ENVISIONING VIRGINIA TECH

BEYOND BOUNDARIES

VISIONING INITIATIVE:

INVENTING THE FUTURE OF VIRGINIA TECH

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Executive Summary

The year 2047 will be the 175th anniversary of Virginia Tech. In order for the university to be well positioned to meet the needs of the communities it serves at this monumental point in time, Virginia Tech is preparing for two related goals: advancing as an internationally recognized, global land-grant institution, and strategically addressing the challenges and opportunities presented by the changing landscape of higher education.

This paper offers as a university-wide visioning process to address the complex questions facing our institution. The effort is conceived from an analysis of Virginia Tech's strategic plan, President Sands' installation remarks, the State Council for Higher Education in Virginia's 2014 strategic plan, literature on the changing landscape of higher education, and the work and characteristics of benchmark institutions. From this research, we identified seven elements of the changing landscape and four thematic areas of inquiry that will serve as the foundation for the initiative.

Thematic Areas of Inquiry

Elements of the Changing Landscape of Higher Education						
Campus Setting	Funding and Cost	International Focus	Scholarship and Research	Service	Teaching and Learning	Technology

As Virginia Tech works to address the challenges and opportunities associated with each complex area of inquiry, improvements will be reflected in national and international rankings systems, thus contributing to our position as a global land-grant university with international distinction. We performed a focused analysis on the Times Higher Education World Rankings (THE) after identifying it as the best system for our continued study. THE ranks universities in the categories of teaching, research, citations, industry, and internationalization. Virginia Tech is in the 276-300 range among world universities in the 2014-2015 THE World Rankings, below all but two of our SCHEV peer institutions. With these indicators as a guide, Virginia Tech has the opportunity to commit to a long-range visioning process that will help us reach the ultimate goal of becoming a global land-grant institution.

The Virginia Tech community will be charged with addressing complex challenges and opportunities facing the university and making policy recommendations that will guide the institution towards a 2047 future. High-profile and world-renowned external advisors will help shape the process. A steering committee will lead the university-wide initiative and make recommendations at the conclusion. Public input will be collected through an idea bank and town hall meetings, and seminars will help to educate the university community on the changing landscape of higher education. Working groups organized around thematic areas of inquiry will bring forth new ideas to advance the university's long-range goals. The initiative would take place in five phases between Fall 2014 and May 2016.

Priority outcomes for this initiative include articulating a vision Virginia Tech's future that is informed by the university's broad-based constituent groups. This vision will provide a framework for planning that will help guide the institution through the challenges and opportunities it may face through 2047 as a 21st century internationally recognized, global land-grant institution.

Land-grant of the Future: Virginia Tech in 2047

The year 2047 will be the 175th anniversary of Virginia Tech. In order for the university to be well positioned to meet the needs of the communities it serves at this monumental point in time, Virginia Tech is preparing for two related goals: advancing as an internationally- recognized, global land-grant institution, and strategically addressing the challenges and opportunities presented by the changing landscape of higher education.

Although Virginia Tech is already engaged in numerous activities that may suggest that it is both world-class and globally focused, there are many ways in which it can improve in order to best prepare students and serve the citizens of Virginia and society at-large. Among other elements, Salmi (2009) suggests that world-class institutions have great financial strength and abundant resources which help create well-qualified graduates, leading-edge published research, and a rich learning environment. For Virginia Tech, some improvements are easy to identify—enhance and diversify our resource base, increase support for talented students, faculty, and staff, and create a favorable external policy environment are often at the top of the list. Other necessary changes are less obvious and Virginia Tech will require the creativity and innovative thought of its expansive community to best envision its future. All of these improvements will not only better Virginia Tech as a comprehensive land-grant institution, but will also help to elevate the university to world-class status amongst its national and international peers.

Virginia Tech's strength as a 21st-century, global land-grant university will depend on how we navigate and prepare for these two pursuits in relationship to both its recent strategic planning goals and the statewide strategic plan offered by Virginia's State Council for Higher Education (SCHEV). This paper is conceived from an analysis of Virginia Tech's strategic plan, President Sands' installation remarks, SCHEV's 2014 strategic plan, literature on the changing landscape of higher education, and the work and characteristics of benchmark institutions.

Based on research of the changing landscape of higher education, we suggest a one-year initiative to address the complex questions facing our institution as we look towards 2047. The university must be visionary, inclusive, bold, and efficient in this process to ensure our future success as an internationally recognized, global land-grant institution. Importantly, the initiative builds upon two of the university's recent accomplishments: the 2012-2018 strategic plan and the installation of President Timothy Sands—the university's 16th president.

Looking Back to Move Forward

While 2008 may not feel like that long ago, a look back reveals just how much has changed socially, technologically, and financially since members of the Class of 2015 were in their early high school years:

1. State funding for higher education in Virginia declined 27.89% in constant dollars between FY2008 to FY2013.[1] At the same time, in-state tuition and fees at Virginia Tech increased from $7,397 for the 2007-2008 academic year to $12,017 for the 2014-2015 academic year: a 62% increase in nominal dollars and a 42% increase in 2014 constant dollars.[2]
2. The number of academic students entering the US on F-1 visas was 859,169 in 2008; this number rose to 1,577,509 by 2013, an 83% increase. At Virginia Tech, there were a total of 2,234 international students in 2008, making up 8% of the total undergraduate and graduate student population. By 2015, this number has increased to 3,011 international students comprising 9.8% of the Virginia Tech student body.
3. 2008 welcomed both iPhones and Android smartphones to the market. By January 2014, 58% of American adults had smartphones, with the rates rising to 83% for adults in the 18-29 age range (Pew Internet). The proliferation of these and other mobile devices has dramatically transformed how we learn and communicate.

