



Graduate Education *and the* Public Good



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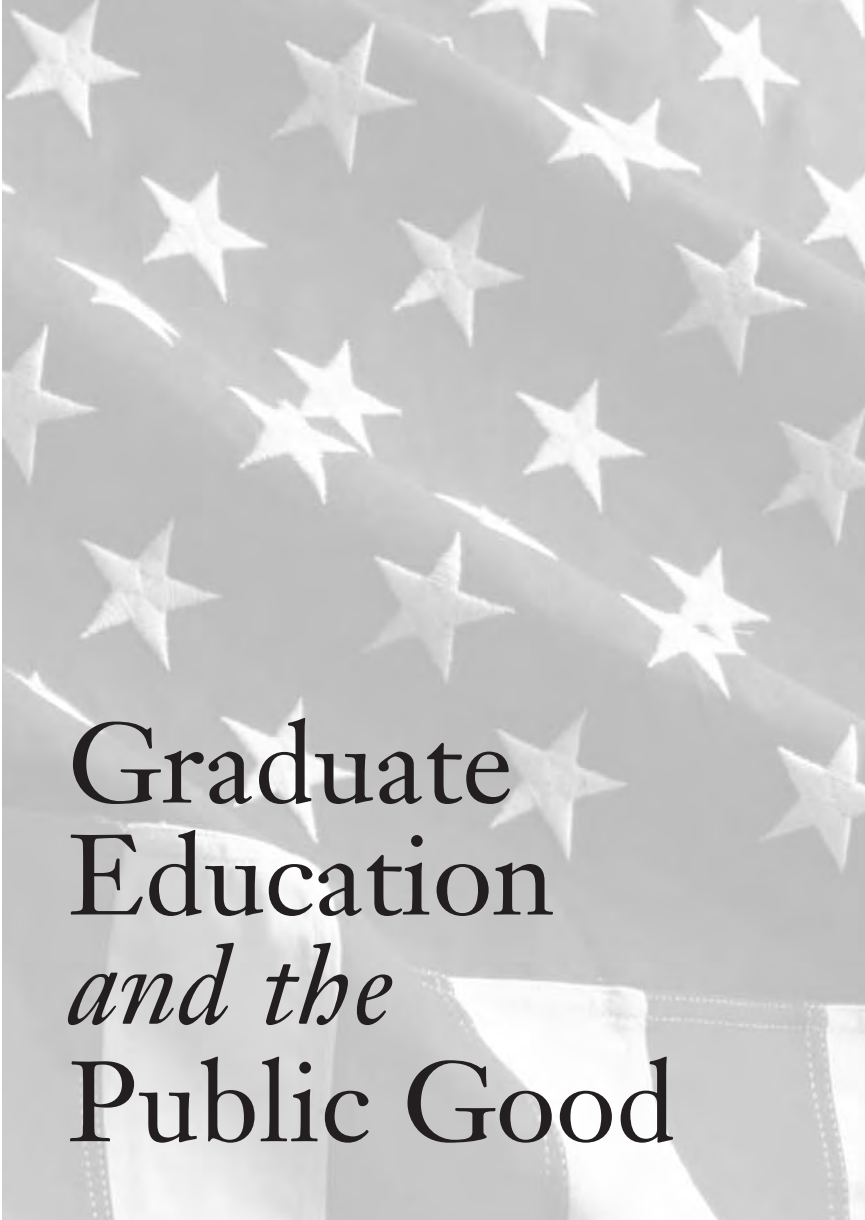
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Executive Summary

A strong link exists between U.S. graduate education, the production of knowledge, and economic and social prosperity. The United States needs a cadre of highly skilled leaders and experts in a variety of fields to address current and future challenges. Increasingly, graduate school is where future professionals obtain the knowledge and skills needed to solve big, complex problems. But fundamentally, graduate education is about people. This report tells the stories of people with graduate degrees from U.S. universities and why their education matters to them and the nation.

The benefits of graduate education extend beyond the economic realm; graduate education also plays a central role in producing an educated citizenry that can promote and defend our democratic ideals.¹ Scholars educated at the graduate level in such fields as science, mathematics, humanities, arts, and social sciences are critically important to our quality of life and the cultural and social fabric of society.

For the past 50 years, U.S. graduate education has been the jewel in the crown of the American system of education, attracting top domestic and international students by creating dynamic programs that foster scholarship, research, and scientific discovery. In the past decade, 62 percent of Nobel Prize winners in chemistry, physics, medicine, and economics received their graduate degrees in the United States.²

The success of U.S. graduate education has not gone unnoticed by other countries and their gov-

ernments. Elsewhere in the world, significant investments are being made in graduate education as part of national economic development strategies. Although the long-term implications of such investments are not entirely clear, we know that the quality of U.S. graduate education must be sustained for our nation to continue to prosper in the 21st century.

Recent reports and public policy that addressed enhancing U.S. competitiveness and innovation recognized the value of graduate education. The National Academies' landmark report, *Rising Above the Gathering Storm*, recommended increasing the number of U.S. citizens pursuing graduate study in areas of national need by funding 5,000 new graduate fellowships each year. The America COMPETES Act, signed into law in August 2007, included many of the report's recommendations in support of graduate study at the master's and doctoral levels.

This report, *Graduate Education and the Public Good*, illustrates how a world-class graduate education system has benefited this nation and the world. It tells the stories of real people who obtained graduate degrees in the United States and have since made important contributions at the local, state, national, and international levels.

The report documents these exemplars' contributions to our collective good across a broad range of sectors and fields. It examines how graduate education is connected to the following:

- Creating the workforce for the new global economy
- Conducting groundbreaking research
- Facilitating technology transfer
- Developing entrepreneurs and innovators
- Preparing future college and university faculty
- Developing leaders for business, nonprofit, and government sectors
- Preparing the K–12 teacher workforce
- Establishing new start-ups that create jobs
- Strengthening communities through social action
- Promoting public health initiatives
- Enhancing society through arts, humanities, and social sciences

Additionally, this report recognizes the contributions that international students have made to the prosperity of the United States. In 2006–2007, there were a quarter of a million international students pursuing graduate degrees in this country, comprising 16 percent of all graduate students.³ More important, many international students remain in the United States after they complete their studies, starting companies that

create jobs or contributing to the public good in other ways. Those who return to their home countries often assume leadership positions and maintain connections with the United States, fostering positive diplomatic relations and enhanced understanding.

The report concludes with a call for a renewed “social contract” between universities and the public that recognizes the special role played by graduate education in enhancing our quality of life. The companion document, titled *Making a Difference*, includes hundreds of examples of graduate degree holders who were nominated by Council of Graduate Schools (CGS) member institutions based on significant contributions they have made to the public good.

