SCIENCE AT A TIME OF NATIONAL EMERGENCY

Merrill Series on
The Research Mission of Public Universities

A compilation of papers originally presented
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MASC Report No. 106
University of Kansas

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INTRODUCTION

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This year marked the sixth annual research policy retreat hosted by the Merrill Center in Valley Falls, Kansas. As scientists and citizens we have all been preoccupied with the situation in the United States following the terrorist attack on September 11, 2001. For this reason, we selected the topic: "Science at a Time of National Emergency." Twenty-four administrators and senior faculty came as teams from four public universities in Nebraska, Kansas and Iowa. These are: Iowa State University, the University of Nebraska – Lincoln, the Nebraska Medical Center in Omaha, Kansas State University, the University of Kansas – Lawrence, and the KU Medical Center in Kansas City, Kansas. Keith Yehle from the office of Senator Pat Roberts and David Kensinger from the office of Senator Sam Brownback also joined us.

Participants discussed the ways scientists can come to the aid of the country, while also recognizing the difficulties our universities face because of increased security measures. We examined the complimentary areas of expertise among our institutions, and realized we could build a strong base for joint research on preventing and mitigating bioterrorism.

The 2002 topic built on discussions at the five previous retreats in the Merrill series *The Research Mission of Public Universities*. The inaugural event in 1997 focused on pressures that hinder the research mission of higher education. In 1998, we turned our attention to competing for new resources, and ways to enhance individual and collective productivity. Michael Crow, our keynote speaker that year, encouraged us to identify niche areas for research focus, under the premise that it was most promising to do selective areas of investigation at the highest levels of excellence. In 1999, we examined in more depth cross-university alliances. Keynote speaker Luis Proenza encouraged participants to think in terms of "strategic intent" and he highlighted important precedents in university-industry cooperation as well as links between institutions. In 2000, we focused on making research a part of the public agenda. We heard from George Walker who encouraged us to meet the needs of our state citizens, business leaders and students who are quite able to "carry our water" and champion the cause of research as a valuable state resource. In 2001, Joan Lorden brought to the table her experience with the topic of evaluating research productivity. She provided a valuable overview of key elements to consider when selecting measures for evaluating performance, with a focus on the very important National Research Council (NRC) study from 1995.

Our keynote speaker in 2002 was Martin Apple, President of the Council of Scientific Society Presidents. He proposed unique ways to lend our expertise on bioterrorism, while at the same time remaining faithful to the task of generating new knowledge that can lead to societal benefits such as better health and sustainable energy sources.

In 2002 more than ever, we realized the significance of our job at public universities. Our discussions reflect this dynamic engagement. As always, the pages of the Merrill white paper reveal many fascinating perspectives and a frank examination of the complex issues faced by research administrators and scientists every day. This year in particular, we found ourselves faced with questions of paramount importance. As David Shulenburger summarized on our last day together: What do we do now? Should we build capacity in order to respond to the national crisis? Martin Apple also reminded us that universities must honor their social contract and be leaders as we face not just this, but many national crises.

It is with pleasure that I encourage you to read each of the following papers from the 2002 Merrill policy retreat on *Science at a Time of National Emergency.*

EXECUTIVE SUMMARY

KEYNOTE ADDRESS

Martin Apple
President and CEO, Council of Scientific Society Presidents

- The United States is facing several major national emergencies today. Science and universities will be important to solving most of them. University leaders must think outside of the box and show bold leadership.
- Universities are on the cusp of multiple intersecting trends, the uneasy coexistence of successive societal eras and generations. Universities must restore their role as big picture innovators, and develop a twenty-first century social contract with society, industry, and virtual education.
- Scientists are the constituency of the future. The grand challenges for the future include: converting the nation and the world into entirely sustainable systems; developing the human potential to learn; building healthier lives through prevention rather than treatment; stimulating economic engines that prosper without further population growth and environmental damage; developing affordable, sustainable energy autonomy; understanding and developing beneficial human behavior.
- Unlinked tax cuts, not recession or defense buildups, account for most of the burgeoning federal deficits of the last half century. Escalating deficit will constrain science to a "no growth" quiet erosion over the next decade, unless we act now in unison to change that trend.
- Federal funding of graduate student positions has already declined in several scientific disciplines, and the U.S. has lost its edge in the race to build a faster, more efficient supercomputer.
- We need a new defense strategy and paradigm.
- How can science provide a competitive advantage against networks of fanatic murderers? The Council of Scientific Society Presidents has suggested using scientific experts across the country in SWAT-teams (scientifically weighted and analyzed tactics). SWAT-teams could serve as a unique part-time National Guard that matches the agility of our opponents by their very nature as dispersed, rapid learning groups with advanced knowledge.
- Secrecy and science are direct antitheses. New federal security regulations may not only change the way universities do business, but in fact erode the quality of science in the long run.
- Case studies: food security and high consequence pathogens. Do we need a new national center for food system security?

RESEARCH AT KU: MOVING AHEAD!

Robert E. Barnhill
Vice Chancellor for Research and Public Service
and President of the KU Center for Research
University of Kansas

- KU has risen from 93rd to 78th among universities that successfully capture federal research and development dollars for their science and engineering programs. This jump in ranking is the second largest among comprehensive universities in the top 100.
- The National Institutes of Health (NIH) budget has doubled over the past five years and is now five times the National Science Foundation (NSF) budget. Funding in life science research at KU is a significant part of its total federal funding, representing 64%. In fact, KU's rate of increase in federally sponsored life science research was the highest in the country among the top 50 comprehensive public universities.
- Women and minorities are under-represented in science and engineering across the nation. To attract minority cultures, we should develop new educational programs and reach more students.
- Much of the needed science to fight terrorism may already exist and just remains to be suitably implemented.
- Faculty want to contribute to the anti-terrorism effort.
- KU sponsored a "bio-defense" workshop with the Midwest Research Institute on the topic of vaccines, biosensors and public health. This effort is ongoing.

FIRST PANEL OF RESEACHERS

Jerome E. Dobson, Research Professor, Kansas Applied Remote Sensing Program, University of Kansas
Mark R. Ackermann, Professor of Veterinary Pathology, Iowa State University
Steven Hinrichs, Professor, Pathology and Microbiology, and Director, Nebraska Public Health Lab, University of Nebraska Medical Center
Curtis L. Kastner, Director, Food Science Institute, Kansas State University
Dennis R. Alexander, Center for Electro-Optics, University of Nebraska - Lincoln

- The team I headed at the Oak Ridge National Laboratory developed a global population database at a spatial resolution fine enough to identify populations actually or potentially impacted by terrorism, technological accidents, regional conflicts and natural disasters. Population estimates are essential for mission planning to determine: how many emergency personnel to send, how much temporary shelter to provide, and what quantities of emergency supplies are needed. LandScan represents a quantum leap in precision, made possible by the public availability of global databases in the late 1990's, recent advances in geographic information systems (GIS), and traditional geographic analysis techniques.

- Traditionally, animal health issues are directly tied to agriculture, yet we know that research on animal diseases can provide answers for human medicine, and today, animal health may be an issue when preparing for bioterrorism.
- It would be beneficial to create an institute within the National Institutes of Health that focuses on animal health. This would encourage development of animal models of human disease, and bioterrorism research could proceed on issues such as: animal diseases we wish to keep out of the U.S., and emerging animal disease throughout the world.
- The medical centers and public universities represented at this conference are prepared to undertake the challenges of biosecurity preparedness. In the realm of diagnostic modalities, for example, they have expertise in developing algorithms and mathematical models for determining the efficacy of syndromic surveillance information. (Syndromic surveillance detects a pattern or spike in the number of diseases presented by patients in the emergency room or doctor's office.) These universities could also make use of the statewide information services located at the county extension offices and at the health education centers that train medical students and residents.
- A Midwest consortium of universities and medical centers could rapidly investigate and determine the pathogenesis of various diseases and develop appropriate vaccines.
- The U.S. food production and processing industries are vulnerable and must be protected. Disruption of the food supply and loss of consumer confidence would have a devastating impact on public health, social order and economic markets.
- Food safety research and technologies can be used to address bioterrorism issues even though they were not developed with intentional contamination in mind. These resources are available at Kansas State University.
- Lasers generating ultrashort light pulses are now available to researchers. Recent technological advances in ultrafast technologies have resulted in generation of light packets consisting of only a few cycles of the electric and magnetic fields. It is possible to detect chemical and biological warfare agents by using femtosecond lasers for performing FLIBS and second order harmonic generation.

FIRST PANEL OF RESEARCH ADMINISTRATORS

James R. Bloedel, Vice Provost for Research and Advanced Studies, and Dean of the Graduate College, Iowa State University

James A. Guikema, Associate Dean of the Graduate School, and Associate Vice Provost for Graduate Research, Kansas State University

- Universities are challenged by the new security regulations imposed after 9-11. Compliance requires considerable expense. If laboratories use agents such as E. coli or anthrax, the university must install various

security features that could include card or key controlled access, a perimeter fence, and an armed guard. Personnel must undergo background checks and certain foreign nationals are precluded from access to information that has traditionally been shared in laboratories.

- Because of the national crisis, universities have new funding opportunities. Homeland security issues are especially well suited to the mission of land-grant universities. Iowa State University is seeking proposals from its faculty, and intends to capitalize on its strengths in: information assurance; applications that combine quantitative expertise in engineering and agriculture; and applications involving the Virtual Reality Applications Center and the Center of Scientific Forensics.
- Over 20% of the Ph.D. scientists and engineers in U.S. academic employment are foreign-born; in engineering and computer sciences, this figure tops 30%. Since 9-11, it may be more difficult for international students to obtain visas to permit their study in the U.S.
- As of Fall 2002, the Immigration and Naturalization Service (INS) is requiring that universities maintain and update information about international students via the Student and Exchange Visitor Information System (SEVIS). SEVIS shifts the burden of tracking students to universities, and triples the number of data items that a student must report.
- Graduate education and research has become a global enterprise. Kansas State University shares its expertise in grassland biology with sub-Saharan Africa through an NSF program – and this is only one example. A decade ago, only 10% of all publications by U.S. researchers involved international collaboration, but as of 1999, this increased to more than 20%.

SECOND PANEL OF RESEARCH ADMINISTRATORS

Catherine E. Woteki, Dean of Agriculture, Iowa State University
Thomas Rosenquist, Vice Chancellor for Research, University of Nebraska Medical Center

- We could use our scientific might to solve problems at the heart of global instability. Limited access to sufficient food for health may be one of the roots of terrorism. We have the scientific knowledge to significantly increase food production.
- Land grant universities are well equipped to disseminate knowledge and lend aid because their mission includes research, teaching, *and* extension. The free exchange of scientific information may be jeopardized, however, by new security regulations.
- Scientists in academia, the private sector, and government should be actively engaged in policy debates, and should support international research and development in addition to homeland defense and military preparation.

- We are now witnessing simultaneously a significant increase in research funding and a demand for reallocation of effort because of terrorism. Most senior researchers have experienced one or the other of these phenomena in the past, but not the two combined. The national emergency today is different and it presents us with both danger and opportunity.
- The state universities at this conference can produce critical masses of scientists to compete for federal funding with the coastal giants – but they must overcome parochialism, political boundaries and concerns about who will get the credit for success.

PLANNING FOR RESPONSE TO BIOTERRORISM

Donald F. Hagen
Executive Vice Chancellor
University of Kansas Medical Center (KUMC)

- We don't know how to respond in a national emergency. Where do we send the public with their questions? How will hospitals handle infections like smallpox, or mass casualties? Who is in charge? We must begin to assess the threats and work on response alternatives. We must determine the role of the federal government and the state. What kind of leadership can we provide within our region?
- America must take a new look at its public health system. Communities must become better educated, and health providers must get to know each other if they are to function as a team in a crisis. KUMC is working with the Department of Health and Environment to provide distance education so local personnel can identify smallpox, for example. We are also trying to establish better communication between public health professionals and practicing doctors in Kansas.
- It is important to address the causes of terrorism – find homes for the homeless, educate the poorest of the poor and feed the hungry. We must also consider how our foreign policy is interpreted around the world.

SECOND PANEL OF RESEARCHERS

Eric M. Vernberg, Professor of Clinical Child Psychology, University of Kansas
Denis Medeiros, Professor of Human Nutrition, Kansas State University
Michael Meagher, Professor of Chemical Engineering, and Director,
Biological Process Development Facility, University of Nebraska – Lincoln

- The conceptual models we now have for explaining and predicting the psychological effects of terrorism are quite advanced and well validated. Yet we lack the infrastructure, organization and communication systems to apply our scientific knowledge at the national level to help our citizens cope. Only one-third of the children with pronounced psychiatric symptoms in the Manhattan public schools saw a counselor, psychologist,

or other mental health provider in the six months following the September 11th attack.

- It is shortsighted to invest a huge amount of our national resources in single-issue systems at the expense of investments in psychological health. Intellectual leaders must be involved in the public debate about resource allocation.
- Nutrition as a science was galvanized by a previous national crisis – World War II – because we discovered that a number of men were undernourished and could not be drafted. The RDA (Recommended Dietary Allowances) was published for the first time in 1943. We often find that a crisis can be instrumental for an emerging field of study.
- There is a huge agricultural base in Kansas, Nebraska and Iowa and investment in nutrition research has been upward and steady. The challenge is sustaining momentum while other needs outweigh the priorities we established prior to our recent national emergency.
- The Department of Defense (DoD) has been developing countermeasures against bioterrorism agents for many years, but it has focused on the soldier in combat situations. To use these applications for civilians, we must increase production capabilities by 100-fold and include a wider spectrum of society in the clinical testing.
- Vaccines or therapeutic molecules against biological agents are of little monetary value to the pharmaceutical and biopharmaceutical industry. And the pipeline is so full that the industry lacks the resources to produce the drugs already approved for market and those in clinical trials.
- The universities can play a role in assisting the civilian bioterrorism program headed by NIAID, the DoD bioterrorism program, and small biotechnology companies. Universities can provide access to expensive facilities and expertise. They can also train engineering and science students in an FDA-regulated environment. The Biological Process Development Facility (BPDF) at the University of Nebraska - Lincoln has successfully helped companies and the government bring biopharmaceutical molecules to clinical testing.

STATEWIDE ADVOCACY

Kim Wilcox, President and CEO, Kansas Board of Regents
Janet Murguia, Executive Vice Chancellor for University Relations,
University of Kansas

- It is important to bring people from the academic world into the state higher education office, and to maintain a campus culture with its unique values.
- Universities don't prioritize reporting and communications. This puts them at a disadvantage within state government. The higher education officer in the state must devote significant time to this task.
- In the 2002 legislative session, the University of Kansas developed this strategy: present a united front with the other Regents schools and with

K-12 education; communicate directly with key legislators; and promote a grass roots campaign.

- The state of Kansas receives a good return for its investment because higher education is a partner in creating a better destiny for everyone.

REACTION AND CONFERENCE SUMMARY

David E. Shulenburger
Executive Vice Chancellor and Provost
University of Kansas – Lawrence campus

- It is important to assess whether this is the time to build capacity at our universities in response to the national security crisis. In the past, we have put lots of money into projects that were soon abandoned as the situation changed. Perhaps it is better to organize the resources we currently have, rather than make significant additions to them.
- The mission of the university is research and teaching. When we consider how to respond to the national crisis, we must keep this mission in mind, else we risk losing support from our citizens. Is it our job to solve specific problems now, or to train experts for the future?
- For universities to address bioterrorism in a comprehensive way, they must go to several federal agencies to secure funding – the NSF, NIH, USDA, etc. Since there is no multi-grant system, perhaps direct funding is the best strategy for pursuing research on bioterrorism.

KEYNOTE ADDRESS

SCIENCE AT A TIME OF NATIONAL EMERGENCY: BE BOLD, THINK BIG, THINK OUT OF THE BOX

Martin Apple, President and CEO
Council of Scientific Society Presidents

I will address five key points: 1) we are at the nexus of tense coexistence of multiple eras of societal evolution and of disparate generations of our people; we must work together to solve several major national emergencies, not just 9-11, 2) the role of the university is to create enduring value; we ensure this by being the fountain of really bold new thinking under a renewed social contract, 3) everyone loves a tax cut, but did Washington really misplace $5 trillion dollars, and what does it mean for science in the coming decade? 4) science and secrecy are polar opposites, and their growing tension needs resolution now, 5) homeland security requires a new defense paradigm, a streamlined, high agility, increasingly competitive operational system and different sets of expertise to address prevention as well as mitigation.

What Does it Mean to be at a Time of National Emergency?

World leadership requires us to lead the world to a better tomorrow. Because of this, we are indeed in a time of national emergency, but not just a post 9-11 response. There are several national emergencies in the United States today; they are all important and many interact. Each one undermines our future and many challenge our right to lead.

Here are some examples:

- We repeatedly fail to plan and sustain an effort for sustainable energy autonomy.
- Our children finish high school at the bottom of the world in math and science.
- In many cities, a majority of births occur in one-parent families.
- We squander unique opportunities provided by the last decade of economic growth.
- Addicting street drugs and sexually transmitted diseases are runaway epidemics.
- Our personal privacy and Constitutional rights are fast becoming historic relics.
- Justly judged guilty and sentenced to death has become “oops, another mistake.”

- Half our citizens ignore all evidence and condemn the teaching of evolution as “heresy.”
- Although the global standoff on whether we should annihilate all life on Earth has ended (Cold War), it has now evolved into perpetual tribal warfare, with us as the world’s policeman.
- We overfish coastal areas, causing catastrophic eco-collapses, while invasive species remake or destroy our landscape, and limit its future productivity.
- Fresh, clean water is moving from being a commodity to being a crisis and we despoil the air, the water, the land, to avoid the expense of converting the nation to sustainable systems, and thus severely limit the future of our children.
- Networks of smart, resourceful, imaginative, impatient, fanatic murderers from the pre-industrial age devastate the infidels who dare to live happily in the post-industrial age.

What is the Role of Universities?

Society has problems, while universities have departments. Scientists need to be absorbed in many pressing issues, not just the latest problem of national security. It is time for universities to assert their leadership. While all our institutions and commercial enterprises operate in the present, we, in contrast, are the constituency for the future. Many universities are giving up their most useful role – the perpetual stimulation of new ideas. This is where breakthroughs happen. Universities are becoming redirected as a temporary answer to today’s corporate R&D malaise, serving short-term profits. We should reach the pinnacle of our journey as universities by adding the maximum value to society. Too often we confuse success with excellence, and stop along the way measuring proxies of value (e.g., awards, money, rankings) and then become arrested into the pursuit of these proxies instead of value.

We live in a period in which we have a contentious interaction of coexisting pre-agrarian, agrarian, newly industrializing, industrial and post-industrial societies around the world. At the same time, we have colliding generations in the U.S. (named by Lynne Lancaster): the traditionalists, baby boomers, generation-X and the new millennials – each shaped by a wholly different history and expressing a strongly held, very disparate, world view. Each appears confident that they are right, and the other folks will “see the light” as they have, in due time.

Thus we are at a time in which the universities are challenged to assert their leadership, to experiment with very new ideas, to lead – not follow – the evolution of our free society. Adding one more national emergency, even this one, is never a time to fail in this obligation to our society; instead it makes the case for doing so even more compelling.

Now is the time for each of you to build the intellectual underpinnings for the long-term capacity to be a free and just society. Each university should be pursuing a bold, imaginative, even startling research agenda.

This is the time to examine and clarify these questions: What should be the twenty-first-century social contract between society and universities? …between government and universities? ….between industry and universities? ….between virtual education and personal interaction?

Contributions of Science

What is the mission of the twenty-first century university? How do we define it? When will we put behind us the elements of the industrial revolution that no longer fit? When will we institute, and when should we begin to replace, the elements of the information society?

Scientists need to develop and widely communicate the grand challenges of the twenty-first century. All science is foundational. From this foundation, we generate more new ideas and knowledge and can create new amenities. Scientists, in the everyday course of doing research and inquiring into Nature, create much change. The ability to transplant genes, grow whole mammals from any cell nucleus, and hundreds of other discoveries, occur far more rapidly than the ability of our institutions to cope with the implications of the changes created.

Scientists have generated considerable value to the society. In the twentieth century we saw so many revolutions that they often overtook us. A century ago, we did not imagine such advances as these, but they were achieved:

- synthetic hormones and antibiotics
- producing human insulin in bacteria
- humans living in a space station far from earth
- cracking the universal genetic code
- conceiving a baby in a test tube
- discovering lasers and NMR and using them as medical lifesavers
- the transistor, personal computers
- walking on the moon
- conducting electricity without resistance
- the Internet
- storing an encyclopedia on a credit card
- flying a jet across the ocean in 2 hours
- live broadcasts by color TV from around the world in real time
- transplanting hearts from the dead to the living
- remote digital copiers and cell phones

Scientists save lives, create jobs, and provide a unique workforce that can overtake our challenges. Thus scientists are always a constituency for the future. We live at the edge of knowledge and can have the thrill of stepping off into the unseen and the unknown – the future – every day. We can envision the future we would like to create and it is exciting. We will make important new discoveries that benefit humankind. We will create new sciences never thought of before.

Grand Challenges of the Twenty-first Century

Some overarching goals for our future are:

- Discovering new truths of nature;
- Enhancing the value of universities to society;
- Converting the nation, even the world into entirely sustainable systems;
- Developing all the human cognitive capabilities and potentials to learn;
- Healthier lives, built on pre-emptive prevention, rather than treatment, of disease;
- Stimulating our economic engines and inventing new economic paradigms that prosper without further population growth and environmental damage;
- Developing affordable, sustainable, distributed, universal energy autonomy;
- Understanding and fully developing affirmative and beneficial human behavior.