As we look ahead to 2047, a glance back at the 1980s can demonstrate how much the landscape of higher education and society as a whole can change over a third of a century:

1. In the 1980s, public four-year institutions in Virginia maintained a 70/30 ratio of state/student funding. As a result, in-state tuition and fees at Virginia Tech were $2,019 for the 1985-1986 academic year (SREB, 2000). If tuition had risen solely at the inflation rate, in-state tuition and fees at Virginia Tech today would be $4,442 (Bureau of Labor Statistics). Instead, 2014-25 tuition and fees for in-state students at Virginia Tech is 270% more than the inflation-adjusted 1985 rate.
2. In 1984, only 8.2% of US households owned a computer. NSFNet, an early predecessor of the modern Internet for research institutions, launched just two years later. The Internet would not become accessible free of charge for another seven years. By 2013, 83.8% of US households had at least one computer and 73% of households reported high- speed Internet access at home.

[1] In FY08, VT received $8,373 GF per resident student. In FY13, VT received $6,680 GF per resident student. Data obtained by the Office of Budget and Financial Planning, May 4, 2015.

[2] The category of tuition and fees is comprised of tuition, mandatory E&G fees, and mandatory non-E&G fees. Data obtained from SCHEV 2007, SCHEV 2014, and Virginia Tech. Constant dollars obtained from the Bureau of Labor Statistics CPI Inflation calculator.

Virginia Tech in a Changing Landscape of Higher Education

Given the rapid economic, social, and technological changes affecting higher education institutions, we seek to further understand these changes on an international level and within the context of the Virginia Tech community. After conducting a literature review and distilling priorities from both Virginia Tech's recent strategic plan and SCHEV's strategic plan, and President Sands' installation speech, we identified seven elements for further inquiry: campus setting, funding and cost, international focus, scholarship and research, service, teaching and learning, and technology. As Virginia Tech works to address the challenges and opportunities associated with each complex area, our improvements will be reflected in national and international rankings systems, thus contributing to our position as an internationally recognized, global land-grant university. Table 1 offers elements of the changing landscape important for the university to consider in advance of its 175th anniversary.

Table 1
Elements of the Changing Landscape of Higher Education

Areas of Inquiry	President Sands' Speech	VT Strategic Plan	SCHEV Strategic Plan
Campus Setting	Global Neighborhood Interconnection of venues Mobility	Organizational efficiency and flexibility	Provide effective academic and student services infrastructure.
Funding and Cost	Funding for talent Endowment growth Global innovation district	Organizational efficiency and flexibility	Financial health of Commonwealth Affordability
International Focus	Globally interconnecting campus Global research institution Creating global citizens	Global interdependence implications International engagement	Student readiness for civic engagement
Scholarship and Research	Global research institution Undergraduate research	Meeting research expectations Research and innovation	Faculty scholarship Target resources to support research and development
Service	Service to Humanity Academy Ut Prosim Creating global citizens	Ut Prosim	Public service to community State and regional economic development
Teaching and Learning	Academic excellence Undergraduate internship; research T-shaped Learning	Life of the mind	Outreach to K-12 education On-time completion of degree
Technology	Modular and portable classroom content	Needs/challenges of data-driven society	Accessibility

Note. Data from President Sands' installation speech, Virginia Tech's 2012-2018 strategic plan, and SCHEV's 2014 strategic plan.

Campus Setting

Envisioning Virginia Tech in 2047 requires examining the way that classes are delivered, the physical needs of the university community, the geography of the university and its staffing and infrastructure needs. The physical setting will be a reflection of the global land-grant mission at Virginia Tech. We must address questions about the way in which the university of the future will be structured, such as looking at non-traditional delivery options and classes, and the continued need for and investment in large capital projects. Shifts away from both geographic homogeneity and traditional course delivery present new challenges to all institutions as they seek to modify the university campus to best meet the needs of their changing communities and to create new mechanisms for interaction and outlets for socialization for geographically-dispersed populations.

The Internet introduces new potentials for distributed learning and ways of working in which faculty, staff, and students are not anchored to one time and place. As such, technology has the potential to reorient both teaching and working as person-based rather than place-based. For on-campus and distributed courses, plus hybridized courses that offer a combination of in-person and virtual interactions, there is an increasing use of a variety of forms of digital content that requires high-speed broadband connectivity both on and off campus. The university's Technology-enhanced Learning and Online Strategies is one division focused on ensuring that technology is utilized in such a way to improve learning outcomes while other divisions of the university are focused on acquiring the necessary infrastructure.