The new global competition for talent places increasing importance on maintaining a world-class graduate education system. As noted by author and professor Richard Florida, “For decades, the U.S. has succeeded at attracting and growing talented people because of its creative ecosystem—a densely interwoven fabric of institutions, individuals, and economic and social rights. Attracting people does not just happen; it depends on the care and feeding of the organizations and people that make up the ecosystem.”⁴

Introduction

The ways that graduate education contributes to the public good can be demonstrated from a variety of perspectives, including numbers, facts, and solid rationales. But the connection between graduate education and the public good may best be described from the perspective of people who have earned graduate degrees and by what they have gone on to do with those degrees. The unique aspect of this report is that it links people, their graduate education, and their accomplishments to the public good.

The benefits to individuals of having a master's or doctoral degree are well understood. In general, the more education one has, the more one earns and the more likely one is to be employed.⁵ This relationship is increasingly emphasized in the 21st-century global marketplace, which places a premium on advanced knowledge and skills. The knowledge-based economy requires workers who can use technology in creative ways. This economy spans a variety of technical fields and professions, including all scientific disciplines, software design, media, and financial services, and the number of technical fields is expected to rise.⁶ U.S. culture also has benefited, and will continue to benefit, from the work of scholars and teachers in the humanities, the social sciences, and the arts, who “bring the intellectual history of human thought and creative expression to their students, expanding their capacity for critical thinking by applying the lessons of the past to current problems and future challenges.”⁷ Students, employers, and the general public are increasingly savvy about the private benefits associated with graduate education.

As a result, more students worldwide are pursuing graduate degrees.

Graduate education, indisputably, contributes to the good of society as well as the individual. Many of the benefits of graduate education, as well as higher education in general, are intangible, but that does not make them any less real. In this report the phrase *public good* is not used in the pure economic sense. Rather, the phrase describes how having a world-class graduate education system has benefited the country. The products of this system are the graduates themselves, many of whom have gone on to make contributions or produce goods and services that have provided a collective benefit to the nation and, in some cases, the world.

Efforts are under way to highlight the ways higher education serves the public. The American Council on Education has launched an initiative, “Solutions for Our Future,” that highlights the larger contributions of higher education to our standard of living and to America's place in the world. Institutions of higher education play a critical role in producing knowledge and innovation, finding cures for diseases, training teachers to teach our children, developing the talents of artists and writers, and producing scientists that make new discoveries. Maintaining and enhancing the U.S. system of higher education is critical to maintaining and improving our quality of life.

For over half a century, the United States has benefited from its commitment to graduate education

and research. U.S. graduate schools are widely considered to be the best in the world, attracting the top domestic and international students by creating dynamic programs that foster scholarship, research, and scientific discovery. Many world leaders in business, research, technology, science, government, the arts, and humanities have been trained in U.S. graduate schools.

Recipients of the Nobel Prize are regarded as people who have reached the pinnacle of their profession. In the past decade, among the Nobel Prize winners in chemistry, physics, medicine, and economics, 56 out of 91 (or 62 percent) received their graduate degrees in the United States.⁸

The U.S. government is a major supporter of graduate education, and the benefits to our country from this support have been truly astounding. The National Defense

Education Act (NDEA), established in 1958, is one of the most visible and often-cited initiatives. It was a swift and forceful response to the Soviet's launch of Sputnik in 1957 and provided for education in the United States at all levels. It stimulated the advancement of education in science, mathematics, and modern foreign languages, but also addressed other areas of critical need, including area studies and geography.⁹

The NDEA contributed to growth and capacity in doctoral education by supporting institutions of higher education in awarding fellowships for doctoral study to approximately 27,000 individuals over the life of the program.¹⁰ Many of these individuals conducted important research and made groundbreaking discoveries that have contributed to this country's current unparalleled success and prosperity.

In November 2005, the Council of Graduate Schools (CGS) released *NDEA 21: A Renewed Commitment to Graduate Education*, in which it urged the U.S. government to respond again to the global competition threatening the leadership of the United States.¹¹ A set of specific policy principles and recommendations followed the report, and a number of these recommendations were included in legislation introduced in Congress.

CGS's 2007 report, *Graduate Education: The Backbone of American Competitiveness and Innovation*, addressed the role of graduate education in contributing to American competitiveness and innovation.¹² The report also included policy recommendations for future and ongoing partnerships between policy makers and leaders in business and graduate education. Last August, a bipartisan congressional effort led to the enact-

ment of the America COMPETES Act; the legislation provides a national strategy for enhancing U.S. competitiveness and includes support for graduate education in that strategy.

This report, *Graduate Education and the Public Good*, constitutes the next phase in CGS's efforts. It uses examples of real people to illustrate how a robust and world-class graduate education system

has benefited the nation and the world. Where possible, it quantifies, using statistics and data, the contributions of graduate education to the nation as well as to regions and states. The report highlights the stories of what real people who obtained graduate degrees in the United States have done for our collective good.

This report also examines the role of international students in U.S. graduate education and invest-

“In the past decade, among the Nobel Prize winners in chemistry, physics, medicine, and economics, 56 out of 91 received their graduate degrees in the United States.”

ments being made by other countries in their graduate education systems as part of national economic development strategies. American graduate education is being emulated and transported to other parts of the world. While flattering, this development has potential long-term implications, as talented international students who might have come to the United States for graduate study may decide to pursue graduate education elsewhere. Even those international students who elect to enroll in U.S. graduate schools may decide to return to their country of origin after receiving their degrees. However, these highly educated professionals can serve as goodwill ambassadors when they become leaders abroad and build collaborations with their colleagues here. Therefore, it is

important that the United States continue to seek and nurture these talented individuals as we compete in the global economy while simultaneously pursuing efforts to increase participation of domestic students in key fields.

Finally, the report is accompanied by a document titled *Making a Difference*. It contains information on a selection of individuals with graduate degrees who were nominated by CGS member institutions. *Making a Difference* is organized by region, state, and by the nominating institution of higher education, and its stories document the effects that these individuals—with their initiative, drive, and talents—have had on our economy and society.

How Does Graduate Education Contribute to the Public Good?

Graduate education is a key factor in creating the highly skilled workforce necessary to participate and remain competitive in today's knowledge-based economy. The benefits to government, business, and society from a world-class graduate education system are increasingly evident.

The private benefits from higher education cannot be disputed—the results include higher salaries, sustained employment, personal and professional mobility, and improved quality of life.¹³ However, the public good associated with increased levels of education is often taken for granted because it may be intangible or difficult to measure.¹⁴ Numerous examples can be used to demonstrate how higher education, particularly graduate education, affects society at the national, state, and local levels.