Federal Resources

The White House and the Congress told the American people last year that we would accumulate a $5 trillion surplus in the next decade and that we should pay down the debt and return one-third of it in tax cuts now. Office of Management and Budget (OMB) data projected that over the next decade we would spend $800 billion in interest on the National Debt, but then it would be fully paid off. So we voted to cut taxes only to find out that it was not true, and we will be saddled with debt interest payments of $1.8 trillion over the next decade, and the debt will still be there, and the growing government debt is competing with business expansion for new capital. Last year's Bush budget left no margin for error in forecasting the next decade of surpluses. If we look over the last four decades of deficits and surpluses, covering the Johnson, Nixon, Ford, Carter, Reagan, Bush-I, Clinton and Bush-II eras, we find that war and defense were not the factors that produced the largest federal deficits; in the only two cases that the deficit spun out of control, the Reagan-Bush-I and Bush-II periods, it was from enacting a huge tax cut that was not required to be linked to actual federal revenue gains to prevent huge deficits.

2003 Federal Budget: Revenues and Allocations

	FY 2001	FY 2002	FY 2003
US GDP	$9,745	~$10,360	~$10,920

The burden of tax payments is not on corporations in America, but on us.

2003 Federal Budget: Federal Revenues

Tax Burden on Individuals:	$ in Billions (all figures rounded)
Individual income taxes	1,100
Payroll taxes	720
Excise taxes	75
Estate taxes	30
Miscellaneous	45
Tax Burden on Corporations:	
Corporate and profits	220
Customs	25
Total Federal Tax Revenues	2,050

Notes from Martin Apple

The non-defense appropriations are the only real discretion that the White House and Congress have in determining how the huge federal revenues are spent.

Allocations of Proposed Federal Budget

	FY2001	**FY2002**	**FY2003 estimate**
Federal Budget	$1,865	$2,050	$2,130 ($ in billions)
Tax Receipts	1,990	1,945	2,050
Allocations: **Entitlements** (Medicare, Medicaid, Social Security)	1,056	1,189	1,233
Debt Interest	206	178	181
Discretionary - Total	657	741	789
Defense	309	348	379
Non-Defense	348	393	410

Notes from Martin Apple

Did Washington really lose $5 trillion of our planned surplus in less than 2 years?

Ten Year Real Surplus (excluding social security) in Trillions of Dollars

White House Report Date	**Projection for 2002-2011**	**Update for 2003-2012**
April 2001	+$3.046 Trillion	
August 2001	+$0.575 Trillion	
February 2002	-$1.650 Trillion	-$1.464 Trillion

Data from OMB

When you manage to lose $5 trillion, it is quite appropriate to demand to know where it went. We all assume, based on the deliberate daily Washington press spin that it has gone into our new defense requirements. But that turns out not to be the truth. For example, analysis of the OMB's own data shows that the big tax cut created about 45% of the new projected deficit already, the slowing economy accounted for about 25-30%, and all other legislative actions – including all defense buildups – accounted for only about 15-17% of the deficit.

Historical Defense Buildups as Percents of GDP

Buildup Episode	Prior Low	Buildup Peak	Increase
World War II	1.7% (1940)	37.9% (1944)	36.2%
Korea	3.6% (1948)	14.1% (1953)	10.5%
Vietnam	7.4% (1965)	9.4% (1968)	2.0%
Reagan	4.6% (1979)	6.2% (1986)	1.6%
Current	3.0% (2001)	3.5% (2003)	0.5%

Prepared by the staff of the House Budget Committee Source: OMB 2/26/02

In addition, we see a growing squeeze on discretionary spending.

High Growth Sectors are Increasingly Squeezing the Federal Budget

($ billion)

Federal Outlays	1970	1980	1990	2000	2003 est.
Entitlements	$61	$262	$568	$951	$1159
Defense	$82	$135	$300	$295	$ 379

Projected for FY 2003 Federal Science and Technology

[Discovery of new knowledge]

Proposed Budget - $billions

AGENCY	FY 2001	FY 2002	FY 2003
NIH	$20.4	$23.4	$27.3
NASA	7.8	8.1	8.7
Energy	4.9	5.1	5.0
Defense	4.9	4.9	4.9
NSF	4.4	4.8	5.0
Agriculture (+USFS)	1.9	1.9	1.9
Commerce (OAR+NOAA+NIST)	0.8	1.0	0.9
Interior	0.9	0.9	0.9
EPA	0.7	0.7	0.8
Transportation	0.5	0.7	0.5
Education	0.3	0.4	0.4
TOTAL	$48.1	$52.3	$57.0

Not adjusted for inflation
Notes from Martin Apple

Federal Research Trends (NAS and NSF Data)

The 1990s economy prospered, the 1990s federal budget surplus was generated, but…

Fields with Severe Funding Cuts since 1993

Academic Disciplines	**1993-1997**	**Academic Disciplines**	**1993-1999**
Physics	-27.8%	Physics	-24.6%
Electrical Engineering	-35.0%	Chemical Engineering	-25.9%
Mechanical Engineering	-49.8%	Electrical Engineering	-29.0%
Geology	-20.1%	Mechanical Engineering	-53.9%
Agriculture Sciences	-17.1%	Geology	-25.9%

Full Time Graduate Students in many Key Sciences has Declined
(data from NAS study)

FIELD OF RESEARCH	1993	1999	% Change
Physics			
Graduate Students	12,397	9,661	-22.1%
Federally Supported Graduate Students	4,916	3,807	-22.6%
Federally Supported Research Assistants	4,103	3,248	-20.8%
Geosciences			
Graduate Students	5,970	5,239	-12.2%
Federally Supported Graduate Students	1,647	1,263	-23.3%
Federally Supported Research Assistants	1,338	1,040	-22.3%
Ocean Sciences			
Graduate Students	2,177	2,130	- 2.2%
Federally Supported Graduate Students	1,037	932	-10.1%
Federally Supported Research Assistants	865	788	- 8.9%
Mathematical Sciences			
Graduate Students	14,530	11,792	-18.8%
Federally Supported Graduate Students	1,474	1,104	-25.1%
Federally Supported Research Assistants	736	594	-19.3%
Materials Engineering			
Graduate Students	4,249	3,537	-16.8%
Federally Supported Graduate Students	1,605	1,336	-16.8%
Federally Supported Research Assistants	1,393	1,202	-13.7%

What Does This Portend for U.S. Science?

New projections by the Bush Administration will have profound implications for our twenty-first century world leadership and the growth of scientific research.

Preliminary Agency Projections 5 Years Ahead
$ billions of *constant* dollars

AGENCY	**FY 2002**	**%Change by FY 2007**
NIH	$22.8 BN	+16% (most of it this year)
NASA	10.2 BN	+ 9% (most of it this year)
DOD (6.1+6.2+6.3)	10.0 BN	+ 9%
Energy	8.4 BN	- 2%
NSF	3.5 BN	+ 3%
Agriculture	2.3 BN	- 7%
Commerce	1.1 BN	- 1%
Interior	0.7 BN	- 6%
Transportation	0.8 BN	- 6%
EPA	0.6 BN	+ 6%
Non-DOD, minus NIH	$26.9 BN	+ 1.6%

Notes from Martin Apple

Congressional research appropriations are concentrated into eight sub-committees that make all discretionary financing decisions. The members of these subcommittees will decide soon. They need to hear from the science and university communities about the consequences.

Subcommittee that Decides	**Total Spending ($ billions)**	**Research Investment**
Labor, HHS, Education	$131BN	$27.7 BN
VA, HUD, Independent Agencies	93 BN	15.8 BN
Defense (6.1+6.2+6.3)	360 BN	10.0 BN
Energy and Water	25 BN	7.6 BN
Agriculture	17 BN	2.0 BN
Interior	20 BN	1.9 BN
Commerce, Justice	41 BN	1.2 BN
Transportation	20 BN	0.7 BN

Notes from Martin Apple

Why Do We Believe We Cannot Fall Behind in Crucial Leadership?

Recent examples tell us a different story.

Supercomputers

Year	Fastest Computer	Micro-Processors, if used	Number of processors	Speed in Gigaflops*
2002	NEC Earth Simulator		5,104	35,600
2001	I.B.M. ASCI White-Pacific	I.B.M. SP Power 3	7,424	7,226
2000	I.B.M. ASCI White-Pacific	I.B.M. SP Power 3	7,424	4,938
1999	Intel ASCI Red	Intel Pentium II Xion	9,632	2,379
1998	I.B.M. ASCI Blue-Pacific	I.B.M. SP 604E	5,808	2,144
1997	Intel ASCI Option Red	200 MHz Pentium Pro	9,152	1,338
1996	Hitachi CP-PACS		2,048	368
1995	Intel Paragon XP/S MP		6,768	281
1994	Intel Paragon XP/S MP		6,768	281
1993	Fujitsu NWT		140	124
1992	NEC SX-3/44		4	20
1991	Fujitsu VP2600/10		1	4

* Billions of mathematical operations per second
Source: Jack Dongarra, Univ. of Tennessee

The New National Crisis – Responding to 9-11: Key Actions for Scientists

The most important challenge may not be eliminating the bad guys. It may be preserving the freedoms and values we are trying to protect while we are doing so.

Office of Homeland Security

It would be helpful to get the Office of Homeland Security organized in a way that shows practical streamlined functioning. The official version does not lend itself to this. It puts the cart before the horse – it first defines who will be

collected together, and then decides what they will do and when, by whom, etc. In the process, it leaves out crucial scientific and intelligence capabilities. Here's an example: if all on one day a major and different type of incident of terrorism occurs in a U.S. harbor, and a football stadium, and on three dozen farms, and at hub airports, and on a block of urban skyscrapers, and a senior official of each group named in the new HSO hierarchy were coincidental witnesses at each site, who would be in charge of the next five steps of action? How would their actions be coordinated over the next hour? The next 24 hours? What is the plan of action they would follow? It is now nine months since 9-11 and no one seems to know the answer to this simple query. Our defense strategy needs a new paradigm. Business as usual by the Department of Defense, the state governors, and local police is not likely to be optimally effective.

Here are the lessons taken from the twentieth-century wars around which we built the U.S. Department of Defense:

1. Negotiated truces almost always fail and decisive military victories almost always redirect the future to the victors.
2. Winners of wars are those who have the most surviving military people, the most weapons, and/or the most willingness to continue killing. Losers lack one or more of the three.
3. War requires both sides to protect, defend, or lose territory, and both opponents must live within those defined territories.
4. Bigger is better – more troops, more tanks, more ships, more warheads; bigger guns, bigger tanks, bigger ships, more computer power, etc.
5. Project enough force abroad and new wars will be prevented, or if they occur, they will be conducted on the enemy territory, not our homeland.

I suggest we need these attributes for rethinking our new self-defense paradigm:

- Decisive victories, not truces
- Time is the enemy, not a friend
- Agility, not hierarchy
- Dispersion, not concentration
- Brain, not brawn
- Networks, not armies
- Perpetual learning, not doctrines
- Systems vulnerabilities, not obvious targets
- Deep knowledge across disciplines, not narrow expertise
- Imagination, creativity, not replay of prior victories
- Instant information and analysis, not meet next week
- Pernicious insiders, not foreign armies

Security, Secrecy and Science

Another major concern is the growth of secrecy and its impact for both science and security.

The system of science knowledge is based on evidence that must be tested and confirmed by others. To succeed, all scientists must share data, methods and materials. The free exchange of ideas is the indispensable prerequisite that makes science grow and prosper. In recent years our focus on commercial profits for faculty and universities – and now security concerns – may be stifling and eroding the quality of our scientific enterprise, and it may eventually dismantle the integrity that ensures quality and leadership. Unless we maintain leadership, we will ultimately decrease our security.

This is the major conundrum for science and for universities:

- The free exchange of information and ideas is an essential element of scientific research and university effectiveness.
- Access to information is essential for the democratic process to function and succeed.
- Information about key defense technologies can gravely compromise security.
- Current homeland security plans could handcuff U.S. science.
  -- adapted from H. Kelly

Currently, the FBI and the Defense Threat Reduction Agency (DTRA) must frequently screen the research in technology areas, because there will be some instances of potential risk. They classify it as secret when the risk warrants, but limit excesses of secrecy. The Council of Scientific Society Presidents suggests that fundamental science should remain >99.9% open with a very small percentage of restrictions. Senior scientists can evaluate research in progress at any institution and determine security risks. Journal editors and reviewers are the second line of defense.

We need to restructure how the U.S. computer-technology research system obtains, evaluates and utilizes all future relevant information. This requires three developments that are needed now:

1. A system of much faster computers and searching that ties together all the relevant databases in the world, even the ones that do not at first appear to be directly useful for such research.
2. New online knowledge management processes that intelligently store, retrieve and mine data, and discover and report continuously to the user not only answers to predefined questions, but all new and unique patterns, having remotely scanned thousands of databases in minutes. Such a high-IQ next generation search engine can be jointly developed with university artificial intelligence labs or appropriate software companies.

3. Upgrading all our global GIS systems to provide a fully analyzed 24/7 real time surveillance of pre-defined risks from space while coordinating novel undisclosed networks of highly sensitive new ground sensors that can track in real time a variety of inputs (whatever is needed) whenever it is needed. Oversight of this activity is needed.

Tens of thousands of documents freely available on the world wide web in 2001 have been removed, and the library files and CD collections confiscated and destroyed. The FBI follows-up to ensure that libraries comply with this order to destroy data, and under the law there is no appeal. Such actions are certain to hamper Counter-Terror efforts severely.

The Need for More Agility and Perpetual Learning Systems: SWAT Team Model

The Council of Scientific Society proposes a Counter-Network SWAT Team model:

1. The necessary process is not a moral crusade, and the enemies should not be called "terrorists" (that term gives them power over us – to turn us into "fearful victims"). The process should focus on simultaneously preventing harm from and eliminating a specific target that we could call "networks of fanatic murderers."
2. The countervailing force includes organized networks of teams that create and develop Scientifically Weighted and Analyzed Tactics ("SWAT-Teams")
3. CSSP SWAT team networks are each composed of leading Ph.D. scientists with degrees and expertise in dozens of science disciplines (e.g.: chemistry, forensics, risk analysis, psychology, geology, toxicology, optics, operations research, computer science, acoustics, physiology, meteorology, mathematics, microbiology, physics, etc.) who collaborate via a secure Internet.
4. SWAT teams will each start with a *modus operandi* and an agenda of topics that will provide firm initial guidance, but these teams will then each evolve independently.
5. CSSP SWAT teams use a systems approach – define a whole system; discover and rank the importance of its vulnerabilities; and determine the optimal deterrence, threat-reduction, vigilance and mitigation processes.
6. SWAT team scientists are verifiably successful in applying these processes – discovering/defining problems, finding patterns and analogies, creative brainstorming, hypothesizing testable explanation, investigating logically and systematically, reasoning both deductively and inductively, critically evaluating, making effective decisions, transferring understanding to new situations.
7. SWAT teams each select several special additional members who serve as confidential 2-way information conduits – and buffers – that ensure the identities of the SWAT team participants are protected: one each from the

FBI, CIA, DTRA, and the homeland security agency. Each of the four special members will provide their SWAT team a modest budget. These four serve as the regular liaison to all other federal agencies (and other relevant groups). The team may add leaders of relevant industrial organizations.

What are Some Advantages of the SWAT Team Strategy?

CSSP SWAT teams should ideally be able to develop the following attributes that could develop routine superiority. They would represent a unique part-time "National Guard" – a strategy team whose membership is based only on high intellectual competence and advanced knowledge.

- They are always fully dispersed and live and travel independently.
- They set their own goals and pace.
- They are always on a rapid learning curve.
- Their leadership can rotate perpetually and randomly.
- They can have hundreds of independent and highly sophisticated "antennae."
- They stay hard to identify since no two teams start or evolve identically.
- Each team can grow and reproduce by division.
- More than one team can deploy against any one threat or vice-versa.
- Each team may create unique tactics whose sum exceeds the potential and learning rate of their target network of fanatic murderers.
- Based on science underway in their large community of scientists every day, they can discard today's best solutions and create better ones overnight.

Security Questions We Need to Answer

A. U.S. Food System Security

Why should this be a model? It was designed to be expedient, not impregnable. It represents $1.3 trillion of the GDP. There are many sites of vulnerability to chemical-bioweapons.

These are the questions we should ask:

1. What does the quantitative 4-D dynamic model of the whole U.S. food system look like?

- Where are all the vulnerability points in the system?
- What are the quantitative relative risks and consequences of attacks?
- What new procedures or materiel can erase or circumvent these vulnerabilities?

- What are the costs vs. benefits of various strategic interventions that prevent attack?
- How to best protect each target type/location?
- Which are the earliest and best threat indicators?

2. Response preparation: What we need to know now

- How to manage responses to overwhelming surges of activity?
- When/how will we know we are under bio-attack?
- What new biosensor systems can identify a bio-agent with certainty in minutes?
- How ready is our USDA extension network to define risks and spot key events?
- Consequence management – What processes? People?
- Shortest search process to find and nullify those who caused the damage?
- Deter and prevent – best use of current resources?

B. One Subset of Food Security: High-Consequence Pathogen/Toxin Security

1. The issues, questions, and practical threat reduction:
   – modified from Salerno (personal communication)

- Pathogens at restricted laboratory facilities exist in nature and can be obtained from many, even hundreds of laboratories around the world.
- The absolute amount of any given organism in an active biological or medical research facility cannot be reliably quantified from day to day.
- A strategically significant quantity of pathogenic material can be obtained from a single cell because it can be easily cultured with commercially available equipment.
- Smugglings of high consequence pathogens are not identified by current Customs procedures, technology, or Infectious Agent Laboratory practices.

2. What is a high-consequence pathogen/toxin? What is critical high consequence pathogen (HCP) information?

- What are the scenarios of an inappropriate HCP acquisition?
- What and how much can be known, how far in advance of a damaging prerelease event?
- What are the possible routes of transport and smuggling of each HCP?
- What alters and what happens to each agent after release (terrain-specific scenarios)?
- What terrestrial and atmospheric dynamics alter the level of hazard after release?
- What are the high consequence target scenarios?

- What are the most cost-effective damage-preventing changes in each of the points of bio-agent vulnerability in the U.S. food system that can be made this year? In each of the next three years?
- What number of expert personnel can provide definitive answers for these questions during 2002?
- What R&D can be defined in advance to aim at needed answers to these questions?
- What fundamental research areas need enhancement to ensure our world leadership with knowledge about human/plant/animal pathogens and pathogenesis?
- What types of research should be reported, and what agency should have oversight responsibility?
- How should we define HCP information that should be protected? (e.g: formulas and processes for weaponizing pathogens; formulas and processes for creating new lethal organisms.)
- What is the best monitoring system for locations that store, use, and/or transport high-consequence pathogens and toxins for organisms; individuals; research?
- Who would try to steal or divert a HCP? How could they succeed?
- What vulnerabilities exist at every specific relevant facility or system?
- What technologies, policies, and procedures will reduce risk to a very low level?

Restrictions and delays should not impede quality research. Threat assessment should drive security system design, and insiders must be considered part of the risk.

We see that we need a very different set of people, tactics and actions to prevent an event than to mitigate damage from a malicious event that has just occurred – which seems to be most of our focus so far in Washington.

A recent survey by Research!America showed that 9/10 of the people across America believe it is extremely or very important to have scientific research help prepare for and respond to biological and chemical terrorism in the United States.

This is our time to lead. We can do it best by thinking big, being bold, and thinking out of the box.

RESEARCH AT KU: MOVING AHEAD!

Robert E. Barnhill
Vice Chancellor for Research and Public Service
President, KU Center for Research
University of Kansas

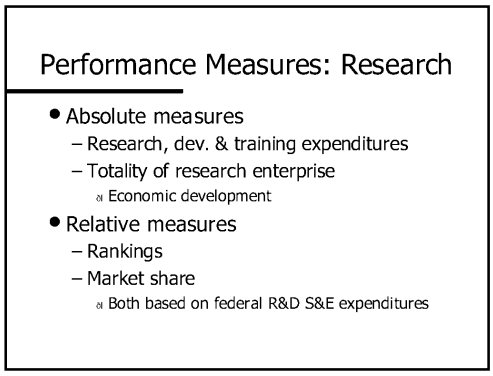
I am pleased to respond to Dr. Martin Apple's opening remarks at this sixth annual research policy meeting sponsored by the Merrill Advanced Studies Center. This is my fifth opportunity to speak at these important meetings. I wish to emphasize our gratitude to Fred and Virginia Merrill for their continuing support of these sessions.

I want to talk about our university's response to the post 9-11 American situation, but first, I will review a few macro-level statistics about the research enterprise at the University of Kansas (KU) in order to set the framework from which 9-11 responses can occur.

The first portion of my talk involves research performance measures – a theme at last year's Merrill Conference. You will recall that Joan Lorden from the University of Alabama - Birmingham discussed them in some detail. I'll mention three kinds of performance measures:

- Research, development and training expenditures (RDT)
- Research rankings
- Research market share

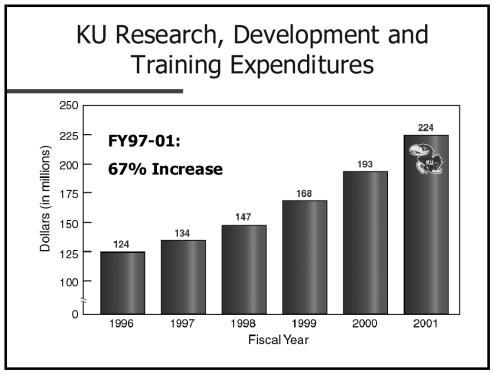
Then I will touch briefly on post 9-11 by means of quotations from John Marburger and Rita Colwell. I'll conclude with a report on a recent KU-Midwest Research Institute bio-defense workshop that we initiated and co-organized.