With this increased use of technology in education and administration, Virginia Tech must focus on where its students, faculty, and staff will work and live in the future. Planning must include reassessing traditional classrooms, offices and research space, recreational facilities, parking lots, and on-campus housing (Educational Advisory Board, 2015). If more people attend Virginia Tech through non-traditional means such as the Internet, this will affect not only the learning environment, but also the need for office space, residential facilities, and transportation systems. The university would need a trained support staff to handle issues associated with connectivity. Virginia Tech must address these concerns before capital outlay is made based on current needs and systems that are rapidly changing.

The campus of the future may look very different in terms of student needs and the traditional residential experience. The majority of college dorms, built in the post-war era of the 1960's and 1970's, no longer meet the needs of today's student (Fabris, 2011). Students today are looking for a place to socialize and grow in addition to the traditional requirements of studying and sleeping. Schools are increasingly looking at ways to improve the residential experience for students while defraying the costs associated with the construction of new resident halls. For example, Arizona State University recently created a partnership with Capstone Management to lease land in return for the creation of new living quarters for students. At the University of Colorado, Pueblo, three new residence halls have classroom space on the bottom floor that can be converted from larger meeting areas to small group rooms (Fabris,

2011). Duke University has made the practice of sustainability a "live-in lab" by creating dorms that have LEED status (Fabris, 2011).

The use of technology, changing student, faculty, and staff needs, and new residential experiences will change the footprint of Virginia Tech. Looking at these trends and considering the impact of new patterns of movement are critical in determining the need for capital projects and infrastructure in the future.

New Funding Models and Considering Cost

Since FY2002, the State of Virginia's overall cost-sharing relationship with resident students has changed significantly. The commonwealth's share of the statewide average cost of resident education has decreased from 77% to 47%, even though there is a state policy goal to fund Virginia residents at 67% (§4-2.01 b.3.b of the Appropriation Act, Chapter 665). At the same time, the in-state student share of the average cost has increased from 23% in FY2002 to 53% in FY2015, resulting in increased tuition and E&G fees (SCHEV, 2014).

For Virginia Tech, the Commonwealth General Fund contribution amounts to 24% of the University Division's education and general program budget. This is a decline from FY2002 when 54% of the University Division's education and general program budget came from the commonwealth. Similarly, between FY2002 and FY2015, the state funded portion of Virginia Tech's annual operating budget (University Division and Cooperative Extension and Agricultural Experiment Station Division) declined from 39% to 18% (Office of Budget and Financial Planning, 2014). As a result, tuition has increased to help mitigate the reduction of state support and cover unavoidable cost increases as well as state cost assignments. While Virginia Tech has been cost conscious and sensitive to student costs while working to ensure continued delivery of quality programs, Virginia Tech is not immune from the national increased sensitivity to the cost of education. These funding shifts—coupled with state's inability to restore previous levels of funding and increased sensitivity to costs—highlight the need for a robust review of cost containment strategies and exploration of new revenue models.

With declining public financial support come increasing pressures on leaders to both manage their costs efficiently and be innovative in the ways in which the university generates revenue. This spirit of entrepreneurialism will require the mind, vision, and willingness to take the initiative of projects far outside the traditional purview of a university. The ideal type of initiative that an innovation-oriented institution might undertake would benefit the larger community through the results of its innovations and create an alternative revenue stream to benefit the university.

The move towards being considered an internationally recognized, or world-class, institution requires financial strength. Salmi (2009) finds that the characteristics of "world-class" universities include "high levels of government and nongovernment sources of funding" not associated with international student tuition (p. 6). These resources include "government budget funding for operational expenditures and research, contract research from public organizations

and private firms, the financial returns generated by endowments and gifts, and tuition fees" (Salmi, 2009, p. 23). Increased alumni giving, endowment funds, and research funding, all associated with achieving world-class status, are other ways in which the university will continue to pursue additional funding sources.

The incorporation of technology in education and administration can likewise change the funding landscape of the university as costs shift as a result of emerging technologies. The use of technology as a mechanism to constrain costs and/or generate new revenue is not necessarily straightforward as "it is not always easy to compare the costs of distance and traditional systems" (Rumble, 2012, p. 95). Investing in technology for distance learning and administration often require significant upfront resources in terms of both capital and training costs that must be recouped over the long term.

Endowment

Virginia Tech's nearly $800 million endowment through the Virginia Tech Foundation provides faculty and research support, student scholarships and internships, and economic development in communities across the Commonwealth (Virginia Tech, 2014). A 2014 study, however, ranks Virginia Tech's endowment well below its SCHEV peers. Virginia Tech ranks 115 as compared to the University of Michigan at Ann Arbor, ranked #9 with an endowment of $9.7 billion, and Cornell University, ranked #19 with $5.9 billion (The Chronicle of Higher Education, 2014). The University of Virginia is ranked #18 with $5.9 billion endowment in 2014 (The Chronicle of Higher Education, 2014). The Office of the Senior Fellow for Resource Development will engage with other university departments to understand the amount in which the endowment should be now (as compared to select benchmarks), and subsequently projections for the future. A healthy endowment is a necessary component for long-term sustainability and international recognition.

