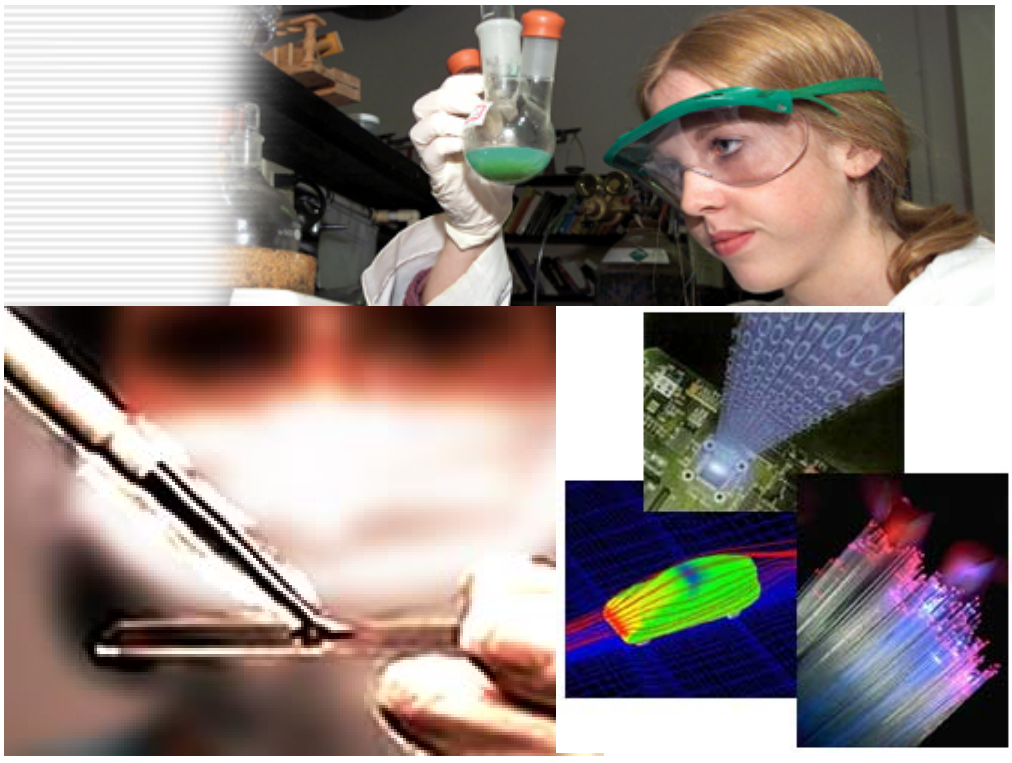
A Vision of Research and Graduate Education



A Report of the Vision of Research and Graduate Education Committee of the Tennessee Board of Regents

A Component of the Vision of Excellence Initiative

March 2005

"Every great advance in science has issued from a new audacity of imagination"

John Dewey in The Quest for Certainty (1929)

Executive Summary

This report of a Vision of Excellence Committee on Research and Graduate Education (Vision Committee) represents the collective vision and wisdom of key personnel charged by the Tennessee Board of Regents (TBR) to "*create a bold and informed vision of research and graduate education which will inspire our actions and will serve as a roadmap to achieving and sustaining excellence in these missions.*" The Vision Committee carried out this charge with the knowledge and understanding that if implemented, our recommendations would result in transforming and enhancing research, education, and public service missions in TBR universities. Given the enormity, the diversity, and the outreach capacity of institutions in the TBR system, it is predicted that such an outcome would have a far ranging and sustained impact on the quality of life of the Tennesseans and will ensure long-term economic stability and the viability of the State and the region.

To accomplish our charge, the Vision Committee reviewed numerous existing reports and surveys, interviewed several key stakeholders in public and private institutions, participated in workshops, interacted with faculty and students in various universities in the State, requested and integrated comments and informed input, and had extensive deliberations. Such an involved and intricate process has been most educational for the members of this Vision Committee for it has not only enriched our understanding but has played an instrumental role in grounding our vision in practical reality. We used two time points (years 2010 and 2020) as milestones and present our recommendations accordingly.

While the detailed outline and recommendations are provided in the ensuing report, the members of the Vision Committee conclude the following:

- Excellence in higher education can only be accomplished by acquisition of new knowledge through research, scholarship, and creative activities.
- Today's regional, national, and global economies are knowledge-based requiring technologically proficient and highly skilled workforce to sustain its dynamically changing complexity and needs.

- Public universities in the U.S. are playing an ever increasing role in educating and training highly skilled workforce to meet the demands of knowledge-based economies.
- Diverse intellectual capacity and technological capabilities of research-oriented public universities also play a vital role in attracting and retaining lucrative technology-based industries.
- Public university-based research and education are important drivers of sustained regional and state-wide economic development and stability.
- Long-term economic growth has a significant impact on improving human health and social conditions.
- Establishment of an entrepreneurial culture, commercialization of university-developed technology, and rapid development of technology-based clusters will be important defining measures of State's competitive advantage in contemporary economy.
- For the Tennesseans to remain competitive in this market place and to attain a more stable financial platform, the State has to invest strategically in improving the research infrastructure of its public universities.
- Given the enormity, the diversity, and the outreach capacity of institutions of higher education in the TBR system, the State must reconsider its prevailing philosophy and invest heavily in improving research and educational infrastructure in the TBR universities.
- The State, the TBR, the Tennessee Higher Education Commission (THEC), and individual TBR university campuses must promote interdisciplinary research collaborations and synergies among each other and with other public and private institutions.

In this report, the Vision Committee has underscored the fact that public research universities are the most reliable and effective economic engines for ensuring long-term state-wide academic, workforce, and financial stability. We have also emphasized the critical role TBR universities are presently playing and will continue to play in ensuring the health, social, and financial well being of the residents of this State. We recommend that the State establish a far-ranging strategy for promoting and developing competitive research environment which engages and involves the universities associated with the TBR system.

Prologue

This report represents the collective vision and wisdom of key personnel currently leading research and graduate education initiatives in the six universities in the Tennessee Board of Regents (TBR) system. To be more inclusive, representatives of the system's two-year colleges and technical centers as well as the State's Technology Development Officer were also invited to participate in this initiative. Throughout this report, a sincere attempt has been made to outline the most realistic and achievable strategic vision for years 2010 and 2020. Milestones of success and failure have been delineated to guide us in the execution phase of this initiative and to allow us to make necessary course corrections as, and when, required.

For the timely accomplishment of this study, the members of the Vision of Research Committee (Vision Committee) extend their most sincere gratitude to the staff of the Tennessee Higher Education Commission, the Tennessee Board of Regents, and the Tennessee Department of Economic and Community Development. Their contributions and assistance were invaluable in the creation of this report.

The members of the Vision Committee are deeply appreciative of our presidents for nominating us for this initiative and of Regent J. Stanley Rogers, Chancellor Charles Manning, and the respected members of the Coordinating Committee for their confidence in entrusting us with this critical task. Lastly, the committee members of the Vision Committee are appreciative of contributions from our faculty, staff, and students who facilitated the development of this vision by their commitment to outstanding research, scholarship, and creative endeavors that continue to preserve instructional and academic excellence in our institutions.

Vision of Research Committee: Membership

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"Where the world ceases to be the scene of our personal hopes and wishes, where we face it as free beings admiring, asking, and observing…there we enter the realm of Art and Science"
Albert Einstein (1879 – 1955)

I. Introduction

A: Background on Vision of Research

With a renewed commitment to learning and service, the Tennessee Board of Regents is entering a historic and exciting time. It is the nation's sixth-largest higher education system governing 45 post-secondary educational institutions, including six universities, 13 community colleges and 26 technology centers, providing programs to over 180,000 students[1] in 90 of Tennessee's 95 counties. The initiative by such an expansive system to more coherently define its long-term vision is accompanied by both opportunities and challenges. To facilitate timely realization of this venture, the Board initiated a comprehensive process to define its long-term strategic ***Vision of Excellence***. Of the four platforms[2] selected for this initiative, this report focuses explicitly on research and graduate education. As a means to accomplish this objective, a Vision Committee was established which was composed of a highly qualified group of principal stakeholders who provide oversight of the research mission at the six TBR universities. It also included representatives from the community colleges and technology centers, staff

[1] Fall 2004 enrollment
[2] Teaching and Learning; Economic Analysis; Public Service; and Research & Graduate Education

from the TBR central office, and a representative from the Tennessee Department of Economic and Community Development.

Recognizing the need to include graduate education in this vision, a Graduate Education Taskforce (Taskforce) was established which included the key stakeholders who presently provide leadership in the oversight of graduate education at the TBR universities. The deliberations of this Taskforce were extremely helpful in understanding and appreciating the value and the irrevocable link that exists between the establishment of a successful research enterprise and graduate education. The recommendations of this Taskforce have been incorporated in this report. To be as comprehensive as we can, we have also sought and integrated into this report the informed contribution of various faculty and staff on our campuses. This latter process has been most educational for the members of this Vision Committee for it has not only enriched our understanding but has played an instrumental role in grounding our vision in practical reality.

In the process of developing this vision report, the Vision Committee outlined a set of specific challenges that were faced by the six TBR universities in their attempts to enhance research and graduate education. As stipulated in its initial charge (Section IB), the Vision Committee has recommended strategies to address these challenges and has developed and identified measurable outcomes and milestones. It is envisaged that the system-wide strategic vision outlined in this report will serve as a framework for individual institutional planning processes that have recently been initiated on individual campuses.

It is noteworthy that strategic planning at the level of the TBR is not being undertaken in isolation. Rather, this initiative is fully consistent with the Master Planning process that has also been initiated by the Tennessee Higher Education Commission (THEC). Both the THEC and TBR processes are in turn congruent with the recommendations jointly published by the National Center for Public Policy and Higher Education and the National Center for Higher Education Management Systems[3]. Their comprehensive report calls for the establishment of a statewide strategy for promoting and developing a globally competitive research environment

[3] Developing a Public Agenda for Higher Education in Tennessee: A Report for Project entitled "Making the Grade: A Partnership to Simulate State Higher Education Dialogue and Change Using a National Report Card (January 28, 2003)

which extends beyond the University of Tennessee system and engages and involves the universities associated with the TBR system.

B: Charge to the Committee

To formally initiate this process, on August 31, 2004, the TBR Oversight Committee for the Vision of Excellence met with the members of the Vision Committee. The charge given to the Vision Committee by Regent J. Stanley Rogers and reiterated by Chancellor Charles Manning was to ***CREATE A BOLD AND INFORMED VISION OF RESEARCH AND GRADUATE EDUCATION WHICH WILL INSPIRE OUR ACTIONS AND WILL SERVE AS A ROADMAP TO ACHIEVING AND SUSTAINING EXCELLENCE IN THESE MISSIONS.*** The Vision Committee was entrusted with the responsibility of outlining a strategic vision for year 2020 and to identify and explore the opportunities and challenges associated with flourishing as a major research-extensive system. The specific charge to the Vision Committee included (but was not limited to) the following:

- To explore possible avenues that promote establishment of partnerships (public, private, and industry) and productive research collaborations
- To examine existing research priorities and to realign them with that of Federal, State, and other funding agencies
- To examine currently existing infrastructure and to recommend changes to effect significant improvements in research and graduate education
- To explore mechanisms that can be implemented at the level of the System to encourage faculty in their research and support of graduate students
- To outline a process that would lead to the development of a robust state-wide cyberinfrastructure
- To make specific recommendations on how to improve further the quality and the quantity as well as the education, training, and research experience of graduate students enrolled in our programs
- To explore possible administrative changes that would facilitate the growth of research and graduate education throughout the System

C: Importance of Research - Education and Public Service

The most vital role played by institutions of higher education is to create and sustain powerful learning environments for both faculty and students. In this context, the word "learning" implies the creation and dissemination of new knowledge for the benefit of the community at large. In vibrant and progressive systems, the genesis and the consumption of new knowledge emerges from productive collaborations among the faculty, staff, and students, who work in unison with shared values to accomplish this goal. Excellence in higher education can only be accomplished by acquisition of new knowledge through research, scholarship, and creative activities. Our ability, therefore, to impart and sustain first-rate education for students enrolled at all levels in our system is deeply reliant on the development and maintenance of outstanding research programs. Accomplishment of the latter outcome is directly dependent on our capacity to recruit and retain the most productive faculty. It is the faculty and their reputation that results in the recruitment of outstanding students, cultivation of new knowledge, and development of an intellectual culture and climate of learning and scholarship that is the hallmark of an institution of higher education.

> ***Research and education are two faces of the same coin… indivisible at any moment in time***
> ***Anonymous***

The association between research and graduate and professional education is well established. Equally recognized is the existence of numerous synergies that coalesce to form a vibrant undergraduate learning environment which facilitates accomplishment of research, scholarship, and innovation. The development of new experiential learning opportunities and the infusion of the concept of life-long learning are just two of the many benefits that undergraduate students reap from a research-extensive environment.