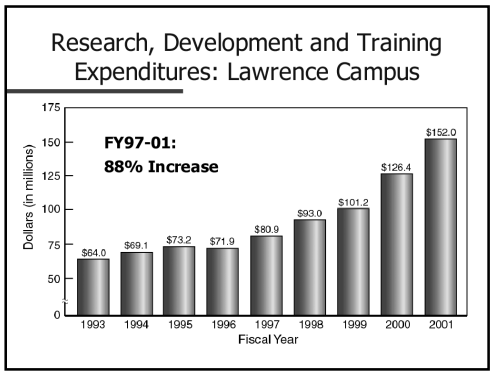
Academic research is multi-dimensional and thus requires a variety of measures. These measures are of two types, either absolute or relative. At KU, we use one principal absolute measure, namely, research, development and training expenditures. This measure involves the totality of the research enterprise. Economic development numbers, such as the number of jobs provided in a ripple effect, stem from this RDT number.

We use two principal relative measures: rankings and market share. Both are based on federal research and development (R&D) expenditures in science and engineering. These expenditure numbers, collected by the National Science Foundation (NSF), are the "gold standard" for rankings because they represent peer-reviewed research.

For fiscal year 2001, our RDT expenditure figure is $224 million. The methodology used to obtain this number is the same as the NSF methodology used for rankings, but it is also applied to non-science and engineering and to training projects.

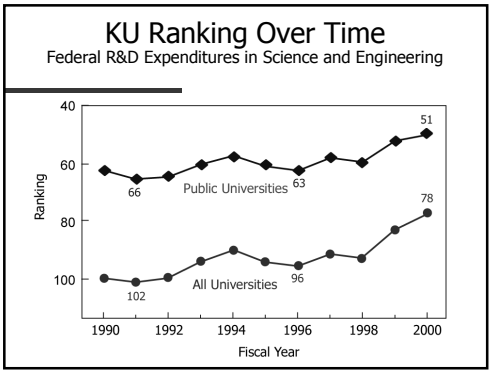


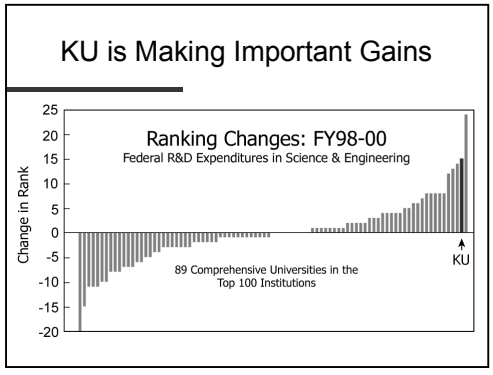
Our RDT expenditure can be used to estimate economic impacts such as the number of jobs produced by the ripple effect of KU research. The U.S. Department of Commerce says that, in Kansas, $1 million of academic R&D produces over 42 jobs; hence $224 million produces almost 9,500 jobs.



KU's RDT number has increased by 2/3 in the four years from FY 1997-2001 – a significant increase. The RDT expenditure numbers for the Lawrence campus have almost doubled over the four-year lifespan of the KU Center for Research (KUCR) from $81 million to $152 million. This is a spectacular increase.

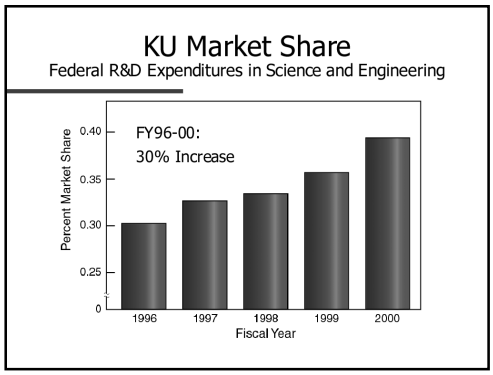
The first relative measure is our ranking based on federal research and development expenditures in science and engineering. Based on this national "gold standard," KU has risen rapidly since KUCR's inception on July 1, 1997.





KU's rise in the rankings has taken place very recently. Over the last two fiscal years for which rankings are available – FY 1998 to 2000 – KU jumped in the rankings 15 positions from 93rd to 78th. **This jump is the second largest among comprehensive universities in the top 100.**

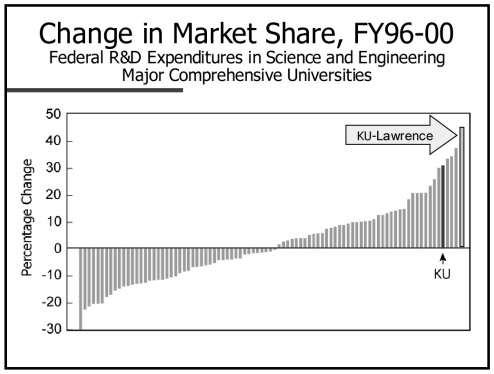
A university could be improving in the quality of its research, but not move up in dollars because of federal funding changes or state problems. Another reason for not moving up in the rankings is that the mountain becomes steeper nearer the top. Thus, another useful measure of research progress can be "market share."

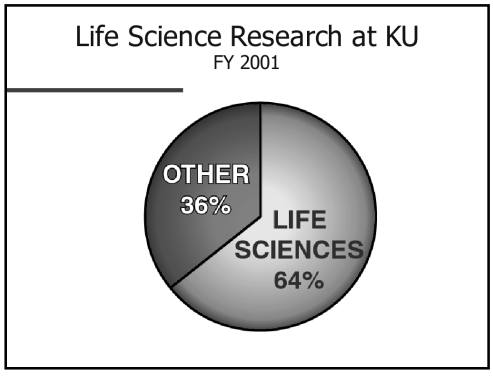


Market share refers to the proportion of federal expenditures spent by an institution. By this relative measure, KU has increased by 30% during the five years from fiscal year 1996 through 2000. Note that, by definition, the average change in market share for a given university is zero. Thus, a 30% increase is significant.

In fact, the market share increase by the KU Lawrence campus has exceeded the increase in market share of all 100 top universities!

Institution	% increase
KU – Lawrence campus	43.8
U of Illinois - Chicago	36.7
U of Colorado	33.8
U of Missouri - Columbia	32.9
KU	30.3
Washington U	29.5





Life sciences is the national research topic most in favor today. For example, the National Institutes of Health (NIH) budget has doubled over the past five years and is now five times the NSF budget. KU's life science research funding is a significant part of our portfolio, representing 64% of the total.

KU Life Sciences
Research Rankings FY99 vs. FY00

	FY-1999	FY-2000
Federal expenditures	$39 million	$47 million
Ranking among public universities	44th	43rd
Rank among all universities	74th	71st
Places gained among all universities	10 places (FY95-99)	15 places (FY97-00)
Public universities with larger ranking increase	6	1

During the four years, fiscal years 1997 to 2000, KU rose 15 positions in federal expenditures in the life sciences, which was the second largest jump in the nation. (The University of South Florida jumped 25 places.)

Our improvement in life science funding has paralleled our improvement in overall research funding.

KU ranked 35th among comprehensive public universities in federally sponsored life sciences research expenditures in FY 2000. KU's rate of increase in federally sponsored life sciences research expenditures from fiscal years 1996 - 2000 was the *highest in the country* among the nation's top 50 comprehensive public universities.

Federal Research Expenditures
KU Life Sciences

Fiscal	All Institutions		KU Total		Lawrence Campus	
Year	Amount	% Change	Amount	% Change	Amount	% Change
1996	7,388,936	---	25,069	---	5,265	---
1997	7,761,199	5.0	28,565	13.9	7,130	35.4
1998	8,330,474	7.3	28,377	-0.7	8,062	13.1
1999	8,942,577	7.3	38,866	37.0	14,770	83.2
2000	10,059,880	12.5	46,879	20.6	18,044	22.2
2001	---	---	54,887	17.1	24,441	25.3
1996-00		**36.1**		**87.0**		**242.7**

Source: National Science Foundation and KU Center for Research

- KU ranked 35th in federally sponsored life science research expenditures among comprehensive public universities in FY2000.
- KU was **number one** in federal life science research growth rate among the nation's top 50 comprehensive public universities from FY 1996 to FY 2000.

Science at a Time of
National Emergency

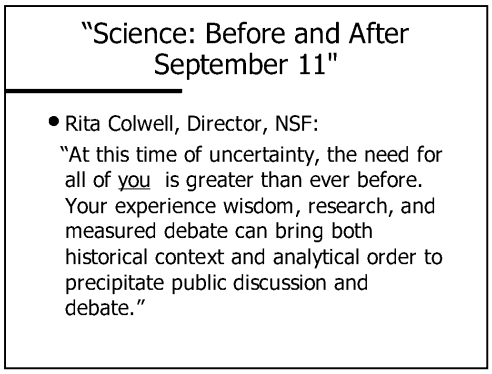
- Historical perspective
- Vannevar Bush during WWII

"Science has a simple faith, which transcends utility…It is the faith that it is the privilege of man to learn to understand, and that this is his mission. If we abandon that mission under stress we shall abandon it forever, for stress will not cease. Knowledge for the sake of understanding, not merely to prevail, that is the essence of our being."

The theme of this Merrill Center conference is "Science at a Time of National Emergency." Humans tend to think that all things begin with them, without history. Here are Vannevar Bush's words spoken in 1943 at the height of fighting in World War II (called to my attention by our University of Missouri colleague, Rob Hall, Interim Vice Provost for Research):

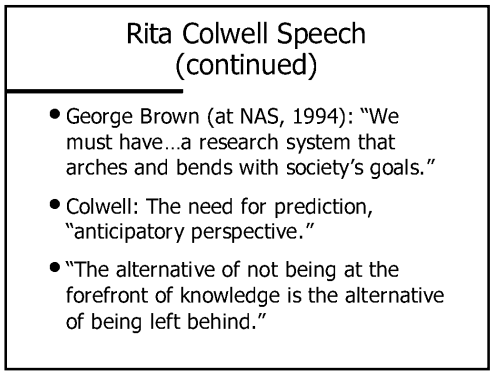
"Science has a simple faith, which transcends utility...It is the faith that it is the privilege of man to learn to understand, and that this is his mission. If we abandon that mission under stress we shall abandon it forever, for stress will not cease. Knowledge for the sake of understanding, not merely to prevail, that is the essence of our being."

On November 7, 2001, NSF Director Rita Colwell spoke at the Woodrow Wilson International Center for Scholars in Washington, D.C. Several quotes from her speech follow. The first one emphasizes the need for all of us to join in on this post 9-11 agenda and the need to remember history.

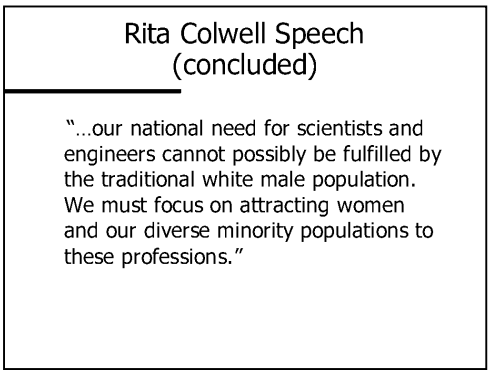


Dr. Colwell quoted the late Rep. George Brown (of California) in a speech at the National Academy of Sciences in 1994. "We must have a research system that arches and bends with society's goals." Emphasizing the need for prediction, in the form of an "anticipatory perspective in our research," Colwell went on to say: "The alternative of not being at the forefront of knowledge is the alternative of being left behind."

Colwell also broached the topic of under-represented groups in science and engineering fields. We are all aware of the need to provide supportive environments in order to encourage women and minorities to enter these fields.

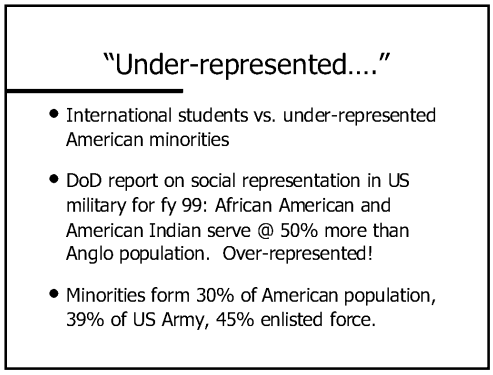


Now, extrapolating beyond Colwell's words, here is another thought: universities and businesses are beginning to complain and gear up in order to deal with SEVIS (the Student and Exchange Visitor Information System) and the tracking of international students. This increased security is necessitated by concerns over these students' national loyalty. If loyalty is to become a criteria for admittance to our science and engineering programs, we should pay heed to a sizeable group of minority citizens whose loyalty to this country, on average, is readily apparent.



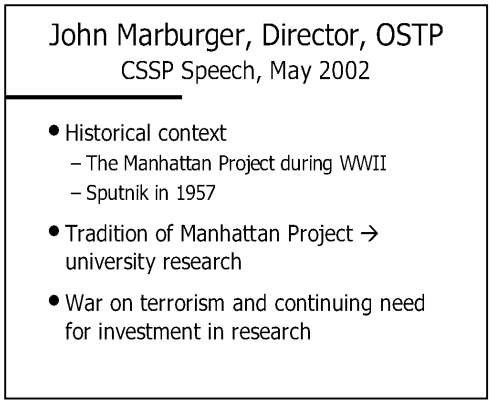
The same minorities that are under-represented in science and engineering fields are vastly over-represented in our country's military branches. An FY99 Department of Defense report on social representation in U.S. military forces reveals that African-Americans provided 20% of our active duty personnel 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%, respectively; hence, Anglos are 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

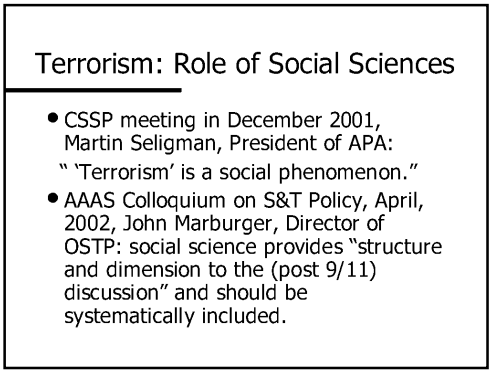


state and local school board can begin addressing immediately. Curriculum experts in our Schools of Education should collaborate with scientists and engineers and with social scientists who understand minority cultures to develop programmatic content and appropriate teaching techniques for kindergarten through 12th grade education. 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, they will be more likely to enter undergraduate and graduate programs in science and engineering.

As I often like to say, a rising tide raises all boats. An additional positive point to this idea is that our majority white students will also benefit. Over time, newer educational programs will also encourage their participation in science and engineering programs.



Dr. John Marburger is the Director of the Office of Science and Technology Policy in the Executive Office of the President of the United States. Last month he gave a speech at a meeting of Martin Apple's Council of Scientific Society Presidents.

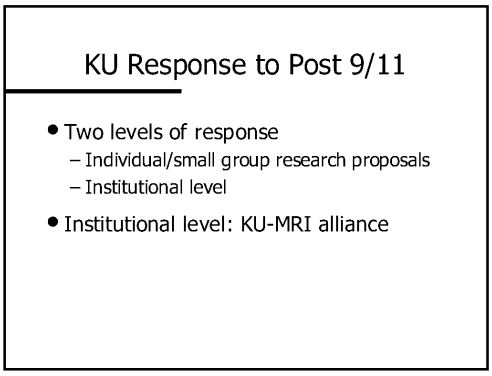


Like Rita Colwell, Marburger began with a historical perspective on American federal science funding and progress. He said, "the modern era of federal science policy begins with World War II and the remarkable contributions the sciences made to the war effort." He went on to cite Sputnik in 1957 as a second epochal event.

Marburger spoke about our current war on terrorism, noting that much of the needed science already exists and remains to be suitably implemented. He went on to say that this does not mean we should slow the investment in science: "The reason we have the needed technology at hand is that the forces of economic competitiveness and the desire to improve the quality of life for all people has driven science and technology in the right direction to address terrorism issues."

Given the Merrill Center's position in KU's Life Span Institute, which focuses on the social sciences, I raise the very illuminating comment from Martin

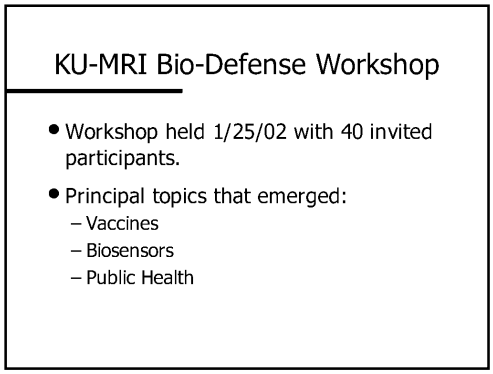
Seligman, President of the American Psychological Association. At the December 2001 CSSP meeting, Marty Seligman pointed out that the goal of "terrorism" is to cause social upheaval. Terrorism per se does not seek mass physical destruction except as a means towards this end. As with all great insights, this is obvious after it is pointed out to you.

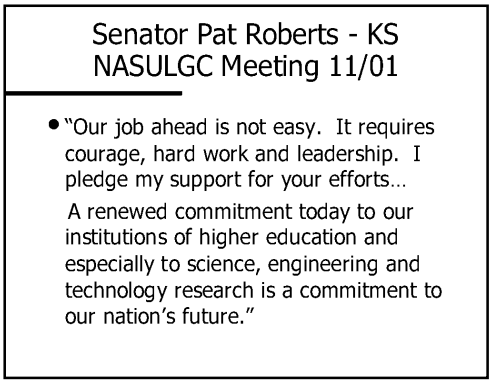


University faculty, the same as other American citizens, wish to contribute to the antiterrorism effort.

KU research is now sufficiently robust that there is much to contribute. There have been many individual and group research proposals to this end. At the institutional level, we decided to work with the Midwest Research Institute within our KU-MRI Alliance for two reasons: MRI's own expertise in science and their expertise in dealing with a broad range of federal projects.

We sponsored a "bio-defense" work-shop under the KU-MRI alliance. The 40 invited participants spent a day discussing our "in-house" areas of expertise and their possible matches to national interests. The principal topics that emerged were vaccines, biosensors and public health. This is a continuing effort and a second workshop will be held this fall.



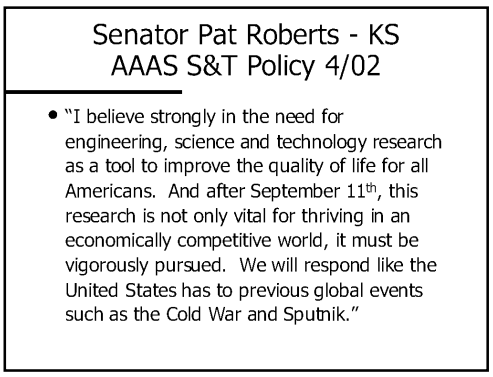


I conclude with two quotations from our own Senator Pat Roberts. The first is from his invited address at last fall's annual meeting of NASULGC, the National Association of State Universities and Land Grant Colleges.

The Senator spoke about post 9-11 and university research, finishing up with this statement:

"A renewed commitment today to our institutions of higher education and especially to science, engineering and technology research is a commitment to our nation's future."

Senator Roberts was invited to address the AAAS, the American Association for the Advancement of Science, at its Science and Technology Policy Colloquium in April, 2002. Let me conclude my remarks by quoting the Senator's words on that gala occasion:



"I believe strongly in the need for engineering, science and technology research as a tool to improve the quality of life for all Americans. And after September 11th, this research is not only vital for thriving in an economically competitive world, it must be vigorously pursued. We will respond like the United States has to previous global events such as the Cold War and Sputnik."

WAR IS GOD'S WAY OF TEACHING GIS

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When people recall the morning of September 11, 2001, most speak of horror, sadness, and shock. My own vivid recollection is of horror and sadness, but not shock. Instead, I felt a sickening realization that the inevitable had finally happened, and I was surprised only by the method. Since 1997, my colleagues and I at Oak Ridge National Laboratory (ORNL) had been helping the United States Government and international organizations anticipate and prepare for threats potentially involving far greater numbers of victims than those that actually occurred that morning in New York, Pennsylvania, and Washington, D.C. I left ORNL for my current position at the University of Kansas (KU) less than one month before the 9-11 attacks, and global threats were still on my mind. The topic scheduled for my graduate seminar that very day was "estimating populations at risk."

Global Coverage

The "New World Order" has come to mean "global threats to local places." Terrorism and regional conflicts have joined natural disasters and technological accidents as ubiquitous threats that can strike anywhere on earth and yet impact areas as small as a neighborhood, city block, or single building. Population estimates are essential for mission planning to determine how many emergency personnel to send, how much temporary shelter to provide, and what quantities of emergency supplies are needed. An over-estimate costs resources, but under-estimates cause unnecessary suffering and may cost lives. Geographic analysis, increasingly based on modern geographic information systems (GIS) and satellite remote sensing, is essential to improving such estimates.

Funded by the U. S. Department of Defense (DoD), the LandScan team I headed at ORNL was responsible for developing a global population database at a spatial resolution fine enough to identify populations actually or potentially impacted by all sorts of global threats to local places. The LandScan Global Population Database was demonstrated for a single country in 1997, completed for the whole world for calendar year 1998, and updated for 2000 and 2001 (Dobson et al., 2000; forthcoming 2003). By the time I left ORNL, the database had been adopted by DoD, the U.S. Department of State, the United Kingdom's Ministry of Defense, several agencies of the United Nations – the World Health Organization, Food and Agriculture Organization, High Commission on Refugees, and ReliefWeb – and other national and international organizations as

a *de facto* world standard for estimating populations at risk from terrorism, technological accidents, regional conflicts, and natural disasters. Actual applications included the accidental release of radiation from a nuclear power plant in Japan and the horrendous flooding of Mozambique in Spring 2000. Hypothetical scenarios ranged from biological agents wafting across a few city blocks to nuclear exchanges affecting whole regions.

The spatial resolution of the global LandScan database is 30 arc seconds of latitude by 30 arc seconds of longitude. That equals about 1 square kilometer per cell at the equator and grows finer toward the poles. The previous world standard for estimating populations at risk was 20 arc minutes of latitude by 30 arc minutes of longitude, or 2,400 square kilometers per cell at the equator. LandScan thus represents a quantum leap in precision, made possible by a remarkable jump in the public availability of global databases in the late 1990's and recent advances in geographic information systems (GIS). Modern GIS technologies would have been powerless, however, without traditional geographic analysis techniques. Best available aggregate census counts, provided by the International Programs Center of the U. S. Bureau of the Census, were distributed to LandScan cells through dasymetric interpolation, a cartographic modeling technique invented by John K. Wright of the American Geographical Society more than 65 years ago (Wright 1936).