Funding for Talent

One of the key factors in attracting top students and increasing university prestige is through the recruitment of renowned professors and researchers. Yet, this can be a challenge as decreased public funds to higher education equates to a reduced capacity to pay for talented faculty and staff. During the 2012-2013 school year, the average salary for full professors at Virginia Tech was $122,100, which was above the median of other doctoral institutions at the 51st percentile (The Chronicle of Higher Education, 2013). However, at the levels of associate professor (46th percentile), assistant professors (43rd percentile) and instructors (30th percentile), Virginia Tech was below the median salary for doctoral institutions (The Chronicle of Higher Education, 2013).

Another effect of the changing landscape of higher education is a reduction of tenure-track positions over time. In 1969, almost 80% of college professors were in tenure-track positions, compared to 34% in 2009 (Kezar & Maxey, 2013). In Fall 2014, there were 2,957 total teaching and research faculty at Virginia Tech; of those faculty, 48% (1427) were either tenured or tenure-track instructional faculty (Office of Institutional Research and Effectiveness, 2014).

The Office of the Senior Fellow for Resource Development will undertake future research on faculty salaries and classifications at Virginia Tech as are compared to select benchmark institutions.

Affordability and Accessibility

One of the primary challenges restricting access to higher education is cost. The university's land-grant mission to be accessible and in the service of Virginia residents in part drives the demand to constrain tuition costs. However, due to a combination of factors including declining state appropriations per student, tuition and required fees for in-state students grew by 96% while tuition and required fees for out-of-state students grew by 63% over the past decade. In-state undergraduate students for the 2005-2006 academic year paid only $6,378 while out-of-state undergraduate students paid $17,836 (University Bursar, 2005). For the 2015-2016 academic year, in-state undergraduate students will pay $12,485 compared to the $29,128 out-of- state undergraduate students will pay in tuition and fees (University Bursar, 2015). As the need to reduce student loan debt, limit tuition increases, and maintain accessibility for all qualified students grows, the university must be innovative in how it manages its resources by both constraining costs and generating additional non-state-based revenue streams.

International Focus

Enrollment and Demographics

The massification, or mass-expanded enrollment, of higher education in the US started in the 1920's and continues today in developing countries where "most of the growth of the 21st century is taking place in developing and middle-income countries" (Altbach, 2013, p. 8). Calderon (2012) finds that "the number of students enrolled in higher education by 2030 is forecast to rise from 99.4 million in 2000 to 414.2 million in 2030--an increase of 314%". The increase in student enrollment and changes in geographic demand for education have important implications for higher education institutions committed to providing quality education in a global environment.

Similarly, the number of international students seeking higher education in the United States is increasing. During the 2012-2013 academic year, the number of international students in the US increased by 7.2% and this trend is expected to continue in the future (IIE, 2013). Foreign students from prosperous non-OECD countries, specifically the Middle East and Northern Africa showed the largest growth with a 1,283% increase in attendance at American universities (Ruiz, 2014).

Table 2
Virginia Tech Student Headcount Enrollments by Tuition Level, 2006, 2010, and 2014

	Fall 2006		**Fall 2010**			**Fall 2014**		
Student Type	Number	Percent of Population	Number	Percent of Population	Change from 2006	Number	Percent of Population	Change from 2010
Undergraduate International	457	2.08%	509	2.15%	11.38%	1,121	4.62%	120.24%
Undergraduate Virginia Resident	16,175	73.53%	17,492	73.84%	8.14%	17,655	72.81%	0.93%
Undergraduate Non-Virginia Domestic	5,517	25.08%	5,734	24.2%	3.93%	5,471	22.56%	-4.59%
Undergraduate Total	21,997	77.26%	23,690	76.4%	7.7%	24,247	77.66%	2.35%
Graduate International	1,542	25.23%	1,821	26.22%	18.09%	1,890	29.02%	3.79%
Graduate Virginia Resident	3,324	54.39%	3,661	52.72%	10.14%	3,174	48.74%	-13.3%
Graduate Non-Virginia Domestic	1,245	20.9%	1,482	21.34%	16.05%	1,448	22.24%	-2.29%
Graduate Total	6,111	21.46%	6,944	22.4%	13.63%	6,512	20.86%	-6.22%
Professional Total	362	1.27%	372	1.2%	2.76%	465	1.49%	25%
Total	28,470	--	31,006	--	8.91%	31,224	--	0.7%

Source: Virginia Tech Office of Institutional Research and Effectiveness, 2015a, 2015c

As a land-grant university in service to the Commonwealth, one could argue that an increase in international students may preclude in-state students from attending Virginia Tech. However, as Table 2 demonstrates, Virginia Tech's total undergraduate population increased by 2,250 students between 2006 and 2015. The number of out-of-state domestic students actually decreased by 46 while the student body gained 664 international and 1,480 Virginia resident undergraduate students. For graduate students, the university community gained 401 students between 2006 and 2015 with an increase of 348 international students compared to just 53 new domestic graduate students. So while university expansion benefited Virginia residents more at the undergraduate level, the demographic shift at the graduate education level has been towards an increase in the number of international students (Office of Institutional Research and

Effectiveness, 2015a; 2015c). Table 3 displays the breakdown of student origins for both undergraduate and graduate students at Virginia Tech in Fall 2014.