Contributing to the Public Good Nationally

The United States benefits in many ways from having a highly educated population: increased tax revenues, greater productivity, increased workforce flexibility, decreased reliance on government financial assistance, and improved ability to adapt to and use technology—critically important in the ever-changing knowledge economy.¹⁵ According to the Bureau of Labor Statistics, one-sixth of the fastest

growing occupations for 2006–2016 require a master's or doctoral degree.¹⁶

Revenues

Higher taxes are associated with higher incomes, and holders of advanced degrees usually earn higher incomes. Therefore, having a highly educated populace may benefit tax bases at all levels of government.

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In general, incomes increase with level of education. Adults with advanced degrees earn an average of 44 percent more than those with bachelor's degrees. The U.S. Census Bureau reported that in 2006, the median earnings for an individual over 25 with a bachelor's degree was \$46,435, compared with \$55,445 for those with a master's, and \$78,212 for

those with a doctorate.¹⁷ Over their working lifetimes, master's degree holders will earn, on average, \$400,000 more than workers with a bachelor's degree, and students who achieve a doctoral degree will earn approximately \$1.3 million more.¹⁸

Those with a master's degree or higher also tend to require less public assistance. In 2003, the percentage of the U.S. population over 25 who received public assistance was 0.1 percent for those with an

advanced degree. This compares with 2.1 percent of the U.S. population with less than a high school degree and 0.9 percent for those with less than a bachelor's degree.¹⁹

Health

As costs have risen, health care has become an increasingly important issue. The federal government and state governments are spending increasingly more for Medicaid and Medicare, while in the private sector, companies struggle to provide health insurance to their workers. Therefore, when only 67.3 percent of the U.S. population over 25 without a high school diploma say their health is good, very good, or excellent (compared with 92.5 percent of those with advanced degrees), one could infer that health care costs for those with advanced degrees will probably be lower and less of a strain on public coffers.²⁰

In the realm of public health, those with graduate degrees are often using their knowledge to improve health care. For example, Dr. James Allison, who received his PhD in biological sciences from the University of Texas, Austin, now chairs the Immunology Program at Memorial Sloan-Kettering Cancer Center.

He and his colleagues have created antibodies that are designed to fight melanoma, renal cell carcinoma, and prostate and ovarian cancers. Another breakthrough in combating cancer came from Dr. Robert Rose, who received his PhD in microbiology and immunology from the University of Rochester. He and his colleagues developed a vaccine against four types of the virus that causes cervical cancer.

Dr. Timothy Crowder, who earned a PhD in biomedical engineering, is helping to improve the quality of people's lives. While a graduate student

at the University of North Carolina, Chapel Hill, Dr. Crowder developed a "smart inhaler" for patients with lung disorders and diseases. Currently vice president of Oriol Therapeutics, Inc., he holds several U.S. patents and has 14 U.S. and associated international patent applications pending.

Nurses are crucial to our public health system, as exemplified by Judi Frerick, who received her master's degree in nursing from Northern Kentucky University. An assistant professor in the School of Nursing and Health Professions at Northern Kentucky University, Ms. Frerick teaches community and public health nursing. She is the Director of the Northern Kentucky Nursing Research Collaborative where she works with local hospitals, schools and healthcare facilities to col-

laboratively reduce lead poisoning hazards and the resulting incidence of learning disabilities in children. In addition, Ms. Frerick promotes nursing as a profession to local area high schools through the Pathways to Nursing program.

In the biomedical sciences, research is being conducted to address specific health issues related to minority populations.

Dr. Martin Farias, III is working on a joint research project to identify the causes of cardiovascular disease in the Mexican American population of southern Texas. He received his PhD in integrative physiology from the University of North Texas Health Science Center and is currently an assistant professor at the College of Pharmacy at Texas A&M University-Kingsville.

Employment

Nationally, employment rates are higher for adults with higher levels of education, though percent-

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ages vary by state as well as by field.²¹ In 2005, though individuals with master's and doctoral degrees represented only 7.3 percent and 1.3 percent, respectively, of the total population ages 25–64, they were 8.1 percent and 1.5 percent, respectively, of the total employed population. In the civilian labor force, of those ages 25–64, 84.5 percent of individuals with a master's degree were employed, and 90.2 percent of those with a doctoral degree were employed; that compares with 82.7 percent of individuals with a bachelor's degree, 72.8 percent of those who completed high school, and 58.1 percent of those without a high school diploma.²²

Although the perception may be that people who receive PhDs pursue academic careers, the reality is that in 2000, over 70 percent of doctoral degree holders worked outside of academia.²³ A host of fields and professions—ranging from health and legal services to manufacturing and educational services outside of colleges and universities—demand highly educated people to fill the positions necessary to keep the economy moving forward.

Civic Responsibility

Parents with postsecondary degrees are more likely to educate their children about community, national, and world events. This interaction helps form the next generation of civic leaders. Nearly 60 percent of parents with a master's degree or higher provide their 10th-grade children with information about world or national events.²⁴ They are more likely than parents who did not complete college to involve their children in community activities, such as concerts, religious services, sporting events, or plays.²⁵ Cognitive skills of preschoolers ages three to five years were highly correlated with their mothers' education levels; for instance, 75 percent

of children whose mothers held a master's degree or higher, could count to 20.²⁶

Higher education also has a spillover effect on voter awareness of public events, such as more frequent reading of newspapers and journals and increased awareness of local issues, including state and local tax policies.²⁷ In the national election in November 2000, the percentage of the U.S. population over 25 who voted varied greatly by education level: 82.1 percent of those with advanced degrees voted, compared with 56 percent of those with a high school diploma.²⁸

In addition, higher education can play a critical role in the health of American democracy by helping students become responsible

citizens in their own communities, the nation, and the world. For example, Dr. Jerry Zurek, who received his doctorate in English from Bryn Mawr, was named the 2005 Professor of the Year in Pennsylvania by the Council for the Advancement and Support of Education. This program honors the most outstanding instructors in the country—those who excel and influence the lives and careers of their students. Dr. Zurek, a professor at Cabrini College, is highly engaged in mentoring and in making sure that his students see the effect they can have on social institutions, the political system, and legislation.

Future Faculty

According to the National Academy of Sciences, graduate education is critical to fulfilling national goals in two discrete ways. First, the nation's universities and colleges produce the teachers and researchers of tomorrow. Second, they provide students with advanced scientific and technological knowledge and the skills to innovate.²⁹

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Jerry M. Evensky is a stellar example of a professor who prepares future faculty. Currently, he is the Laura J. and L. Douglas Meredith Professor for Teaching Excellence, the Maxwell School at Syracuse University. He received two master's degrees from the University of Missouri–St. Louis, one in education and one in economics, and a doctorate from Syracuse University. The recipient of numerous teaching awards, he shares his knowledge through workshops designed to assist other faculty in improving their own teaching skills.