Establishment by universities of productive outreach programs to fulfill their important public service mission is a direct consequence of outstanding research that continues to influence and transform our understanding in this particular area.

D: Importance of Research – Economic Impact and Improvement of Life

In addition to undergraduate and graduate education and public service, research has a strong impact on sustaining and improving regional, national, and global economies. As expected, Tennessee's public research universities are becoming progressively more critical in sustaining the State's economy. It has been estimated that $139 million of external funding at TBR universities infuses more than 700 million/year into the State's economy[4]. From an economic perspective, $5.00 of spending takes place throughout the Tennessee economy for every $1.00 of external funding obtained by Tennessee's universities. Needless to say, by supporting businesses and jobs, externally funded research provides a direct economic benefit to the State and serves as an important driver of long-term economic growth in a market environment where many other contributors to the economy are presently indolent. This benefit becomes even more vital in regions of the State that are striving to improve their economic conditions. The presence of a research extensive/intensive TBR institution in such regions will not only bolster this process but will also serve as a pivotal source of intellectual capital and technical resources and will be a constant provider of the trained workforce that facilitates the establishment and continued growth of small, medium, and large industries and businesses.

> ***In a global environment in which prospects for economic growth now depend importantly on a country's capacity to develop and apply new technologies, our universities are envied around the world. If we are to remain preeminent in transforming knowledge into economic value, the U.S. system of higher education must remain the world's leader in generating scientific and technological breakthroughs and in preparing workers to meet the evolving demand for skilled labor.***
>
> *Alan Greenspan*
> *Chairman, U.S. Federal Reserve, 2004*

The economic impact of university research has two distinct yet unifying components. The first is the static or one-dimensional impact used in traditional economic studies. Static impact is an assessment of how spending on a particular activity affects the rest of the economy. An input-output model is customarily used to determine the impact of expenditure as

[4] FY 2004 data

it works its way through the economy. The second is the dynamic impact that the development of new knowledge through university research has on the economy. The effects of the dynamic impact on the economy are far larger and more sustained than the static impact and they also have a greater influence on enriching and improving the quality of life of state residents.

It must be emphasized that the static impact of university research on regional and national economies is far from trivial. For example, in the state of California, university research accounted for $5.2 billion in economic productivity and 1.3% of the state's GNP growth in 2000-2001 was attributable to University of California (UC) research activity gains[5]. Furthermore, as a result of UC research gains, 104,000 new jobs were created during this period and a total of $3.89 ($2.63 of federal and $1.26 of private funding) was generated for each dollar of state funding for university research and development in year 2000-2001. Similarly, in 1993, university research in Canada sustained $5 billion of Canadian GDP and created 81,000 new full-time jobs, including support for 8,032 students[6].

However, despite the enormity of the static impact of university research on an economy, dynamic impact is far more significant and sustained. University research has a measurable impact on long-term economic growth through its influence on the underlying productivity of the economic engines. University research contributes uniquely to the ability of other parts of the economy to improve productivity both of labor and capital. The success of technology growth poles (technopoles) such as the Research Triangle Park in North Carolina and the Silicon Valley in California provide examples of the long-term impact of university research on local and regional economies. In addition to its impact on the economy, the development and commercialization of university research also has a measurable influence on improving human health and

[5] T. Lynch & N. Aydin, Literature Review of the Economic and Social Impact of Higher Education Research Funding, Florida State University, 2004

[6] F. Martin & M. Trudeau The Economic Impact of University Research, *Research File*, March 1998

social environment. Since the end of World War II, university research has been responsible for development of the computer-based global information system, vaccines, drugs, and medical equipment.

Economic and human benefits attributable directly to university research can perhaps best be exemplified by the outcome witnessed in the North Florida Mental Health Pilot Project. Interventions that were developed by university mental health researchers to assist abused and depressed young and low-income mothers and children resulted in a dramatic reduction in child abuse/neglect from 97% (prior to treatment) to 0% (among those successfully completing the study). Of those children who were not in parental custody at the time of the start of this study, 58% were ultimately reunified with their family or were placed in a more stable foster care environment. As anticipated, children in this study showed a remarkable improvement in developmental functions. In addition to the improvement of social and mental health, the final benefit: cost ratio was 6.39, which meant that for every dollar invested in this project, $6.39 was ultimately saved[7].

University research is the most fertile environment for training innovative people and for generating new ideas and knowledge

Anonymous

In addition to its effect on retention, strong university research serves as a magnet for corporations and a sanctuary for intellectual talent. This occurs because universities not only produce new knowledge that facilitates novel developments in the knowledge-based economy but also play an important and pivotal role in the development of a skilled workforce. For a region, state, or country to be competitive in today's knowledge-based economy, it must incessantly affect the drivers of technological change. However, technological change does not simply happen. It requires the efforts of a technologically skilled workforce without which there will be no innovation and technological progress.

Yet another measure of the dynamic impact of university research on regional, national, and global economies is the

[7] T. Lynch & N. Aydin, Literature Review of the Economic and Social Impact of Higher Education Research Funding, Florida State University, 2004

commercialization and transfer of intellectual property. For example, the University of Michigan, which received $591 million in external research support in 2001, was involved in establishing 32 university-related start-up companies between 1998 and 2002. However, this entrepreneurial activity is not limited to large research universities. The University of Central Florida (UCF), a regional university founded in the early 1970s, developed a university-based technology incubator in 1999. Since its establishment, the UCF Technology Incubator has helped more than 70 emerging technology companies create over $140 million in revenue and more than 450 new jobs with an average annual salary of $59,000[8].

In summary, university research is an important driver of economic development and a significant force for continued improvement of human health and social conditions. Some of the sustainable impacts of a robust research enterprise include education and training of an academically and technically skilled workforce; technology transfer and commercialization; entrepreneurial development; spawning and attracting new businesses to the region; industrial extension and technology; industrial education and training partnerships; and community relations. Although in the recent past, TBR and its institutions have underscored the importance of research and have consequently improved the portfolio of external funding, they still lag behind peer institutions in this initiative and have done very little in the areas of technology transfer and business incubation. Given the size of the TBR system, the potential for growth in these areas is enormous with far-ranging benefits to the region, state, and the nation.

It is therefore imperative that greater emphasis be placed on the value of research and its application both at the level of the Board and its individual institutions. Additionally, it is incumbent upon us to educate the governmental and community leaders on the importance of research for the long-term viability, vitality, and growth of this region. We sincerely hope that this report will serve this latter purpose and result in the dawn of a new era in the TBR system and in the State of Tennessee which values and rewards the contributions of those who pursue research and scholarship and its application in education, public service, and the growth of new sustained economic opportunities.

[8] Universities and the Development of Industry Clusters, Economic Development Administration, U.S. Department of Commerce, 2004

E: Importance of Research – Undergraduate Education

Given that creating knowledge demands persistence in finding answers and seeking solutions, it has become evident that if undergraduates are to have ownership of such an enterprise, they must be given opportunities to experience research and the scholarly production of knowledge. There is substantial evidence that the one-on-one interaction that takes place when a faculty mentors an individual student in original research serves as a powerful catalyst for true learning. It has also been demonstrated that this quality of intellectual exchange between faculty and student stands almost alone as the most important variable in student learning and in student satisfaction with the college experience[9]. Undergraduate research can also be a key factor in student retention[10,11]. A successful pilot program in one of the TBR universities demonstrated that undergraduate students could add to the body of knowledge when properly mentored by creative faculty[12].

> ***"An inquiry or investigation conducted by an undergraduate that makes an original intellectual or creative contribution to the discipline"***
>
> *Definition of Undergraduate Research*
> *Council on Undergraduate Research*

The TBR vision for undergraduate research in the university system should be congruent with the mission of the Council on Undergraduate Research (CUR). This clearly sets undergraduate research apart from the ordinary university experience. We envision a concerted endeavor that will have life-long value for the student and will create notable prestige for those universities embracing and implementing such a vision of student learning. For students, successful completion of a research project represents the pinnacle of undergraduate achievement. To accord these students the highest distinction, we would add to the CUR definition of undergraduate research, "which is deemed by peer review to be worthy of and published in the best journals in the discipline." Students whose work meets this stringent condition would graduate as Regent's Research Scholars and have this distinction duly noted on their transcript.

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[9] A. W. Astin, *What Matters in College? Four Critical Years Revisited* (Jossey-Bass, San Francisco, 1993)
[10] T. Campbell, and D. Campbell, Research in Higher Education, 38, 727, (1997)
[11] J. Johnson, J. College Student Retention, 2, 219 (2001)
[12] Undergraduate Research, Scholarship and Creative Activity Program, MTSU

To enhance undergraduate involvement in research, the vision presented here includes a research-supportive curriculum with two components or phases. The first component is presented early in the curriculum and provides undergraduate students the basic knowledge and skills they will need to engage successfully in original discovery. The second component or phase immerses them into the conduct of research and provides course credit in their program of study for undertaking research. It takes significant time for faculty to guide new apprentices in the practice of inquiry. Therefore, the vision includes due recognition of the time, value, and contribution to learning and the students' undergraduate experience of such mentoring. Credit for involvement with undergraduate research must be formally incorporated into faculty workloads to enhance the undergraduate research experience. For the State of Tennessee, successful implementation of this part of the vision will ensure that a cadre of students entering the workforce has a sense of empowerment and confidence in their ability to create new knowledge that will equip them, through this habit of mind, to solve the problems of the future.

F: Entrepreneurial Education and Entrepreneurship

Just as there are formidable ties between research and graduate education, there exists a strong correlation between successful technology transfer and entrepreneurship. Entrepreneurship is one of the twelve categories used by *U.S. News* to rate schools of business[13] and is one of only four specialties used by *Business Week*[14] for similar purposes. As an academic discipline, typically housed within the College of Business, the popularity of entrepreneurship has grown dramatically in the last decade. Of the 337 AACSB (the Association to Advance Collegiate Schools of Business) accredited business schools, 56 have undergraduate and 132 have graduate entrepreneurship programs.

[13] America's Best Graduate Schools 2005, *U.S. News* (www.usnews.com). Of the TBR schools, MTSU is the only university on the undergraduate list and ETSU is the only university on the graduate list

[14] Best Schools By Specialty: *Business Week Online* (www.businessweek.com)

Beyond business schools, the National Collegiate Inventors & Innovators Alliance (NCIIA) has been a pioneer in extending entrepreneurship education across all disciplines. The NCIIA not only promotes and funds curriculum development in entrepreneurship, but also has successfully created a grant program for Entrepreneurial Teams (E-Teams) which requires graduate and/or undergraduate teams comprised of two or more students drawn from different disciplines (e.g. business/engineering, engineering/law, business/engineering/law) to design or to improve a product or a service. The idea is to get students to recognize through first-hand experience that the resolution of a complex problem requires an interdisciplinary approach and collaboration. A list of numerous universities/colleges that have embraced the concept of extended entrepreneurship is included in this report (**Appendix I**). Perhaps the most noticeable observation is that there is not a single public or private institution of higher learning in the State of Tennessee that is included in this list.

Entrepreneurialism and cluster-based development are essential to moving states beyond the lowest common denominator of state economic development policy[15]

The strong link between entrepreneurship and economic development has also been articulated in a recent report published by the Center for Best Practices, National Governors Association (NGA)[15]. It is widely recognized that successful economic and technological models of regional development such as the Silicon Valley in Northern California, the Route 128 Corridor in Massachusetts, and the Research Triangle in North Carolina are clustered around research universities. The Vision Committee endorses this perspective and extends its unwavering support for NGA's claim that economic development based solely on business retention and industry recruitment (and resultant emphasis on workforce development, infrastructure investment, tax and regulatory incentives) is not sufficient for long-term stability. Establishment of an entrepreneurial culture and rapid development of technology-based clusters are two very important accomplishments that will serve as defining measures of a state's competitive advantage in contemporary economy.

[15]A Governor's Guide to Strengthening State Entrepreneurship Policy: National Governors Association, Center for Best Practices, 2004 (www.nga.org)

The report published by the NGA suggested five strategies that a state needs to embrace to achieve a more entrepreneurial environment:

- Integrate entrepreneurship into state economic development efforts
- Use the education system to nurture and encourage future entrepreneurs
- Incubate entrepreneurial companies
- Invest in diverse sources of risk capital
- Assist through regulatory streamlining.

The Vision Committee expressly endorses adoption of this strategy as part of the TBR mission. Our vision includes a TBR-mandated thrust to build on a K-12 readiness platform and to introduce and expand traditional business school-related entrepreneurship education to campus-wide 'extended entrepreneurship' (upgraded curriculum and non-curricular activities). Needless to say, faculty entrepreneurship and commercialization of university-developed technology should be concurrently encouraged.