Table 3
Top 10 Countries of Origin for Undergraduate and Graduate Students at Virginia Tech, 2014

Virginia Tech Undergraduate Students		Virginia Tech Graduate Students	
US	23,208	US	4,667
China	529	China	709
South Korea	80	India	350
India	80	Iran	131
Germany	22	South Korea	79
Vietnam	20	Egypt	65
Unknown Nation	20	Turkey	37
Malaysia	20	Bangladesh	36
Saudi Arabia	19	Germany	26
Turkey	11	Taiwan	25

Source: Virginia Tech Office of Institutional Research and Effectiveness (2015b)

Advantages of Internationalization

This growing population of international students could create a different environment for the students and faculty of Virginia Tech, as well as the town of Blacksburg and the state of Virginia. One of the major advantages of a more diverse campus is that it gives all students the opportunity to interact with different cultures, creating a more globally focused student body. Internationalization can also improve research by eliminating research "silos" by expanding research across cultures, fields and disciplines (Popenici, 2012).

Feedback obtained during Virginia Tech's Presidential Search emphasized the importance of Virginia Tech's strong relationships with Blacksburg, the New River Valley, and all across Virginia. One respondent noted that the university "has been the driving force as the economic bedrock of Blacksburg, Southwest Virginia and beyond. As [Virginia] Tech flexes its new-found economic muscle, it is expanding its influence and service into virtually all areas of the commonwealth." In addition to improving student education at Virginia Tech, one of the ways in which internationalization will be advantageous to the region and the commonwealth as a whole is the great economic benefit to communities in which international students study. Across the commonwealth, Virginia's 17,145 international students made a net contribution to the state economy of $487,539,000 while directly or indirectly creating 6,541 jobs during the 2013-2014 academic year (NAFSA, 2014). For Virginia Tech, the 3,133 international students

made a net contribution to the community of $73,693,200 and created 1,236 jobs (NAFSA, 2014). These economic benefits continue after graduation as many students choose to stay and work in the area. Approximately two-thirds of foreign students who received their PhDs from 1989-1997 remained in the US ten years after receiving their degrees (Finn, 2011).

Integrating Campus Locations Domestically and Abroad

Participants from the presidential search input sessions and survey revealed a desire to better integrate Virginia Tech's various campus locations throughout the state and around the world. Individuals suggested doing so would both make better use of these resources and promote interdisciplinary exchange. Effective communication across campuses was seen as a key element to this success, and improvements in this area could be facilitated through utilization of technology assets. In addition to linking current campuses, some participants expressed the importance of moving from a regional institution to one that is not only recognized throughout the world, but also fulfills its land-grant mission through research and service at the international levels.

Scholarship and Research

In February 2015, Virginia Tech was ranked 38th for research expenditures with nearly $500 million awarded to the university. This is important not only for our research efforts, but also for the university's national and international reputation. Yet despite the importance of these numbers, many respondents during the Virginia Tech Presidential Search felt that the university's increased focus on research has had a negative impact on the quality of teaching and learning. We must continue to improve in both realms of research and discovery and teaching and learning, working to better integrate these equally important endeavors.

Although spending for research has improved in the federal government since 2006, "the growth rates were well behind the pace of gross domestic product (GDP) expansion" (Boroush, 2013). In the past, "total R&D spending outpaces that of GDP-regardless of whether the averaging period is the past 5, 10, or 20 years" (Boroush, 2013). With changes in federal funding, opportunities to capture necessary research dollars must be found in other areas. Universities working to build a greater presence in the global sphere can build relationships with international funders as well as other national governments that have research or other types of funding available for higher education (Altbach & Knight, 2007). Partnerships with researchers in other countries can help build the types of relationships that make international funds more accessible.

Technology licensing, venture capital, corporate and public-private partnerships may offer new avenues for funded research. Technology transfers offer universities the ability to capitalize on research that is paid for by federal funds and conducted by their faculty (Hollingsworth, 1999). For example, MIT is seeking to increase revenue by fostering an environment for "inventors as they seek to translate their fundamental discoveries into

production-ready products" (The Institute-Wide Task Force on the Future of MIT Education, 2014). In addition to helping inventors with the patent process, MIT also plays a fundamental role in helping researchers who wish to create start-up companies as a result of their research (Fisher, 1998). The technology incubator at North Carolina State University similarly helps match talented entrepreneurs and researchers with start-up capital to market their ideas (Higher Education Works, 2015). Additionally, Stanford University started its Office of Technology Licensing in 1970 and has remained on the forefront of the process by working as a marketing, rather than a legal office, staffed by employees who understand the technology that has been created (Fisher, 1998).

Extending Service Impact

A History of Outreach

The American approach to higher education emerged in the 19th century, resulting in a new type of institution based on "a set of beliefs about the social role of the university" (Bonnen, 1998, p. 28). Based on these beliefs, the Morrill Act of 1862 called for the creation and support of institutions in each state that would "teach such branches of learning as are related to agriculture and the mechanic arts...in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life" (APLU, 2012). As such, land- grant institutions were charged with the goal of educating the whole person beyond the traditional confines of teaching and learning and to further integrate research and outreach/extension into the undergraduate and graduate student learning environments. This both practically-oriented and outwardly-focused approach to higher education positioned these state institutions to be sources of community support and sites of technical innovation.