LandScan provides a 24-hour ambient population estimate, undistinguished by nighttime, daytime, seasonal, or other mobility factors. As with any population database, it can serve a vast number of applications, and most of them do not involve threats. A telecommunications company, for instance, acquired LandScan to determine optimal locations for cell phone towers. Its popularity for emergency management and humanitarian response derives from the fact that its database structure and spatial resolution were designed specifically to suit key software programs used by the U.S. military to project air plumes associated with chemical, biological, and nuclear releases. The LandScan project, now under E. A. Bright's leadership, continues to provide global population data for free online.
LandScan2000 is online at: http://sedac.ciesin.columbia.edu/plue/gpw/landscan
LandScan2001 is at: http://www.ornl.gov

City Block Resolution in the U.S.

Even finer resolutions are needed for many types of disasters. To illustrate, simply recall how desperate New York City's first responders were to know how many people likely were in the World Trade Center that fateful morning. No reliable estimate was available, however, because the U.S. Census, like most official censuses around the world, counts people where they sleep, not where they work. Months before my departure from ORNL, we proposed LandScanUSA with daytime and nighttime population estimates at 3 arc seconds, or 100 times more precise than the global LandScan database

(Dobson et al., forthcoming 2003). We chose Houston, Texas, and 29 surrounding counties in Texas and Louisiana as our initial study area. There we demonstrated that such fine resolution is possible for the U.S. due to its established collection of high-resolution spatial databases. Through dasymetric interpolation we disaggregated block-level Census 2000 populations (by age and sex characteristics) to LandScanUSA cells. That is equivalent to having the finest city block resolution for the entire countryside. In this particular study area, less than 0.1 per cent of city blocks are smaller than 3 arc seconds by 3 arc seconds, and most are substantially larger. Indeed, 89 per cent of the land area exists in blocks even larger than the global LandScan cells (30 arc seconds by 30 arc seconds). Daytime populations are estimated by adjusting for block-to-block worker flows, placing school-age children in elementary and high schools, keeping prisoners in prison, modeling traffic flows on streets and highways, estimating the number of "shoppers" in commercial areas, and retaining the rest in their census residences.

In retrospect, of course, we wish we had chosen New York for our demonstration. Instead, on September 11 emergency managers had no choice but to reject the (nighttime) census block count (55 people in the large block containing the World Trade Center) and make educated guesses that turned out to be 2 to 4 times greater, respectively, than the actual number of people at risk and the actual number of deaths. Since then, ORNL has received funding to develop LandScanUSA for many of the nation's larger cities.

City Block Resolution Worldwide

From its beginning, the LandScan project faced ever-increasing pressures from many quarters to make the database finer not just for the United States but for any place on earth. Our LandScan experience convinces us that it's technically feasible to generate a global population database at 15 arc seconds by 15 arc seconds resolution, based on currently available global databases, but no agency has yet funded the effort. Partly, that's because potential sponsors believe the resolution needs to be even finer, more like the city block resolution of LandScanUSA. Hence, no global capability currently exists to estimate populations in buildings, city blocks, or neighborhoods smaller than 30 arc seconds by 30 arc seconds. Presently, I foresee no imminent breakthrough in data availability that will support such spatial resolution worldwide, and daytime versus nighttime mobility factors are out of the question in all but a few advanced nations. Yet, national and international organizations, especially the United Nations (UN), often must conduct humanitarian missions anywhere in the world in response to such local incidents.

Faced with overwhelming need and the impossibility of producing a suitable global database, I concluded the only hope was to develop a technique that could be employed in real-time once the location and extent of any given disaster or potential disaster was known. I decomposed the problem into two

parts: 1) estimating how many people typically occupy each type of building by day or night and 2) measuring how much floor space is available for occupation. That second component – measuring floor space through field observation, map analysis, or image analysis – is the labor-intensive part that prohibits worldwide application. It's best done for specific locations where the disaster or potential disaster is known, and the need is clear and compelling. The first part, however, must be done with forethought for large world regions, and that is the part we tackled.

Our approach is based on field observation in each world region to determine typical floor plans of 35 or more functional building types (single family dwelling, hut, shanty, store, kiosk, restaurant, hospital, etc.). For each general building type, field observations are made to determine typical numbers of occupants at full capacity. Ultimately, the enclosed area is divided by the number of occupants to create a coefficient that can be applied per square meter of space. Coefficients are distinguished by day and night, but not by precise hour of the day. Coefficients for certain episodic events, such as church services, are estimated as well. The resulting coefficients apply to any local area within each general region. Once the precise location of a disaster is known, the building sizes and types can be determined through remote sensing aided by *in situ* observations conducted by the responsible agencies. A population estimate can then be derived by multiplying the building area times the number of floors times the appropriate coefficient for that building type for day vs. night or episodic event. The resulting data and associated improvements in population estimation procedures will greatly improve national and international capabilities to estimate casualties and assess damage for disaster areas of all types and for refugees in transit or in camps.

In 1999, A. L. King and I demonstrated the efficacy of this new technique for test areas in the U. S. In 2000, R. W. Peplies and I implemented the technique in the Horn of Africa, and in 2001 we implemented it for Northwestern South America. Current funding will extend coverage to the Balkans, Middle East, and Far East over the coming year.

Our approach is a revival and enhancement of methods used by settlement geographers principally from about 1920 to 1970. During that era, diverse geographical studies were made of building forms, types, and styles. Albert Demangeon (1872-1940) examined vernacular dwelling designs, sometimes including detailed floor plans. Fred Kniffen (1901-1993) focused on characteristic folk styles of housing, barns, fences, and outbuildings. Kirk Stone (1914-1997) focused on the spatial organization of settlements. Of these three leading experts, Demangeon's observations of building designs came closest to the type of observation adopted here. His purpose was different, however, and he did not measure the area of enclosed spaces and calculate population densities.

R. W. Peplies and I view this application as a new call for settlement geography of a type that all but disappeared in the last quarter of the previous century. Throughout the previous era of settlement studies, there was a conspicuous emphasis on the developed world. Hardly any extant studies focus on less developed nations. We hope to extend our enhanced approach to the entire world.

Geography in the War on Terrorism

Comedian Paul Rodriquez once said, "War is God's way of teaching geography." No truer words have ever been spoken. He meant place name geography, no doubt, but the same principle applies to geography as a science, as a professional field of research and analysis, and now as GIS. During World War I, the American Geographical Society (AGS) ran "the Inquiry" – a multi-disciplinary information gathering, scientific integration, geographic analysis, and foreign policy venture commissioned personally by President Woodrow Wilson. During World War II, *one-third* of all academic geographers moved to Washington, D.C. to work in the Office of Strategic Services (OSS) and other federal agencies. Today, geographers and GIS analysts are contributing mightily to the war against terrorism.

The LandScan Global Population Database has been acknowledged as an important foundation to many counter-terrorism and humanitarian response efforts. That, in turn, has opened avenues for me to witness several modern day heroes of geography in action. The newness of my move from ORNL to KU, coupled with my election as President of the American Geographical Society (AGS) in February 2002, gave me a unique vantage – half observer, half participant – on subsequent events (Dobson 2002). I'd like to share some of those observations with you:

When the attacks came, Executive Director Mary Lynne Bird and the AGS staff were in our headquarters at 120 Wall Street. They remained until the order came to evacuate. At midday, they were instructed simply to "start walking north." Officers, Councilors, Fellows, and friends waited anxiously for word that all had arrived home safely. Not until they were allowed to return to the office several days later, could they and we rest assured the facility itself was unharmed.

· In October, I gave a lecture, scheduled long before 9-11, at the Centers for Disease Control in Atlanta, where LandScan was being considered as a boon to epidemiology. Within days, my host Jerry Curtis was called to Washington to help in the Anthrax investigation at the Brentwood Postal Facility. For about three weeks, we communicated frequently, and I witnessed from afar as he struggled with and overcame the technical and institutional difficulties of conducting an extremely fine resolution GIS analysis inside the facility.

On November 11, my family and I visited Ground Zero in New York City while most of the debris was still in place. The next day, I visited the temporary Emergency Operations Center on Pier 92 to see the Geographic Information Systems (GIS) facility that had been hastily assembled on September 11 by Sean Ahearn and 50 or more heroic geographers and GIS analysts. By coincidence, I was there when American Airlines #587 crashed on Long Island. I watched firemen and policemen urgently request maps and images of Belle Harbor, Long Island, and I watched Chris Schielein and others satisfy those demands in less than 30 minutes. All bridges, tunnels, and airports were closed for most of the day, but my wife and I flew out on one of the first jets to leave JFK Airport that evening.

Throughout the year I was called by various federal and international agencies to comment on the quality of LandScan data in various countries around the world. That kept me in contact with people who are working to monitor the refugee crisis in Southcentral Asia and, notably, with Chris Auricht of the UN Food and Agriculture Organization, who used LandScan to help plan the seed supply for the spring planting in Afghanistan.

Throughout the year, I encountered several federal agencies and private corporations struggling with internal GIS development. In each case, some in-house geographer or GIS analyst sacrificed his or her own interests to force revolutionary changes on a stodgy bureaucracy. Those heroes must remain unnamed.

University Strategies in a Time of National and Global Emergency

GIS is increasingly demanded in funded research projects. Of all National Science Foundation awards granted last year, for instance, $140,000,000 went to projects involving GIS in one way or another. To understand the current boom in academic research opportunities, it helps to understand what is happening commercially. The world market for GIS has grown rapidly and continuously since the technology first appeared two decades ago. In 2000, global revenue hit $6.9 billion, and an estimated 2,000,000 users operated 500,000 systems worldwide. Annual growth rates for software (15-20%) and services (10-15%) were impressive, and the current national crisis increases demands for homeland and national security, even at this time of economic recession. According to Daratech, a leading market survey company, current market trends are topped by expansion into “new disciplines, industries, markets, and applications.” Identical trends are evident in academe.

Universities clearly have a vital role to play in post 9-11 recovery and prevention of future catastrophes, especially in terms of geographic research and education. Geography, GIS, and remote sensing will be essential to the analysis

and prediction of global threats to local places. Ultimately, GIS is essential to a wide variety of local, state, and federal applications including homeland and national security, emergency management, resource and environmental management, energy development, hazardous waste management, policy analysis, and improved understanding of global threats to local places.

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ANIMAL HEALTH RESEARCH AT A TIME OF NATIONAL SECURITY: THEN WHAT?

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Introduction

The biological relationship between animals and humans has never been more intertwined. The persistent outbreaks of diseases such as *Escherichia coli* O157:H7, the malicious spreading of anthrax spores, the emergence of West Nile Virus, and the economic impact of non-zoonotic diseases such as Foot and Mouth Disease, have gripped the attention and, in a peculiar way, the lure of the general public and scientific community (Table 1). These events, coupled with the plethora of other animal diseases that range from cancer to mastitis, have triggered introspection of animal health as it relates to human health, national security, and the national economy. Clearly, there are a number of medical diseases of animals, both infectious and non-infectious, that are vital to: 1) the basic understanding of disease processes that overlap in human and veterinary medicine; 2) the general health and well-being of animals (and potentially humans); and 3) the national economy and bioterrorism. In addition, veterinarians, physicians and scientists have long been aware of the many nearly identical similarities between diseases and conditions of animals to those of humans. However, animal health issues have been strongly tied with issues of agriculture such as soil science, plant health, food stamps, farm management, waste disposal, etc. This tie, in certain ways, has obscured the view of veterinary medicine and animal health as a close correlate to human medicine and health. Is it time for aspects of veterinary medicine and animal health to be viewed, side-by-side, with human medicine and health?

Table 1. Selected zoonotic (passed from animals to humans) diseases with potential for human outbreaks and biosecurity risk and selected non-zoonotic diseases (diseases not passed to humans) of potential economic importance.

Zoonotic diseases:
anthrax, *Yersinia pestis* (bubonic plague) , *Francisella tularensis* (tularemia), brucellosis, leptospirosis, rabies, tuberculosis, Nipahvirus, Hendravirus, Chlamydia, bovine spongioform encephalopathy (BSE; Mad cow), food and water-borne diseases: *E. coli* O157:H7, west nile virus, VEE, EEE, WEE, Giardia, Salmonella; viral hemorrhage fevers: Marburg, hantavirus.

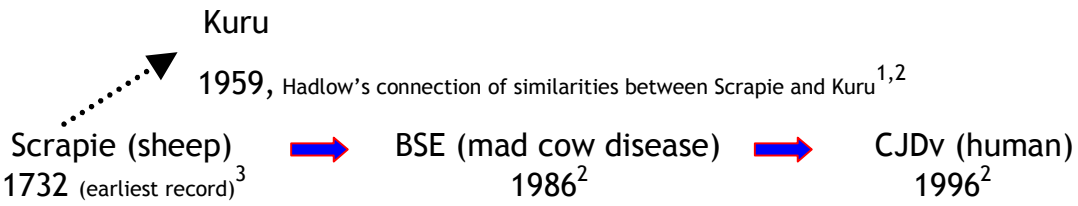
Non-zoonotic diseases:
Foot and Mouth disease (FMD)*, African swine fever, Vesicular exanthema, vesicular stomatitis, *Mycoplasma mycoides* (contagious pleuropneumonia), rinderpest, classical swine fever (Hog Cholera).

*Can infect humans on rare occasions

Overlaps in Human and Veterinary Medicine

Some diseases of veterinary importance have been scarcely known in previous times, but their importance has skyrocketed due to outbreaks and/or newly discovered attributes that are now recognized in diseases of humans. Scrapie, for example, was a little known disease entity of sheep and considered an oddity nearly 50 years ago until Dr. William Hadlow, a veterinary pathologist, linked similar aspects of Scrapie in sheep with those of Kuru in humans.[1-3] Today, it is becoming increasingly clear that the Scrapie disease agent has important similarities to bovine spongioform encephalopathy (BSE; a.k.a., Mad Cow disease) in cattle which, in turn, is linked by some investigators to the emergence of a new and deadly variant of Creutzfeld-Jacob Disease in humans (Fig. 1).[2] Similarly, *E. coli* O157:H7 and strains with similar attributes were first detected in animals and considered relatively unimportant in animals, but have since risen in prominence as important food pathogens that can cause diarrhea, anemia, and life-threatening renal disease in children and susceptible adults.[4,5] These are but two examples of the types of animal diseases that were once considered incidental diseases with no relation to human health but now highlight and underscore the blending of animal and human disease.

Figure 1. A little known disease of sheep becomes well known in human medicine. The similarities of Scrapie in sheep with Kuru in humans were first suggested by William Hadlow. Thereafter, cattle fed sheep tissues developed bovine spongioform encephalopathy (BSE) and a new variant of Creutzfelt-Jacob disease was identified in humans.



General Health and Well-Being of Animals (and potentially humans)

Other animal health issues seemingly have, at this time, no connection with human health and biosecurity; however, they are important to the general health and well being of animals because of the suffering they inflict and the economic loss they impose on producers. For example, pneumonia, certain forms of diarrhea, and mastitis cost billions in production loss each year, not to mention the animal suffering that they invoke. Research on such diseases could be eliminated if money is shifted to bioterrorism, biosecurity, and food safety. Unfortunately, loss of research activity in these diseases is shortsighted and somewhat risky because some could become even more widespread problems in animals, and some, like Scrapie and *E. coli* O157:H7, could eventually contribute to human disease.

A better understanding of some of these diseases may also provide a fuller appreciation of the pathogenesis of human disease. Respiratory syncytial virus of cattle and sheep, for example, are very similar to their human counterpart and make excellent animal models. Spontaneous non-infectious and aging diseases of dogs (osteosarcoma, prostatic cancer, hemangiosarcoma, hyperlipidemia), cats (type II diabetes mellitus, lymphoma), non-human primates, and other species are numerous and have many potential similarities to their counterparts in humans. In fact, cancer in domestic animals may prove to parallel the incident of cancer in humans in some instances. However, many such diseases remain under-investigated.

In addition, xenotransplantation of organs from pigs to humans will require close scrutiny of several viruses of pigs (such as the porcine retrovirus, circovirus, and hepatitis E virus) for their potential to replicate in human recipients. Wildlife diseases such as chronic wasting disease of deer and elk, tuberculosis of deer, and brucellosis of elk and bison, are spreading and all have human health implications. Rodents and other animals used for research, and racing animals used for entertainment also have their own set of diseases and conditions that may affect human health. Who, for example, wants data from laboratory rats or mice that spontaneously grow tumors or carry an infectious agent? In short, a variety of diseases that appear to be only of veterinary importance today have potential in fitting in the mission of the United States Department of Health and Human Services (DHHS), because investigative research of these diseases may: 1) increase understanding of the comparative aspects of disease pathogenesis, and 2) lead to prevention or therapeutic strategies against diseases and conditions of humans in the future.

National Economy and Bioterrorism

Bioterrorism can result in death, inflict immense human suffering, and/or greatly alter the national economy. Recent bioterrorism threats coupled with food safety and security issues have greatly influenced research priorities. Simultaneously, Americans seem less and less worried about having a plentiful supply of food from animals, because meat and dairy production in the United States generally meet demand and food is relatively inexpensive. Such changes in priorities, coupled with limitations in USDA funding of animal health issues, may result in subtle, but continual shifts away from research activity on animal diseases with no immediate threat listed above (pneumonia, diarrhea, etc.). What would be lost may include insight of the comparative features of animal disease as they relate to similar human diseases. In addition, it would erode information on animal diseases that are currently unforeseen threats to human health in the future.

The National Institute of Animal Health (NIAH)

Although it will likely never happen, aspects of animal health research could be more closely aligned with human diseases as an institute within the National Institutes of Health (NIH). The NIH already houses institutes for nursing, mental health, dental health and has numerous specialized centers for many diseases and conditions of humans. An agency with a mission and focus on animal health could be named the National Institute of Animal Health (NIAH) and exist along with the National Institute of Allergy and Infectious Diseases (NIAID), the National Heart, Lung, and Blood Institute (NHLBI), and other Institutes and Centers. Potentially, the NIAH could strike a balance in the funding and resources that would be allocated to outbreaks and crisis issues and those areas that are not an immediate threat to humans, but require a long-term appropriation. If expanded, the NIAH could also serve under-represented areas such as wildlife and aquaculture and perhaps have a regulatory role to oversee care and use of animals used for research.

Divisions of the NIAH

What would the NIAH look like? It could house six divisions that are primarily focused on extramural research funding and a few divisions with regulatory activity (Table 2). A first division could emphasize the interaction of animal health on human health. This would include supporting the development of animal models of human disease, pathogens of bioterrorism, and the maintenance of healthy animals for research. The second could emphasize animal health research simply for animal health, with an emphasis on food-producing animals and aquaculture. The third could include animal diseases to be kept out of the United States, both zoonotic and non-zoonotic, and also include emerging animal diseases throughout the world. The fourth could be for wildlife and environmental habitat, particularly for the control of existing wildlife infectious diseases with potential human health concerns, and eventually, the

Table 2. Divisions of The National Institute of Animal Health (NIAH), a proposed new institute in the National Institutes of Health (NIH).

Division 1:	Zoonotic disease, food safety, bioterrorism, animal models of human disease, regulatory manners of mice, rats, non-human primates.
Division 2:	Diseases of food animals. Cattle, sheep, swine, poultry, aquaculture.
Division 3:	Foreign animal diseases of national security/emerging diseases of animals.
Division 4:	Wildlife diseases and environmental habitat.
Division 5:	Racing animals (horses, dogs), domesticated pets (dogs, cats, horse), animal shelters, the health benefits of human-animal bonds.
Division 6:	Training programs for animal health care specialists.

elimination of such diseases. The fifth could emphasize disease and safety for racing animals and domestic pets, operation of animal shelters, and the psychological benefits of the human-animal "bond." The sixth and last division could emphasize training programs for animal health specialists. All NIH-funded projects have requirements for adequate animal care; therefore, the continual training of such experts is vital.

Food Safety, Animal Nutrition, Environment, and Aquatic Life

At least two areas may not fit within such an institute or would require overlap with agriculture: food safety and animal nutrition. It may be reasonable that pre-harvest (pre-slaughter) food safety issues could be funded under the NIAH and post-harvest (post-slaughter) issues could remain under the USDA. For nutrition, perhaps animal nutrition studies for animals would remain in the USDA. In addition, there may be overlap with environmental agencies concerned with animal waste issues and the effects of water pollution on aquaculture and marine life. Fresh-water and marine life are often important sentinels for environmental pollution and disease outbreaks or accumulations of toxins within fish and other aquatic life can be critical indicators of environmental pollution. Details in deciphering these issues would be, admittedly, numerous.

Summary

Many microbiological agents that infect animals as well as many other aging and metabolic diseases of animals are often similar to correlates of diseases in humans. In the past, veterinary medicine and animal health have been aligned closely with agriculture and this structure may maintain a subtle barrier for appreciating the similarities of animal and human diseases and conditions. Although some animal diseases and conditions may not have a direct connection with human disease and health, many of these cause great suffering in animals and, in addition, historical events have repeatedly demonstrated that very obscure diseases of animals can eventually affect human health in a direct manner. Therefore, maintaining and even expanding research on animal diseases and conditions is prudent for human health, and it is economically savvy. Aligning aspects of veterinary medicine and animal health with the mission of the Department of Health and Human Services (DHHS) and the National Institutes of Health (NIH), may be beneficial in revealing subtle connections to human disease processes. Identification of such connections may enhance disease prevention and treatment in both animals and humans.