To bring this issue into perspective, the words of Dr. Joan F. Lorden, then associate provost for research and dean of the graduate school at the University of Alabama at Birmingham, explained the challenge: “Taxpayers may not realize they have an important stake in graduate education. At the state level, undergraduate students are often the focus of public discussions. But it is the people with advanced degrees who train our future teachers—their impact is felt all the way up the line.”³⁰ Others agree, noting that good graduate students often become the teaching faculty who are training the next generation of undergraduates.³¹

These “preparers of future faculty” also conduct groundbreaking research—research they could not accomplish had they not been taught during their graduate studies by scholars and academicians.

The Next Generation of Researchers

The U.S. system of combining graduate education with cutting-edge research is unique. It not only strengthens the country's research enterprise, but also produces a highly educated cadre of individuals to assume leadership positions in

academia, industry, and government. These individuals will address the pressing challenges we confront today by developing new technologies and industries, devising methods to combat disease and hunger, creating ways to reduce environmental pollution, and discovering new sources of energy—all directed toward improving our quality of life and maintaining U.S. competitiveness. They will follow in the footsteps of the countless individuals trained in America's graduate schools who have truly made a difference under extremely challenging circumstances.

When the terrorist attacks of September 11, 2001, occurred, citizens stepped forward to assist in the recovery efforts. One such individual was Dr. Robert C. Shaler, who received his doctorate in biochemistry from Penn State. He used his

expertise in forensics and DNA identification to lead the work of identifying the majority of the 2,749 victims of the World Trade Center attacks.

As new technologies and products are implemented and developed, it is important to evaluate how the populace might be affected, particularly children. Dr. Janice Chambers, who received her doctorate in animal physiology from

Mississippi State University, is a toxicologist who has been the principal investigator for over \$20 million in competitive federal grant funds. She leads the university's Center for Environmental Health Sciences, whose work has assisted the U.S. Environmental Protection Agency in its risk assessments of pesticide levels in children.

In addition to those graduates featured in this report, the companion document, *Making a*

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Difference, provides a further sampling of the accomplishments of a range of people who received their graduate education in the United States.

Contributing to the Public Good at the State and Local Levels

Data show that in states and localities, residents' quality of life increases with higher levels of education.³² A growing number of states are emphasizing the importance of graduate education. A recent report from the New York State Commission on Higher Education included a number of recommendations on how New York can improve its higher education institutions and remain competitive in the 21st century. Among other things, the report called for hiring an additional 2,000 full-time faculty over the next five years, as well as recruiting a minimum of 4,000 doctoral students who would be provided with competitive financial packages.³³

At the local level, many programs have been instituted within graduate schools to involve students in community initiatives and service. This type of engagement often leads to students becoming further involved in addressing community needs after they receive their degrees. Through such programs, universities enable students to become "citizen scholars" with a broader understanding of how they can directly affect society and find solutions to problems both large and small.

A sampling of what some other states and localities are doing follows.

Alabama

When the Alabama Council of Graduate Deans surveyed Alabama businesses, it found that increased collaboration and cooperation between

businesses and graduate schools are integral to the continued growth of the technology and service sectors in the state. An investment in graduate education can provide an immediate payoff for the state because a large majority of new alumni of graduate programs remain in Alabama and contribute to the state's economic growth and strength.³⁴

California

Research programs at leading universities, which are undertaken in part through graduate education, economically benefit their surrounding areas as

well as the nation. In California, university research accounted for \$5.2 billion in economic productivity in 2000–2001.³⁵

California universities are creating initiatives that will benefit the state's population in many other ways. For example, about 10 years ago, the University of Southern California (USC) began research on community and social problems in the

greater Los Angeles area. They suspected that issues in their region were also of concern in other urban areas in the United States. The research resulted in a series of publications on innovative "best practices" to address homelessness and poverty, as well as action plans to combat sprawl.³⁶

Kentucky

Dr. Lee Todd, Jr., president of the University of Kentucky, has explained to local businesses that "research drives jobs" and that the university is critically important to the economic well-being of the population of the local community and all of Kentucky. Dr. Todd has pushed forward a plan to bring in more research grants and private funding to strengthen the university. As a result, federal research grants to the university have grown from

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\$100 million in 1997 to \$300 million in 2007, which has benefited the local economy.³⁷

Missouri

Governor Matt Blunt declared the week of April 2–9, 2006, Graduate Education Week. Several events were held at various graduate schools across the state, celebrating the contributions of graduate students and the value of graduate education to the state. Similar events were held in 2007 and 2008.³⁸

Montana

Sheila Stearns, commissioner of higher education, said that the state needs to invest in education and partnerships between institutions and industry in order to build the state's economy and maintain its strength into the future. One requirement for building that strength is to increase interest and enrollment in gradu-

ate education programs. Montana currently has fewer students in graduate study than other states do.

Commissioner Stearns notes, "Investing in graduate students isn't high on the list of any legislator, but often times, those graduates become important to economic development."³⁹

North Carolina

Linking graduate education to the people is integral to connecting a university to its state's residents because graduate students and faculty can have a tremendous impact through their research.⁴⁰ In North Carolina two public research universities, North Carolina State University and the University of North Carolina, help build the state's economy. Start-ups generated by North Carolina State students and faculty have created over 2,000 new jobs and brought in over a quarter

billion dollars in funding from venture capital firms. In 2007, North Carolina State University was issued 38 U.S. patents.⁴¹

While in school, graduate students at the University of North Carolina do research that helps communities as a whole. Projects in 2007 included studying the effects of air pollution on health, creating a public-private partnership to assist in economic recovery efforts, evaluating the results of an anti-tobacco campaign, and improving middle school students' understanding of and interest in a variety of careers.⁴²

Pennsylvania

In 1992, the University of Pennsylvania's Barbara and Edward Netter Center for Community Partnerships was founded to serve as a catalyst for the transformation of West Philadelphia from a

declining neighborhood to one with a promising future. More than 150 academically based community service courses from diverse disciplines and schools across the university are offered through the Center. In 2004–2005, more than 2,100 students were involved at the undergraduate and graduate level.⁴³ One of the grad-

uate courses explores critical issues and implications of various policies pertaining to college access, with particular attention to the effects of these policies for underrepresented groups. In its 16 year existence, the Center has received numerous awards and many other colleges and universities in the United States have used it as an example upon which to build their own community partnership programs.⁴⁴

Virginia

Governor Timothy Kaine recently lauded the Virginia Council of Graduate Schools Annual Graduate Student Research Forum by writing,

"Investing in graduate students isn't high on the list of any legislator, but often times, those graduates become important to economic development."