At Virginia Tech, a commitment to outreach and service is instilled in the "Hokie culture," as was evident in many of the comments provided through public input mechanisms during the Virginia Tech Presidential Search. Although difficult to define, participants describe Virginia Tech as being friendly, welcoming, and dedicated to serving others. Virginia Cooperative Extension formalizes this commitment to outreach and service and marked its 100th year in 2014. In its 2011-2016 strategic plan, the Virginia Cooperative Extension lays out its intent to focus on six major areas: enhancing the value of Virginia's agriculture, sustaining Virginia's natural resources and environment, creating a positive future through 4-H youth development, strengthening Virginia's families and communities, cultivating community resiliency and capacity, and improving its organizational effectiveness (Virginia Cooperative Extension, 2010). What began as a program more oriented towards agriculture and the home has remained true to its roots while expanding to meet the needs of increasingly-urbanized communities across the state. At the same time, Extension has remained true to its original purpose of working to solve social and economic problems facing the communities it serves.

Addressing 21st Century Challenges

In his 1937 *New York Times* article commemorating the 75th anniversary of the passage of the Morrill Act, Montana State College President Alfred Atkinson noted the need for land-grant institutions to expand beyond a focus strictly on evolving technologies and other innovations and also to study and understand the ramifications of these technologies' influence on society (Bresciani, 2012). Even as the society which is served by land-grant institutions transforms, these institutions still aim to serve the public good, however that public is defined (Gerber, 1992). For example, the growth of urban areas has led many land-grants to include economic and community development as part of their outreach and extension services rather than the more traditional focus on agriculture (NASULGC, 2007). Such a focus fits with calls for land-grants to be future focused and "designed to respond to today's constraints and opportunities" (Gerber, 1992). Some of the priority issues for land-grant institutions looking forward include energy independence, food security, public health, environmental sustainability, workforce preparation, and community resiliency (APLU, 2010).

Service to Humanity

"Advancing the land-grant mission" was rated as the third most important challenge facing the university in the Virginia Tech Presidential Search input survey following "Attracting and retaining talent" and "Affordable and accessible higher education" (2014, p. 19). Qualitative analysis of Presidential Search data revealed that a commitment to the land-grant mission was held in high regard, most often expressed through references to the university motto of *Ut Prosim* (That I May Serve). One respondent commented on this spirit of Ut Prosim:

> Research and innovation should be understood, not as a means to line our individual or collective pockets, but as a means to improve our lives and solve problems. Education, not as a means of student throughput but rather as a form of service to students and our polity--creating thoughtful, caring, and deliberate citizens. Outreach and engagement not as new cash stream, but as a means to strengthen the state and enrich the lives of individuals. (2014, p. 24)

Teaching and Learning

Looking forward, land-grant institutions are called upon to educate citizens for a complex and changing society. In addition to the technical skills and depth of knowledge for which many of these institutions have been known, there are calls to further develop critical thinking and problem-solving skills to develop so-called "T-shaped individuals" (Bresciani, 2012; CERI, 2014). Similarly, T-shaped land-grant institutions will best integrate outreach, teaching, and research.

Academic quality was one of the greatest concerns taken from the Virginia Tech Presidential Search feedback mechanisms. Several respondents noted that reprioritizing teaching and learning and working to increase prestige would enhance the academic quality of the university. Respondents believed that there needed to be more focus on undergraduate teaching,

and that there should be greater opportunities for professor-student interaction. Others discussed the need to increase collaboration among disciplines and organizational units as a means of increasing creativity and organizational synergy. The general sentiment of these comments was that academic quality is important to the prestige of the institution and people wanted to see Virginia Tech improve in terms of rankings and prestige.

Creating Partnerships with K-12

As universities adapt to the demands of the 21st century, it is increasingly apparent that the needs of undergraduate and graduate students need to be considered alongside K-12 students who will eventually populate these higher education institutions. By linking the K-12 system to initiatives focused on preparing universities for the future of education, institutions can better prepare young people entering the ranks of their student body with important and necessary skills.

One approach to linking K-12 students to their undergraduate institution is to integrate high school and college through classes, like the Early College High School Initiative launched in 2002 by the Bill and Melinda Gates Foundation to provide access to tuition-free college credit for "student populations statistically underrepresented in higher education," including low-income, first-generation college students, non-native English speakers, and/or students of color (Jobs for the Future, 2015). With students entering college as sophomores or juniors, such an initiative can reduce the cost of education to families as well. In the 2010-2011 academic year, approximately 1,363,500 high school students took courses for college credit, including through a dual enrollment program and outside of it (Marken, Gray, and Lewis, 2013). These numbers show the potential to expand the relationship between K-12 students and their undergraduate institutions to the benefit of both.

In the area of preparing students for a global society, the Partnership for 21st Century Skills has developed a Framework for State Action on Global Education that includes the adoption of global competency standards for students and teachers, effective and scalable teacher support, a new approach to language instruction, models focused on international education, and global experiences for students and educators (Partnership for 21st Century Skills, 2014). These priorities may be more easily achieved if the internationalized university is able to bring its resources to bear on the needs of K-12 students.

In addition to preparing for a global society, integrating technology into education is key to the future of education and an area of much study. For instance Inan and Lowther (2010) find that "teachers' readiness, teachers' beliefs, and computer availability indicated a significant positive direct effect on technology integration" (p. 145). Goldberg et al. (2013) claim that incorporating computer science into the classroom can help students improve creativity and innovation, critical thinking and problem solving, communication and collaboration, information literacy, media literacy and information, and communications and technology literacy. The university may be more able to link to K-12 students by expanding upon expertise in these areas.