Modest evidence that this can be successful comes from ETSU which opened its Innovation Laboratory in 2002[16]. The ETSU Innovation Laboratory currently has five biotech/high tech companies, all of which have ties to the University and one of which is a spinout from ETSU. These companies created 29 jobs in 2004 with an average salary in excess of $50,000, which is twice the Management Science Associates mean salary. The companies have collectively garnered $7 million in angel investment from outside the northeast Tennessee region and have put $1.5 million into the economy. Each company has accepted interns from ETSU and three have hired ETSU graduates. We strongly support the proposal that all TBR universities and many of the Community Colleges and Technical Centers should develop business incubators appropriately linked to the mission of each institution.

[16] http://www.etsu.edu/innovationlab/University_Park.htm

G: Cyberinfrastructure

Cyberinfrastructure refers to infrastructure based upon distributed computer, information, and communication technology combined with the personnel and integrating components that provide a long-term platform to empower the modern scientific research endeavor[17]. Development of a robust cyberinfrastructure is essential, not optional, to the aspirations of research communities. For scientists and researchers, cyberinfrastructure has the potential to revolutionize what they can do, how they can do it, and who participates.

> What infrastructure is for an *industrial economy*, cyberstructure is for a *knowledge economy*[17]

In the recent past, many Federal agencies have initiated wide-ranging efforts to address future cyberinfrastructure needs of science and engineering research and allied education. In 2002-03, the Directorate of Computer and Information Science and Engineering at NSF commissioned a Blue Ribbon Advisory Panel on Cyberinfrastructure to address the following tasks[17,**Error! Bookmark not defined.**]:

- Evaluate current major investments in cyberinfrastructure and its use
- Recommend new areas of emphasis relevant to cyberinfrastructure
- Propose an implementation plan to pursue these recommendations

The final report of the Panel was released in February 2003 and their overarching finding was "*that a new age has dawned in scientific and engineering research, pushed by continuing progress in computing, information, and communication technology, and pulled by the expanding complexity, scope, and scale of today's challenges. The capacity of this technology has crossed thresholds that now make possible a comprehensive cyberinfrastructure on which to build new types of scientific and engineering knowledge environments and organizations and to pursue research in new*

[17] Revolutionizing Science and Engineering Through Cyberinfrastructure: Report of the National Science Foundation Blue-Ribbon Panel on Cyberinfrastructure, 2003 (http://www.nsf.gov/cise/sci/reports/toc.jsp)

ways and with increased efficacy. Such environments and organizations, enabled by cyberinfrastructure, are increasingly required to address national and global priorities, such as understanding global climate change, protecting our natural environment, applying genomics-proteomics to human health, maintaining national security, mastering the world of nanotechnology, and predicting and protecting against natural and human disasters, as well as to address some of our most fundamental intellectual questions such as formation of the universe and the fundamental character of matter" [17].

Recognizing the lack of any coordinated state-wide effort, in June 2004, at the recommendation of the TN EPSCoR, a Cyberinfrastructure Commission (CIC) was established in the State. Co-chaired by Dr. Paula Myrick Short, the CIC's goal was to develop a comprehensive Technology Roadmap for Tennessee higher education system by year 2005. To address this objective, two committees were established; Optical Network (One TN) and Research Computing Grid (TenREG). The charge to the Optical Network team (OneTN) was as follows:

- To investigate and to design statewide optical network to provide at least one giga byte per second (1 Gbps) interconnectivity and advanced services (such as Internet2) to 19 TBR campuses (which includes all six TBR universities), five (5) UT campuses, and the Vanderbilt University
- To provide details of technical architecture, schedule, cost, and operating approach

The charge to the Research Computing team (TenREG) was:

- To catalog all scientific and engineering resources currently existing and/or planned at all Tennessee higher education institutions and government facilities
- To develop methodology for sharing of these resources including provision of technical support, costs, and management issues

To discuss these issues further and to develop a consensus among participating institutions of higher learning, TN EPSCoR and MTSU

jointly organized a meeting in Murfreesboro, TN[18]. The deliberations of this two-day symposium underscored the critical need for a statewide optical network for the future growth of research, education, and economic development in Tennessee. It recommended that the State must invest in building its cyberinfrastructure and that OneTN and TenREG must be State and regional initiatives which will serve the growing needs of the research community in public and private universities. It was also envisioned that if fully implemented, TenREG will reduce cost and increase collaboration among various public and private universities in the State of TN.

[18] Computational Applications & Cyberinfrastructure Symposium. January 19-20, 2005, Murfreesboro, TN (https://san4.dii.utk.edu/servlet/page?_pageid=3344&_dad=portal30&_schema=PORTAL30)

The relationship between research and education is similar to that between the body and the soul…take one away and the other will wither to obscurity
Anonymous

II. Current Status of System-wide Research & Graduate Education

The data presented in this section has been derived exclusively from the six TBR universities. This approach is justified given the argument that for the period under review, the level of external funding for research at the TBR-associated community colleges and technical schools was minimal thus has a less significant impact on the analysis. Similarly, delivery of graduate education is a distinctive function of the universities.

A: Profile of Extramural Funding

In the past eight years (1997-2004), the amount of external funding in the six TBR universities has increased from approximately $69 million to approximately $139 million annually (**Figure 1**).

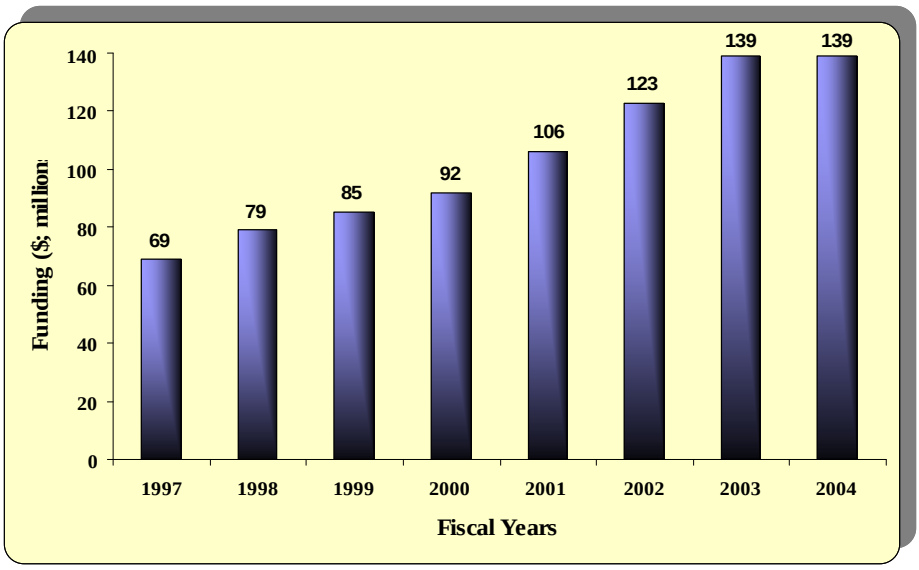

Figure 1: The level of external funding in the six TBR universities in years 1997-2004

This increase represents a doubling of the level of external funding in the system. With the exception of Austin Peay, each and every university in the TBR system contributed their relative share in this doubling of extramural funding. Many different causative factors with comparable merit could have contributed to this observed outcome. Some of those factors are delineated below:

- Greater emphasis placed by many campuses on the acquisition of external funding by their faculty to support research, public service, and instructional activities
- The doubling of National Institutes of Health (NIH) funding in the years 1998-2002
- The progressive increase in National Science Foundation (NSF) funding in years 1997-2004[19]
- The sustained increase in funding for other Federal agencies such as the Department of Defense (DOD), the Department of Education (DOEd), the Department of Energy (DOE), the National Endowment for the Humanities (NEH), and others

The relative plateau witnessed in the growth of external funding in the last three fiscal years suggests that TBR universities were indeed beneficiaries of the increased federal funding that was available for research and scholarship during this period (Figure 1). However, it is important to note that the U.S. is presently confronted with its most serious economic challenge in decades. The precarious national economy has created a serious predicament for these funding agencies and they are now bracing themselves for budgetary reductions. The downstream detrimental effects of such a volatile economy and accompanying budgetary reductions could hamper the growth of research at many universities. This problem will be compounded by the fact that a worsening national and global economy will have a reverberating effect on regional and state economies. Mandatory statewide reductions in appropriations for higher education coupled with declining income from endowments, private gifts, and donations to the universities could potentially have a serious detrimental effect on the research mission. Having witnessed the favorable impact of research on increasing economic development, many states are investing in increasing the research capacity and improving the infrastructure of their public universities in order to

[19] The U.S. Congress has reduced NSF budget for FY05 by $105 million below that of last year and $232 million below the FY05 request (http://www.nsf.gov/about/congress/108/highlights/cu04_1123.jsp)

become more viable in the new knowledge-based economy. It is envisioned that such a strategic investment will improve the state's tenuous economic conditions and create a more stable financial platform. The State of Tennessee and the TBR system must adopt a similar approach and invest strategically in research and its infrastructure to enhance the research competitiveness of the faculty in its public universities. The result will be a more stable academic, social, and economic future for Tennesseans.

- **Total Extramural Funding – By Source**

Another meaningful way to evaluate the reliance of our research enterprise on a dynamically changing economic landscape is to ascertain, by source, the funding portfolio of universities in our system (**Figure 2**).

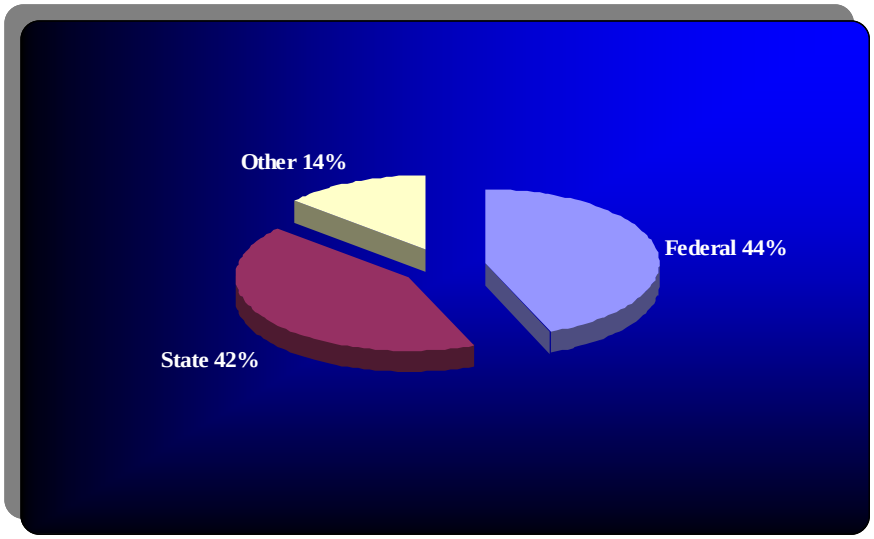

Figure 2: The relative percentage of external funding by source in the six TBR universities in year 2003-04

As depicted in Figure 2, in year 2003-04, our universities obtained approximately 44% (~$61 million) of their total external support from Federal funding agencies and approximately $60 million (42%) from State entities. The distribution of our portfolio in terms of sources of funding is indeed quite encouraging. In fact, as far as the reliance on Federal sources of funding is concerned, our data are not very dissimilar from that of the UT system. In the year 2003-04, approximately 52% of the external funding obtained by the UT system was from Federal sources[20].

While reassuring, serious caution needs to be exercised in interpreting and extrapolating these observations. There needs to be a paradigm shift in our national spending strategy and we need to impress upon the Federal and State lawmakers the advantage of persistent

[20] University of Tennessee Fact Book (2004) p64 (http://pr.tennessee.edu/UTFactSheet.pdf)

investment, both nationwide and statewide, in the research enterprise. Such an investment will enhance the competitiveness of faculty in public universities to acquire external funding from a variety of sources. This will also assure establishment of a perpetual source for a robust economic platform for long-term viability of the region. Unless this objective is accomplished, the significant reliance of our university-based research on Federal and State dollars may reflect our vulnerability rather than our strength.

- **Total Extramural Funding – By Project Type**

The type of research and scholarship activities that are adopted by an individual university or a system remarkably influences its capacity to attract and sustain extramural funding. In the U.S. in year 2003-04, most (~52%) of Federal, State and private funding was earmarked for basic and applied research (**Figure 3**).