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REGIONAL AND UNIVERSITY ROLE IN BIOTERRORISM PREPAREDNESS

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Thank you for inviting me to make this presentation. I am currently a Professor in the Department of Pathology and Microbiology at the University of Nebraska Medical Center (UNMC). In addition, I have a second position as Director of the Nebraska Public Health Laboratory (NPHL). Our relationship with the Nebraska Health and Human Services systems enables diagnostic procedures to be performed under a contractual relationship with the State of Nebraska. This system is unique in that NPHL is fully integrated into the University and its clinical partner.

I would like to modify my presentation in response to previous talks and address the regional and university role in biocrime or biosecurity preparedness. I agree with our earlier speaker that we must transition from shock and fear associated with anthrax and the bombing, and develop an appropriate effort to prevent these occurrences in the future.

While some aspects of the NPHL at UNMC are unique, we share many features in common with academic medical centers in the Midwest. For example, we are a bone marrow and solid organ transplantation facility. We operate a radiation health center that provides emergency services to the nuclear power plant facilities in our region. We also maintain and operate high-risk isolation facilities for patients who have been exposed to highly infectious agents such as those on the select agent list. These are functions that exist at other university medical centers. Because we have a common base of experience and significant capabilities, our regional medical centers and land grant universities could come together and develop an interactive program that benefits our country and our region. The challenges faced by our nation are the same challenges that universities in our region are fully prepared to undertake.

Many of the pathogens we face are capable of causing disease in both humans and animals. In addition, a threat to water quality is a threat to both the medical community and the agricultural community and, of course, a threat to crop production and food production is a threat to all living things. An adequate response to these types of threats requires a high degree of interaction between experts at all levels whether they deal with water, food crop production, veterinary sciences, basic research or medical treatment of humans. The universities represented here are well positioned to interact and develop a unified approach to these challenges.

Our challenges can be summarized under four topic areas: genetics, immunology, novel therapeutics, and diagnostic modalities. These topics are typical for developmental or research programs at our institutions. In addition, we share common opportunities in new cutting-edge technologies, such as information exchange and data analysis, and we all have the responsibility to educate students and the public. My associates have recently developed and made use of microarray technology for the rapid application to infectious diseases. One of the most difficult challenges is that of rapid triaging – distinguishing the possible cause of disease and determining whether it is bacterial, viral or fungal in origin. By using microarray technology, the distinction can be rapidly determined. One of the new areas we are investigating is the interaction and collaboration between researchers involved in diagnostic test development and those involved in large-scale test automation. There are a number of opportunities for applying molecular technology to organism identification using automated procedures. One specific application might be the use of multiplex PCR for the detection of enterohemorrhagic *E. coli* associated genes in various patient materials as well as foods. The automated technology is necessary to reduce the cost so that it approximates standard culture technologies. Although we may never be able to completely approximate culture technique costs, molecular approaches offer another benefit – rapid availability of results.

A cooperative program between our regional medical schools, veterinary schools, and agricultural colleges would be a highly effective approach for utilizing animal models for the study of vaccine efficacy as well as identification of virulence factors within organisms on the select agent list. Through the development of a regional consortium, it might be possible to rapidly investigate and determine the pathogenesis of various diseases and develop appropriate vaccines. Beyond this, a cooperative regional approach is needed to take advantage of new developments in information technology. The Centers for Disease Control and Prevention (CDC) has done the nation a great service by developing standards for exchange of electronic information. All of us have a credit card that can be used in any number of stores or restaurants, but I challenge you to pull out of your wallet a medical information card that can instantly download your relevant medical records. The reason a card does not exist is largely due to the lack of standards allowing it to be used and produced. Through the development of standards and the creation of a National Electronic Disease Surveillance System (NEDSS), the CDC is working to address this problem. We must be prepared to take advantage of the opportunity it presents.

While much has been said about the disease monitoring capabilities possible through syndromic surveillance programs, I also think they represent a significant problem that will result in less functionality than expected. Syndromic surveillance commonly refers to the detection of a pattern of diseases from patients appearing in emergency rooms or doctors' offices. Since much of this

information is required to be anonymous, it will be difficult to determine what level of investigation should be prompted by an upturn in certain disease types, and what those active interventions should or could be. However, our universities already have the expertise and capability to develop algorithms and mathematical models for determining the efficacy and usability of this information. Therefore, we must leverage our resources and make them available for addressing the problem of disease surveillance. Information technology is not the only resource our universities have available; we also have highly capable statewide information services at our county extension offices as well as area health education centers for the training of medical students and residents. Education is our number one job. We should educate the public by using the skills and capabilities we have developed to address problems on the farm or ranch, and in medical practice.

We all recognize the many challenges raised by the threat of bioterrorism. The Heartland of America has its own regional concerns and challenges, and politics is a reality here as well. On the other hand, many of the traditional obstacles and political problems encountered in large metropolitan areas of the country may not be obstacles to a Midwestern research consortium on biosecurity. I'll leave this issue, however, to those experts in the university chancellors' offices and to our distinguished visitors here. I do believe a cooperative strategy would be highly competitive with other programs put forward by the large private research universities on the east or west coast.

In closing, I would like to thank Mr. Keith Yehle for his comments and suggestions regarding delivery of anthrax-contaminated mail to the Senate Hart office building. Thank you, Dr. Mabel Rice, for the opportunity to attend this meeting and give this presentation.

FOOD SAFETY RESEARCH AT A TIME OF NATIONAL EMERGENCY

Curtis L. Kastner
Director, Food Science Institute
Kansas State University

Introduction

My objective is to summarize food safety research at Kansas State University and to relate how that research addresses agricultural biosecurity challenges in the nation.

Particularly since September 11, 2001, it is imperative to develop strategies of preparedness. It is obvious that terrorists are motivated and they have been effective in achieving their goals. The logical response strategies include being prepared to: prevent terrorism if possible, and respond in a systematic way to minimize the impact. The attacks caused immediate loss of life, and also set off a cascade of events with long-term implications that are psychological, social, environmental, economic, and public health related. The challenge is to be prepared and to minimize the consequences of terrorism.

The U.S. food production and processing industries are as vulnerable as any target and must be protected. Even though attacks on the food supply might be less likely to result in immediate loss of life when compared to direct attacks, the outcomes are similar. Disruption of the food supply and loss of consumer confidence would have devastating impacts on public health, social order, and domestic and international markets. Terrorists have identified the U.S. food supply as a viable, vulnerable target. Therefore, attacks on the food supply must be prevented if possible, or systematically addressed to minimize the impact.

Protecting America's food supply and associated agricultural infrastructure from deliberate acts of bioterrorism is of paramount importance to the U.S. and world economies. America's agribusiness sector routinely provides more than $1 trillion annually to the U.S. economy, nearly 15% of the Gross Domestic Product. Assault on this sector of the economy could be catastrophic.

The recent Foot and Mouth Disease (FMD) outbreak in Great Britain illustrates the potential economic costs of an attack on America's food crop, food animal, or food processing industry. The losses in Great Britain have been calculated at $25 billion and have crippled a once-robust industry. Along with Bovine Spongiform Encephalopathy (BSE), it has virtually destroyed British consumer confidence in the safety of red meat and in their government's

oversight capabilities. While BSE has not yet occurred in the U.S., it is of great concern.

With concentrated and intensive production practices that help feed the world, the cost of a successful bioterrorist attack would certainly dwarf Great Britain's economic devastation. In addition to a compromised U.S. economy, the shockwaves of a significant attack would certainly have global implications. Immediate losses in the tens of billions of dollars could be counted in days or hours, as trade sanctions and embargos would quickly follow. Loss of consumer confidence and compromised public health would ravage an already shaky economy.

Food safety research is not new. Processes such as canning of meats, pasteurization of milk, and irradiation of pork have already been researched and brought to application for the purpose of addressing food safety issues. Food safety research efforts continue to capitalize on those historical as well as new technologies, and apply them in unique ways to address today's food safety challenges. Incidents such as the 1993 Jack-in-the Box E coli 0157:H7 outbreak intensified the focus on food safety. Until the events of September 2001, research did not emphasize the potential for intentionally caused food safety incidents. Even though we have examples of this problem, the focus has been on incidental food safety challenges. Nonetheless the strategies used to address incidental food safety events are transferable to intentionally caused events.

Meat Safety Research

Meat safety research at Kansas State University is an excellent model for using food safety strategies to address national biosecurity challenges.

The best way to achieve food safety is by working with the continuum of meat production from farm to fork as a total system. The approach is to make, for example, incremental pathogen reductions from the live animal level all the way to the carcass and then to the individual meat cut that goes to the consumer. For example, strategies to reduce pathogens in drinking water at the feedlot, steam pasteurization of carcasses, and precooking of the individual meat item all contribute to the ultimate safety of the product. Incremental pathogen bio-load reduction along the continuum of production and processing results in a safe product. That same strategy can be used to address events whether incidental or intentional. The points at which hazards can be reduced pre- as well as post-harvest, and the technologies to eliminate hazards are the same whether incidentally or intentionally introduced.

Pre-harvest food safety practices that reduce hazardous exposures to the animal include treatment of water and feed to reduce exposure to pathogenic bacteria. Physical protection and treatment of those feedlot consumables will also be required in a biosecurity system that addresses bioterrorism threats.

Those reductions can then be coupled with carcass steam pasteurization and chemical treatments plus treatment of the end product by using, for example, post-process steam pasteurization. Those and other strategies can be used to address bioterrorism issues.

Another strategy involves combining more than one intervention in the food processing chain. A good example is the use of steam pasteurization of beef carcasses followed by post-process, in-package steam pasteurization. Steam pasteurization of beef carcasses greatly reduces pathogen contamination on the surface of the carcass. However, upon subsequently handling, some pathogens could be reintroduced. Therefore, additional control of pathogens is required. The post-process, in-package steam pasteurization intervention technology eliminates pathogens on the surface of ready-to-eat (RTE) meat products. The steam-based, post-process pasteurization system is effective in reducing pathogen populations on the surfaces of frankfurters and can be used in the manufacture of frankfurters and similar RTE meat products. The process does not result in significant deterioration in quality due to secondary heat exposure of the RTE meat surfaces and could improve the shelf life of these products. The effectiveness of the system could be improved by incorporating bacteriostatic agents (i.e. lactic acid) either as a topical application or as an ingredient in the RTE meat formulations to reduce the risk or recovery of the sub-lethally injured organisms during subsequent refrigerated storage during commercial distribution and by the consumers at home. By combining intervention strategies, food safety is enhanced and the process addresses pathogen contamination regardless of where or how it is introduced.

Summary and Conclusions

Terrorism can take a variety of forms, including attacks on our agricultural and food systems. Attacks on the food supply would likely be less dramatic as compared to a nuclear attack. However, the impact on consumer confidence, export markets, food cost, and the economy would be significant. Some terrorists are willing to sacrifice their lives and take human life; more may be willing to perform acts that do not take their lives and primarily impact our economic infrastructure. Some hazards impact only the animal or crop whereas others impact humans as well. To completely prevent terrorist attacks is impossible. Therefore, the strategy is to be prepared so that the impact is minimized. Food safety research has generated strategies that can significantly help minimize the impact of terrorism. Whether a hazard is incidentally or intentionally introduced, we have interventions that can be used to eliminate hazards. In the face of terrorism we must couple what we already know with strategies specifically focused on terrorism. For example, physical protection and intervention strategies used by the military can be combined with our food safety know how.

Fortunately, food safety research has provided information and technologies we need to address our national bioterrorism emergency. With the

legislative approval of the new biosafety research facility at Kansas State University and our designation as the National Agricultural Biosecurity Center, we will be better equipped to address each aspect of bioterrorism that includes crops, animals and food from those sources.

FEMTOSECOND LIBS AND SECOND HARMONIC GENERATION TECHNIQUES FOR DETECTION OF CHEMICAL AND BIOLOGICAL AGENTS

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The following scientific paper was presented at the Merrill conference by Prem Paul, Vice Chancellor for Research, as an example of the unique expertise available at the University of Nebraska – Lincoln. It was prepared by Dennis R. Alexander at the Center for Electro-Optics.

Introduction

Lasers generating ultrashort light pulses from about 5 to 100's of femtoseconds are now available to researchers for carrying out femtosecond laser induced breakdown spectroscopy. Recent technological advances in ultrafast technologies have resulted in the generation of light packets consisting of only a few cycles of the electric and magnetic fields. The spatial extension of these wave packets along the direction of propagation is limited to a few times the wavelength of the radiation (~ 0.5-1 μm in the visible and near-infrared spectral range). On the other hand, a 100 fs pulse has a packet length of 30 μm. When using diffraction limited parabolic mirror for focusing and moderate pulse energies of one microjoule, peak intensities at the focal spot of over 10^{15} W/cm^2 can be achieved. The corresponding amplitude of the electric field at these intensities approaches 10^9 V/cm^2. These field strengths are high enough to trigger optical field ionization. Hence, detachment of the first electron is completed at substantially higher field strength and the optical-field ionization rate becomes comparable to the laser field oscillation frequency. The released electrons gain unprecedented kinetic energies (up to and beyond the keV level) during the first field oscillation cycle following their detachment, and a substantial fraction of the ionization occurs during one cycle of light. In comparison, long pulsed laser systems containing many field oscillation cycles depletes the atomic ground state. The above linear and nonlinear processes result in very precise thresholds for plasma formation since femtosecond interactions produce their own source of free electrons to initiate the plasma formation process. Longer nanosecond pulses produce breakdown at less defined thresholds. This paper discusses some preliminary results into the use of femtosecond lasers for performing FLIBS and the second harmonic detection of chemical and biological warfare agents.

Experimental Facilities

The Center for Electro-Optics at the University of Nebraska - Lincoln has three femtosecond laser systems that can be used for FLIBS and second order harmonic generation. The first system is a Spectra Physics Millennium pumped Tsunami oscillator that is then amplified with an Applied Photonics Industries Nd:YLF laser. This system typically produces 100's of fs pulses at a center wavelength of 795 nm. The system is capable of producing 900 mJ pulses at a frequency that can be selected from 1 to 1000 Hz. The second laser system is a FemtoSource Compact manufactured by FemtoLasers, Viena, Austria. This system is capable of producing < 10 fs pulses. The laser operates at a wavelength centered at 795 nm and at a frequency of 75 MHz. The third femtosecond laser system is a Spectra Physics Millennium Pumped Spitfire system that is pumped with a Kapteyn-Murnane oscillator. This system produces < 35 fs pulses at a frequency of 1000 Hz with 700 mJ of pulse energy. Plasmas as well as second harmonic generation are produced by focusing the laser pulses on the material of interest using both lens and parabolic mirrors. Femtosecond produced plasmas and second order harmonic generation are collected on an Instruments SA Optical Multi-channel Analyzer (OMA). The detection device is a Princeton Instruments gated CCD array, Model ICCD-1-24MG-E, with a 6-phase array.

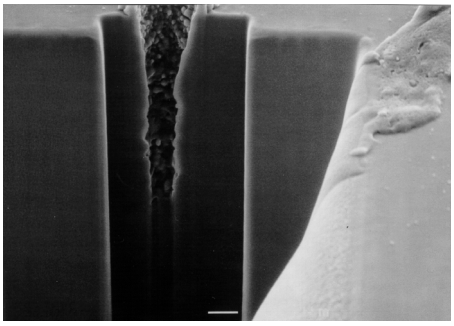
Results

In many LIBS applications for the detection of chemical and biological agents there is a need to limit the degree of damage to the material of interest. In addition there is a need to be able to detect these species at very low concentrations. Fig. 1 demonstrates the chemical detection of the chemical keratin in the human hair. The spot on the middle right appears distinctly blue and is the second order emission from the keratin molecule. The hair strand is being illuminated at 800 nm and the blue emission occurs at 400 nm.

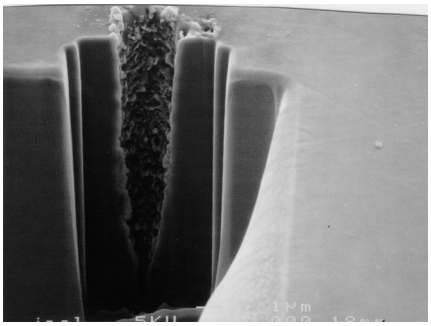
Fig. 1. Second harmonic generation blue emission (SHG) (λ = 400 nm) is visible in the image during femtosecond laser interaction (λ = 800 nm) on a human hair. A CCD camera captures the blue emission for demonstrating this capability to detect chemical agents

Because of the unique breakdown thresholds offered by the femtosecond laser, it is possible to produce very small damage sites. These damage sites can be as small as about 1 micron. Shown in Fig. 2 is a one micron hole drilled in a silicon wafer. In this application, FLIBS was used to investigate the penetration of a beam to various layers in the silicon chip. By monitoring the spectral components of the emission, it is possible to determine which layer in the chip one has reached. This has important applications in chip failure analysis.

One of the problems with using longer pulsed lasers is that they produce plasmas containing large continuum components. The usual mode of performing LIBS is to wait for these components to die out before the collection of the longer lived atomic emission lines. Fig. 3 compares the difference between femtosecond produced plasmas on an aluminum target and the nanosecond case. The advantage of the femtosecond spectrum is that the peaks emerge from the base line while in the nanosecond case the peaks appear on top of a broad continuum. Fig. 3 demonstrates the difference in the size of the damage region for nanosecond laser ablation as compared to that achieved for femtosecond ablation. Further information will be presented that relates the plasma formation and the damage to the unique way that plasmas are produced during femtosecond interactions. The advantages and disadvantages of using femtosecond LIBS will be presented in greater detail.



100 pulses, 44.2 nJ



1000 pulses, 44.2 nJ

Fig. 2 Femtosecond lasers allow less than the diffraction limit holes to be placed in materials. Another advantage is that high aspect ratio holes can be drilled in materials. The material in these images is an AMD silicon chip.

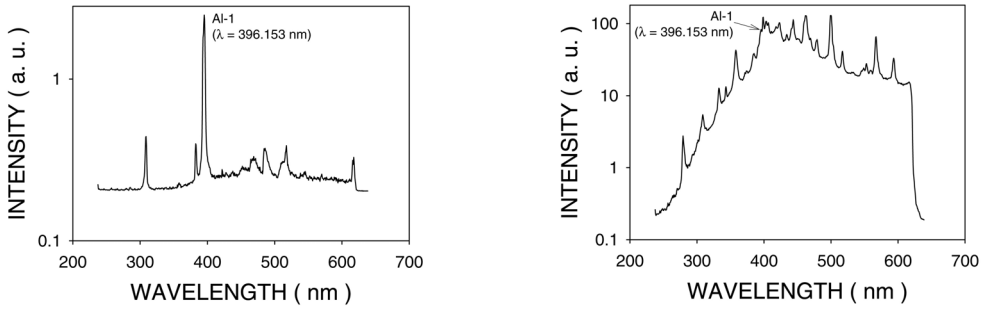


Fig. 3 Comparison of femtosecond produced plasma emission lines (left) or aluminum film and those obtained from a nanosecond formed plasma (right). The broad background emission is not present in the femtosecond case. This makes the detection of chemical and biological agents at low concentrations easier since the peaks come directly out of the baseline.

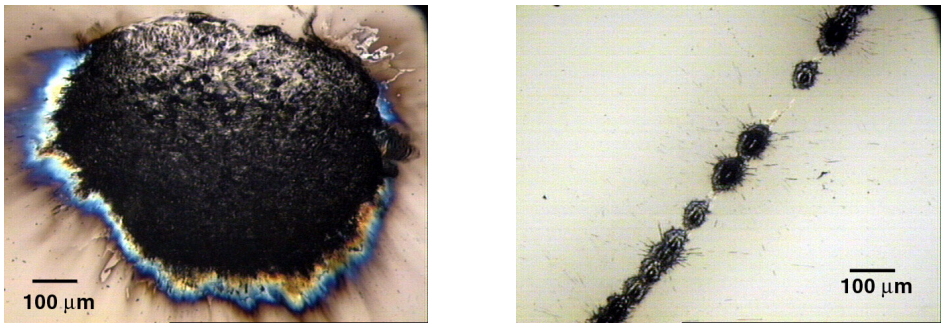


Fig. 4. These images show the difference between the size of the damage spot for the nanosecond (left) and femtosecond (right) of aluminum films

IMPACT OF SEPTEMBER 11th ON FUNDING PRIORITIES AND CAMPUS PROGRAMS

James R. Bloedel, Vice Provost for Research and
Advanced Studies and Dean of the Graduate College
Iowa State University of Science and Technology

The tragedy of September 11th has had a significant impact on the functions of American government and society. University operations are clearly being changed by legislation that was either passed or enforced after that date. Historically, the university has been loath to tolerate external regulations, particularly those suppressing freedom of interactions among faculty and students. New legislation not only affects our research and teaching, it carries requirements for implementation without necessarily providing the resources to accomplish the government's mandates. This circumstance occurs at a time when many public universities are experiencing significant cuts in financial support from their state legislatures. Nevertheless, the resolve of the government to implement new rules and regulations as soon as possible ensures that compliance will not be optional! Furthermore, the war against terrorism will not be short lived. Consequently, universities will have to develop strategies to cope with these new costs. We must determine the costs of new security mandates and biomaterials regulations and then acquire the additional funding necessary to implement them.

Rules, Regulations and Guidelines

In the state of Iowa, new regulations were initially specified by the National Guard in collaboration with and based on the guidelines of the Center for Disease Control (CDC) for use of select agents and the security required in the laboratories investigating them. The lists to be used nationally will soon be announced by the Department of Homeland Security (DHHS) and will undoubtedly reflect the well-recognized categories and guidelines established by the CDC. Most relevant to the research universities are the high security lists based on the CDC's B list and the maximum-security list encompassing most of the agents on the CDC A list. Both lists contain agents commonly employed in research laboratories across the country. Tetrodotoxin, certain viral pathogens, and E. coli are among the frequently used items on the B list. The A list includes anthrax, botulinum toxin, and Ebola virus. Of critical importance to this discussion is the spectrum of security required for laboratories using these agents. Based on the guidelines specified by the National Guard for use at Iowa State University, laboratories using agents on the B list must have these security requirements: card or key controlled access, electronic building access, batter-proof doors and windows, and motion detectors in research areas. The requirements for laboratories using agents in the maximum-security list (the A list) are even more stringent. In addition to the requirements for securing

laboratories using items on the high security list, a perimeter fence or comparable structure is required. A 24-hour guard or doubly secured facility that would include a monitored camera system is also necessary.