Virginia Tech's Future and Technology

Technology in Distributed Learning and Working

Technology has been one means through which universities have tried to contain costs through automation of services, digitalization of resources, and streamlining of processes. Use of technology has also increased accessibility to university courses and services by growing numbers of nontraditional students who attend classes on a part-time basis, have outside responsibility to family, are outside of the traditional 18-24 years old age range, or some combination of these factors. Thinking innovatively in terms of course delivery will include determining what investments will be needed to supply appropriate technologies as well as how to best leverage technology to reduce the overall costs associated with it while improving flexibility and accessibility of course offerings.

Information and communications technologies and land-grant institutions have deeply connected relationships. Indeed, many of the early innovations that led to today's Internet emerged from land-grant institutions. Society has been transformed by these innovations and the resulting information revolution, and higher education has not been exempt from their influences. Technological innovations have presented opportunities to radically alter how information is conveyed and how learning occurs.

One of the major challenges to higher education institutions is to ensure that use of technology contributes a value added to the quality of educational offerings rather than being utilized solely to increase the quantity of students to be educated (Bowen, 2013). Appropriately integrating technology is key to improving academic quality. Yet, participants in the Virginia Tech Presidential Search processes commented that in doing so, Virginia Tech must maintain academic standards that are not compromised with alternate mechanisms of course delivery. One participant noted that we must give online education "the same care and consideration as bricks and mortar."

Telecommunications Infrastructure

In today's networked society and knowledge economy, affordable, high-quality broadband internet connectivity has become perhaps the most critical and fundamental technology. Not having high-speed, high-quality telecommunications infrastructure creates a "digital divide" between communities with and without access that grows into educational and economic divides. Since 1996, Virginia Tech has had an active role in expanding and improving internet connectivity across the commonwealth through NetworkVirginia as part of its outreach mission as Virginia's land-grant institution. Additionally, it provides operations support for the Mid-Atlantic Research Institution Alliance (MARIA) to facilitate high-performance connectivity for seven higher education research institutions in Virginia.

Through its role in MARIA and the Virginia Tech Foundation, Virginia Tech has been involved in research and education network infrastructure at the national level through the National LambdaRail prior to its dissolution in 2014 and Internet2. It is also one of 37 Gig.U members, an organization formed to encourage the deployment of next-generation broadband

infrastructure around colleges and universities. Looking to the future, internet connectivity will become even more essential in even more aspects of education and daily life, and new technological developments will likely lead to greater demands for increased speed and capacity. Virginia Tech's ongoing efforts in this area will ensure that the university and its surrounding community have the necessary infrastructure to respond to these demands.

Positioning Virginia Tech as a Global Land-Grant Institution: Benchmarks and Rankings

Another way in which Virginia Tech can achieve its status as an internationally recognized, global land-grant institution is by improving its position and practices in comparison to other institutions nationally and internationally. Because we are interested in movements to internationalize institutions in the US, we first sought to understand the residency of students at Virginia Tech and at a select list of 45 peer institutions. A second inquiry underway is an analysis of Virginia Tech's position on and potential movement within two international ranking systems. Although rankings are controversial in terms of what they measure, how, and why, they remain popular as an easy-to-understand performance metric (Rauhvargers, 2011). As such, we are interested in knowing 1) Virginia Tech's international rank and how it may be improved and 2) the characteristics of higher-ranked benchmark institutions. In order to answer these questions, we have begun an analysis of Virginia Tech's position within the Times Higher Education (THE) World University Rankings. Of four commonly used internationally ranking systems, we selected THE for continued analysis because we found it to be the best and most often cited ranking system.[3]

World rankings of universities are recent developments that try to gauge how universities in different countries compare to one another on a variety of indicators. There is not a definitive ranking system that universities use because of the high degree of variation in what ranking systems measure and how they measure it (Usher & Savino, 2007). The variation calls into question the reliability of such rankings even as Dill and Soo (2005) find that world ranking systems are beginning to converge in how they measure academic quality. The world ranking systems most commonly in use today include the Quacquarelli Symonds World Rankings, Times Higher Education World Ranking, Academic Ranking of World Universities (ARWU), and the recently-developed United States News and World Report (USNWR) Best Global Universities Ranking. Not surprisingly, there are concerns with each of these systems: the QS and THE systems are dependent on reputational surveys and the ARWU is strongly focused on bibliometric data measuring research performance (Huang, 2012; Taylor & Braddock, 2007; Aguillo, Bar-Ilan, Levene, & Ortega, 2010).

Although these ranking systems differ in what they measure, they generally try to capture research impact, academic quality, and the international mix of faculty and students by measuring indicators such as "major international awards, highly cited researchers in important fields, articles published in selected top journals and/or indexed by major citation indexes, and performance per capita" (Liu & Cheng, 2005, p. 127). In addition, reputation surveys are a common component of these rankings (Bowman & Bastedo, 2010). The methodologies

[3] See Appendix C for a review of four international ranking systems from 2014/15: Times Higher Education World Ranking; QS World Ranking; Academic Ranking of World Universities; and U.S. News and World Report Best Global Universities

associated with world university rankings continues to be under criticism because of the subjectivity associated with the weights assigned to different indicators (Aguillo, Bar-Ilan, Levene, & Ortega, 2010).

