

RESEARCH CHALLENGES IN CHANGING TIMES:

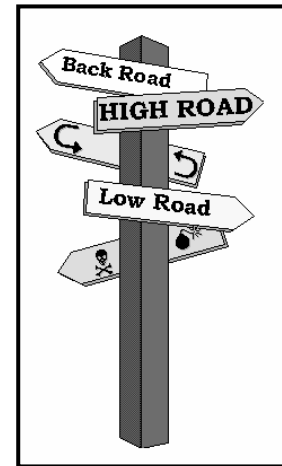
LEAD, FOLLOW, OR GET OUT OF THE WAY

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Doctoral research universities have been riding the momentum of research for many years, but maintaining that momentum will be problematic in today's fluid environment. The crossroads at which universities find themselves is not new – they've been there awhile. But the challenges regarding which way to go are continuing to grow. And given their choice, most universities would opt to stay where they are, maintaining the status quo. However, doing nothing during times of significant change is not a viable option. Institutions not moving forward strategically – changing with the times – will soon be left behind, becoming ever less relevant and underutilized.

There are many roads to choose from, but each university must identify the best one for its institution – its high road – if research momentum is to be sustained and perhaps even enhanced. To be done effectively, universities should seek advice and counsel from their institutional customers and stakeholders. Today these include: students and trainees (undergraduate and graduate students, as well as postdoctoral researchers); the employers of their students and postdoctorals; sponsors of institutional research and scholarly activity; citizens/taxpayers of the state; governing board officials; and state legislators. Most universities do not solicit strategic planning input from these customers and stakeholders, but their various perspectives would be invaluable in identifying the best road to follow. Internal self-assessments alone won't get the job done. Real-world considerations are essential.



In looking to the future, research universities must decide whether they will lead, follow, or just get out of the way; the latter relegating them to the *Status Quo U* ranking where they'll atrophy and allow other entrepreneurial institutions to gain preeminence in their state or region. Perhaps a few elite research universities will be able to sustain their momentum without instituting substantive changes, but they're likely to be the exception.

The Academy in Flux at the End of the Twentieth Century

Educational Providers. There has been a major proliferation of educational providers in recent years, and there's little doubt that the unresponsiveness of existing providers contributed to this propagation. Various for-profit institutions have entered the market (some quite successfully), which signifies there was a need and there's money in it. Also, a number of Fortune 500 companies have created substantial education and training programs, something they probably wouldn't have done if their needs were being met. While that might be perceived as strictly a teaching issue, research is a required component for training the science and technology workforce required in the new millennium.

Disciplinary Silos. The disciplinary silos within universities produced constraints that became increasingly problematic in the 1990's. Research in the sciences isn't practiced on a disciplinary basis anymore – at least, not often. Most of the truly illuminating questions and answers are now at the boundaries between disciplines and across various disciplines. In fact, Alan Leshner, chief executive officer of the American Association for the Advancement of Science (AAAS), noted during a 2004 presentation in Washington: “There is no longer such a thing as disciplinary science.”⁽¹⁾ Interdisciplinary and multi-disciplinary science is where the action is these days. However, conducting such research can present difficulties for university faculty who reside in discipline-based departments.

Participating in interdisciplinary research can be especially problematic for young faculty who must be promoted and tenured within their academic unit. Allowing them to have research appointments in multidisciplinary centers offers one means for addressing this dilemma, but it's an open question whether such centers provide sufficient fluidity in these changing times. Many university research centers become just another vertical silo restricting horizontal interactions and external teaming opportunities. Building horizontal flexibility, or bridges, in the vertical world of universities is an ongoing challenge.⁽²⁾

Technology Innovation. As also stated by Dr. Leshner, AAAS: “Technology is now driving science. It used to be the other way around.”⁽¹⁾ That has created unique and unexpected problems for research universities as well as the sponsors of research. Funding agencies can't be approached for the acquisition of high-tech instrumentation if the technology is ahead of the science; data required to justify the purchase are lacking. Leshner offers the early days of

⁽¹⁾ Leshner, Alan. “National Perspectives on Traineeships and Support.” *Support of Graduate Students and Postdoctoral Researchers in the Sciences and Engineering: Impact of Related Policies and Practices*, Council of Graduate Schools, NSF, and NIH sponsored meeting, Washington, DC, June 17-18, 2004.

