center. They must provide a significant "return on investment" and have ties to departments and benefits to researchers.



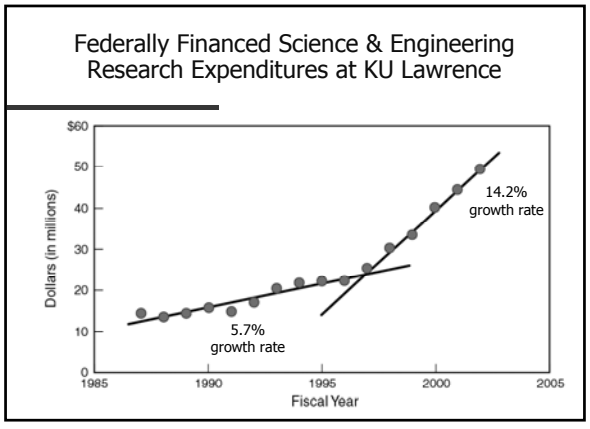
How has KU performed in research competitiveness? The gold standard for comparing research universities is federal expenditures in science and engineering. This graphic depicts how KU has improved from the arbitrary starting point of fiscal year 1992 through the latest data available. One notes that KU tracked the national trend fairly closely until about 1997 when the KU Center for Research (KUCR) was formed on the Lawrence campus; since then, KU has increasingly outstripped the national trend.



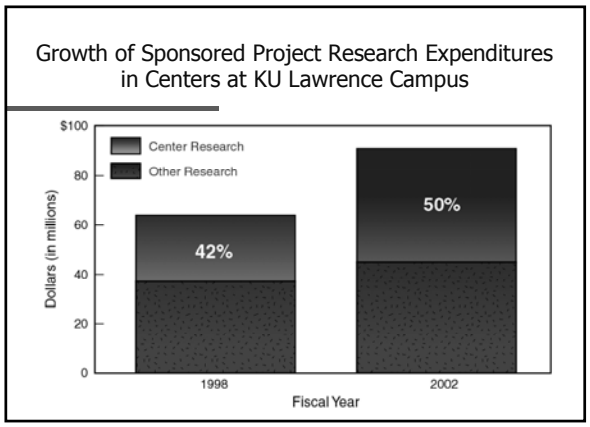
The best measure of institutional research competitiveness is market share, which is the fraction of the federal funds obtained by a given university. The average change for the system is, of course, zero. Thus KU has done well with a 28% increase over the last few years for which data are available.



The Lawrence campus has been one of the national leaders in its increase in market share, with a 44% increase over the last few years.

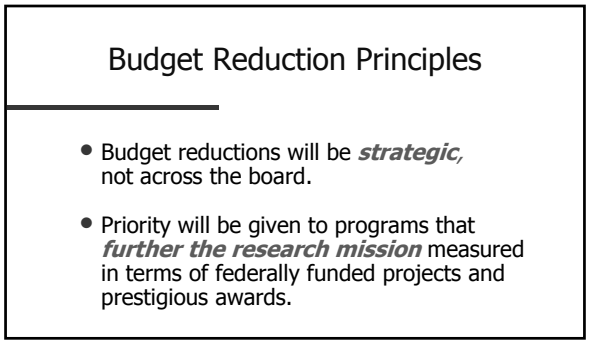


Growth in federal expenditures in science and engineering on the Lawrence campus was proceeding at an average rate of under 6% from fiscal year 1987 through fiscal year 1997, when KUCR was formed. Since then, the growth rate has been about 2 ½ times as large, over 14%, and actual expenditures have doubled.

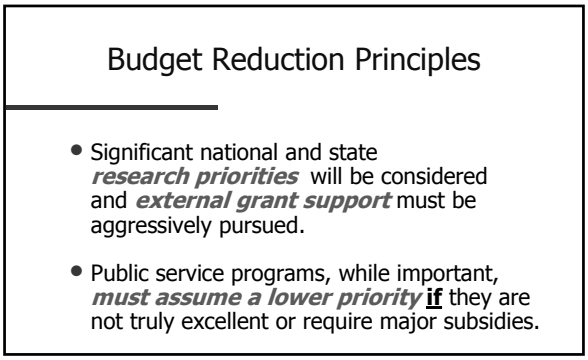


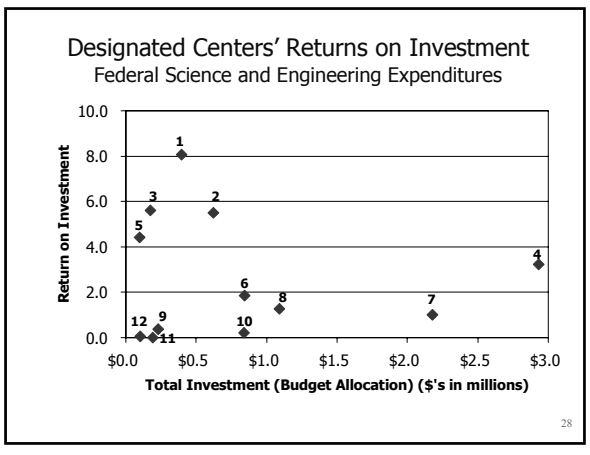
As the amount of research on the Lawrence campus has increased dramatically over the past few years, so, too has the proportion of research that is performed in centers. This figure has increased from 42% to 50%. Thus, centers have been extremely important in KU's institutional success.