“Graduate education is an essential component of the research agenda for the Commonwealth of Virginia . . . Graduate students work closely with faculty to create new understandings and discoveries which are applied to the social and economic challenges facing society. They also contribute to the learning and engagement missions of our colleges and universities as they prepare for careers as scientists, teachers, leaders, artists, and professionals.”⁴⁵ The tagline on his letter reads “Investing in graduate education is investing in Virginia!”⁴⁶

To honor the victims of the 2007 shootings at Virginia Tech, the university has initiated a com-

munity service initiative called the VT-ENGAGE challenge for students, faculty, staff, and alumni. The goal is for volunteers to serve at least 10 hours of community service by graduation with a total goal of 300,000 hours. The Virginia Tech Alumni Association, with a membership of more than 197,000, voted to challenge its members around the world to donate an additional 300,000 hours of community service for a total of 600,000 hours.⁴⁷ Graduate students are very much involved through the graduate school’s Citizen Scholars program, the Graduate Student Assembly, and the Alpha Epsilon Lambda graduate honor society.

How Does Graduate Education Improve Our Quality of Life?

Many of the recent reports on enhancing U.S. competitiveness including those by the National Academies and the Council on Competitiveness, indicate that innovation is a key factor in the future prosperity of the United States. They also show that other countries are challenging U.S. economic leadership. Graduate students' work and that of graduate degree holders contribute directly to sustained growth and prosperity. Therefore, graduate education is vital to the United States' ability to maintain its economic leadership. Overall, graduate education serves as a catalyst in the following ways:

- Creating the workforce for the new global economy
- Conducting groundbreaking research
- Facilitating technology transfer
- Developing entrepreneurs and innovators
- Preparing future college and university faculty
- Developing leaders for business, nonprofit, and government sectors
- Preparing the K–12 teacher workforce
- Establishing new start-ups that create jobs
- Strengthening communities through social action
- Promoting public health initiatives
- Enhancing society through arts, humanities, and social sciences

Creating the Workforce for the New Global Economy

A highly trained workforce is essential to America's future economic competitiveness and national security. Graduate education plays an important role in creating this workforce. In the words of C. Judson King, former provost and senior vice president for academic affairs of the University of California system, graduate students are highly qualified to meet future state workforce demands because their programs "require intensive study, highly honed analytical skills and original contributions to knowledge that fosters creativity."⁴⁸

But changes are occurring that will affect U.S. graduate schools. The demographics of the graduate school population differ greatly from 25 years ago. Prior to 1984, men were the majority in U.S. graduate schools; today, women account for nearly 60 percent of total enrollment.⁴⁹ According to Patricia Maguire Meservey, president of Salem State College in Massachusetts, this demographic will "significantly alter the landscape of the future workforce. The emergence of more women in leadership roles will almost certainly bring new ways of thinking to the business-as-usual milieu in the not-too-distant future, and we must be prepared for it."⁵⁰ She argues that tomorrow's workforce must not only be technically talented, but also be effective communicators, problem solvers, and team players. "In the world that looms before us, a bachelor's degree alone will no longer suffice, and more jobs than ever will require both advanced degrees

and advanced credentials.” She believes that universities can produce the talent we need; however, with traditional funding sources becoming tighter, universities will have to develop new funding sources through development of private, public, and corporate partnerships. The importance of collaboration within and among all sectors was also highlighted by the Council of Graduate Schools in its 2007 report on the role of graduate education in enhancing U.S. competitiveness and innovation.

Other concerns will put pressure on the United States to produce the workforce of the future. Increasingly, other countries are competing for the best and the brightest global talent, and the cost of recruiting that talent is increasing. Both Craig Barrett, chairman of Intel Corporation, and Bill Gates, chairman of Microsoft, have expressed concerns about current immigration policies in the United States, which affect our country’s ability to augment the workforce with highly educated and skilled foreign professionals. This contrasts with immigration policies in other countries, which are designed to attract and recruit talent.⁵¹

Despite these challenges, U.S. graduate schools continue to produce high-achieving individuals who nurture and help create the workforce for the global economy. Here are a few examples of people who have made important contributions.

Dr. Mary Good is founding dean and Donaghey professor of the Donaghey College of Engineering and Information Technology at the University of Arkansas at Little Rock. She holds a PhD in chemistry from the University of Arkansas and has served at the highest level in all three sectors: aca-

demia, industry, and government. During her time in industry as senior vice president of technology at Allied Signal, Inc., she was responsible for technology transfer and commercialization support for new technologies. While serving in the federal government, she was a member of the National Science Board and the President’s Council of Advisors on Science and Technology and was under secretary for technology for the Technology Administration in the Department of Commerce.

A PhD in chemistry from the University of California, Berkeley, helped Dr. Andrew Grove. He cofounded Intel Corporation five years after receiving his degree in 1968. He has written over 40 technical papers and holds several patents on semiconductor devices and technology. He currently is a lecturer at the Stanford University Graduate School of Business and is involved in the Grove Foundation, a private philanthropic organization. Intel just topped the Corporate Responsibility Officer (CRO) magazine’s Best Corporate Citizen list by designing energy-efficient products and investing heavily in education—recognizing that its future success depends upon an educated workforce.⁵²

Dr. Stephanie Pace Marshall holds a PhD in educational administration and industrial relations from Loyola University in Chicago. She was the founding president and is now president emerita of the internationally recognized Illinois Mathematics and Science Academy. Dr. Marshall is recognized as a pioneer and innovative leader and teacher in pedagogical approaches to science and math education. She also is an inspiring speaker and writer on leadership, learning, and schooling, and on the design of generative and life-affirming learning organizations.⁵³

“In the world that looms before us, a bachelor’s degree alone will no longer suffice, and more jobs than ever will require both advanced degrees and advanced credentials.”

These are just a few examples of those who emerged from U.S. graduate schools and went on to become leaders in academia, industry, and government, while playing an important role in helping to create the workforce for the global economy.