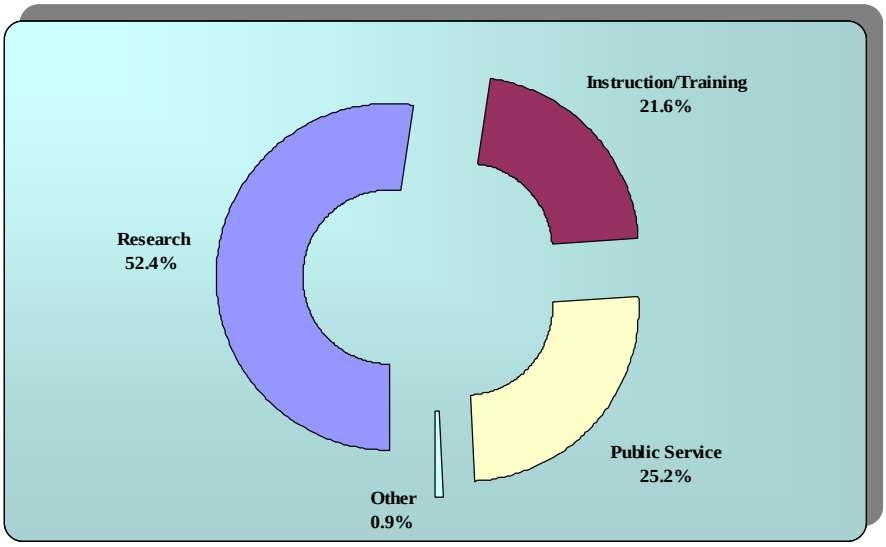

Figure 3: The relative percentage of available funding for various types of activities in the U.S. in year 2003-04

It is notable that the combined funding in the U.S. for public service-related and instruction and training projects was approximately 47% in year 2003-04 (**Figure 3**). For a university to be able to sustain long-term external funding, it is most desirable (indeed required) that the types of on-going sponsored activities on its campus closely emulate the dynamically changing national trends and priorities. This fact must be recognized by the TBR which has universities in its system with many novel and unique research capacities and interests.

Interestingly, despite this inherent limitation imposed largely by the enormous size and diversity of the TBR system, the pattern of extramural

funding as a reflection of type is not vastly dissimilar from the national trend (**Figure 4**).

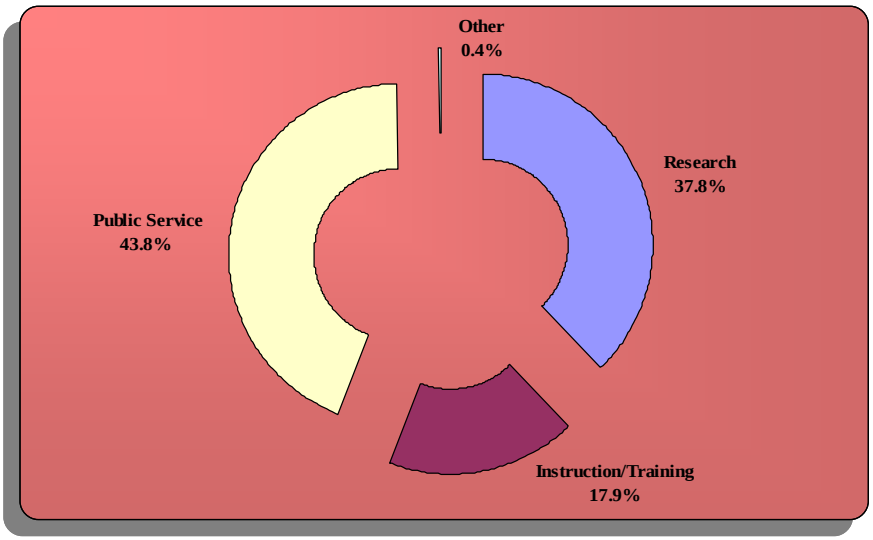

Figure 4: The relative percentage of funding for various types of activities in the TBR system (year 2003-04)

There are however, some areas of concern in the funding pattern of the TBR universities that deserve careful examination. The extent of public service-related sponsored activities conducted by universities in the TBR system is inconsistent with the national funding trend. As depicted in Figure 3, approximately 25% of the total available funding in the U.S. (in the year 2003-04) from various sources was earmarked for public service-related projects. On the contrary, in the same fiscal year, an inordinately higher percentage (~43%; ~$61 million) of external funding in the TBR system was associated with public service-related projects (**Figure 4**). This latter statement does not imply that the TBR universities should make a deliberate effort to reduce public service-related funding and activities. We are, however, strongly advocating that TBR as a system and its universities individually should develop a strategy to increase the research component of the sponsored programs portfolio such that the system-wide funding profile becomes (by project type) more closely realigned with that of the nation. Such a strategic repositioning of our vision and portfolio is crucial for the realization of our continued attempt to become a research extensive system thus allowing us to participate more effectively in creating a knowledge-based economy.

In this report, we have given particular attention to the challenging issues that have been identified in this section (Section II A, B, & C). In the ensuing segments (Section IV), we will discuss these challenges further and provide a potential solution that involves strategic identification of target areas of growth in research and state-wide collaborations. It is a conviction of the members of the Vision Committee that by investing in the

research enterprise of public universities (both TBR and UT), the State of Tennessee will establish the necessary platform to bolster its economy. For the State of Tennessee this would be the most gratifying return on investment.

B: Patent and Licensing Activities

Up until 1980, it was illegal for grant recipients to retain title to any research invention developed with Federal funds. As a consequence, the Federal government accumulated a huge repository of patents and technical knowledge that resided dormant in its vaults. The government's cumbersome agency-by-agency licensing process and its bias against exclusive licensing were stifling transfer of technology to the commercial sector. Recognizing the problem, Senator Birch Bayh (Indiana) and Senator Robert Dole (Kansas) co-sponsored legislation to revamp the federal technology transfer system. On December 21, 1980, the Bayh-Dole Act[21] was enacted. This legislation permitted universities to retain title to inventions developed with federal funds, encouraged them to grant both exclusive and non-exclusive licenses (particularly to small businesses), and allowed them to retain any revenues generated from said inventions (so long as the inventors shared in the royalties). Today, some twenty-five years later, the Bayh-Dole Act (referred to as "Innovation's Golden Goose"), stands as one of the most successful pieces of legislation in U.S. history.

Enactment of this legislation created a very strong motivation for public and private universities to commercialize their inventions. Metrics unique to technology transfer are now employed as yet another significant benchmark of an institution's research productivity and creative capacity. As depicted in Table 1, academic technology transfer adds billions of dollars to the U.S. economy and is responsible for creating thousands of high-tech jobs in the nation. It is noteworthy that the level of total direct revenue generated from university licensing activities collectively exceeds that of many Fortune 500 multi-national companies (**Table 1**).

[21] P.L. 96-517, Patent and Trademark Act Amendments of 1980

Table 1: Research and Academic Technology Transfer Activities in the U.S. Universities[22]

	Sponsored Research ($; billion)	Invention Disclosures	Patents Issued	License Income ($; billion)	Start-up Companies
FY03	38.5	15,510	3,933	1.3	374
FY02	37.0	15,573	3,673	1.3	401
FY01	31.8	13,369	3,721	1.1	424
FY00	29.5	13,032	3,764	1.3	454

Furthermore, technology transfer serves as a catalyst for the creation of small businesses, products, and services that continue to improve our lives and our environment. Perhaps the greatest beneficiary of academic technology transfer has been the public. In addition to improving the economy, university-industry partnerships allow inventors to be engaged in the continued development of their technology thus significantly reducing the time required for the translation of an idea to a product. Conversely, the revenue collected from commercialization of inventions augments the advancement of scientific research and education through reinvestment in the academic enterprise. In addition to (partially or totally) supporting the compensation of the inventors (i.e., faculty, staff, and students), this revenue has been used to create start-up packages for recruitment of outstanding faculty, improvement of research infrastructure, seed funding for new and innovative projects, establishment of graduate assistantships and fellowships, and establishment of new small businesses and production facilities.

Unfortunately, the myriad advantages of academic technology transfer have not yet been fully realized in public and private universities in the state of Tennessee. As depicted in Table 2, despite the relative increases in sponsored research activities, the performance in the last three years of technology transfer indicators continues to remain sub-optimal in both public university systems in the State.

[22] Association of University Technology Managers (AUTM; http://www.autm.net)

Table 2: Research and Academic Technology Transfer Activities in the Three Principal University Systems in the State of Tennessee[23]

	Sponsored Research ($; million)	Invention Disclosures	Patents Issued	License Income ($)	Start-up Companies
FY03					
VU[24]	294	112	21	8.9 million	1
UT	193	53	28	876,900	1
TBR	139	09	04	1,000	0
FY02					
VU	231	75	26	11.9 million	1
UT	247	62	36	938,000	1
TBR	123	10	01	11,000	0
FY01					
VU	195	93	25	1.4 million	0
UT	182	46	21	2.0 million	1
TBR[25]	106	--	--	--	--

Of particular note is the less than desirable performance of the universities in the TBR system (**Table 2**). For the TBR and its universities, this unwanted outcome has many plausible explanations some of which are iterated below:

- Failure (by the State and by the TBR) to understand the role of science and technology in post-industrial society
- Lack of a strategic plan (Statewide and in the TBR) recognizing the need for, and beginning a transformation to, knowledge-based learning and the New Economy
- Lack of appreciation and understanding (by the State and by the TBR) of the value of research, graduate education, technology transfer, and commercialization as key ingredients in and catalysts for transition to a knowledge-based economy

[23] Association of University Technology Managers (AUTM; http://www.autm.net)
[24] Vanderbilt University
[25] The Tennessee Board of Regents initiated data submission to AUTM in year 2002

- Lack of emphasis and investment (by the State and by the TBR) on enhancing statewide technology transfer and commercialization activities
- Lack of a robust and stable infrastructure in the central office of the TBR system to facilitate technology transfer and commercialization
- Prevailing culture and customs (within the State and the TBR) that are not conducive to technology transfer
- Small number of innovative/inventive technology in the TBR pipeline to build a successful technology transfer program
- Lack of success stories within the TBR system to demonstrate how technology transfer can work, thereby building program momentum
- Small number (within the State and within TBR[26]) of Innovation Parks or Technology Business Incubators
- Small number of industrial outreach initiatives; little dialog or systemic investigation of existing industrial impediments
- Small number of technically-skilled workforce for commercialization and production of scientific inventions

In the judgment of the members of the Vision Committee, most of the above-mentioned challenges are observed across the State and in the TBR system thus greatly undermining our ability to fully realize the enormous short and long-term benefits of commercialization of discoveries made by faculty and students through technology transfer. In Section V, we have put forth a set of recommendations which if executed, will facilitate the reversal of this trend in the State and in its two public systems of higher education. Lack of technology transfer-related activities is one of the most serious deficiencies in our system. It needs immediate attention and resolution.

[26] Only East Tennessee and Tennessee State Universities presently have such facilities

C: Graduate Education

One of the hallmarks of the U.S. higher education system is its most enviable graduate-level education and training programs. This distinction is most apparent at the doctoral level. As a consequence, the U.S. graduate research and education system is burdened with the enormous task of instructing and preparing the highly skilled workforce required to meet the dynamically changing global needs. Doctoral students are not only considered the backbone of successful research programs but they are also viewed as junior scholars providing academic mentoring and guidance to their graduate and undergraduate peers. This bi-directional vertical and horizontal enrichment of both knowledge and social skills is considered a key factor in raising the bar of excellence across the academic horizon, leading not only to improvement in student performance but also recruitment and retention of outstanding undergraduate and graduate students.

> ***Graduate education is a movement from darkness to light, from anguish to ecstasy***
>
> ***Anonymous***

One of the key variables that determine the regional, national, and global reputation of an institution or system of higher learning (particularly a university) is the quality of its graduate research programs. Recognizing the sustained need for a highly skilled workforce in the State, the universities in the TBR system are fulfilling their required role in this process. All universities in the TBR system offer courses leading to a Masters degree in various disciplines. However, only five of the six TBR universities offer doctoral-level training and education[27]. Additionally, East Tennessee State University is home to the Quillen College of Medicine which graduates approximately 55 physicians (MD:Doctor of Medicine) each year. This college has received national accolades for its leadership in rural medicine and in training primary care physicians. Similarly, the University of Memphis is home to the Cecil C. Humphreys School of Law which graduates approximately 140 students per year.

[27] At the present time, Austin Peay State University does not have a doctoral degree program

- **Number of Graduate Degree Programs**[28]

As of January 2005, a total of 225 graduate degree programs were offered by the universities in the TBR system (**Figure 5**). While the majority of these programs are at the Masters level (77%), the number of Doctoral programs (~18%) is consistent with the existing vision and mission of the universities in the TBR system.