⁽²⁾ Trewyn, R.W. “Graduate Education and Research in the Year 2000: Fashioning Horizontal Flexibility in a Vertical World.” *Building Cross-University Alliances that Enhance Research*, Merrill Advanced Studies Center, University of Kansas, MASC Report No. 103, pp. 59-68, July 1999.

microarray technology as an example. Few public universities have the flexible resources to invest significant internal dollars into unproven tools, and in cases such as microarrays, scientific advances are slowed as a result.

Information technology may be the most demanding illustration. Keeping up with the nearly exponential growth in this field is basically impossible. Universities could spend every flexible dollar every day on the information technology infrastructure and still not be leading edge. Strategic investment is required, but what's strategic – and for whom?

Graduate Education. The graduate education enterprise in America has been the standard of excellence worldwide for decades, and graduate programs have contributed a major human resource component – a sizeable pool of graduate assistants – that has underpinned university research. Unfortunately, the number of domestic students in the sciences and engineering has been inadequate for years. These graduate programs have become increasingly reliant on international students, a potential problem that became substantial ON September 11, 2001. In addition, the quality of graduate education in other countries has improved in recent years, so U.S. programs are now less attractive to foreign students. The diminution of that talent pool does not bode well for the future.

Furthermore, that's not the only problem. For well over a decade, fewer than half the graduates of doctoral programs in the sciences and engineering have been hired into U.S. research university faculty positions. Yet, graduate programs across the country continue to train doctoral students for jobs in the academy. That's not very insightful. Graduates should be provided with the skills needed for the positions they'll obtain, and there should be enough flexibility in their programs to allow for appropriate courses and training.

Economic Development. Commercialization of intellectual property (IP) has become an increasingly important activity of public research universities in the past two decades — beginning with the passage of the Bayh-Dole Act in 1980. Wherever technology-based economic development has had a significant impact in the country, one or more research universities played a crucial role (e.g., Research Triangle Park, Silicon Valley, San Diego, Pittsburgh). Noting these successes, additional universities have opted to get involved, while state legislators, governing officials, and related institutional stakeholders have pressured others into expanding the commercialization of IP emanating from their research. Licensing revenue and job creation are mighty incentives, but only a few universities have been highly successful in this realm. Most are lucky to recover the out-of-pocket and other costs associated with patenting inventions and otherwise protecting university IP. When staking out a position in the global economy, the IP costs can be substantial, the rewards hypothetical – and hypothetical doesn't pay the bills.

Comprehensiveness. In the 1970's and 1980's, being a comprehensive research university was a primary goal for many institutions. Big-time universities had to be all things to all people. Fortunately for university stakeholders, those times are a thing of the past – at least, for the most part. It's just too expensive; few public institutions can afford it.

Although it was by no means universal, many public universities were beginning to figure out by the 1990's that they would have to focus on their core research and academic strengths in order to prosper. Even during those economic boom years, state funding for higher education was not keeping pace in many states (Kansas, for example), so it became increasingly difficult to stay competitive in the full spectrum of disciplines, sub-disciplines, specialties, and sub-specialties. In states with multiple public universities, program duplication was tough to defend in the statehouse. And while it was largely negative factors that drove institutions to focus on their core competencies, when they did so, many realized real benefits in teaming with other public and private entities in research. In optimal circumstances, synergistic outcomes were achieved.

Return on Investment. University faculty members tend to dislike having their students referred to as “customers” or “clients,” since it draws parallels to marketing and sales in the profit-driven private sector. The thought of documenting return on investment (ROI) for higher education is probably not appreciated either. Nonetheless, there is increasing pressure on universities to develop appropriate metrics to quantify various outcomes of the educational enterprise. And why shouldn't prospective students have an indication of the ROI they might expect?

In fact, there have been increasing expectations among outside interest groups (including, but not limited to, the institution's customers and stakeholders) that outcome measures should be provided for all the institutional missions — teaching, research, and service. Of these, teaching is probably the easiest to quantify (the U.S. Census Bureau publishes data for mean annual earnings by level of education); the value-added by research is the most difficult.⁽³⁾ Campuses are attempting to judge the latter nonetheless.^(3,4) And while the time spent by faculty, staff, and students on public service activities should be relatively easy to quantify, few universities track these activities. That's changing though, due to the ever-increasing scrutiny from both outside and inside the institution.

⁽³⁾ Trewyn, R.W. “Evaluating University Research Productivity: What's the ROI ... and Who Cares?” *Evaluating Research Productivity*, Merrill Advanced Studies Center, University of Kansas, MASC Report No. 105, pp. 71-75, June 2001.