The costs for generating these changes are significant. In preliminary estimates at our university, securing a corridor of laboratories with a key card system and camera exceeds $130,000. This excludes any modifications to the doors or windows themselves. The cost for personnel to monitor a facility using agents on the maximum-security list would exceed $150,000 per year. This does not include the cost of any perimeter fencing, which undoubtedly would be extremely expensive, particularly if aesthetics were considered in the design.

In addition to physical facilities, the new DHHS regulations include a requirement to monitor and control all personnel involved in the research with any of the select agents. This will require methods for obtaining background checks and a plan for educating our personnel. Estimated personnel costs for managing and implementing this system, excluding the educational component, approximates $100,000, although the exact amount will depend upon the extensiveness of the background checks required by the new mandates.

Other rules and regulations have significant implications for traditional interactions that occur in research laboratories across our universities. One of the most notable is the so-called “deemed export rule.” Based on both ITAR (International Traffic in Arms Regulations) and EAR (Export Administration Regulations), any release of information to foreign nationals from specific countries requires an export license. This includes release of information not only through formal mechanisms such as presentations and publications but also through casual interactions such as telephone conversations, discussions in the laboratory, laboratory tours, etc. Since half of the graduate students at Iowa State University are from foreign countries, the new rule could pose problems especially in those areas of research focused on software development, communication hardware, and certain areas of electronics. Because these regulations are intended primarily for investigations producing classified data for federal agencies or research in which there are mandated restrictions on publications, only a limited portion of research on most campuses will be affected. A useful guideline in determining the applicability of the deemed export rule is whether or not the data resulting from the study will be publicly disseminated. If so, the deemed export rule would not apply.

Funding Opportunities

We must also recognize that many funding opportunities are now available because of the shift in research priorities toward disciplines that are critical to homeland security. This trend embraces a variety of topics that are well suited to the mission of a land-grant university. Iowa State University has responded by forming a committee (a marvelous university tradition!) to evaluate requests for

proposals and other announced funding opportunities that are optimally suited for research by collaborative teams at our institution. This strategy should ensure that campus resources are focused on initiatives that are well received by our faculty and appropriate to their areas of expertise. In addition, our approach enhances the formation of effective collaborative teams – an important factor for competing optimally for these awards. Our campus has also refocused attention and resources on existing areas of expertise that fit well with the funding priorities that have evolved since September 11th. Our strengths include: an information assurance program, applications that combine quantitative expertise in engineering and agriculture, applications involving the Virtual Reality Applications Center, as well as activities in the Center of Scientific Forensics sponsored by the Department of Energy. Interest in homeland security has stimulated a number of programs in both the National Institutes of Health (NIH) and the National Science Foundation (NSF) to consider applications in these areas. Very recently the National Institute of Allergy and Infectious Diseases (NIAID) announced a large program supporting research "leading to the prevention, detection, diagnosis, and treatment of diseases caused by agents with the potential to be used for the purpose of bioterrorism." Some funds for infrastructure are intermittently available from the Technology Support Working Group, which identifies, prioritizes, and coordinates interagency and international research and development requirements for combating terrorism. NIH continues to award matching grants for animal facilities. Finally, some private foundations such as the MacArthur Foundation provide some funds for proposals focused on antiterrorism research.

In conclusion, it is already very apparent that the aftermath of September 11th will have a significant impact on the research environment in major research universities, particularly those with a strong land grant heritage. Some of the changes will reduce openness with regard to our physical facilities as well as personal interchange and contact. Our universities will meet this challenge just as we have met several others. Collectively, we must make every effort to ensure that the government provides funds that enable us to comply without negatively impacting current programs on our campuses. We must also minimize the intrusion of rules, such as the deemed export rule and those related to personnel and student screening. To accomplish this, universities should develop campus strategies that minimize the impact of regulations without decreasing compliance. We should also prepare our faculty for the evolution in funding priorities at the federal level. If developed correctly, new initiatives could have very positive, long-term consequences for the research programs on our campuses. Furthermore, some federal funding will be particularly conducive to multiple institutional awards. This opportunity may provide a valuable framework for enhancing collaborations between our universities in the heartland of the United States.

RESEARCH AND GRADUATE EDUCATION: A GLOBAL WORLD DURING TROUBLED TIMES

James A. Guikema
Associate Dean of the Graduate School
Associate Vice Provost for Graduate Research
Kansas State University

The theme for this meeting is timely. Since I serve the Kansas State Graduate School, I wish to focus my time and thoughts on the impact that the events of 9-11 may have on the research and graduate education enterprise.

Interestingly, just as the events of 9-11 were unfolding, the National Science Board was about to release a document titled *Toward a More Effective Role for the U.S. Government in International Science and Engineering.* The prologue states that "the recommendations of this report, developed over the past year, remain as relevant as before September 11, and their implementation even more compelling." The underlying theme is cooperation in science and engineering – bilateral and multilateral. Such cooperation builds a universal culture in science by promoting objectivity, tolerance, integrity, and free inquiry.

The National Science Board further suggests that the U.S. government should work toward a more effective, coordinated framework for global research and graduate education. Twentieth-century problems require a global approach in seeking solutions. For example, a regional or national perspective cannot meaningfully address the extent and significance of global warming. Human health and the spread of infectious diseases are issues that cross the borders of countries.

The globalization of university science and technology is a real phenomenon. This development could be at risk because of the policies enforced following 9-11. There are several examples at Kansas State University. For example, expertise in grassland biology, generated by decades of research on the Konza Prairie Biological Station, extends now to the savannahs of sub-Saharan Africa through the NSF International Long Term Ecological Research Program (ILTER). Furthermore, educational projects link Manhattan, Kansas with sister sites in the Russian Federation. Gravitational biology projects funded by NASA have K-State investigators partnering with colleagues in the Ukraine. The K-State presence in international agriculture has been a long-standing strength.

A decade ago, only about 10% of all publications by U.S. investigators involved international collaboration. As of 1999, it had increased to more than 20%. Physics, earth and space science, and mathematics showed the largest

globalization, with over 30% of the publications by U.S. investigators documenting an international collaboration.

The science and engineering workforce in the U.S. reflects globalization as well. Over 20% of the Ph.D. scientists and engineers in U.S. academic employment are foreign-born. This figure tops 30% for engineering and computer sciences. Employment in industry is even more striking. Over 30% of the Ph.D. scientists and engineers in industry are foreign-born, with engineering and computer sciences nearing 50%.

It is not surprising that the enterprise of educating graduate students is international. The number of doctorates in science and engineering earned by non-U.S. citizens rose from under 4,000 in 1980 to over 11,000 in 1995. The U.S. is not alone in this phenomenon. In 1999, 49% of the doctorates earned in the U.S. were awarded to international students, while in the United Kingdom, the percentage was 44%, Japan 43%, and France 30%.

In preparation for this meeting, I located the most recent Department of Education numbers for the degrees granted by the institutions represented here. These are shown in Figure 1, and contrast doctorates awarded in 1990 with 2000. Our graduate student clientele mirrors the profile at the national level. Well over 30% of the total doctorates earned at our institutions were by international students. The profile becomes even more interesting when looking at the School of Education (where 10% of the doctoral students are international) as compared with Engineering (over 70%).

Can the events of 9-11 have an impact on such a healthy, global graduate research/education enterprise? The answer is yes, in both positive and negative ways.

The federal government will likely take control and focus funding in relevant areas. The biology of infectious disease will probably see funding increases, and will focus on diseases that are emerging and not currently endemic in the U.S. I imagine that this will promote international cooperation between U.S. investigators and researchers in countries that currently have these diseases.

Hopefully, 9-11 events will serve as a wake-up call to our young American student colleagues. Interest in careers requiring doctorates in the sciences and engineering has been declining among Americans. This is a major issue to be addressed.

With increased funding for research, and with (hopefully) a renewed domestic interest in research activities, comes an increased regulatory burden for the research administrator. Laboratory security costs will soar. International

students may experience increased difficulty in obtaining visas to permit their study in the U.S. This has been observed already.

The enhanced reporting system that the federal government now requires is another daunting issue in graduate education post 9-11. The Student and Exchange Visitor Information System (SEVIS) is scheduled to come online during the Fall 2002 by the Immigration and Naturalization Service (INS). SEVIS shifts the burden of maintaining and updating information about our graduate students from a student/INS interchange to a student/university/INS interchange, and triples the number of data items that a student must report. Universities will be responsible for reporting changes in a student's status to INS with a very short deadline. All of this by Fall 2002, and INS only recently published the format of their database, such that software vendors can only now begin to develop the tools we will need in the university/INS linkage. And expensive tools they will be. Many graduate schools and foreign student advisors across the nation view SEVIS as a speeding freight train – with the school administration and the advisor right in the middle of the railroad tracks.

Regardless of the challenges before us, the institutions represented at this conference have programs for research and graduate education that will remain robust and international.

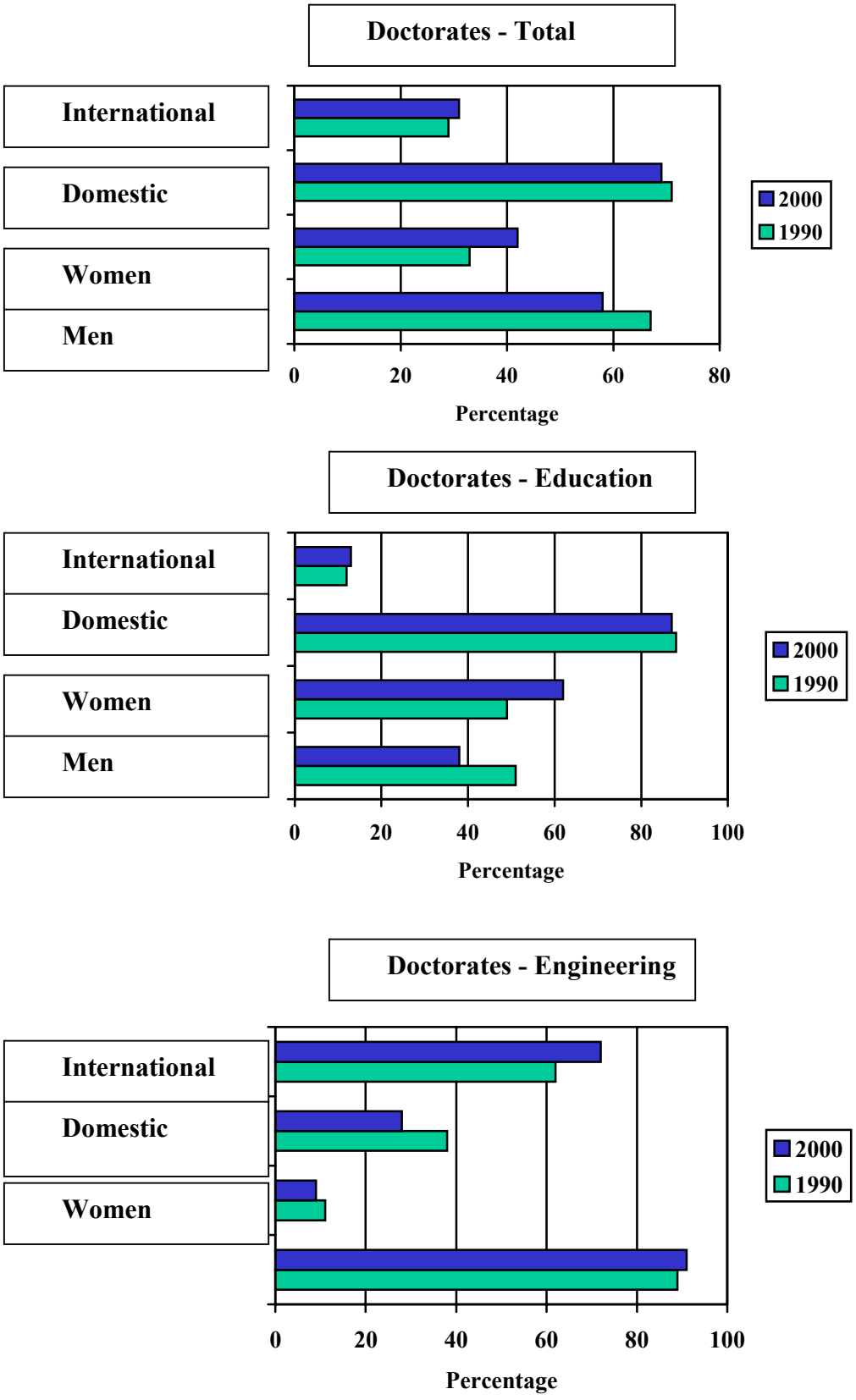


Figure 1. Profiles of the doctorates awarded from the universities represented at the Merrill Conference in 1990 and 2000.

THE USES OF AMERICAN SCIENTIFIC POWER

Catherine E. Woteki
Dean of Agriculture
Iowa State University of Science and Technology

The world is faced by a perplexing paradox. We have unmatched scientific knowledge that could be used to alleviate hunger, malnutrition, and many of the diseases and dilemmas that afflict humankind, yet nations across the globe are plagued by these and other problems that seemingly defy remedy due, at least in part, to fundamental ignorance of the available solutions.

The editors of the New York Times recently opined (The Uses of American Power, *N.Y. Times,* March 3, 2002) that "before President Bush decides where next to take the war against terrorism, he and the American people ought to pause for a moment to think about how we intend to behave in this new and awesome role." While we debate what the root causes of terrorism might be, and how and whether the United States should address them while waging war on terrorism, it is worthwhile to consider how we might use American scientific expertise and power to address the underlying causes of terrorism.

Scientific expertise contributes to our domestic security through a myriad of military and homeland defense applications. Science also contributes to global security by addressing fundamental human needs that have been the causes of discontent and war throughout history: hunger, disease, lack of fuel and energy, and economic disparities.

One issue that continues to divide the world is food insecurity – the lack of access to sufficient food to sustain health. As we meet today in Kansas, another important meeting is being held in Rome to follow up on progress since the World Food Summit of 1996 where heads of state and governments from 140 countries pledged to reduce by half the number of undernourished people by the year 2015. At the time the Summit was held, the best estimate of the number of undernourished people worldwide was 840 million. Since 1996, some progress has been made, and estimates are that 815 million people are now undernourished. China has made major improvements in food production and distribution, and most of the drop in the estimates of hungry people is due to China's success. However, trends point to major increases in hunger and malnutrition in the rest of the developing world. Approximately 63 million children are born into poor and undernourished families each year (An appeal by the 15 World Food Prize Laureates on the occasion of the World Food Summit: Five years later, June 2002, Rome).

Nobel laureate Dr. Norman Borlaug and 15 recipients of the World Food Prize believe that meeting basic human needs, such as adequate food, is

important for global stability. They wrote in a recent op-ed piece: "the world as a whole cannot enjoy durable peace, social stability and economic prosperity while hundreds of millions of people suffer from abject poverty and hunger" (*Des Moines Register*, June 9, 2002). They also recognize that we have the knowledge to increase significantly food production and food availability worldwide. Rich nations fund $68 billion each year of international aid, but only $11 billion is for assistance to farmers. The Food and Agriculture Organization of the United Nations is seeking $24 billion per year more for agriculture and rural development to help the world's undernourished feed themselves.

What better example could there be of American scientific power benefiting those in need, and in doing so, contributing to global stability? Also, what institutions are better equipped to contribute than the Land Grant Universities? These institutions devoted to teaching, research, and extension are a training ground for students from around the world. Through exchange of faculty and students with partner universities in other countries, the Land Grant Universities disseminate scientific knowledge, and also build an understanding of different cultures. Free exchange of scientific information has been a fundamental principle of these partnerships, and many faculty scientists are concerned about government limits that may be imposed because of fear of disseminating biological technologies to developing countries.

The United States faces a critical decision – whether to focus inward and secure ourselves against those who would do harm through terrorism or to focus outward and use our scientific expertise to help remedy some of the root causes of terrorism. Certainly, we need to strike a balance between the two approaches. To do so, scientists in academia, the private sector, and government will need to actively engage in policy debate on security measures to be placed on research and education. We, in the scientific community, also need to responsibly oppose unrealistic and unnecessary restrictions that could be placed on the free exchange of scientific information. We need to advocate for a balanced program of military, homeland defense, and international research and development while not forsaking our missions. We should also encourage faculty and student involvement internationally, and so continue our tradition of sharing knowledge and building cultural understanding worldwide. We should also advocate for the reform of international organizations such as the Food and Agriculture Organizations and the World Health Organization while we simultaneously support their missions. Achieving greater productivity from important United Nations projects and programs will have long-term benefits for us all. If we decide to engage with the world by sharing our scientific knowledge, we may be able to achieve a *Pax Americana* that eliminates the inequities that are the foundation for terrorism.

THE FEDERAL ANTI-BIOTERRORISM FUNDS: A POTENTIAL CATALYST FOR COOPERATION

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Consistent with the general theme of this year's meeting, "Science at a Time of National Emergency," I wish to consider first that the current emergency is different from our previous experiences with crises that have impinged upon, and changed, research activities in a given laboratory or institution. In the past, resources may have been reduced, and research activity consequently limited; or, a threat may have arisen in society that demanded a reallocation of a constant level of resources, and in response, investigators may have altered the direction of their work while maintaining their typical scale of work. Most senior investigators today have experienced, and have responded to, both of these kinds of crises. The current crisis is different from either of the above. The real threat of biological, chemical and explosive terrorism has resulted in a simultaneous increase in research funding, and a demand for reallocation of effort.

Individual investigators and research institutions as a whole are likely to address this crisis by doing more research, and by addressing the specific problems of terrorism through a change in the direction of their research. It therefore is a time of both danger and opportunity, consistent with the Chinese symbols that together mean "crisis." Indeed, while it is the duty of the great universities at this meeting to apply the strength of their research enterprise to help protect the people of the United States, simultaneously it is our duty as research administrators to gain our appropriate share of these newly allocated resources. So, the question is, what resources have been made available, who has them, and how do we get them?

At this time, there are no well-defined answers to these questions. It is obvious that the government of the United States will be allocating several billions of dollars to the current anti-terrorism mission, and that these funds will be distributed widely among the myriad of federal departments and their constituent agencies. Major distributions of anti-terrorism funds will be carried out by the Departments of Defense, Agriculture, and Health and Human Services; and we, the research universities, have both the experience with these agencies and the research expertise to address these new sources effectively. Our best strategy for doing so will include our collaboration. The heartland state universities at this meeting can produce critical masses of scientists to compete effectively with the coastal giants for these (and all other) research funds – if we can overcome our parochialism, political boundaries that inappropriately limit

intellectual sharing, and concerns about which university or politician will get "credit" for any successes.

Indeed, each year at this meeting we discuss ways to establish a functional cooperative network of scientific investigation among the Big Square States of Iowa, Kansas, Missouri and Nebraska, that will help us establish critical masses and larger scales to improve our position nationally. In 1999, Charlotte Bronson of Iowa State University gave a wonderful summary of the benefits of cross-university linkages and the problems inherent in their establishment. The benefits she described are perfectly suited to the current crisis, and to our proposal for seizing this opportunity for funding: highly coordinated research that is synergistic and free from duplication, operating on a scale beyond the reach of any of us acting alone, and the capacity to assume niches that would otherwise be available only to the Coastal Giants. Unfortunately, and certainly not to our credit as administrators, the limiting conditions she described are still with us.

At the same meeting, Bruce Harmon of Iowa State University was a strong advocate of the need to establish a functional inter-institutional science network among us, and suggested that a goal of this network should be to address the 1999 priority areas of the National Science and Technology Council, including: global change; emerging infectious diseases; protecting against twenty-first century threats; aviation safety and security; and food safety. The prescience of this list – its obvious relevance to the current crisis – is breathtaking. If we had listened to Drs. Bronson and Harmon, by now we would be well situated to address the current crisis. But we didn't. So, how do we proceed from here?

I would like to use the states of Kansas and Nebraska (fraternal, not identical, twins) to illustrate some potential synergies that might be used to meet the challenges of the present crisis. Data prepared by the National Science Foundation Division of Science Resources Statistics show that Nebraska and Kansas each do poorly overall in federal funding. If dollars flowing out of a state are in balance with those flowing into that state, then its rank among the states in a given federal funding category should be about the same as its population rank; thus, for Kansas a rank of 33 is neutral and for Nebraska, 39. By this approximation, Kansas is in negative territory (rank worse than 33) for 7/10 of major federal funding sources, and Nebraska is negative (rank worse than 39) for 8/10. Both states clearly need help; each may be able to help the other. Kansas is disproportionately well funded from the Department of Defense (rank of +6) and Nebraska is quite low (-8); whereas, Nebraska is disproportionately well funded from the Department of Agriculture (+21) and Kansas is low (-4). Thus, researchers in Kansas might expand their Defense-funded research by utilizing the reservoir of NU investigators; and conversely, Nebraskans may provide the backbone for Agriculture. There are other, better examples I'm sure, and this principle can be applied more widely among all of the Big Square States in the Middle, i.e., the principle that each of us has special expertise that can be applied to the good of all of us, if we can get smarter and more generous.

Are there ways the universities from the Big Square States may help each other, share expertise, develop synergies, and grow to be more competitive for federal research funding? Obviously. Will we do so? Let us say that we should, and that we can. It is easier said than done, but embedded within the current crisis is the opportunity for substantial gain in our research enterprise, if we, the research leaders among the universities, take the lead in overcoming the restraints, including parochialism and political boundaries, that inappropriately limit intellectual sharing, and concerns about which university or politician will get "credit" for any successes – as discussed above.