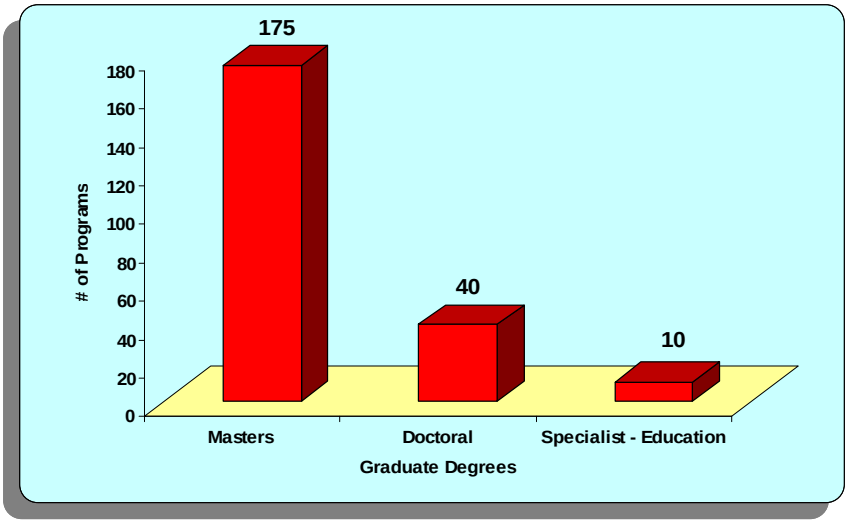

Figure 5: The number of graduate programs offered by the universities in the TBR system (as of January 2005).

Our short-term goal must be to ensure that the graduates of these masters and doctoral programs are competitive both regionally and nationally, and have the requisite education and training to participate in the Knowledge Economy workforce. Attainment of this goal requires that the quality of the graduate programs currently offered meets (and exceeds) national standards. This however, does not imply that the universities should not be encouraged to initiate new and innovative doctoral and master-level programs. In fact, quite the contrary is true. Long-term viability of new and existing graduate programs would be assured by taking maximum advantage of the existing resources in research and education at the respective campuses. In addition to identifying signature areas of excellence, the universities must deliberate on issues such as the recruitment and retention of qualified faculty, provision of adequate time and resources to the faculty to mentor students effectively, and recruitment of the brightest and the best students to enrich these programs. These particular challenges will be addressed in much greater detail with specific recommendations in Section V.

- **Graduate Student Enrollment**

[28] Does not include the MD (Doctor of Medicine) and the JD (Doctor of Jurisprudence) programs

Of the over 180,000 total students in the TBR system, 81,767 (~45%) are enrolled in the universities (Fall 2004). Of the latter group, in Fall 2004, approximately 13% (10,989) of the students were enrolled in the various graduate programs (**Figure 6**).

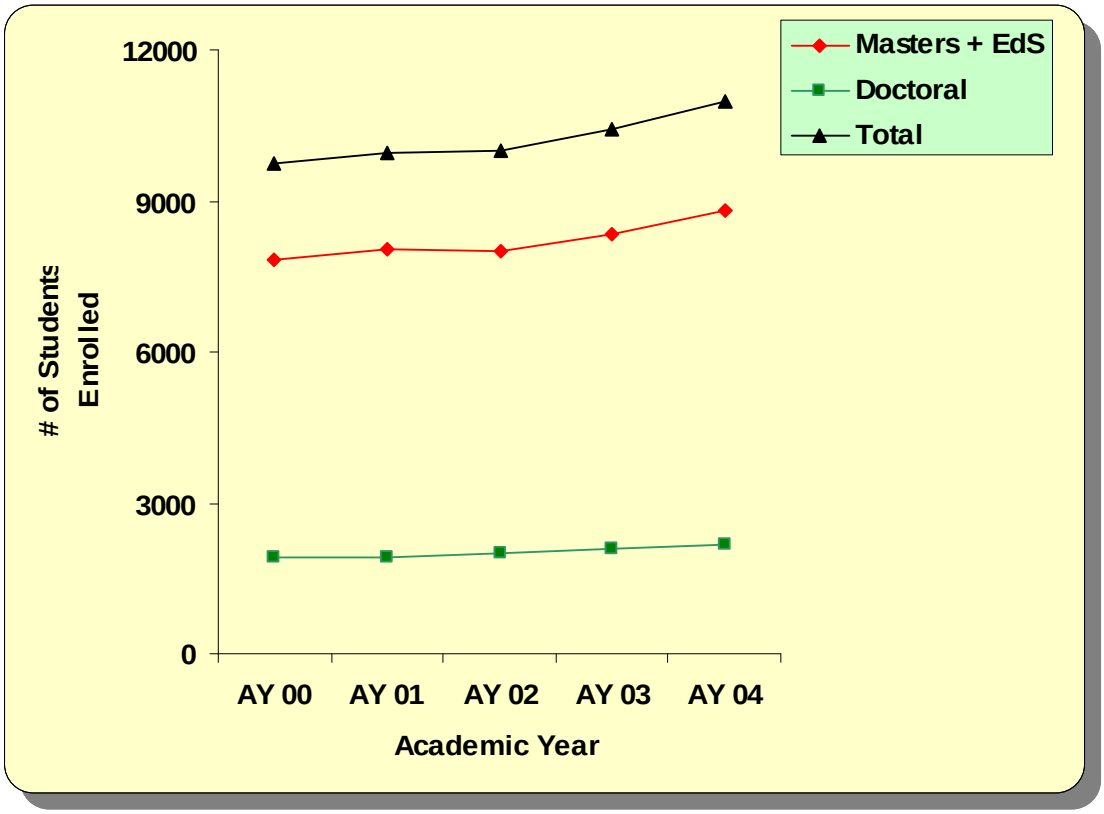

Figure 6: Number of students enrolled in various graduate programs in universities in the TBR system (AY: academic year; EdS: Specialist in Education)

As depicted in Figure 6, there has been a rather gradual yet progressive increase in the number of students enrolled in the graduate programs. In consonance with the national trend, this increase has been more pronounced for students enrolling in the Master-level programs. However, as the quality of our existing and new doctoral programs continues to improve, and as the statewide need for a skilled workforce is realized and emphasized, it is predicted that the enrollment in our doctoral programs will rise. Imparting adequate education, training, and mentorship to graduate students (particularly doctoral) is a very serious undertaking. For the system to attain a much desired leadership position in graduate education, particular attention has to be paid to numerous factors which will be discussed in greater detail in Section IV.

- **Number of Graduates Produced**

Yet another parameter used as a measure of success/failure is the number of graduates produced by the programs. As illustrated in Figure 7, in the last five years, approximately 3,500 students per year have graduated from various graduate programs in the TBR system.

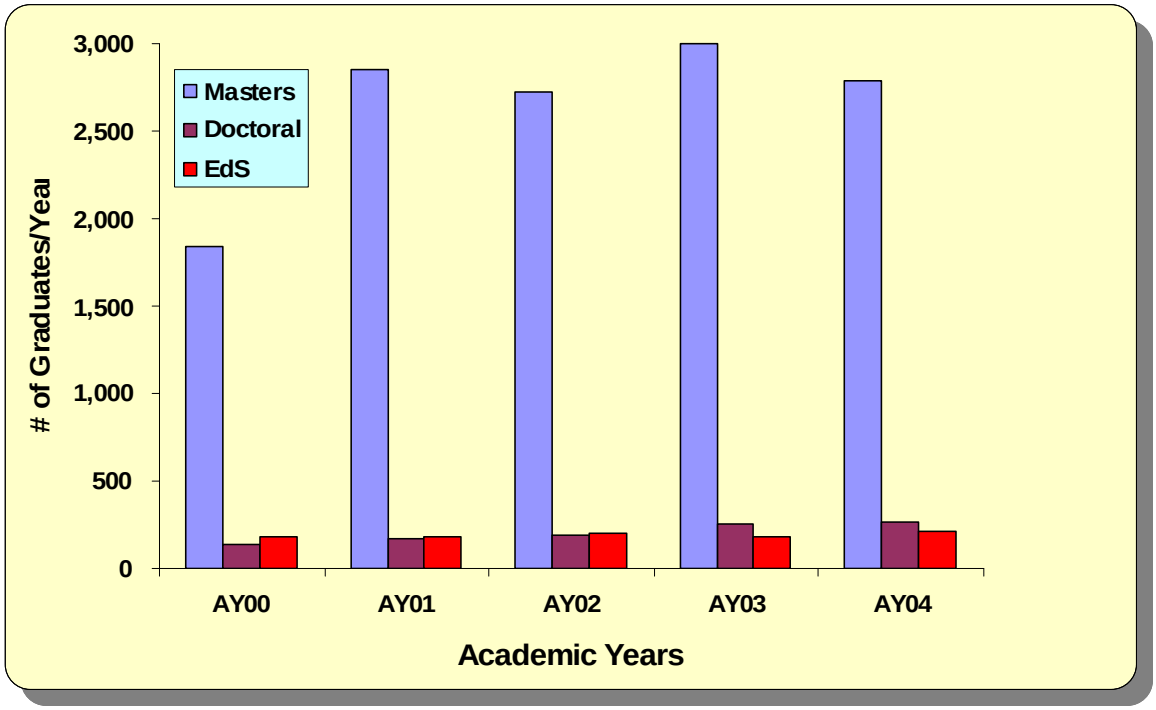

Figure 7: Number of students who have successfully completed graduate studies at universities in the TBR system (AY: academic year; EdS: Specialist in Education).

In the past five years, approximately 80% of the graduates produced were recipients of the Masters degree and approximately 6% successfully completed their doctoral requirements (**Figure 7**). Recipients of MD or JD degree are not included in this analysis.

The Vision Committee has concluded that TBR must strive to increase the number of graduate-level degrees awarded to keep pace with the growth needs of a Knowledge Economy workforce. Nonetheless, its primary focus should be on the continued improvement of the quality of education, training and mentorship that is provided to our graduate students during their association with our universities. We also need to recognize that education (particularly graduate) is viewed by many students and parents as

a value-added proposition. If a system is not prepared to appreciate and add value to a student's contribution of time, energy and money, we will likely discourage the student from pursuing higher education or else lose them to our competitors. In Section V, we will address this issue and forward a series of recommendations to improve both the production capacity and the quality of our graduate programs. We will also discuss changes in the human and capital infrastructure that are required to attain a position of excellence in graduate education.

D: Centers and Chairs of Excellence

Establishment of Centers and Chairs of Excellence plays a very important role in enhancing research and scholarship in institutions of higher learning. Normally endowed through a process of public-private partnerships, they serve to attract the most qualified and the most distinguished faculty in a given discipline. Some of the immediate impacts of establishing Centers/Chairs are listed below:

- Bring greater visibility to the region and to the institution
- Enhance excellence in research, scholarship, and creativity
- Serve as a focal point for productive congregation of scholars from various disciplines to conduct research in specific areas of interest
- Facilitate recruitment and retention of outstanding faculty, staff, and undergraduate and graduate students
- Facilitate submission of grant proposals for successful extramural funding
- Facilitate the education and training of skilled workforce

As such, these Centers and Chairs of Excellence[29] play a very vital role in enhancing the research capacity and the quality of graduate education.

- **The Centers of Excellence**

[29] Within TBR, Centers and Chairs of Excellence are limited to the research universities. The community colleges and technical centers have a comparable program called "Centers of Emphasis."

In 1984, the General Assembly and the Governor of Tennessee announced the creation of a new Centers of Excellence (Centers) program associated with the Tennessee public higher education system. Selected through a statewide competitive process, the Centers are designed to build upon the research strengths of the campuses of the TBR and the UT systems. Their purpose is to focus on the capabilities of public higher education to serve the people of Tennessee by expanding the State's research base thereby, increasing its national and international stature and its economic competitiveness[30]. At the present time, there are sixteen Centers in the TBR system (Table 3) and ten in the UT system.

Table 3: List of Centers of Excellence in the Six TBR Universities

TBR University	Centers of Excellence
Austin Peay State University	Creative Arts Field Biology
East Tennessee State University	Appalachian Studies and Services Early Childhood
Middle Tennessee State University	Historic Preservation Popular Music
Tennessee State University	Basic Skills Information Systems
Tennessee Technological University	Manufacturing Water Resources Electric Power
University of Memphis	Applied Psychology Communicative Disorders Earthquake Information Egyptology Educational Policy

[30] Part of this narrative is extracted from the THEC website and modified to accommodate the needs of this report

When this program began, the total annual budget for the Centers was approximately $20 million (present funding is at $17.7 million) per year. This money is used by Centers as seed funding to attract extramural support and for promoting research in and among various disciplines. The Centers provide a fertile ground where scholars with similar research interests can develop research teams. In many Centers, State funding makes possible the commercialization of research findings (in the form of start-up companies) and/or transfer of technology to business and industry.

- **The Chairs of Excellence**

The Chairs of Excellence (Chairs) program began in the midst of the education reform and the improvement measures passed by the General Assembly in the mid-1980s. This program brings eminent scholars to Tennessee public institutions and attracts research initiatives and private funding to our state. The program has resulted in an unprecedented level of donations to higher education from private and corporate sources. At the present time, there are 49 Chairs in various universities in the TBR system (Appendix II). The list represents the Chairs at the selected institutions by sponsor.

The appointees to these chairs have been world-renowned. This program has brought new levels of scholarship to our campuses and has enhanced the research output of all universities. This program, coupled with the equally successful Centers of Excellence program, raised Tennessee's status, among national peers, to new heights. This program was initiated with $44 million in State funding matched to private funds raised by individual campuses.