⁽⁴⁾ Bloedel, James. “Judging Research Productivity on an Entrepreneurial Campus.” *Evaluating Research Productivity*, Merrill Advanced Studies Center, University of Kansas, MASC Report No. 105, pp. 81-84, June 2001.

State Budgets. As already mentioned, state financial support for higher education has been declining nationally for years. Seldom has it kept pace with annual increases in either inflation or state revenue. During most of the 1990's, state revenues in Kansas were substantially higher than inflation; however, the annual state budgets for higher education were not. As a result, the state proportion of the budget at K-State and other Kansas public institutions continued to drop, a trend consistent with the majority of public universities in America. Out of necessity, tuition and other resources have been used to cover shortfalls.

September 11th

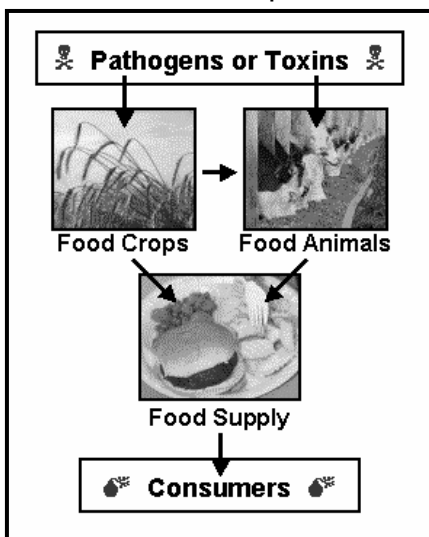
September 11th, 2001 “will live in infamy,” just like December 7th, 1943. There’s no question that 9/11 changed America in momentous ways, and public research universities were not immune to the consequences. In fact, they have been impacted significantly.

Clearly, the national research agenda has changed post-9/11. Even if the new Department of Homeland Security were to provide little support for research at universities, the agencies that traditionally fund such projects have modified their focus areas in response to new threats and America’s vulnerabilities. However, research universities are adapting.

Another highly significant effect has been on the international graduate student population that supports much of the university research enterprise. The new screening systems now in place have created major impediments. Substantive fees have been added in 2004, and it’s unclear how big that negative impact will be. In addition, the improvement of the international educational competition will decrease the availability of scientific talent even further. With too few students, research momentum will be difficult to maintain.

K-State Initiatives

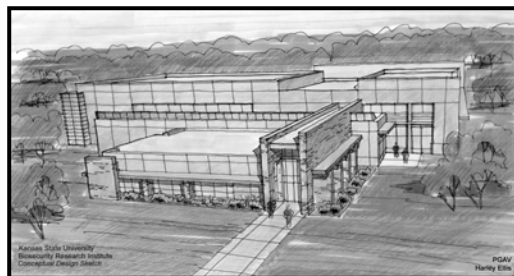
Research. Because of the changing academic landscape, K-State launched new research-related initiatives to become better positioned for the future. For example, the National Agricultural Biosecurity Center (NABC) was established to coordinate multidisciplinary activities focused on protecting America’s agricultural infrastructure. Having recognized the vulnerability of American agricultural to terrorist attacks, K-State crafted a broad *Homeland Defense Food Safety, Security, and Emergency Preparedness Program* in early 1999. It’s referred to most often as the food safety and security (FS²) program. The FS² mission is to protect the agricultural economy (food crops and food animals), the domestic food supply, and the



American public from endemic and emerging biological threats. In October 1999, K-State President Jon Wefald presented testimony to the U.S. Senate's Emerging Threats Subcommittee on the asymmetry of the agricultural biological weapons threat. K-State's efforts have continued unabated since that time, but the relevance and importance of the FS² program were not widely recognized nationally until after 9/11 and the ensuing bioterrorist assault with anthrax in the U.S. mail.

The NABC has received significant funding from the USDA to: (1) evaluate the means, hazards, and obstacles involved in disposing of large numbers of contaminated animal carcasses, (2) assess agroterrorism exercises and their outcomes, and (3) analyze pathways by which foreign plant and animal diseases might enter the country. The NABC has also been funded by: (1) the Department of Defense (DoD) to conduct agroterrorism exercises involving National Guard and NORTHCOM military assets, (2) the General Services Administration (GSA) to develop select agent monographs, and (3) the Department of Justice (DoJ) to conduct law enforcement agrosecurity assessments. In addition, K-State has funding from the USDA to manage the Great Plains Diagnostic Network – a nine-state regional hub (one of five) – that provides county-by-county plant disease/pest surveillance and diagnostics, and from the National Science Foundation (NSF) to perfect a veterinary telemedicine system with livestock health sensors and wireless data storage capacity.