Conducting Groundbreaking Research

Eminent individuals and organizations have called for increased federal investments in basic research and graduate education. One of the most prominent is the National Academies Committee on Science, Engineering, and Public Policy, which produced the 2005 report *Rising Above the Gathering Storm*. The report identified insufficient funding by the federal government to support basic research and called for increases of 10 percent annually for seven years. It also called for additional research grants to early-career researchers, as well as portable fellowships for graduate students.⁵⁴

Research and innovation have been the drivers of the U.S. economy and have helped propel the nation to its current leadership position in the world. Numerous reports have warned that with threats to that leadership position, strengthening graduate education is essential for a prosperous and secure future. Graduate students' work contributes directly to sustained economic growth and prosperity, because these individuals conduct groundbreaking research in science, medicine and health, education, and the arts and humanities at universities, in national laboratories, and in private industry. After graduation, many go on to continue groundbreaking research. A few examples illustrate the case.

Graduate programs at The Ohio State University helped develop the expertise of both Dr. Lonnie

Thompson (MS and PhD in geology) and his wife, Dr. Ellen Stone Mosely-Thompson (MA and PhD in geography [Climatology]). Both are internationally recognized researchers who are at the forefront of climate change science, serving as members of the Intergovernmental Panel on Climate Change (IPCC). In 2007, the IPCC

shared the Nobel Peace Prize with former vice president, Al Gore. Hundreds of other scientists from all over the world participate in the work of the IPCC as authors, contributors, and reviewers.

Dr. Robert E. Kahn, after receiving his PhD in electrical engineering from Princeton University, began his career at the

Massachusetts Institute of Technology. In 1972, he took a break from his professorship at MIT and moved to the Defense Department's Advanced Research Projects Agency (now DARPA) and subsequently became director of DARPA's Information Processing Techniques Office. While director he initiated the U.S. government's billion-dollar Strategic Computing Program, the largest computer research and development program ever undertaken by the federal government. Dr. Kahn is the co-inventor of the TCP/IP protocols, which are the technologies responsible for the modern Internet.

Facilitating Technology Transfer

Technology transfer is a key facet of graduate education and research, acting as a driving force for entrepreneurship and innovation. New products and services often germinate in partnerships between universities and industry. Additional revenues generated by the commercialization of inventions are then available for reinvestment in the local economy and in further research.⁵⁵

Dr. Robert Kahn is the co-inventor of the TCP/IP protocols, which are the technologies responsible for the modern Internet.

Businesses are increasingly calling upon universities to create and share scientific and technical knowledge. As a result, universities, primarily at the graduate level, are filling this need by increasing the amount of research they do with industry, then commercializing the results through campus technology transfer centers, or partnering with industry to bring new technologies to the marketplace. Every research university in the United States has an office or center of technology transfer that manages the use of university research results for the public benefit. These offices provide faculty and researchers in the graduate schools with information on patenting, licensing, and other commercialization support.

An example of a university “spin-off invention” comes from Bret Lanz, who received his master’s of business administration from Kansas State University (KSU). Mr. Lanz is the manager of the Advanced Manufacturing Institute, which is networked to diverse groups of experts at KSU and other key businesses and organizations. He was responsible for the commercial success of a decontamination agent for biological and industrial hazards.

Developing Entrepreneurs and Innovators

The 2007 CGS report *Graduate Education: The Backbone of American Competitiveness and Innovation* underscored the importance of entrepreneurship and innovation, citing Google as an example of a company creating groundbreaking, innovative products and services that resulted from university research.⁵⁶ The creators of Google, Sergey Brin and Larry Page, began the site as a graduate research project in computer science at Stanford University.

The growing recognition of the benefits of entrepreneurship in graduate education, combined with its apparent neglect within the nonbusiness graduate curriculum, led the Council of Graduate Schools to initiate a national discussion around entrepreneurship as part of graduate education. This effort

resulted in the publication of a monograph—“Capitalizing on Innovation: Entrepreneurship and Graduate Education”—which provides recommendations for capitalizing on innovation through graduate curricula in entrepreneurship.⁵⁷

Entrepreneurial success is manifested in the career of Robert L. Johnson, former chief executive officer of BET Holdings II, Inc. With a master’s degree in international affairs from Princeton University, Mr. Johnson developed a niche for the African American community using cable television technology. BET, which was one of the leading Black-owned and operated media-entertainment companies in America, is now a subsidiary of Viacom. Mr. Johnson also serves on the board of several nonprofit organizations, including Johns Hopkins University in Maryland.

While in graduate school completing his doctorate in chemistry from Duke University, Dr. Carmichael Roberts developed molecules now being used by a number of academic and industrial biologists to determine mechanisms and cures for a variety of diseases. Having also completed an MBA from MIT, he then combined his knowledge of business and science as the cofounder and president of Surface Logix, a Boston-based biotechnology company, which makes microdevices that are used with proteins and cells to discover new drugs. Dr. Roberts also cofounded WMR Biomedical, Inc., with George Whitesides (of Harvard University), his mentor, partner, and best friend. The company focuses on materials for medical devices. He was selected in 1999 by *Technology Review Magazine* as one of the top 100 entrepreneurs in the United States.

Dr. Allen R. Atkins was a leader in innovation and technical expertise for several major aerospace engineering firms, including Lockheed Martin and the Boeing Company. After receiving his PhD in engineering from Tennessee Technological University in 1975, Dr. Atkins excelled in business, but he also made it part of his life’s work to lead and foster partnerships to support minority innovators. He was chairman of the board of the group Advancing

Minorities' Interest in Engineering and facilitated partnerships between industry, government, and designated historically black colleges and universities.

Preparing Future College and University Faculty

One of the most successful models of how graduate education can prepare future faculty to teach undergraduate students is the Council of Graduate Schools' Preparing Future Faculty (PFF) program. The PFF program, a collaborative project, provides graduate students interested in becoming future faculty with opportunities to observe and experience faculty responsibilities at a variety of academic institutions. In the PFF program, clusters of diverse institutions work together to integrate preparation for faculty careers into the graduate experience. Graduate students in the program participate in faculty roles at nearby institutions as they complete their doctoral work. The program seeks to make research and teaching careers and graduate education more attractive by raising the caliber of undergraduate teaching. Participants are enthusiastic about how the PFF program expands their knowledge and strengthens their preparation for faculty work. Today, PFF programs are active in more than 45 institutions with doctoral programs and nearly 300 partner institutions in the United States. The initiative has become a well-recognized national movement.

An example of a graduate student who researched and evaluated teaching methods and curricula in biology and earth science is PhD candidate Russell Benford, from Northern Arizona University (NAU). Mr. Benford has collaborated with researchers, administrators, and other educators on

research and evaluation of educational strategies at both NAU and Arizona State, as well as collected and analyzed data that monitor the pedagogical impact of curricula.

Developing Leaders for Business, Nonprofit, and Government Sectors

The demands on government at all levels, as well as business and nongovernmental organizations, are enormous and growing. Highly skilled individuals such as those described below are needed to pursue careers in all three of these sectors.