Given the importance of these Centers and Chairs in advancing the mission of research and creativity in our institutions, the Vision Committee has devoted significant attention to further integrating and enhancing the capabilities of these entities. Section V contains specific recommendations to increase the role of Centers and Chairs in the accomplishment of our short and long-term vision.

E: EPSCoR

The Experimental Program to Stimulate Competitive Research (EPSCoR) was initiated by NSF in 1978. It is a joint program between NSF and 27 U.S. States and territories[31] and includes the State of Tennessee. The primary impetus of the program is to stimulate competitive research in states that had traditionally received low percentages of Federal support for research and development. The program promotes the development of science and technology resources through partnerships involving a state's public and private universities, industry, and government, and the Federal research and development enterprise. EPSCoR operates on the principle that aiding researchers and institutions in securing Federal funding will develop the state's research infrastructure thus advancing academic and economic growth. EPSCoR's goal is to maximize the potential inherent in a state's science and technology resources and use them as a foundation for economic growth. The program's current annual budget is in excess of $90 million.

TN EPSCoR is a state-wide program and the universities in the TBR system are involved in this initiative[32]. There is a wide range of participation in this program by individuals who represent the State, public and private universities, industry, and the Oak Ridge National Laboratory. Dependent upon the level of NSF research funding are the following three major EPSCoR initiatives :

- Research Infrastructure Improvement Grant Program (RII):
  - For any State or territory to be eligible for this initiative, it must receive less than 0.70% of the total NSF research budget. The State of Tennessee is not eligible to participate in this

[31] Includes 25 U.S. States and Puerto Rico and the U.S. Virgin Islands

[32] To get more information about TN EPSCoR, please visit this website: https://san4.dii.utk.edu/servlet/page?_pageid=464&_dad=portal30&_schema=PORTAL30

initiative since our current share of the NSF research budget is ~0.72%

- Co-funding Initiative:
  - This mechanism allows meritorious proposals that have received marginal reviews to be funded jointly by this program. In essence, this initiative increases the probability of funding. For any state or territory to be eligible for co-funding and the outreach initiative, it must receive less than 0.75% of the total NSF research budget. As the present time, the State of Tennessee is eligible to participate in this initiative
- Outreach Initiative:
  - This initiative provides financial support for campus/regional visits by the staff of the NSF to brief investigators about the agency and its various on-going programs

As indicated earlier, Tennessee's share of the NSF research budget is about 0.72%. Because of state-wide research enhancement initiatives it is predicted that the State's performance will soon place us outside the eligibility criteria for inclusion in the NSF EPSCoR program. The success of the NSF EPSCoR program has lead to the establishment of six other similar programs with Federal funding agencies[33]. Collectively these Federal initiatives will help TBR institutions realize their vision of enhancing research and graduate activities on their respective campuses. As alluded to earlier, the greatest limitation to enhancing research in the TBR universities is the lack of adequate infrastructure. However, due to the existing funding formula, our ineligibility to compete in the NSF EPSCoR RII program clearly places us at a disadvantage. The Vision Committee strongly recommends that our policy makers re-visit this criterion with the NSF to ensure that the State of Tennessee is eligible to compete for the NSF EPSCoR RII funding, allowing us to improve our research infrastructure. In the section that follows (Section IV), we will revisit TN EPSCoR in the context of discussing the TBR's Strategic Areas of Research Interests that will be congruent with the national and state-wide goals.

[33] Department of Defense; Department of Energy; Environmental Protection Agency; National Aeronautics and Space Administration; National Institutes of Health; and the Unites State Department of Agriculture

"The difficulty lies not in adopting new ideas, but in escaping the old ones, which ramify, for those brought up as most of us have been, into every corner of our minds"
John Maynard Keynes

III. Environmental Scan

As a first step towards formulating its forecast, the Vision Committee conducted an extensive environmental scan of influencing factors, both internal and external, to assess our strengths, constraints/challenges, opportunities, and potential threats in the areas of research and graduate education. Representatives of each TBR university were requested to conduct an in-depth institution-specific, system-wide, and State-wide analysis. Subsequently, common elements from various evaluations were collated and are presented as a component of this report. An outcome of this environmental scan that was unique to an institution was considered outside the scope of this vision and was referred back to the originating entity for use in their campus-specific strategic planning process which is currently underway at several of the TBR universities. This analysis is consonant with the Vision Committee's intent to maintain, build, and leverage generic and unique programmatic strengths, overcome weaknesses or challenges, prioritize, optimize, and explore opportunities, and minimize constraints and threats in the TBR institutions. The following four key questions led the Committee through its deliberations:

- What are the shared and unique strengths in research and graduate education?
- What are the constraints in the State, the TBR system, and the TBR universities?
- What are the existing and emerging opportunities? (Locally, Regionally, Nationally, Internationally)
- What are the sources of future threats?

A: What are the shared and unique strengths in research and graduate education?

The comprehensive nature of TBR, the State's largest system of higher education, is perhaps one of its greatest assets. It is the nation's sixth-largest higher education system governing 45 post-secondary educational institutions, including six universities, 13 community colleges and 26 technology centers, providing education and training to over 180,000 students. Institutions in the TBR system perpetually impact the people and the economies in 90 out of 95 counties in the State of Tennessee. TBR's continued commitment to excellence is best exemplified by the existence of 16 Centers and 49 Chairs of Excellence in various universities in the system (Section IID; Appendix II). In addition to their expansive sphere of influence, the TBR institutions have a very diverse and progressively increasing portfolio of research, scholarship, and creativity. This latter fact underscores the enormity and the resilience of the intellectual capacity that resides within the ranks of its faculty, staff, and students.

This diversity in human capital is further complemented by the unique strengths and attributes of individual TBR institutions, some of which are listed below:

- A comprehensive university with strong regional prominence in the area of field biology – Austin Peay State University (APSU)
- Nationally acclaimed medical school with emphasis on research and the practice of rural medicine – East Tennessee State University (ETSU)
- Largest undergraduate campus in the State of Tennessee – Middle Tennessee State University (MTSU)
- A HBCU[34] land-grant university located in the State's capital – Tennessee State University (TSU)
- Tennessee's "technological" university – Tennessee Tech University (TTU)
- Home to one of the country's most state-of-the-art corporate-sponsored research institute (FedEx Institute) – University of Memphis (UoM)

[34] Historically Black College or University

- Three of the six TBR universities designated Carnegie Doctoral/Research Universities – Intensive (ETSU, MTSU, and TSU) and one as Carnegie Doctoral/Research Universities – Extensive (UoM)[35]

The size and the diversity of the graduate education programs are also a hallmark of universities in the TBR system. TBR universities collectively offer 225 graduate degree programs, including 40 doctoral programs (Section IIC), to more than 11,000 graduate students in such diverse disciplines as medicine, law, biology, engineering, humanities, business, economics, music, language, agriculture, mass communications. Responding to an acute need in the State, TBR and its institutions offer many certificates, diplomas, and degrees through the Regents Online Degree Programs (RODP)[36]. While the certificates are offered largely by the community colleges and the technology centers, the six TBR universities exclusively offer the two baccalaureate programs in professional and interdisciplinary sciences, and the two masters programs in nursing and education.

Another strength that can be taken advantage of is the fact that the Tennessee Small Business Development Center (TSBDC) program is housed in the TBR system[37]. The process for translation of university-based discoveries into commercial products can be facilitated by the TSBDC which has 12 full service centers and two satellite offices across the State of Tennessee. In addition to some community colleges and technical centers, an office of the TSBDC is located at each of the six TBR university campuses with its Lead Center located at MTSU.

Supplementing this academic and economic diversity is the existence of strong leadership at the level of the TBR and in many universities provided by individuals who not only support research and graduate education but are serving as catalysts for its widespread recognition and integration in the system. Collectively, these strengths underscore the fortitude of this system which, if harnessed appropriately, could lead to effective and most efficient acquisition and dissemination of knowledge-

[35] For additional information, please visit this website: http://www.carnegiefoundation.org/Classification/CIHE2000/PartIfiles/partI.htm
[36] For additional information, please visit this website: www.tn.regentsdegrees.org
[37] For additional information, please visit this website: www.tsbdc.org

based learning, development of skilled workforce, and long-term economic prosperity of the State of Tennessee.

B: What are the constraints in the State, the TBR system, and the TBR universities?

The existence, importance, and capacity of a system of higher education as large as the TBR cannot be dismissed or diminished. With this stipulation, any perceived or real constraints that exist at the level of the State, the TBR system, or its universities have to be resolved and the important role that TBR can (and will) play in academic, technological, and economic stability of the region, the State and the Nation has to be recognized. TBR and its universities cannot be relegated to the role of a "postscript" to another system of higher education when it has the intellectual capacity to make an immediate and significant contribution in the State. The most effective manner in which this fact could be realized is by advocating that the policy makers articulate a compelling argument to their respective constituents that the long-term economic stability in the State is strongly linked to further enhancement of research and graduate education and in partnership with other public and private institutions, TBR can play a very vital role in this process.

Several TBR universities are also struggling with the concept of distinguishing research and scholarship as one of the three primary missions of an institution of higher education[38]. Given their historical role in teaching predominantly undergraduate students, it is often professed that comparable emphasis on research, scholarship, and creativity would somehow distract the faculty from this primary mission. The most important attribute of an effective teacher is to appreciate and participate in the acquisition of knowledge and its dissemination through knowledge-based learning. Acquisition of new knowledge requires an unwavering commitment on the part of the faculty to engage in original inquiry and to communicate effectively the outcome of this inquiry to the students in as timely a manner as is possible. Such a practice not only improves the quality of instruction but also inculcates in the undergraduate and graduate students the desire to become life-long learners.

[38] The three missions of a comprehensive university are Education, Research & Scholarship, and Public Service

The value of original inquiry and its critical role in imparting quality education has to be widely appreciated on TBR university campuses. Interestingly, many of the TBR universities have evolved from being largely an undergraduate campus to a more comprehensive institution awarding doctoral degrees. This transition in itself demands a culture change. Doctoral degrees by definition require a very high level of inquiry and research and for this reason mentorship of doctoral students is an extremely serious and demanding responsibility that is jointly shared by the mentor and the institution. TBR can help facilitate this transition by setting a higher threshold of expectation from its faculty, staff, and students and by partnering with the university campuses in supporting professional development of faculty which is crucial for the success of this endeavor.

The evolution of many of the TBR universities from predominantly undergraduate campuses to comprehensive doctoral awarding institutions was not accompanied by a parallel and comparable emphasis on improving human and capital infrastructure. This has created a serious challenge for many institutions and if it remains unresolved the lack of adequate infrastructure has the potential to undermine the long-term viability of undergraduate and graduate education and training in TBR universities as well as the continued enhancement of the quality of research.

Faculty, staff, and students in many TBR universities need adequate state-of-the-art research facilities and core laboratories to remain competitive with their peers. This deficiency must be reversed and the policy makers and key stakeholders in the State have not made a persuasive argument to the public and to the legislature to accomplish this goal. Lack of an appropriate infrastructure has many undesirable downstream effects. It thwarts the ability of universities to recruit and retain outstanding faculty, staff, and students and to service adequately the rapidly changing workforce needs which will require more (not less) qualified graduates in the foreseeable future.

In the modern era, innovation is interfaced throughout the disciplines. Recognition of this fact has prompted many systems and institutions of higher education around the globe to embrace the concept of promoting interdisciplinary collaboration and synergies. Contrary to some other states in the U.S., in Tennessee, productive research collaborations between various public universities and public/private partnerships are not pervasive. The State, its legislature, and the TBR system can play a cardinal

role in reversing this limitation. In the section that follows (Section VB), the Vision Committee has made some specific recommendations which, if adopted, have the potential of alleviating this concern.

C: What are the existing and emerging opportunities?

From a purely economic point of view, the environment for conducting research and for seeking higher education has never been more conducive than it is today. The relative stagnation in global, national, and state economies has resulted in the progressive erosion of financial support for public universities in the U.S. However, the cost of delivery of quality education continues to increase. Many institutions are therefore forced to explore and adopt alternative, more entrepreneurial approaches to meet their burgeoning financial needs. Strategic investment in the research enterprise has been most advantageous in bringing new resources to campuses. In addition to strengthening the core missions of the institution, commercialization of university-owned intellectual property has mushroomed into a multi-billion dollar industry. The direct and indirect effects of such an important economic contributor are immeasurable. In recognition of this fact, many states have made a conscious and strategic decision to invest in building research capacities in their public universities and to establish a state-wide infrastructure which facilitates technology transfer and commercialization. For the State of Tennessee to take maximum advantage of this environment, it must invest in further enhancing the research enterprise of the universities in the TBR system. It must be emphasized that the enormity, the diversity, and the intellectual capacity of the institutions in the TBR system are key ingredients which will yield maximum benefits from such strategic investments.