During the past several years we have had to make some budget cuts. Adapting principles developed by our Chancellor and Provost to the research mission, we have emphasized strategic cuts and furthering the research mission. In general, the sustainability of research requires external funding, so this has been emphasized. Public service programs must be truly excellent and cost-effective to receive funding.



We evaluated our research centers on a number of measures, both quantitative and qualitative. In selecting criteria, we focused on measures that external reviewers use to gauge the prestige of the university. We focused on peer-reviewed research funding and on prestigious awards.



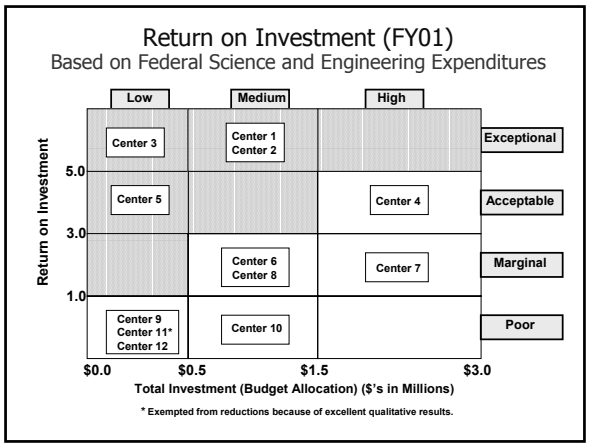


Return on investment in our research centers was calculated by dividing research expenditures or indirect cost return by the total center investment (budget allocation plus returned over-head). This calculation was done in two ways, by both including and excluding public service budgets. In

these analyses, the overall magnitude of research expenditures, indirect cost return, and budget allocations was also considered. The number of prestigious awards, as defined by the Association of American Universities, was used as a qualitative performance measure for our humanities center. On almost all return on investment measures, the relative ranking of the research centers was the same.

A nationally agreed-upon benchmark is that the return on investment in academic research should be at least 4:1 (one internal dollar produces four external dollars). This chart is an example of research center performance using return on investment for federal science and engineering expenditures.

The return on investment data, using the criterion of federal science and engineering expenditures, locates each individual center in one of twelve sectors. Also important to us is the total investment made per center, because centers receiving considerable funds reduce our flexibility of investment. Thus, both the return on investment ratio, as well as the total dollars invested, are considered. The same methodology applies to increasing budgets as well as decreasing them.



It's also important to the missions of research and graduate education to consider and to encourage innovative thinking. Quotes from several renowned innovative individuals follow:

> Hell, there are no rules here, we're trying to accomplish something.
>
> ~ Thomas Edison

> The human mind treats a new idea the same way the body treats a strange protein; it rejects it.
>
> ~ P. B. Medwar

> The intuitive mind is a sacred gift and the rational mind is a faithful servant. We have created a society that honors the servant and has forgotten the gift.
>
> ~ Albert Einstein

University resources comprise people, space and funds. We should carefully look at who makes the decisions on their allocation and what their rationale and processes are.

A verse from Proverbs, “Without vision, the people perish,” is on the walls of the chamber used by the U.S. House of Representatives Science Committee. It behooves us all to remember that without vision, research and graduate education also perish.

References

Barnhill, Robert E., & Linton, Marigold. (1992). Promoting research in science and engineering departments. In C.R. Haden & J.R. Brink (Eds.) *Innovative models for university research*.

Barnhill, Robert E. (July, 2002). *Redefining the international agenda post-9/11.* Presentation at the NASULGC International Relations Council.

Bush, Vannevar. (1945). *Science: The endless frontier*. National Science Foundation.

Bush, Vannevar. (1967). *Science is not enough*. William Morrow & Co.

Christensen, Clayton. (2000). *The innovator’s dilemma.* Harper Business.

Conant, Jennet. (2002). *Tuxedo park*. Simon & Schuster.

Florida, Richard. (2002). *Rise of the creative class*. Basic Books.

Geiger, Roger. (1993). *Research and relevant knowledge: American universities since World War II*. Oxford University Press.

Gladwell, Malcolm. (2000*). The tipping point: How little things can make a big difference.* Little, Brown & Company.

Graham, Hugh, & Diamond, Nancy. (1997). *The rise of American research universities.* Johns Hopkins University Press.

Grove, Andrew S. (1995). *Only the paranoid survive: How to exploit the crisis points that challenge every company and career*. Doubleday Publishing Company.

Hamel, Gary, & Prahalad, C.K. (1994). *Competing for the future.* Harvard Business School Press.

McInerney, Michele. (March 24, 2003). Biological, chemical threats lead scientists in new directions. *Kansas City Business Journal*. kansascity.bizjournals.com/kansascity/stories/2003/03/24/focus4.html

Sample, Steven. (2002). *The contrarian's guide to leadership*. Jossey-Bass.

Stokes, Donald E. (1997). *Pasteur's quadrant: Basic science and techno-logical innovation*. Brookings Institution Press.

Teich, Albert H. (Ed.) (1996). *Competitiveness in academic research.* AAAS.

Thurow, Lester. (June, 1999). Building wealth: The new rules for individuals, companies and nations. *Atlantic Monthly.*

Zachary, G. Pascal. (1997). *Endless frontier, Vannevar Bush, engineering of the American century.* The Free Press.

Zemsky, Robert. (May 30, 2003). Have we lost the "public" in higher education? *Chronicle of Higher Education*.