Strategies for developing inter-university collaborations among the attendants at this meeting clearly is not a new topic, and I haven't discovered any new and exciting strategies that will be sure to work. However, the current crisis *is* new and significant, and should induce our serious consideration of the old strategies, such as: inform our respective investigators about the value of collaboration; develop appropriate incentives; dedicate ourselves to educating our university presidents, boards, state legislators, and federal representatives about the advantages of playing nicely together. We need to get together, form a coalition that works, and get some "anti-terrorism" funding that we couldn't have attracted without working together. With this example, we will have the basis for more, bigger, better research based upon new critical masses.

PLANNING FOR RESPONSE TO BIOTERRORISM

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From 1981-1984, I headed the Contingency Planning Division for the Navy's Bureau of Medicine and Surgery and planned medical treatment for situations such as conventional warfare, ships at sea, and studied medical response alternatives to nuclear, chemical and biological warfare. It was our job to evaluate risks and plan medical support alternatives. We worked inside a well-structured and controlled environment, and used modeling to develop our plans. This was easy compared to what we have now. I'm no longer in the navy and found myself outside the box on September 11. It was frightening. Our first concern was the safety of our faculty and students. Our people at the University of Kansas Medical Center (KUMC) work globally. I was pleased that the schools could give me a complete list of staff and students' locations within half an hour. On a personal level, the attack at the Pentagon was a shock. The plane hit the area that included where my office had been located in 1985. We were all shocked by events.

Our first response at KUMC was to take care of our people. We have students from many countries, and we care about them, but in retrospect we made some mistakes. We asked our chaplains to put together an interfaith service. It turned out to be a Christian interdenominational service, but the people attending were Jewish, Muslim, Sikh, and Christian. Some were offended. We have learned that in these types of situations, innocent people can inadvertently become victimized by situations they would not have experienced before. A landlord evicted one of our Muslim medical students from her apartment. One of our professors is of the Sikh and wears a turban every day. He is often taken aside and questioned at airports as he travels about the nation – this causes a great deal of stress upon him and upon people of his faith.

Before September 11th, we thought chemical, biological and nuclear warfare was unlikely in the continental United States. Now we know this is not true, and that America must take a new look at its public health system. There is much to do. Our detection systems are inadequate. We must decide whether or not to keep viruses for vaccines. In the early 1980's we thought the only reason to keep the smallpox vaccine was to counter the military threat of the Cold War. This is a major issue for the country – smallpox is a viable agent for biological warfare. We do not seem to be prepared. And no one is standing up saying that they'll work on the problem. There is no clear message.

America needs to change – we know this. It is important to understand the threat. In a nuclear war, medical providers would respond immediately. In a

chemical attack, the effect is immediate and devastating, and medical treatment is limited. Bioterrorism is different – there is a long delayed reaction time. I'm concerned that no single agency has the answers. The federal government should do the threat assessment and work on response alternatives. Someone has to be in charge of command and control. At the state level, the Governor's office would likely define our roles in a disaster. Regionally, our responsibilities could include coordinating toxicology labs and other functions that require interstate coordination.

I remember when I came to Kansas seven years ago, I asked – who is in charge of the health of Kansans? It is hard to find an answer. The Kansas Health Foundation has been bringing people together with common interests to talk about public health. We strongly believe that communities need to be better educated. And we must get to know each other. It doesn't matter what kind of plan you have, if people don't know each other and have a sense of operating together, it won't work in an emergency. Communication is critical.

What is the role of the university? At KUMC, we have been working with the Kansas Department of Health and Environment, with our own infectious disease specialists, and with the KU School of Continuing Education to provide distance education conferences that reach health care people in their communities. We are talking with them about their role in diagnosing a bioterrorist action – for example, what is smallpox? We must be prepared to receive casualties. Most hospitals don't want to take smallpox cases because they might contaminate their entire facility. We must decide where to take people who are infected. And how do we deal with the dead? Our morgue at the Medical Center can only accommodate six people.

We've had concerns about the preservation of the food supply. We had a conference a couple of years ago on agri-medicine. It was sponsored by Iowa State University, but included representatives from all of the universities represented here today. We discussed the gamut of issues regarding agriculture and health and it was very successful. In Kansas, Dodge City, Garden City and Liberal rely on a migrant work force that moves back and forth between Kansas and Mexico. I worry about an outbreak of measles or tuberculosis in that population, and am not convinced that these issues are all appropriately addressed. So what happens if migrant workers are exposed to biological agents?

We must keep current anti-bioterrorism initiatives going and maintain visibility. KU's Continuing Education School develops programs for firefighters, police and community leaders. We work with the Kansas Health Foundation, the Academy of Family Physicians and others. We have been preparing grant applications to build better communications between public health professionals and practicing doctors in Kansas. If we do not work together, the public will be

sent back and forth between the public health department and their family doctors in an endless loop as they look for answers about anthrax, for example.

We must ask ourselves, what will we do when the phone rings tomorrow? Will we call the Kansas Department of Health and Environment? Should we call the local public health department or the medical society? Should the public go to the emergency room? One reliable source of emergency information is the web site of the Center for Disease Control.

Terrorism is caused by something and we should address that cause. In my opinion we need a Marshall Plan for the Middle East. Together, we must find homes for the homeless, educate the poorest of the poor and feed the hungry. How is our foreign policy interpreted around the world? We are the dominant power – let's not become the Roman Empire of 2002 debating in the Senate while the terrorists are invading. We must move forward. We need an early defense system, but we must not forget to address the causes of terrorism and work together to create a more peaceful world.

PSYCHOLOGICAL SCIENCE AND TERRORISM: MAKING PSYCHOLOGICAL ISSUES PART OF OUR PLANNING AND TECHNOLOGY

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One of the primary objectives of terrorism is to create a widespread sense of vulnerability. The attacks of September 11, 2001, along with the anthrax mailings, clearly achieved this goal throughout the United States. It is understandable that the government and other social institutions have responded by committing massive amounts of our resources to improved security, such as detection and surveillance systems, military readiness, vaccine or antidote development, and intelligence services. The news media has extensively reported on our reactions to terrorist acts, yet our nation has invested very little in the science of psychology, which could provide many benefits to children and adults during the "war on terror."

To engage social and behavioral scientists in lending their expertise during this national crisis, the American Psychological Association passed a resolution on December 12, 2001, outlining five major avenues for action:

- Use psychological knowledge and expertise to alleviate stress, anxiety, and fear among the public.
- Increase the use of behavioral knowledge to deal with the threat and impact of terrorism.
- Study the roots of terrorism and methods to defeat it.
- Study the prevention and treatment of trauma-related problems.
- Combat prejudice leading to violence and hate crimes.

We have a considerable amount of research documenting the effects of trauma – including terrorism-related trauma. We can document numerous acute short-term, and serious long-term, negative effects when people are directly exposed to trauma, and the rise in diagnosable psychiatric disorders is striking. The most common are anxiety disorders, especially Acute Stress Disorder, Posttruamatic Stress Disorder (PTSD), Generalized Anxiety Disorder, Agoraphobia, and Separation Anxiety Disorder. Mood disorders, especially Major Depressive Disorder and Dysthymic Disorder, often emerge in circumstances where the person is experiencing bereavement, substantial economic loss, occupational disruption, or forced resettlement because of violent acts of terrorism. Aside from clinical syndromes, many people experience a decrease in adaptive functioning which is reflected in diminished performance on occupational or educational tasks, increased use of alcohol, tobacco, and other psychoactive substances, and restriction of normal routines and activities. At a

more subtle level, underlying attitudes and beliefs about the world are shaped by terrorism; this is reflected in a changed view of social justice, suspicions about racial or ethnic groups, and diminished expectations for the future.

The conceptual models we now have for explaining and predicting psychological effects are quite advanced and well validated. We believe there is a dose-response effect for trauma exposure whereby certain experiences produce increasingly severe reactions. The psychological effect is directly proportional to: the duration of the experience, the intensity of the experience, and the type of exposure (direct threat of harm, witnessing grotesque scenes, bereavement, serious personal injury). The news media may inadvertently amplify and increase traumatic exposure for a wide segment of the population by showing graphic and emotionally-laden images of terrorist acts and the aftermath; in previous eras, the public could only imagine such a scene of violence, whereas today we can experience it over and over again in Technicolor. Although the dose-response phenomenon is the first rule of thumb, science has also documented individual differences in reacting to trauma exposure. Those at risk for more intense reactions include persons with: pre-existing vulnerabilities (e.g., prior exposure, anxiety sensitivity), ongoing stress and disruption in their lives, little access to social support, lower levels of education and economic resources, and ineffective coping skills (e.g., denial of events, extreme avoidance).

In the U.S., we lack the infrastructure, organization, and communication systems to apply our scientific knowledge at a national level so that we can help our citizens cope psychologically with the aftermath of terrorism this past year and the threat of future attacks. Psychologists have developed a number of promising interventions based on validated models for children, adolescents, and adults who already exhibit (or seem likely to develop) significant adjustment difficulties related to traumatic exposure. Surveys with children and adolescents in the Manhattan public schools conducted six months after the September 11 attacks indicated that 25% of respondents displayed significant symptoms of one or more of the previously noted psychiatric disorders. The proportion of children with symptoms increased notably in schools closer to the World Trade Center, especially among those who directly witnessed more traumatic events, suffered injury or loss of a family member, and sustained economic loss due to the attack. Despite all the attention, sympathy and money donated to help people in Manhattan and surrounding areas, only one-third of the children with pronounced psychiatric symptoms had any contact with a counselor, psychologist, or other mental health provider in the six months after the attack.

As a nation, we have invested in deterrence, surveillance, and revenge rather than addressing the profound psychological costs of terrorism. To be fair, concern for mental health in the past decade has become much more a part of disaster response plans among relief organizations such as the Federal Emergency Management Agency (FEMA) and the American Red Cross.

However, these agencies focus primarily on the acute, crisis phases of disasters, leaving resource allocation for long-term care to local or state systems. Responsibility is inevitably turned over to local mental health centers, private practitioners, religious or community groups, and public schools. Few of these local agencies have access to the expertise, organizational structure, trained staff, and financial resources to mount an effective, science-based response to a catastrophic event such as the September 11 attacks. We find ourselves at a strange juncture: we have a relatively sophisticated science-based knowledge of psychology, but we have not successfully put it into practice for our citizens during this national crisis.

Thoughtful leadership from the scientific community is sorely needed in the current debate on resource allocation during the "war on terror." Among the many avenues for potential action, it is important to emphasize broader uses for terrorism-related technology and systems. It seems particularly shortsighted to invest a huge amount of our resources in single-use systems (i.e., only useful following the terrorist attacks) at the expense of investments in psychological health. Psychological science has much to offer the public in positive ways to prepare, respond, and cope with terrorism and other traumatic events (e.g., natural disasters, bereavement, severe life adversity). The failure to incorporate psychological research in our policies and procedures for disaster plans represents a major lapse in our vision and our commitment to the public welfare. And the way intellectual leaders respond to the current crisis will shape the next generation's attitudes and beliefs about the value and benefit of the scientific endeavor.

NUTRITION AND FUNCTIONAL FOODS AT A TIME OF NATIONAL EMERGENCY: LESSONS FROM A PREVIOUS NATIONAL EMERGENCY

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Events emulating from 9-11 have made the scientific community more proactive in mitigating or preventing possible future terrorist attacks. An aspect of bioterrorism already discussed at this conference deals with maintaining a healthy food supply, and methods to combat potential pathogens and adulteration of food products aimed at harming large groups of people. Why should we be concerned with nutrition and functional foods research at a time of national emergency? We may be able to learn from the past since the science of nutrition was born out of a previous national emergency that the United States faced.

When the United States entered World War II, a large number of conscripts for the military were rejected for medical reasons. The medical basis for their maladies was often nutrition related. Keep in mind that the United States was just coming out of the Great Depression, and many parts of the nation suffered from undernutrition and exhibited signs of specific nutrient deficiency.

To help correct this problem, the U.S. Congress authorized the Food and Nutrition Board in 1940 under the direction of the National Research Council of the National Academy of Sciences. The Board was charged with making recommendations as to the levels of nutrients that should be consumed by individuals of different ages and genders to maintain health. With this charge came the Recommended Dietary Allowances, first prepared in 1941, and published in 1943. The first edition was to serve as a standard for good nutrition. The recommended intakes for the known nutrients at that time were to be used as a guide for large feeding programs and as a yardstick on which to judge adequacy of diets on a population scale. The RDAs have since been in existence and have been updated periodically every 5 to 10 years. Prior to the RDAs, nutrition research had been practiced in various labs throughout the country and elsewhere in the world, but in a piecemeal fashion. Physicians, chemists and physiologists conducted much of the work. Nutrition as a science was in its early evolution when World War II erupted. That national emergency galvanized the field into becoming a modern discipline.

Given the history of nutrition research, it is not surprising that research today continues to focus on deficiencies of essential macronutrients and micronutrients, their roles in living organisms, and the mechanism of actions. Research in the twentieth century has led to the identification and

characterization of essential nutrients and has provided the basis for dietary guidelines for optimal health throughout the life span. Furthermore, research findings have firmly established the importance of proper nutrition for maintaining good health, and also preventing the development of various degenerative diseases associated with affluence. We have seen a substantial rise in overnutrition, life-style changes, and also the incidence and prevalence of chronic diseases such as coronary heart disease, diabetes, and various cancers associated with affluence. Dietary intervention, along with life style modification, has become a primary strategy for preventing and treating such diseases. Genetics has an important role in the development of such diseases, but a focal point of nutrition research in recent years has been the impacts of nutrients and other bioactive components on health via their interactions with specific genes.

The RDAs that were developed out of a national emergency have since had widespread application, among the most important being the subsidized federal programs like school lunch and Medicare-funded programs. The Food and Drug Administration uses the RDA's as a guide for food labeling. Scientists have used them as a way to judge the adequacy of diets for various parts of the population and to identify high-risk groups. Since a change in a value of one nutrient, up or down, can mean a change in how much of a certain food type must be present in a feeding program to receive federal dollars, the political aspects of the RDAs may be contentious.

In the last decade, much attention has been directed toward the health benefits of such food components as fibers, carotenoids, tocopherols, isoflavones, polyphenols, terpenes, conjugated linoleic acids, marine oils, and other organic compounds such as protease inhibitors and saponins found in grains, oil seeds, and vegetables. Epidemiological studies have shown that the consumption of foods rich in these compounds of plant and animal origin is associated with a reduced incidence of coronary heart disease, cancer, osteoporosis, or other degenerative diseases. Only recently, researchers have begun to uncover the biological and physiological effects of certain bioactive components of foods, which sharply increased our awareness of their potential importance in health maintenance and disease prevention. Some important findings include: the anticarcinogenic potential of conjugated linoleic acids, carotenoids, isoflavones, saponins, and inositol hexaphosphate; inhibition of bone resorption by phytoestrogens in women; the cholesterol-lowering effect of dietary polyphenols; stimulatory action of a soy protein component(s) on thyroxine secretion; antiatherogenic and anticarcinogenic effects of conjugated linoleic acids, n-3 fatty acids, and tocopherols; and preventive effects of L-carnitine and natural and synthetic antioxidants on neurodegeneration and cognitive dysfunction.

Clearly, nutrition and food research for the twenty-first century will place great emphasis on bioactive functional components in grains and oil seeds as well as animal and marine products. The search for new bioactive compounds

will continue with renewed vigor. In recent years, funding from the federal agencies and industry for research in these areas has increased substantially and is expected to increase in response to the ever-increasing public demand for information on dietary supplements and the health effects of plant- and animal-based functional/designer foods and nutraceuticals. This new direction will have a significant impact on public health. Information generated from the research will undoubtedly influence future strategies for nutritional intervention in health and disease. It is anticipated that those functional components of foods proven to be effective in prevention and treatment of diseases will be commercially manufactured and marketed as nutraceuticals and functional ingredients of processed foods. However, given the shifting national priorities of post 9-11, it is not clear whether other issues will take priority over this evolving science. Similarly, great strides have been made with the human genome project. Will funding for applications coming from this work be curtailed and replaced by research on bioterrorism? In the case of functional foods, many of these new products have been modified in some form, some genetically altered. This poses an additional point of entry from which harmful components to the food supply could be added.

These issues are not to be taken lightly for states such as Kansas, Nebraska, Iowa and Missouri, where there is a large agricultural base on which to capitalize. Investment in nutrition has been upward and steady. The interest in these food products has intensified among the food industry over the last 10 years. In 1992, the market for functional foods was $5.4 billion, and by 2001 the market was expected to be over $18 billion. It is not clear which food companies will continue to invest in this emerging area of interest, who will become the market leaders, and what the target audience will be for many of their products. Nevertheless, it is clear that the markets for functional foods are large and growing, ranging from specialty niches to mass-market opportunities. For agricultural states, the challenge is sustaining momentum for nutrition research while other needs outweigh the priorities established prior to our recent national emergency. On the other hand, we could experience long-term economic benefits as we shift research dollars to combating bioterrorism. Clearly, we have observed the many benefits that the space program has given modern medicine from its spin-off technologies. Another concern is the bandwagon effect — everyone jumps to try and capture new short-lived research dollars, and the infrastructure that was used to create the research support becomes obsolete in a short amount of time. Clearly research administrators and researchers must keep both the short term and long term perspective in making adjustments to their grantsmanship strategies and institutional investments.

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THE ROLE OF UNIVERSITIES IN SUPPORTING THE UNITED STATES EFFORT TO COMBAT BIOTERRORISM FROM A NON-TRADITIONAL PERSPECTIVE

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Challenges Facing the National Institutes of Health and the U.S. Government

The U.S. government must protect the civilian population against biological agents that under "normal" circumstances have been significantly reduced or eliminated, such as anthrax and small pox. The challenge is to develop countermeasures to combat biological agents. The Department of Defense, in particular the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID), has been developing countermeasures against bioterrorism agents for the last 30 years. The Army's efforts concern only the solider in combat situations, which has an impact on how the Army addresses the issue of developing countermeasures. For example, the Army is only concerned about treating a select group of combat soldiers – young healthy adults with no known health problems. Also, the Army may only have to treat at most 200,000 to 300,000 soldiers. The Army's demographics do not completely fit the civilian population, where the most severely affected individuals from a bioterrorism attack will be the young and old, immuno-compromised, and the sick. The good news is that the technology developed by USAMRIID has applications for the civilian population, but production capabilities will need to increase nearly 100 fold and clinical testing will need to include a wider spectrum of society.

The next challenge is that a majority of the vaccines or therapeutic molecules against biological agents are of little monetary value to the pharmaceutical and biopharmaceutical industry. As an example, the Department of Defense (DoD) and the National Institute of Allergy and Infectious Diseases (NIAID) would like to have monoclonal antibodies (MAb) against biological agents to treat exposed individuals that are not vaccinated or cannot be vaccinated, i.e. vaccinating against botulism eliminates the therapeutic potential of Botox. At present, the biopharmaceutical industry pipeline is so full that the industry lacks the resources, especially production capacity, to produce the drugs that are already approved for the market and those in clinical trials. Enbrel is a MAb for treatment of juvenile rheumatoid arthritis and is produced by Immunex. Presently, Immunex has only enough production capacity to meet approximately 60% to 70% of the market needs. Immunex is building additional production facilities, but this will take three to five years to complete. At present the biopharmaceutical industry is challenged to find facilities to produce material for

clinical studies, especially smaller companies who lack the resources to build and validate cGMP facilities.

On the other side are the contract manufacturing organizations (CMO) that are designed to meet the needs of the biopharmaceutical industry. Because of the significant investment to build and validate a commercial facility, the CMO are primarily interested in companies with advanced product portfolios that have multiple products and can commit to a long term relationship (five years or more). The goal of each CMO is to be the primary manufacturer of a fully approved product. The major CMOs, such as DSM and Diosynth, and large biopharmaceutical companies that have additional capacity, i.e. Chiron, have virtually no interest in small biotech companies that may have only one or two products. This leaves these smaller companies scrambling to find a place to produce material for pre-clinical and clinical testing.

Based on this information, there are very few alternatives for small companies, university investigators or government agencies to do process development, scale-up a process, and produce sufficient material for pre-clinical and clinical testing. The government does have two small cGMP facilities, the NCI facility at Ft. Detrick in Frederick, Maryland, and Walter Reed Army Institute for Research (WRAIR). Unfortunately, these two facilities can only handle a limited number of products. In my own experiences with DoD and the botulism vaccine program, the contractor in charge of transitioning into clinical production the process technology developed at the UN-L Biological Process Development Facility had a difficult time finding suitable contractors that were interested.

This is where universities can play a role in assisting the civilian bioterrorism program headed by NIAID, the DoD bioterrorism program, and small biotechnology companies. In addition to providing access to expensive facilities and expertise, such facilities at universities can be an excellent place to train both engineering and science students in a FDA-regulated environment.

The focus of this talk is to describe how the University of Nebraska – Lincoln (UN-L), the Department of Chemical Engineering, and the UN-L Biological Process Development Facility developed a non-traditional program that blends basic and applied research with process development and scale-up and manufacturing of clinical material in a current Good Manufacturing Practice (cGMP) facility. This facility has successfully helped companies and government agencies bring biopharmaceutical molecules to clinical testing.

Why Should Universities Move into this Role?

With regard to science and engineering, a university's primary mission is to educate students and expand the basic knowledge of science and engineering for the betterment of society. Universities are also involved in applied research and technology that is of value to society. With regard to the fight against

biological threats, universities will play a very important role in the classical sense, by understanding the basic science of different pathological organisms and toxins with the intent of identifying molecules as vaccine candidates and targets for therapeutics. Universities excel in this role.

Recently I was involved in a Blue Ribbon Panel held February 4-5, 2002 to discuss the research agenda for NIAID's bioterrorism program. Dr. Anthony Fauci, Director of NIAID, gave the opening speech to the conference and made what traditional scientific circles would call a very unusual request of NIAID-funded scientists. Dr. Fauci told the audience that the American public and the President expect scientists working on bioterrorism to "get products into vials." This is a profound statement coming from NIH, which prides itself on serving the very basic science needs of society. This is not to say the NIH does not support STTR and SBIR type of proposals; in fact, NIH has a very active program on commercializing potential technology. It was apparent at the meeting that scientists were asked to think outside the box in order to serve society's need to combat bioterrorism.