Infrastructure. A foundational component called for in the 1999 FS² program was a fully integrated (food crop, food animal, food safety) biocontainment [BL-3 (Ag)] facility on the K-State campus. That proposition is to become a reality in 2006. Construction has begun on a \$50 million Biosecurity Research Institute (BRI) that will include: livestock infectious disease research space (holding up to 32 800-pound animals); a slaughter floor and processing capabilities; plant pathogen/pest, insect vector, molecular biology, and diagnostic laboratories; and research support space. The BRI should help sustain, as well as generate, research momentum. The NABC will oversee the diverse BRI research programs, linking them to other campus efforts.



Graduate Education. Modernizing graduate education has been another focus at K-State. The Graduate Council eliminated a number of old policy impediments (e.g., antiquated restrictions on transfer credits) and developed modern-day policies (e.g., authorizing concurrent degree programs). To address professional development needs and enhance course flexibility for students, graduate certificate programs are proliferating; more than 20 are now being offered and many more are under development.

K-State led the development of the first real-time Internet-II (I-2) course in the country. It is an advanced graduate course in plant pathology created in partnership with the University of Nebraska and Oregon State, first offered in 1999. Three of the world's experts in molecular plant-microbe interactions (one on each campus) team-teach the material to students on all three campuses. Remarkably, the same sort of dynamic interchange between students and instructors that one expects in the classroom for an advanced graduate course occurs between all three distant locations. The I-2 class is so successful, it has been taught multiple times with varying partners; Oklahoma State has also been part of the mix. The only problem is that the course has become too popular.

K-State has also focused substantial resources on developing mediated instructional materials for on-campus courses and adapting these for use in distance education. Complete master's degree programs are now offered remotely, and many more are being developed. The food science, safety, and security (FS³) distance education program is one effort that's expanding rapidly, an outgrowth of the FS² initiative in 1999. K-State has also received pilot funding from the Ford Foundation via the Council of Graduate Schools to establish two multidisciplinary graduate programs, in Security Studies and Community Development – the latter a collaborative effort involving multiple universities.

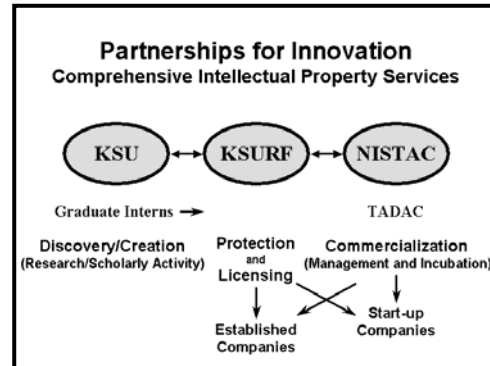
Economic Development. K-State has a long history in technology transfer, given that the KSU Research Foundation (KSURF) responsible for such activities was formed in 1942. KSURF is a not-for-profit corporation involved in protecting and licensing university IP. Traditional licensing transactions with major corporations have been the mainstay over the years, but company start-up ventures are becoming a substantially bigger focus.



The first enterprise of this type (launched in 1995) created *NanoScale Materials, Inc.*, a company that now has its corporate offices and laboratories in the K-State Research Park. Products currently on the market include *Fast-Act*TM, a “chemical hazard containment and neutralization system” that almost instantaneously destroys hazardous chemicals including chemical warfare agents such as Sarin nerve gas. With the homeland security concerns post-9/11, *NanoScale* should be well positioned in the market place.

It is anticipated that equity positions in technology-based start-up companies will provide greater returns than traditional licensing, but that remains to be determined. Obviously, it's not without risk, since many such ventures fail each year.

K-State’s approach to commercialization of university and non-university IP was described at last year’s Merrill Conference.⁽⁵⁾ It’s a partnership effort involving multiple entities. One of the crucial team members was the Mid-America Commercialization Corporation (MACC), a regional innovation center in the Kansas Technology Enterprise Corporation (KTEC) network. MACC has recently evolved into the National Institute for Strategic Technology Acquisition and Commercialization (NISTAC). While MACC focused on local and regional economic development, NISTAC will be doing that plus partnering with non-profit entities in other parts of the country to promote technology-based economic development nationally.