The dynamically changing workforce needs demands more technically proficient and highly skilled individuals. To address this challenge, many individuals are now seeking graduate-level education and training. Investment by the State in research and graduate education in the public higher education system ensures availability of a skilled labor force, thus attracting and retaining lucrative technology-based industries in the region. The comprehensive nature of the TBR system assures broad access of the public to the benefits of higher education. Public policy makers in the State should recognize this fact and advocate for enhanced investment in

further developing the research and graduate education enterprise in institutions within the TBR system.

D: What are the sources of future threats?

The most significant threat to our ability to continue to enhance research and graduate education in the public universities in the State of Tennessee is the deteriorating regional, national, and global economies. The burgeoning U.S. budget deficit has impacted the Federal appropriations to the states which has had a very significant negative effect on the funding for public higher education. Further compounding this challenge is the on-going budgetary limitations that Federal research funding agencies are facing thus making it more difficult for our faculty, staff, and students to obtain extramural funding.

The events of 9/11 have changed the U.S. research priorities significantly. They have prompted both Federal and State governments to invest heavily in homeland security and in research and development projects that are related to this endeavor. Public universities which had ongoing research or had the capacity to invest in initiating research in this area stand to benefit the most from this strategic shift in national priority. Because of the lack of existing infrastructure and a limited number of faculty with the required experience and expertise, public universities (particularly TBR institutions) in the State of Tennessee have not been able to participate fully and engage as a dominant contributor in this research and educational priority. If strategic investment is made by the State in TBR institutions to enhance their research capacity particularly in the area of homeland security, then working in collaboration with the UT system, the public universities in the State of Tennessee could conceivably play a dominant role in this new initiative.

Perhaps the most valuable mechanism for sustaining a long-term economic viability in a region or a state would be to attract, to develop, and to retain technology-based industry. Besides contributing directly to the economic well being of the region, such corporate enterprises thrive in the proximity of a research intensive institution of higher education. In addition to being able to recruit highly skilled labor with relative ease, university/industry partnerships in the area of research and development are mutually beneficial. It gives the university the financial resources it needs to continue to enhance its research and graduate education capacities while providing an industry partner with access to unique intellectual and capital

resources. Public policy makers must recognize this fact and make every effort to create an environment of intellectual excellence in the TBR universities to ensure long-term academic and economic stability in the State.

"Discovery consists in seeing what everyone else has seen and thinking what no one else has thought"
Albert Szent-Gyorgi
1937 Nobel Prize in Physiology and Medicine

IV. Identification of Strategic Areas of Growth, Synergy, and Collaboration in Research

Each University within the TBR system has areas of strength in research that are not necessarily duplicated at other schools within the system. The diversity of the Centers of Excellence provides an example in support of this proposition. Notwithstanding the differences in research and education missions and geographic locations, the Vision Committee believes that a system-wide research vision cannot be developed by focusing on the differences but rather emphasis should be placed on further harnessing collaboration in areas of common research interests in the TBR institutions. Such a strategic shift in focus would result in increased research support and productivity across the State of Tennessee.

A substantial amount of work has already been done to identify areas of strength in science and technology within the State of Tennessee, including not just the TBR institutions but also the UT system, Vanderbilt and the other private colleges and universities, the Oak Ridge National Laboratory and certain technology-intensive R&D companies in the private sector. This was done by a State-wide committee established to develop a plan to maximize the opportunities presented to Tennessee's universities when the State became eligible for the NSF EPSCoR program. The central goal of the TN EPSCoR program was to increase R&D competitiveness in the State by accomplishing three aims:

- Strengthening the science, engineering and technology R&D infrastructure
- Enhancing/promoting the transfer of ideas and technology from the university and public laboratories to the private sector
- Enhancing education in science, technology, engineering and mathematics (STEM) at all levels

In February and March of 2004, forums were held in five different cities in the State. Two hundred and sixty-six faculty members,

administrators and members of the business community attended these forums. The goal of these forums was to identify research themes that recurred at institutions and laboratories across Tennessee. These themes were to include the following:

- Existing programs that already had a success record and are recognized as being significant because they are associated with a nationally recognized researcher, must form the basis of each theme;
- Support for multi-campus and industry participation;
- Promise of a multi-disciplinary, team approach;
- High probability of major improvement with modest investment;
- Evidence of long-term sustainability and have promise of growth; and
- Linkages to enhancement of education and human resource development in Tennessee.

Five major themes emerged from the forums, each of which had several subcategories. The Vision Committee recommends adopting the areas/sub-areas identified by TN EPSCoR to serve as focal points for growth of R&D within the TBR system.

Bio-medical/Health Sciences	**Environmental Sciences**
• Biology/Toxicology • Biological complexity • Infectious diseases • Cancer research • Neuroscience • Biotechnology • Bioinformatics • Proteomics • Genomics	• Biology/Microbiology • Remediation of hazards (water, air) • Urban ecology • Geographic Information Systems/Geomatics • Agri-bio Security • Wildlife/Agriculture • Sensor technology • Clean, renewable fuels • Transportation policy • Conservation Biology

Computational Science & Applications	Cyber-infrastructure
• Applications in chemistry, material science and biology • Large scale simulation • Robotics and artificial intelligence • Intelligent control systems • Data fusion from disparate sensors • Information security • Large complex data systems • Visualization technology • Computational fluid dynamics, finite element methods	• Network infrastructure • Grid computing (sharing resources across boundaries) • Design of information production and services • Human-computer interface • Information technology • Cyber and information security • Building data systems • IT for health sciences • Wireless, ultra wide band • Fault tolerant computing • Communications • Sensor technology
Materials Science	
• Nano-science/technology • Strategic/novel materials • High-temperature ceramics, composites • Bio-materials, implants, devices • Laser processing • Opto-electronics	

In addition to Homeland Security, the Vision Committee believes that these thematic areas are also appropriate foundations for research collaborations. The synergies that can develop in these fields among researchers at TBR institutions and with their peers at other research facilities will be a cost effective way to accomplish the three goals identified through the TN EPSCoR process. However, successful implementation of a program to encourage collaborations will require significant leadership and the allocation of additional resources by the State to provide incentives to faculty to seek collaborators.

"Imagination is more important than knowledge"
Albert Einstein (1879-1955)

V. Research Vision and Final Recommendations

The charge given to the Vision Committee was to develop a bold vision unencumbered by any present or future limitations. We were encouraged to dream and to develop a plan of strategic growth and enhancement of research and graduate education which was not only inspirational but achievable. Our goal was to articulate a process by which we could catalyze transformation of TBR and its institutions into an organization which values research as an important component of knowledge-based learning and continued creation of a skilled workforce and a stable economy. In the process of accomplishing our goals, the members of the Vision Committee met on numerous occasions to review the available information and to deliberate on the possible outcomes. The preceding sections provide a succinct overview of not only the importance of research and graduate education but also the present status of these missions in the TBR universities. We will refrain from reiterating previously discussed facts in the section that follows, but instead focus on articulating our vision for years 2010 and 2020. We will use these two time points as milestones and present our recommendations accordingly.

A: Transform Existing Culture: Emphasis on Research

Recommendations:

- Continue to emphasize the importance of research by the State of Tennessee and the TBR as a fundamental driver for growth and economic prosperity
- Underscore the importance of research and acquisition and dissemination of knowledge-based learning in the mission statements of the TBR and its six universities.
- Facilitate progressive change in campus-wide culture which encourages and rewards research and scholarship in the following areas:
    - Faculty appointment and tenure and promotion process
    - Provision of adequate release time for research faculty
    - Provision of incentives and bonuses to productive research faculty
    - Provision of adequate start-up funds and competitive salaries for newly recruited research-oriented faculty
    - Provision of adequate internal seed funding to support new research projects
- Develop an Annual Research Brochure by TBR to inform the Office of the Governor, the members of the Tennessee Legislature, THEC, the 45 post-secondary TBR institutions, and other public, private, and industry partners of the ongoing research at its universities
- Diversify TBR institutions through determined efforts to recruit and retain underrepresented minority and women faculty
- Encourage THEC to consider including research, scholarship, and creative activities outcomes into the Performance Funding Standards
- Encourage development and implementation of a Research Strategic Plan at each TBR university

B: Enhance Research Collaboration

Recommendations:

- Enhance collaboration and synergy between TBR universities
    - Provision of seed funding by the State and the TBR for collaborative projects (Approximately $1 million/year for the next 5-10 years) between TBR institutions including the community colleges and technical centers, between TBR institutions and other universities, and between TBR institutions and the public (e.g. ORNL) and private sectors
    - Establish a review committee composed of experts from both within and outside Tennessee to review grant proposals for seed funding of collaborative projects
    - Require that partners in such grants provide a matching commitment in the form of cash or in-kind

C: Enhance Research Funding

Recommendations:

- Double extramural research funding from approximately $53 million (FY 2004) to $106 million by 2010
- Quadruple extramural research funding from approximately $53 million (FY 2004) to $212 million by 2020
- Triple total extramural funding from approximately $139 million (FY2004) to $417 million by 2020
- Continue to improve the Federal share of extramural funding to reach approximately 50% of the total by 2010

D: Enhance Research Infrastructure

Recommendations:

- The State of Tennessee and the TBR must partner with individual university campuses to improve their research infrastructure
    - Ensure that by 2010, each Carnegie Doctoral/Research Universities - Intensive TBR university will move towards acquiring at least one state-of-the-art basic and applied research facility of adequate size to meet the present and growing research and education needs of the institution
    - Ensure that by 2010, the Carnegie Doctoral/Research Universities - Intensive TBR universities (ETSU, MTSU, and TSU) will move towards reclassification as Carnegie Doctoral/Research Universities - Extensive
    - Ensure that by 2010, the two existing Carnegie Master's Colleges and Universities - I institutions in the TBR (APSU, TTU) will move towards reclassification as Carnegie Doctoral/Research Universities - Intensive
    - Ensure that University of Memphis – the only TBR university with Carnegie Doctoral/Research Universities – Extensive classification continues to retain and improve its research status
    - Encourage TBR universities to establish and adequately support core facilities that are critically needed to further their research and education missions
    - Establish state-of-the-art regional core research facilities shared by various TBR and non-TBR institutions
    - Develop a program to ensure that teaching laboratories are adequately housed, equipped, and staffed
    - Encourage our policy makers and legislators to work with the NSF to ensure that the State of Tennessee is eligible to compete for the NSF EPSCoR RII funding, allowing us to improve our research infrastructure
    - Ensure that the State invest in the establishment of a robust cyberinfrastructure. Implementation of the forthcoming recommendations of the TN EPSCoR's CIC are endorsed
    - Ensure that TBR universities have adequate library facilities and print and electronic holdings to meet the present and growing needs of the graduate students and faculty

E: Enhance Technology Transfer and Commercialization

Recommendations:

- Advocate for the State, TBR, County and City Offices, and individual universities to collaborate to develop business incubators or innovation parks in each research-extensive TBR university by 2008 and explore mechanisms to partner with the neighboring Community Colleges and Technology Centers in this effort
- Incorporate Tennessee Small Business Development Centers as an integral component of these regional incubators or parks
- Encourage TBR and its universities to develop jointly an educational brochure/workshop to inform and encourage entrepreneurship and commercialization of university-developed technology for its faculty, staff, and students
- Establish an RODP curriculum in entrepreneurship leading to a certificate using existing entrepreneurial programs
- Encourage establishment of Research Foundations (501c3) in each TBR university by 2006
- Establish an Office of Research and Technology Transfer at the level of the TBR to facilitate this process (see Section VH)
- Facilitate establishment of Office of Technology Transfer and Commercialization in each TBR university

F: Establish a State-wide Science and Technology Advisory Group:

Recommendations:

- The State of Tennessee should consider establishing a State-wide Science and Technology Advisory Group which must include:
  - Associate Vice Chancellor for Research, TBR
  - Vice President for Research, UT System
  - Vice President for Research, Vanderbilt University
  - President, Oak Ridge Associated Universities
  - Director, Oak Ridge National Laboratories
  - President, Tennessee Independent Colleges and Universities Association
  - Executive Director, EPSCoR
  - Vice President for Research, Tennessee Valley Authority
  - Head of R&D at two or three private industries in the area of biotechnology, manufacturing, engineering, etc.
- The primary function of this group is to:
  - Develop and implement State-wide strategic plans for the enhancement of research and collaborations
  - Serve as an advisory to the Governor, the Tennessee Legislature, THEC, and TBR and inform them on issues related to research
  - Work collaboratively with other State agencies to enhance economic development and education and training of skilled workforce for advanced technology-based industry

G: Establish a TBR System-wide Research Council:

Recommendations:

- TBR must consider establishing a system-wide Research Council which includes:
  - Chief Research Officers of the six TBR universities
  - Vice Chancellor for Academic Affairs, TBR
  - Vice Chancellor for Administration and Finance, TBR
  - Associate Vice Chancellor of Research, TBR (Chair)
  - Associate Vice Chancellor for Research & Assessment, TBR
  - Director, Technology Transfer, TBR
  - Chief Information Officer, TBR
- The primary function of this group is to:
  - Develop and implement system-wide strategic plans for the enhancement of research and collaborations
  - Facilitate development and implementation of policies and procedures which encourage system-wide enhancement of research
  - Assist the TBR Office of Research and Technology Transfer (proposed in Section H below) in the implementation of this vision
  - Serve in an advisory capacity to the TBR Board, the Chancellor, and the University Presidents and Chief Academic Officers
  - Review strategic areas of research interests for the TBR based on the list provided in Section IV of this report
  - Recommend strategies to align faculty research expertise with national and regional workforce needs
  - Facilitate development and implementation of policies and procedures which encourage system-wide entrepreneurship and university-based technology commercialization
  - Develop strategies to improve cyberinfrastructure in the State and in the TBR institutions
  - Facilitate development of a model that links faculty workload to research, mentoring and teaching of undergraduate and graduate students

H: Establish an Office of Research and Technology Transfer - TBR

Recommendations:

- TBR must establish an Office of Research and Technology Transfer which is located within the Academic Affairs, this office must be provided with adequate funds to support on-going initiatives and adequately staffed as follows:
  - Associate Vice Chancellor
    - A researcher of national significance must be recruited to provide a leadership role in this position
    - Serve as Chair of system-wide Research Council
  - Director, Technology Transfer
  - Director, Research Collaborations
  - Administrative Assistant
- The primary function(s) of this office will be to (among others):
  - Facilitate growth of research and technology transfer across all TBR institutions
  - Develop productive relationships with other public and private universities, institutions, and industry partners
  - Inform and educate key stakeholders about the importance of research in higher education
  - Develop and disseminate Annual Research and Technology Transfer Reports
  - Provide assistance and support to system-wide Research Council
  - Provide oversight of the timely execution of the recommendations of this vision report
  - Support Office of Technology Transfer at individual TBR university campuses
  - Develop and maintain a central repository of faculty experience and expertise

I: Centers and Chairs of Excellence: Enhanced Emphasis on Research

Recommendations:

- Greater emphasis must be placed by the THEC and the TBR on discovery and innovation and reliance on extramural research funding to support growth and scholarly activities in the Centers and by the Chairholders
- THEC and TBR must exercise greater level of oversight of Centers and Chairs of Excellence to assure:
    - Accountability
    - Resourcefulness
    - Outreach programs
    - Level of integration into campus-related activities
    - Alignment of mission with State and institutional priorities
- TBR and its institutions must maintain a longitudinal database of acquired extramural research and public service funding, scholarly publications, and other such related activities by the Centers and the Chairholders
- THEC, TBR, and its universities must facilitate greater integration of these Centers and Chairs into graduate and undergraduate teaching and training
- THEC and TBR must develop a standardized assessment tool to periodically review the progress of a Center or a Chair with the ultimate objective of evaluating its regional and national role in enhancing research, scholarship, creative activities, public service, public-private industry partnerships, and undergraduate and graduate education

J: Enhance Graduate Education and Research

Recommendations:

- The important link between research and graduate education must be emphasized by the TBR and its universities
- Each TBR university must be encouraged to focus on enhancing the quality of its existing graduate programs
- Initiation of new Masters and Doctoral programs must be facilitated by THEC and TBR on the basis of need, uniqueness, and institutional strengths and expertise
- TBR must continue to facilitate development of interdisciplinary Masters and Doctoral programs at its universities
- TBR must continue to facilitate development of collaborative inter-university (within the TBR system) Masters and Doctoral programs in the State
- TBR must encourage its Centers of Excellence to actively support graduate education initiatives by involving graduate students in research and by providing them with assistantships and other forms of financial support
- TBR universities must be encouraged to increase the number of available assistantships to approximately 20% of its total graduate enrollment by year 2010
- TBR universities must be encouraged to provide competitive stipends and health benefits to recruit and retain outstanding graduate students
- TBR universities must be encouraged to allocate a portion of their indirect cost recovery from research grants and contracts to support graduate education initiatives
- TBR must continue to seek funding from the State and/or other resources to provide scholarships to outstanding graduate students
- To maintain diversity, TBR institutions must make every effort to recruit and retain underrepresented minority and women students

K: Enhance Undergraduate Research

Recommendations:

- TBR must promote and facilitate the recognition of the importance of research and knowledge-based learning for undergraduate students
- TBR and its institutions must facilitate systematic integration of research into the undergraduate curriculum
- TBR universities must be encouraged to allocate a portion of their indirect cost recovery from research grants and contracts to support undergraduate research initiatives
- TBR and its institutions must facilitate development of a model that links faculty workload to research mentoring of undergraduate students
- TBR and its institutions must be encouraged to obtain extramural funding to support the establishment and growth of undergraduate research programs on their campuses
- TBR must continue to seek funding from the State and/or other resources to provide scholarships to outstanding undergraduate students to engage in research at its universities
- Each TBR university campus must establish an Office or a Center for Undergraduate Research to facilitate this process
- Students who participate in undergraduate research and satisfy the requirements should graduate as Regent's Research Scholars and have this distinction duly noted on their transcript

SUMMARY

The members of the Vision Committee and the Graduate Education Taskforce realize that the enterprise to articulate this vision comes at a very important juncture in the history of the State of Tennessee and the TBR system. Our objective was to continue to underscore the fact that public research universities are the most reliable and effective economic engines for ensuring long-term academic, workforce, and financial stability in the State. We also wanted to emphasize the critical role TBR universities, community colleges, and technical centers are presently playing and will continue to play in this endeavor. We envision that there will be a renewed interest in enhancement of the research mission of the TBR institutions allowing them to continue to play a more dominant role in acquisition of knowledge-based learning, in preparation of a highly-skilled workforce, and in achieving regional and state-wide economic stability. The Vision Committee is unanimous in its view that implementation of the recommendations provided in this report will facilitate enhancement of research and graduate education in TBR institutions and beyond. ***We trust that this vision report will inform the campus-specific strategic planning process that is currently underway at several of the TBR universities.***

It takes a long time to bring excellence to maturity
Publilius Syrus (Maxims)

APPENDIX I

EXTENDED ENTREPRENEURSHIP PROGRAMS IN THE U.S.[39,40]

- University of Maryland (Holistic Approach to Entrepreneurship Education)
- Case Western Reserve (Physics Entrepreneurship Program)
- Rowan University, University of Tulsa, and Georgia Tech (Interdisciplinary Programs in Technical Entrepreneurship)
- Carthage College and University of Wisconsin (the CATI Model)
- Penn State (Engineering Entrepreneurship)
- Rose-Hulman (Entrepreneurship & Engineering Design)
- University of Rhode Island (Team-Based Product Design)
- Rose-Hulman/Florida Institute of Technology (Wireless Entrepreneurship Program)
- Illinois Institute of Technology (Experiential Learning)
- University of Southern California, Illinois Institute and Case Western (National Network for Technology, Entrepreneurship & Commercialization)
- Worcester Polytechnic Institute (Fostering Student Entrepreneurship)
- Georgia Tech (Cross-Campus Collaboration, TI-GER)
- MIT (Ideas Competition, Public Service Design Seminars)
- Lehigh University (Integrated Product Design)
- Rose-Hulman (Ingenious Solutions)
- University of Maryland (Venture Accelerator Program)
- Drexel University (Baiada Center)
- Rowan University (Boot Camp Model)
- UCSD (Positive Introductory Design)
- Stanford (Biomedical Engineering Portal)
- University of Connecticut (Medical Device Innovation & Entrepreneurship Program)
- James Madison University (Meta-cognition in Integrated Science & Technology)
- Penn State (Market Pull Technology Commercialization)
- University of Florida (Integrated Technological Ventures Program)

[39] "Big Ideas in a Small World," Proceedings of the 7th Annual Meeting of the NCIIA, March 20-23, 2003 Boston, MA

[40] "Education That Works: Invention, Innovation & Entrepreneurship in Practice," Proceedings of the 8th Annual Meeting of the NCIIA, March 18-20, 2004 San Diego, CA

- Louisiana Tech (InVenture Research)
- Lawrence Technical University (Intrapreneurship)
- Rochester Institute of Technology (Multidisciplinary Engineering Senior Design Program)
- Tri-State University (ECITE)
- Clemson, University of Florida and North Carolina State (Engineering Entrepreneurship Program)
- Babson College (Model-Driven design)
- Rice University (E-Team Cultures)
- USC, Claremont and Caltech (Technology Commercialization Teams)
- University of Pittsburgh (Interdisciplinary Materials Research Program)
- University of Detroit Mercy (End-to-End Product Creation)
- Florida Institute of Technology (Commercialization of Senior Design Projects)
- University of North Dakota (Building Cross Campus Partnerships in Product Development & Entrepreneurial education)
- San Jose State University (Cross-Functional Education)
- Purdue University (Interdisciplinary Entrepreneurship Training)

APPENDIX II
LIST OF CHAIRS OF EXCELLENCE IN THE TBR UNIVERSITIES

INSTITUTIONS	CHAIR	ACADEMIC AREA
Austin Peay	Roy Acuff	Creative Arts
	Harper/Bourne	Business
	APSU Foundation	Free Enterprise
	Leonora C. Reuther	Nursing
East Tennessee	Cecile Cox Quillen	Geriatrics & Gerontology
	AFG Industries	Entrepreneurship in Business and Technology
	Allen and Ruth Harris	Business
	Carroll H. Long	Surgical Research
	Paul Dishner	Family Medicine
	James H. Quillen	Teaching & Learning
	Wayne G. Basler	Integration of the Arts, Sciences & Technology
	LeeAnne Brown/Phys. Group	General Academic Pediatrics
Middle Tennessee	John Seigenthaler	First Amendment Studies
	Jennings A. Jones	Free Enterprise
	Carl Adams	Health Care Services
	National HealthCorp	Nursing
	Robert & Georgianna Russell	Manufacturing
	Katherine Davis Murfree	Dyslexic Studies
	Mary E. Miller	Equine Health
	John C. Miller	Equine Reproductive Physiology
	Jennings & Rebecca Jones	Regional & Urban Planning
Tennessee State	Frist	Business
	(Unnamed)	Banking & Financial Services
Tennessee Tech	J. E. Owen	Business Administration
	William E. Mayberry	Business Administration
Univ. of Memphis	W. Harry Finestone	Molecular Biology
	Herbert Herff	Law
	Morris F. Fogelman	Real Estate
	Sales & Marketing Execs.	Sales and Marketing
	Thompson-Hill	Accountancy
	Arthur Andersen Alumni	Accounting II
	Lillian & Morrie Moss	Philosophy
	Wunderlich	Finance
	Herbert Herff	Biomedical Engineering I
	Bornblum	Judaic Studies
	Shelby County Government	International Economics
	Robert Wang	International Business

INSTITUTIONS	CHAIR	ACADEMIC AREA
Univ. of Memphis (Contd)	(Unnamed)	Free Enterprise Management
	Lillian & Morrie Moss	English Poetry
	Herbert Herff	Biomedical Engineering II
	William & Ruth Loewenberg	Nursing
	Dorothy K. Hohenberg	Art History
	Federal Express	Management Information Systems
	Lillian & Morrie Moss	Psychology
	Lillian & Morrie Moss	Urban Education
	Jabie Sanford Hardin III	Combinatorics
	Helen and Jabie Hardin	Economics/Managerial Journalism
	Sparks	International Business Relations
	Plough	Audiology

APPENDIX III
ABBREVIATIONS

AACSB: Association to Advance Collegiate Schools of Business
APSU: Austin Peay State University
Centers: Centers of Excellence
Chairs: Chairs of Excellence
CIC: Cyberinfrastructure Commission
CUR: Council on Undergraduate Research
DOD: Department of Defense
DOE: Department of Energy
DOEd: Department of Education
EPSCoR: Experimental Program to Stimulate Competitive Research
ETSU: East Tennessee State University
E-Teams: Entrepreneurial Teams
HBCU: Historically Black College or University
MTSU: Middle Tennessee State University
NCIIA: National Collegiate Inventors and Innovators Alliance
NEH: National Endowment for the Humanities
NGA: National Governors Association
NIH: National Institute of Health
NSF: National Science Foundation
ORNL: Oak Ridge National Laboratories
RII: Research Infrastructure Improvement Grant Program
RODP: Regents Online Degree Program
STEM: Science, Technology, Engineering and Mathematics
TBR: Tennessee Board of Regents
THEC: Tennessee Higher Education Commission
TSBDC: Tennessee Small Business Development Center
TSU: Tennessee State University
TTU: Tennessee Tech University
UC: University of California
UCF: University of Central Florida
UoM: University of Memphis
UT: University of Tennessee