NIAID is asking scientists to incorporate a more company-like approach to drug discovery. NIAID still insists on good basic science on pathogenesis and mechanisms of toxin, but if a promising drug candidate comes along, that molecule needs to be "transitioned" into development. This is where academicians tend to struggle and companies succeed. Companies do not fail because they were unable to make material for clinical trials. Companies fail because the product did not live up to its clinical expectations. The BPDF's role is to operate in that realm between drug discovery and clinical trials and to assist scientists, government agencies and companies' transition molecules through Phase I/II clinical testing.

The Mission of the Biological Process Development Facility at UN-L

The BPDF has three distinct missions. The first is to educate students in bioprocessing in an FDA-mandated environment. The second is to expand and disseminate basic and applied science and engineering knowledge as it relates to all aspects of recombinant protein expression and production through publications. The third is to assist companies and government agencies in bringing biotherapeutic products to clinical trials.

Description of the Biological Process Development Facility at UN-L

The BPDF is a state-of-the-art biological process research and development facility that specializes in developing manufacturing processes for vaccines and therapeutic proteins derived from recombinant organisms. The BPDF is a "turn key" facility that deals with all aspects of process research and development including, molecular biology, fermentation and protein purification,

analytical methods, quality control, quality assurance, process scale-up, and manufacturing of Phase I clinical material under cGMP as mandated by the FDA.

The BPDF trains students for the biotech industry, disseminates information on biological process research, and services the clinical manufacturing needs of industry, non-profit institutions, and government. The BPDF accomplishes this mission by working in an environment similar to industry on relevant projects. The BPDF will either develop processes for transfer back to the client or produce the product in our own pilot plants. This includes the production of materials that are currently being used for human clinical trials, which requires the operation under cGMP.

The BPDF is recognized as one of the leading university bioprocess facilities specializing in methylotrophic yeast, *Pichia pastoris.* The BPDF has 35 full-time staff and employs 6 to 10 engineering undergraduate students annually, providing them with a "real world" work experience. The BPDF has an extensive network with both small and large biotechnology companies providing potential employment opportunities, especially for students who have worked in the facility. The BPDF gives students a unique opportunity to gain practical engineering and research experience while remaining in an academic environment that allows for continued education and personal development.

The BPDF is composed of eight units: Molecular Biology Laboratory (MBL), Fermentation Development Laboratory (FDL), Purification Development Laboratory (PDL), Analytical Methods Development (AMD) and Quality Control Laboratory (QCL), Fermentation Pilot Plant (FPP), Purification Pilot Plant (PPP), and Quality Assurance (QA). These combined entities provide the BPDF with "turn key" capabilities to clone a gene of interest, develop the analytical methods and the process, and manufacture the protein under cGMP for Phase I/II clinical trials.

Molecular Biology Laboratory: The MBL conducts research in protein expression primarily in *P. pastoris*, in particular promoter regulation and strain improvement.

Fermentation Development Laboratory: The FDL conducts research in fermentation modeling, methanol control strategies, and interaction of control strategies on protein expression in *P. pastoris*. The other function of the FDL is to develop fermentation processes at the 5 L-scale and transfer that process to the fermentation pilot plant. The FDL must take into account fermentation scale-up issues when developing the fermentation process. It is essential that the process is straightforward and generates a consistent yield with high product quality and can be readily transferred to the pilot plant (500 L). This is invaluable to a company that wants to make a product that will eventually be used in human clinical trials.

Purification Development Laboratory: The PDL performs bench-scale protein purification research and develops scalable purification processes for production of proteins under *c*GMP. The PDL is capable of both basic protein chemistry, process development, and scaling-up a purification process into production.

Fermentation Pilot Plant: The purpose of the FPP is to scale-up a fermentation process that has been developed in the FDL, and produce *c*GMP material for clients. To a lesser degree the FPP conducts process research and has been involved in publishable activities. The FPP has fermentation capabilities up to 400 L working volume and is capable of harvesting/down stream processing using cell disruption, centrifugation, crossflow membrane filtration, or expanded bed absorption.

Purification Pilot Plant: The purpose of the PPP, which compliments the FPP in scale, is to scale-up a process that has been developed in the PDL and produce *c*GMP material for clients. To a lesser degree, the PPP conducts process research and has been involved in publishable activities. Both pilot plants operate under cGMP.

Analytical Methods Development: The purpose of the AMD is to conduct research in analytical methods and to develop in-process analytical methods to support process development and the pilot plants. The AMD is also responsible for developing analytical methods for testing raw materials and methods for final product release. The AMD, when required, is responsible for validating methods. Once AMD has developed a method it is then transferred to Quality Control.

Quality Control: QC is responsible for providing analytical support to the BPDF. The QC laboratory is responsible for more sophisticated assays, such as HPLC, ELISA and endotoxins. The development laboratories are responsible for routine protein assay and electrophoresis. The QC lab does all analytical methods for the pilot plants.

Quality Assurance: The function of QA is to insure the BPDF is in compliance for both Good Laboratory Practices, GLP, (FDL and PDL) and cGMP (FPP and PPP). The BPDF serves its clients by providing either a process that can be transferred into a GMP facility or production of GMP material for clinical trials. In either case, QA, in collaboration with BPDF staff, generates the necessary documents to successfully transfer/produce the product. The biggest responsibility of the QA program is to bring the BPDF into cGMP compliance.

The Research Component of the BPDF: The BPDF sustains an active research program by supporting Research Assistant Professors (RAP) in critical areas in bioprocessing. The BPDF supports RAPs in molecular biology, fermentation modeling, protein purification, and analytical methods. The BPDF supports a tenure track faculty position in quality assurance/analytical methods. Each individual is expected to have a research program and generate

publications that further elevate the BPDF. The RAP's are involved in grant and contract writing that is either independent or multi-disciplinary within the BPDF or the university.

cGMP Capabilities: The ability of the BPDF to manufacture Phase I clinical material under cGMP is what makes the BPDF unique among university bioprocess facilities. Bringing the BPDF into cGMP compliance to produce Phase I clinical material has taken nearly 4 years, and is a process that is always evolving. A significant amount of resources (equipment, validation, establishment of systems and documentation) were needed to establish cGMP compliance. At present nearly 30% of the BPDF staff is dedicated to QA.

This capability is what attracts clients to UN-L to do bioprocess research and development. Nearly all of the BPDF clients have the same goal, which is to bring a molecule to clinical trials. Once a molecule has been discovered and preliminary studies suggest a therapeutic use, the next stage for the client is to develop a process that can be scaled-up to produce clinical material. This is not a trivial matter and includes everything from additional strain development and validation to final product tests for release of the product. Typically, it takes 9 to 12 months for the BPDF to develop a process capable of producing cGMP material. Once a process is developed it only takes 3 to 4 weeks in the pilot plant to produce a clinical lot.

It is this step between process development and clinical manufacturing, i.e. technology transfer, which can take 2 to 6 months if the process needs to be moved from one facility to another, i.e. from the facility that did process development to the cGMP production facility. If this step can be eliminated, it can save a company a significant amount of time and money. It is said that for each day a product launch is delayed it costs a company one million dollars/day in revenue. Thus, from a client's perspective one stop shopping is preferred.

Educational Aspects of the BPDF: The Department of Chemical Engineering, the departmental home of the BPDF, and the BPDF provide a very unique opportunity for science and engineering students to receive "real world" training in a cGMP environment. As a discipline, bioprocessing must be affiliated with a chemical and/or biochemical engineering program. The curriculum in chemical engineering is best suited for students in bioprocessing. It is critical that these students receive the necessary background is transport phenomena, kinetics, thermodynamics, process control, reactor design, and unit operations.

The BPDF encourages students to work in the BPDF during the school year, 10 to 15 hours per week, and to work full time through the summer. Students following this regime have succeeded very well when competing for employment and have had an opportunity to come up through the ranks in the BPDF. By the time students are juniors or seniors they are working for a scientist in a capacity similar to a graduate student. Some of the better students receive

cGMP training and work in the pilot plants. They receive training in writing standard operating procedures and working with batch records.

The BPDF and the Army Bioterrorism Program: The BPDF has been working with USAMRIID for the last seven years on research and development of processes to produce vaccines against botulism toxin. The BPDF has transitioned five of the seven serotypes of *Clostridium botulinum*, A, B, C, E and F. Serotypes A and B have been officially transitioned to a contract research organization that is responsible for producing clinical material. This was accomplished by working with Dr. Leonard Smith, chief scientist at USAMRIID, who was responsible for discovering vaccine candidates. Dr. Smith worked closely with the BPDF to develop processes for transitioning the vaccine candidates into clinical trials. The BPDF is funded to work with USAMRIID an additional three years on additional vaccines and therapeutics, i.e. MAbs. The BPDF is involved in all aspects of process development from strain development to process scale-up for USAMRIID. Presently, work for the Army comprises about 20-25% of the BPDF total activity.

The Civilian Bioterrorism Program and University Involvement: For the civilian bioterrorism program to succeed it will be critical for NIAID-funded scientists doing drug discovery and pathogenesis research to initiate a collaborative relationship as soon as possible with a process scale-up group. There are many things that can be done early on in drug discovery that will save the process development scientist a significant amount of time and effort. The BPDF works very closely with USAMRIID at all stages of drug discovery.

Major universities typically have the biological scientists (drug discovery) and the biochemical engineers (process development and scale-up) that are necessary to accelerate the transition from discovery to a vial. The challenge is getting the two parties collaborating and making decisions based on what is required by the FDA. This is not the typical thought process for a university scientist, but it is necessary to accelerate the transition of product candidates into vials.

BPDF Funding: The BPDF is entirely funded by grants and contracts, except for the Director's salary. The annual contract and grant activity is from $3 to $4 million per year.

Future Direction of the BPDF: The BPDF is currently in the Food Processing Center on East Campus at the University of Nebraska – Lincoln. In April - May of 2003, the BPDF and two biochemical engineering faculty will occupy 10,000 ft^2 of bioprocess research laboratories and 2,500 ft^2 offices dedicated completely to bioprocessing and bioengineering research on the third floor of the new Othmer Hall. In addition, there will be 3,000 ft^2 of non-GMP research pilot plants in the basement. Also in the plans is a new 10,000 ft^2 cGMP pilot plant with half of the

facility dedicated to yeast/bacteria and the other half to mammalian cell culture. Maximum reactor size in each facility will be 1,000 L.

Future Direction of Bioterrorism Research and Development at Universities

I would recommend that universities form bioterrorism research clusters. This is initiated by identifying a particular area of research, such as a pathogen or diagnostics, as an emphasis. In the case of vaccine or therapeutic discovery, it will be important to identify all of the necessary resources and present a plan that takes into consideration all aspects of drug discovery and clinical manufacturing. Taking this approach will insure that the scientific community will have the quickest response in bringing a product to a vial.

STATEWIDE ADVOCACY

Kim Wilcox
President and CEO
Kansas Board of Regents

With the title of this panel *Statewide Advocacy*, I was reminded of last year's meeting when I arrived with a press clipping whose headline was "Regents Advocacy Criticized," and I wondered if you really wanted to trust my opinion on the topic.

At previous Merrill conferences, I've talked about the differences between academic culture and the culture of a governing board, and differences between academia and the legislative culture. This year, I'd like to continue that theme by talking about what somebody like me does and why they persist in doing it. Also, how we could all help my job line up more closely with life at the universities.

I'm the State Higher Education Officer – SHEEO – for Kansas. There is at least one higher education officer per state. They go by lots of names. In most cases, the duties involve coordination (interpreted by too many as simply reducing unnecessary duplication); program administration; leadership; and advocacy. I admit that I knew relatively little about these types of positions before I assumed mine, and my experience is that most of my colleagues in higher education are in a similar situation.

My comments today will be in the form of advice to future SHEEO's, but first, I should share with you some of my personal biases:

1. All of the real activity happens on campus. If we are about education, research and service to the state, then nothing much happens in our office. It takes place at the colleges and universities.
2. Research and universities lead states. By necessity, states must support lots of different activities, including Kindergarten through 12th grade education, social services, and prisons; but none of these will shape the future of the state and its economy. Higher education alone, and especially the research universities, can fill that role.
3. One size doesn't fit all. It is often a difficult notion to sell, but all institutions should not be treated the same. Some should have resources and opportunities that others do not. Just as campuses must be wise about where they invest, knowing that spreading money thinly across the campus is not the best strategy, so too states must be willing to target resources strategically among their institutions.
4. We can always do better at working together. Expanding collaborative efforts is not only important to our political image, but it is also the right

thing to do. That said, we are almost always doing better at working together than others give us credit for.

With that backdrop, here is the advice I'd give to future state higher education officers:

1. Resist the state culture and the natural tendency toward bureaucracy. In state government, programs are often federally funded or legislatively directed to address a concern or to satisfy an individual's concerns. Too often, these become entities unto themselves. This, of course, is different from campus, where "program" generally means academic program, with internal integrity in concept, tradition, and values. Program in this sense is simply the outward realization of a set of ideas. SHEEO offices, like other state offices, house "programs" (in the state agency sense) and they tend to take on lives of their own. They also tend to impose their structure on the other activities of the organization.
2. Force the campus culture onto the enterprise of the higher education office. If you don't actively push campus culture into the environment in the state capital, the values of the campus will be overcome by those of state government. This can be accomplished in several ways, not the least of which is the people you hire. They must, whenever possible, have real campus experience; the more engaged in the academic aspects of campus, the better. But even with that, the leader must constantly restate the campus values to keep them a priority in the office.
3. Understand the priority that state government puts on reports and documentation. The big difference between academia and state government is the time put into documentation. In higher education, we don't prioritize reporting. We're generally too wrapped up in our research to spend a lot of time producing regular full-color documents describing our results. University Relations works hard to capture what is going on, but if someone were to ask any single scientist to discuss her research today and then again next week, they'd get different answers because the activities in academia change constantly. So the task of a University Relations Office is almost impossible. As a result, however, we are at a disadvantage in state government, because we do not have the same visibility as other groups.
4. Resist the natural tendency to minimize negative effects and make short-term sacrifices. Recognize that compromise is the order of the day, but when you let things go over time, it has a cumulative effect that leads to real problems. This is most easily seen in the budget. It becomes too easy to accept a several hundred thousand, or several million-dollar budget cut when you're removed from the full impact of that cut.
5. Communicate. You can't spend too much time doing this. I joke that my job is to drive around the state and talk on the phone – usually at the same time. As academics, we feel that the issues and challenges of academic life make it difficult to take time to talk with people or write

reports. The SHEEO has that primary responsibility and, given the priorities of others in academe, must shoulder significant responsibilities for communicating information on all aspects of the higher education enterprise to a wide constituency.

As with any good state official, I'm also here to ask for something! For the good of the operation, I would ask each of you to become engaged in the process of staffing your state higher education office. I would never have considered this position if David Shulenburger and Kathleen McCluskey-Fawcett hadn't asked me to consider a position in the Board Office four years ago. But, I'm eternally grateful to them for thinking of me, because these have been the most rewarding years of my professional career. Having served in the role, I am now more convinced than ever that we need the right people in Topeka to get things done. You and others must help identify those who can do these very important jobs.

During the past two days, we have spent a lot of time talking about communication and the need to help the broader public understand what we do and how we can be helpful in any number of arenas. In that vein, I would also suggest that the Merrill Center hold a Research Summit focused on educating the editorial boards of regional newspapers. The summit should include the six CEO's of the universities represented here, the editors of the newspapers in the major cities in the area (i.e. St. Louis, Kansas City, Wichita, Des Moines, Omaha) along with editors from our university cities. The purpose of the Summit should focus on increasing the collective awareness of our research operations in the Midwest and on the various shared needs and challenges that we face. It could help us address a number of issues – for example, the indirect cost recovery rate from the USDA that arguably affects us more than any other group in the nation. With the right leadership, the press could be our ally in helping to move our region ahead.

STATEWIDE ADVOCACY

Janet Murguia
Executive Vice Chancellor for University Relations
University of Kansas

I've just completed my first experience with the state legislature after having worked in Washington for many years. I want to comment on the differences I've noticed at the state level, and then talk about our advocacy this session.

In Washington, D.C. you have 435 members of Congress and 100 senators. Our state government involves 125 legislators and 40 state senators. So, the scale is different at the state level. I was surprised by the partisan nature of state government. The very first week of the session, we heard comments about the Governor's address that could be called mean-spirited. In Washington, we didn't experience partisanship so early in the session. We have a three-party system in Kansas. Within the Republican Party there are the moderates and the conservatives and then we have the Democratic Party. Usually, a three-party split produces alliances between moderate Republicans and the Democrats. This session, the Democrats allied with the conservative Republicans. This kind of alliance is not based on ideological agreement – it is about politics. We saw an overwhelming level of political maneuvering from the very start of the legislative session and it continued throughout.

When I arrived at the University of Kansas (KU), one of my first jobs was governmental affairs and state relations. The budget dominated the legislative session. We worked hard to protect our interests in the budget. Our strategy had several components: keeping a united front with other Regents schools and kindergarten through 12th grade (K-12) education, going directly to key legislators, and developing a grass roots campaign. It was clear to me that we had to work through the Board of Regents. A united front with other institutions was the best possibility. We made sure that we all used the same message. This takes a lot of discipline and trust building. It is not in the interest of KU to step apart from the other Regents institutions. We worked hard to build coalitions and get to know the key legislative leaders. We built constructive alliances with leaders in K-12 education. At the same time, we went to the public with our message. We held two events. One was at Silver Lake elementary school and included mascots from the six regents schools. The media picked up this story. We also did an event with the Kansas Chamber of Commerce and several business leaders who said they would support taxes that go to education.

When you are doing statewide advocacy, you've got to create a grass roots public campaign. Sometimes the issues are most real to the legislators when they go home and a constituent talks to them about their concerns. It is

important to have letters and conversations. Some people were very creative. Kansas State University asked their football coach to send a letter to legislators. It is important to remind people that they have a role to play.

We must also continue to say that the state receives a good return for its investment. We must talk about economic development. Higher education is a partner with the state in creating a better destiny for us all.

REACTION AND CONFERENCE SUMMARY

David E. Shulenburger
Executive Vice Chancellor and Provost
University of Kansas – Lawrence campus

This conference gave me an opportunity to learn a lot of things I wouldn't usually have the opportunity to learn. The University of Kansas is not an agricultural institution, but much of what is happening in the agricultural schools is complementary to us. It is important to realize the ways in which our missions interact.

Kim Wilcox talked about having academics in the Board of Regents office. Let me expand his statement: it is important to have the *right* academics there – people who can get the message across. Administering academic institutions is difficult. Higher education is a fragile system and can be taken apart. We need people in the Regents office who are sensitive to what happens on campus and can motivate faculty to do their best. There is no substitute for having the right kind of academics in the Regents office.

I have four conclusions about science in a time of national crisis:

1. The universities represented here have a great deal that could help the country.
2. Our country has not been able to organize the expertise it needs during this crisis.
3. What we know hasn't been well used by our country.
4. We are eager to help. There is nothing we wouldn't do to bring our expertise to the aid of the country.

What do we do now? Should we build capacity in order to respond to the national crisis? One of the important things an administrator says is "no" – and sometimes this is what we really should say. The super-conducting project is an excellent example. Many universities put lots of money into super-conducting, and these investments were wasted when the project was abandoned. In retrospect, it would have been far better for the university to use this money elsewhere. If we build staff for the current crisis and things calm down, will the university be left with lots of investment in areas that are no longer relevant? In terms of vaccines, if we focus resources on projects like developing a botulism vaccine, we are aiming for a narrow market.

I'm not suggesting we have to be in perpetual crisis to justify an investment, but I am suggesting that we must be careful about where we put resources. We should organize the resources we currently have, rather than make significant additions to them. Higher education is not simply about

research. Our concern must be research *and teaching*. Our mission is best accomplished when we do what encompasses research and teaching. Training experts for the future is better than solving specific problems now. Preparing our citizenry for the future is why universities exist. In deciding how to respond, we must keep our mission in mind, else we risk losing support from the individuals who support our educational mission.

Martin Apple, our keynote speaker, said that society has many big problems, and the university has departments. He urged us to work across departmental boundaries. We do this with research institutes and other devices. He also said to think large. If we want to address societal crises, are the university boxes too small? Universities don't have it all. We are accustomed to putting together grant proposals that expand the university with great expertise from other places, but with a single university base. Think about the nature of the problem, and the dysfunction of the federal funding system. If you want to address bioterrorism, where do you go for funding? NSF? NIH? USDA? We've mentioned a dozen entities and every one of them has a piece of the action. You probably would have to go to all of them because there is no multi-grant system.

That brings me back to what Martin Apple said about earmarking. He is opposed to it. At my core, I probably agree. But how will the federal government respond to this problem through its individual agencies – none of which can address the problem with a multi-university team? The Merrill Advanced Studies Center does a great service in bringing us together. Are there areas where it makes sense for us to collaborate across multiple disciplines? Can we put together such a persuasive collaboration that it might be a candidate for direct funding? Given the reality that things are being done piecemeal in Washington and the resources of academia aren't being used, is it worth investing our time to see if we can create a successful collaboration?

CONFERENCE PARTICIPANTS
2002

Keynote Speaker
Martin Apple, Ph.D., President and CEO, Council of Scientific Society Presidents

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Catherine E. Woteki, Ph.D., Dean, College of Agriculture

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James A. Guikema, Ph.D., Associate Vice Provost for Graduate Research and Associate Dean of the Graduate School
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Kathleen McCluskey-Fawcett, Ph.D., Senior Vice Provost and Merrill Board
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Keith Yehle, Legislative Director, Office of Senator Pat Roberts
Robert Woody, KU Counsel in Washington, D.C.