MACC established the Technology Acquisition, Development, and Commercialization (TADAC) program in 1998, which was designed to acquire dormant corporate technologies that offer significant commercial potential. It’s not uncommon for companies to abandon a technology they’ve invested in heavily and brought close to market – e.g., when corporate strategic priorities change or market projections fail to meet company thresholds. A \$100-million annual market may not be big enough for some Fortune 500 companies, but in Manhattan, Kansas, that wouldn’t be bad. Last year, the TADAC portfolio contained about 600 patents that had a combined independent valuation at the time of donation of almost \$400 million.⁽⁵⁾ There are now over 800 patents in the portfolio.

The fact that most acquired corporate technologies are much closer to market than is typical of university technologies makes them highly attractive for start-up ventures. The *Cal-C*[®] “smoothies” sold by the Manhattan start-up *NutriJoy* were based on a *Procter & Gamble* donation,⁽⁵⁾ and they entered the market in less than 2 years from the time MACC acquired the patents. *Cal-C*[®] is being sold in Kansas, Arizona, the Pacific Northwest, and various other places in the West. It will be distributed widely in the Midwest soon.

In addition to facilitating local start-ups like *NanoScale* and *NutriJoy*, NISTAC is working with economic development entities in other parts of the country to match regional needs with TADAC-held technologies. The NISTAC leadership team has concluded that the standard economic development model in use nationally is dysfunctional at best. The “rob thy neighbor” approach to job creation has been utilized for decades, with communities and regional alliances

⁽⁵⁾ Trewyn, R.W. “Recruiting and Training Future Scientists: Converting Intellectual Capital into Intellectual Property.” *Recruiting and Training Future Scientists: How Policy Shapes the Mission of Graduate Education*, Merrill Advanced Studies Center, University of Kansas, MASC Report No. 107, pp. 51-58, June 2003.

investing heavily to steal companies from other locales. NISTAC contends that the billions of dollars invested in these activities may have had a net negative impact on the national economy. As a result, NISTAC is attempting a new approach – delivering dormant corporate technologies to areas in need. Discussions are ongoing with multiple distressed urban areas for that purpose.

However, reversing the decline of rural economies will be more difficult. Rural America comprises 80% of the landmass, but only 20% of the population.⁽⁶⁾ And, unfortunately, the dawn-to-dusk work ethic cultivated in rural settings seldom equates to sweat equity – just lots of sweat, with little or no equity. Novel strategies are needed to stimulate rural economic competitiveness, because only 6-7% of new innovation is occurring in non-urban areas.⁽⁷⁾

Riding the Momentum of Research in the 21st Century

Public universities must take control of their destiny – they must lead – if they are to continue to ride the momentum of research into the future. They must evolve with the times or resign themselves to sliding backwards, eventually being by-passed for some entrepreneurial *New Millennium U* that is positioned to seize emerging opportunities.

Many of the keys for universities to continue riding the momentum of research listed in Table 1 are interdependent or overlapping with one another. And, clearly, not all of the issues would have to be addressed. Nevertheless, these are some areas where public research universities could take the lead if they so choose. Every one of them is important in this era of rapid change.

Kansas State is working on all these topics with varying degrees of effort (from moderate to major), and the intent is to assume a leadership role in some. Others may be areas where K-State will eventually follow, but there is no thought of K-State getting out of the way of any. All are vital to the land-grant mission. Time will tell how successful K-State's "lead or follow, but never get out of the way" stance will be.

⁽⁶⁾ Porter, Michael, Ketels, Christian H.M., Miller, Kaia, and Bryden, Richard T. "Competitiveness in Rural U.S. Regions." Report from a project at Harvard University supported by the *Economic Development Administration, U.S. Department of Commerce*, pp. 3, 2004.

⁽⁷⁾ Reamer, Andrew, Icerman, Larry, and Youtie, Jan. "Technology Transfer and Commercialization: Their Role in Economic Development." Report from award #99-06-07435 to the Georgia Institute of Technology from the *Economic Development Administration, U.S. Department of Commerce*, pp. 59, 2003.

Table 1.

New Millennium Keys to Research Momentum
<p><i>Dialog with Institutional Customers and Stakeholders:</i></p> <ul style="list-style-type: none">➤ Institutionalize Opportunistic Flexibility and Fluidity➤ Facilitate Inter- and Multidisciplinary Research➤ Leverage Areas of Competitive Advantage➤ Partner with “Win-Win” Organizations and Entities➤ Address Local, State, National, and International Needs➤ Enhance Institutional Economic Development Activity➤ Develop Incentives to Reward Entrepreneurship➤ Modernize Graduate Education Programs and Options➤ Implement an Information Age Outreach Philosophy➤ Market Unique Attributes and Value-Added Outcomes➤ Identify Metrics to Document Returns on Investment

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