A holder of multiple graduate degrees, Dr. Joann M. Eisenhart is at the forefront of recruiting highly skilled professionals for the Pfizer Corporation. As Vice President for Human Resources for Pfizer's Global Research and Development Organization and Pfizer's Medical Division, Dr. Eisenhart has first hand experience with the challenges facing the U.S. pharmaceutical industry in recruiting scientists. She holds a PhD in inorganic chemistry from the University of Wisconsin-Madison and a PhD in human and organizational development from the Fielding University.

One outstanding example of a leader in the non-profit world is Dr. Moira Gunn, host of radio show Tech Nation, which airs on many National Public Radio member stations. Dr. Gunn, who received her PhD in mechanical engineering from Purdue University, worked for the National Aeronautics and Space Administration (NASA) as a scientist and engineer and holds a technical patent in human nutrition. Her program Tech Nation is the only national weekly radio program on the impact of science and technology on everyday life.⁵⁸

Dr. Moira Gunn hosts Tech Nation, the only national weekly radio program on the impact of science and technology on everyday life.

The Honorable Lois Capps represents the 23rd District of California in the United States House of Representatives. She received her master's degree in education from the University of California, Santa Barbara. Representative Capps is a champion of issues that affect people's daily lives, such as better schools, health care, and a cleaner environment. She serves on the Committee on Energy and Commerce and the Natural Resources Committee. She spent 20 years as a nurse and health advocate for the Santa Barbara school district and taught part-time at Santa Barbara City College for a decade.

U.S. graduate schools have been in the forefront of creating new programs that respond to current workforce needs in government, nonprofit organizations, and the business sector. One of the most innovative graduate degrees responding to the needs of the nonacademic sector is the Professional Science Masters degree (PSM). These degrees are designed to allow students to pursue advanced training in science or mathematics while simultaneously developing workplace skills highly valued by employers. PSM programs consist of academic training in an emerging or interdisciplinary area, along with a professional component that may include internships and cross-training in business and communications. While these programs currently represent a very small portion of all graduate programs, indications are that they are increasing and that the graduates are finding satisfactory employment.

Preparing the K–12 Teacher Workforce

The United States must have a high-quality K–12 workforce so that our children will be prepared for their future. Universities are responsible for producing future teachers and for producing the professoriate who will prepare teachers. Students pursuing graduate degrees in teaching need more instruction in interacting outside the classroom with students and in teaching students with different learning styles.

One excellent example of a K–12 teacher is Kenneth Huff, who received his master's degree in elementary education from Buffalo State College. As a sixth-grade science teacher at Mill Middle School in Williamsville, New York, he has influenced generations of students and the teaching profession, particularly in the area of aerospace education. In 2006, Mr. Huff was honored with a Presidential Award for Excellence in Mathematics and Science Teaching. In 2001, NASA chose him as a field-test teacher. He also works with NASA in the development of its Engineering Design Challenges Program, SpaceSim Orbiter Docking Simulation, and Distance Learning Network.

There are many effective programs that prepare future teachers. For example, the University of Wyoming has a program linking Science, Technology, Engineering, and Mathematics (STEM) graduate students with K–12 school systems and communities. The “Science Posse” program, partially supported by the National Institutes of Health's Science Education Partnership Award and the National Science Foundation's Graduate Teaching Fellows in K–12 Education programs, involves a group of graduate students with a passion for both science and education. The students work with teachers in middle and high schools to develop demonstrations and workshops about science topics. By sharing their enthusiasm about their research, these graduate students instill excitement about science among teachers and students. The Science Posse has developed interdisciplinary, inquiry-based curriculum for middle and high school classrooms, which challenges students to solve problems by examining the world around them. Students are turned on to science by solving the problems.⁵⁹

Establishing New Start-Ups That Create Jobs

At many universities, graduate program research generates new products. Moreover, “entrepreneurship education” is a rapidly growing field of study on many campuses. These programs can also play a

role in successfully creating start-up companies. Examples of people who received graduate degrees and went on to form start-up companies follow.

Dr. Sol J. Barer, with a PhD in chemistry from Rutgers University, is currently CEO of Celgene—one of the world’s largest biotech companies. While he worked at Celanese Corporation, he founded the research and development group from which Celgene was created and helped orchestrate its spin-off as a stand-alone company. His group developed therapeutic uses for thalidomide derivative drugs that have had significant impact on patients, including for the treatment of multiple myeloma.⁶⁰

A spinal cord injury led Michael Stephens to change the lives of thousands through the founding of ReLife. Before being acquired by a larger company, ReLife spanned twelve states and included forty-six rehabilitation facilities designed to treat people with brain and spinal cord injuries. After receiving his master’s of science in health administration from the University of Alabama Birmingham, he not only founded ReLife but also the Lakeshore Foundation, a nonprofit organization with the mission of developing the independence of individuals with physical challenges. The Foundation’s facilities serve as a training area for the U.S. paralympic team.

Strengthening Communities through Social Action

Many U.S. graduate schools offer programs that educate, train, and encourage students to become “citizen scholars.” In these programs, students acquire scholarship and experience in real-world settings and provide services to the community. They often use this knowledge after graduation, joining the ranks of graduate degree holders who have made a difference in their communities. For

example, Marco Figueiredo, who received his master’s degree in engineering from Loyola College in Maryland and works with NASA’s Goddard Space Flight Center, founded the nonprofit Loyola Center for Community Informatics (CCI). The CCI works to expand Internet and computer access in poorer communities by engaging faculty and students from Loyola College.

Julia Demichelis, who earned her master’s degree in urban planning from the University of Oregon, has worked for years with nongovernmental organizations committed to rebuilding communities

destroyed by wars in the Balkans and Africa. She currently serves as chief of party of the U.S. Agency for International Development’s Morocco Parliament Support Project in Rabat, Morocco. Ms. Demichelis has applied her planning skills to create community

reconciliation and reconstruction mechanisms within countries experiencing conflict around the world, most recently in Iraq.

Promoting Public Health Initiatives

Graduate students are an important and integral part of universities’ efforts to promote public health initiatives. The students are prepared for productive and rewarding careers in many areas of the sciences and public health. They serve the nation in public service, create new knowledge, train the next generation of scientists, and contribute to the advancement of health and science in both public and private positions.

Dr. Kelly Brownell, who received his doctorate from Rutgers University in clinical psychology, is on a decade-long crusade against America’s “toxic food environment.” Dr. Brownell wants to “hit junk-food junkies where it hurts: in their wallets”.⁶¹ He is best known for having first proposed

Dr. Sol Barer is currently CEO of Celgene—one of the world’s largest biotech companies.

the “Twinkie tax.” One of the leaders in the fight against childhood obesity, Dr. Brownell has called for a ban on sweetened-cereal ads aimed at kids and a tax on high-fat, low-nutrition food (with the revenue earmarked for children’s nutrition). He is often cited as a “moral entrepreneur” with special influence on public discourse in the obesity field. *Time* magazine recognized him as a leader in the area of nutrition and public policy.

Dr. Paula Sherwood received her PhD in nursing from Michigan State University and is an assistant professor of nursing at the University of Pittsburgh. She conducts research to examine the effects on family members as they become primary caregivers for patients with brain tumors. The issues are critical, considering the need to prevent caregiver burnout and institutionalization of patients.

Enhancing Society through Arts, Humanities, and Social Sciences

The benefits of graduate education extend beyond science, technology, engineering, and mathematics to encompass a broad cadre of leaders and experts across a range of fields. Nearly 10 years ago, in a report on graduate education, the Association of American Universities addressed the importance of graduate programs outside of science and technology. “Graduate programs... educate the scholars in the humanities, social sciences, and the arts who preserve and enlarge our understanding of the history and scope of human thought and the human condition, and transmit that knowledge to succeeding generations.

Moreover, graduate education produces the scholars in all disciplines who become the faculties of the nation’s more than three thousand colleges and universities... In the classroom and beyond, teaching and scholarship in the humanities, social sciences, and the arts inform the public discourse essential to the functioning of a democracy.”⁶²

Scholars in the humanities, arts, and social sciences have been critically important to the cultural and social fabric of our society. For example, Carole Artigiani, who received her master’s in women’s history from Sarah Lawrence College, founded Global Kids, Inc., which has helped transform thousands of at-risk New York City teens into global citizens. Global Kids has served over 100,000 young men and women in New York City and other areas by offering leadership and professional development along with academic assistance. In 2006-2007, nearly 600 student leaders worked with more than 16,000 youth and educators at schools and other sites and involved others through its work in digital learning.⁶³ They have worked on such issues as human rights, global health, and ethnic conflict.

Another example is Michael Van Milligen, who received his master’s degree in public administration from Southern Illinois University. He is an innovator in public service and administration and presided over the “rebirth” of Dubuque, Iowa, by developing key community assets. In 2004, he was featured as part of the Harvard University John F. Kennedy School of Government’s “Innovators in Public Service” Series.

What Do International Students Contribute to a Prosperous United States?

“Foreign students enrich the cultural diversity of the educational experience for U.S. residents as well as enhance the reputation of U.S. universities as world-class institutions.”⁶⁴ In 2006–2007, international students made up 16 percent of students seeking advanced degrees in this country.⁶⁵ Additionally, many of these international students find teaching positions at some of the most prestigious schools in the United States, thereby training some of the very best students. They also carry out groundbreaking research.

Those who return to their home countries often have an impact on the public good there by disseminating the results of their research or creating companies. For example, the 2006 Nobel Peace Prize winner, Bangladesh banker and economist Dr. Muhammad Yunus, received his PhD in economic development from Vanderbilt University. After three years as an assistant professor in economics at Middle Tennessee State University, Dr. Yunus returned to his home country and developed the concept of microcredit. He founded the Grameen (which means rural in Bengali) Bank to fully implement this theory. He

believed that if money were made available to poor people on appropriate and reasonable terms, “these millions of small people with their millions of small pursuits can add up to create the biggest development wonder.”⁶⁶ The Grameen Bank has loaned nearly \$6 billion to over 6 million people, and 99 percent of the loans have been repaid.⁶⁷

Dr. Marwan Muasher was appointed deputy prime minister of Jordan and negotiated the first free trade agreement between the United States and an Arab nation.

Those international graduate students who return to their home countries are more likely to collaborate with U.S. researchers and retain good memories of the United States, thus serving as public diplomats. Dr. Marwan Muasher, who received his master’s and doctoral degrees in computer engineering from Purdue University, returned to his

home country of Jordan. He served as the first Jordanian ambassador to the State of Israel and ambassador to the United States. He exemplifies the kind of invaluable outreach and connection that graduate education can provide. Dr. Muasher was appointed deputy prime minister of Jordan and negotiated the first free trade agreement between the United States and an Arab nation. He is currently senior vice president of external affairs at the World Bank.

What Is the Reach and Impact of U.S. Graduate Education?

The impact of graduate education extends beyond developing the workforce for the global economy and scientific research. Graduate education plays a central role in producing scholars in a broad range of fields as well as an educated citizenry devoted to democratic principles and ideas. Many people with graduate degrees donate large numbers of hours to community service, particularly in social service agencies, educational systems, local governments, and nonprofit agencies.

“The future of graduate education depends crucially on the capacity of our graduate deans to make the case for the public value of the graduate enterprise,” stated Debra W. Stewart, CGS president.⁶⁸ Other countries understand the connection between graduate education, quality of life, and economic success, and they are investing resources accordingly. This “social compact” that used to exist in the United States between universities and the public has been eroded. This issue must again become prominent—the public must be more aware that higher education exists primarily for the public good.⁶⁹

The benefits of higher education have never been clearer than they are now, in this rapidly growing and changing global economy. The challenges fac-

ing the United States in the 21st century are complex and daunting. Having a large pool of people with advanced knowledge, skills, and abilities who can solve complex, tough problems is the best way to meet the challenges now and in the future.

To remain competitive and to flourish, the United States must recognize graduate education’s special status in the U.S. education system. Graduate education works as a catalyst for many individuals who have initiative, drive, and talent to become successful and contribute to the public good. The knowledge economy depends on these talented, skilled, and highly trained workers with master’s and doctoral-level degrees. These educated and dedicated people touch every sector of our economy and society. By strengthening graduate education, we enable our nation to play a vital leadership role in the evolving knowledge economy and to improve the quality of life worldwide.

This report has provided a narrative about many people whose graduate education prepared them to make important contributions to the U.S. economy and our quality of life. The examples in the report and the companion document illustrate the ways that people with U.S. graduate degrees have made a tremendous difference in this country and around the world.

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The Council of Graduate Schools (CGS) is an organization of 500 institutions of higher education in the United States and Canada engaged in graduate education, research, and the preparation of candidates for advanced degrees. CGS member institutions award 94 percent of the doctoral degrees and 80 percent of the master's degrees in the United States.* The organization's mission is to improve and advance graduate education, which it accomplishes through advocacy in the federal policy arena, research, and the development and dissemination of best practices. This CGS report, *Graduate Education and the Public Good*, was released at the Legislative Forum on April 24, 2008 in Washington, DC.

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Debra W. Stewart

President, Council of Graduate Schools

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