Acknowledging the controversy over world rankings, it is nonetheless useful to see where Virginia Tech stands in regard to these different measures. Table 4 presents Virginia Tech's score and ranking in the four most common world rankings for the years 2011-2014. It is interesting to note that Virginia Tech declines in rank over time in the QS ranking system even though the overall scores do not generally decrease. In the THE world university rankings, Virginia Tech's component scores actually improve even as its overall rank declines (component scores not reflected in Table 4). The implication of this data is that Virginia Tech is not necessarily declining in regard to the measures but that other universities are improving in theirs.

Table 4
Virginia Tech Ranking and Scores in the Four Most Common World Ranking Systems

World Ranking System	2011 Rank (Score)	2012 Rank (Score)	2013 Rank (Score)	2014 Rank (Score)
QS	326 (34.8)	337 (35.2)	316 (38.9)	355 (38.0)
THE	251-275	276-300	276-300	276-300 (39.4)
ARWU	151-200	151-200	151-200	201-300
USNWR	--	--	--	248 (42.8)

The component measures that make up these ranking scores are of interest in order to better understand why Virginia Tech ranks as it does. Each of the ranking systems make different types of data available, although ARWU does not list its component scores. It is important to note that each of the rankings have components not captured by the others. For example, QS looks at employer reputation, THE captures industry income, and USNWR includes regional research reputation. Below is a comparison of scores from 2014:

- Research. THE gives Virginia Tech a research score[4] of 40.0 out of 100.0; QS gives it a score of 38.2 for academic quality;[5] and USNWR ranks the school 215th globally in terms of research reputation[6] and 206th for total number of publications.

[4] THE's research score includes "a university's reputation for research excellence among its peers," "university research income, scaled against staff numbers and normalized for purchasing-power parity," and "research output scaled against staff numbers" (Times Higher Education, 2015)
[5] QS's academic quality score is "based on a global survey of academics" (QS, 2014)
[6] USNWR's global research reputation is an "aggregation of the most recent five years of results of the Academic Reputation Survey for the best universities globally for research (Morse & Foster, 2014).

- Teaching. THE gives Virginia Tech a teaching score[7] of 40.1 out of 100; QS gives it a faculty score[8] of 37.5; and USNWR ranks it as 155th in number of PhDs awarded but 524th in the number of PhDs awarded per academic staff member.
- Citations. THE gives Virginia Tech a citation score[9] of 40.7; QS gives it a citation score[10] of 38.5; and USNWR ranks it 425th for normalized citation impact[11] even though it's ranked 237th for total citations.
- Internationalization. THE gives Virginia Tech an international outlook score[12] of 25.1 out of 100; QS gives it a score of 26.2 for international faculty and 35.0 for international students;[13] and USNWR ranks it 425th in international collaboration.[14]

Of the ranking systems reviewed thus far, THE and QS provide longitudinal data of component scores, overall scores, and ranking. We decided to focus continued analysis on THE World University Ranking because of THE's inclusion of a diversity of indicators that capture Virginia Tech's comprehensive nature. This diversity of indicators include those that are particularly important to Virginia Tech, such as teaching, international outlook, and research income. The teaching component is unique to THE; it includes a teaching reputation survey along with a research reputation survey whereas the other ranking systems include only a research reputation survey. Its measures of research excellence move beyond the typically used reputation survey and citation indices to also include research income and doctoral degrees awarded. These other factors bring objective indicators that balance the subjective reputation survey. The THE system also includes three international outlook indicators as opposed to the one to two internationalization indicators in the other ranking systems so as to provide a nuanced

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[7] THE's teaching score includes the findings from an "invitation-only academic reputation survey," "staff-to-student ratio," "the ratio of doctoral to bachelor's degrees awarded," "number of doctorates awarded by an institution, scaled against its size as measured by the number of academic staff it employs," and "institutional income scaled against academic staff numbers" (Times Higher Education, 2015).

[8] QS's faculty score is a "measure of the number of academic staff employed relative to the number of students enrolled" (QS, 2014).

[9] THE's citation score includes "the number of times a university's published work is cited by scholars globally" "normalized to reflect variations in citation volume between different subject areas" between 2008 and 2012 (Times Higher Education, 2015)

[10] QS's citation score measures the total citation count "in relation to the number of academic faculty members at the university" over the last five years (QS, 2014).

[11] USNWR normalized citation impact is "the total number of citations per paper" "normalized to overcome differences in research area, the publication year of the paper and publication type" (Morse & Foster, 2014).

[12] THE's international outlook score includes "the ratio of international to domestic students," "ratio of international to domestic staff," and "the proportion of a university's total research journal publications that have at least one international co-author" (Times Higher Education, 2015)

[13] QS's international faculty score and international student score is "based on the proportion of international students and faculty members in relation to overall numbers" (QS, 2014).

[14] USNWR's international collaboration measure is "the proportion of the institution's total papers that contain international co-authors divided by the proportion of internationally co-authored papers for the country that the university is in" (Morse & Foster, 2014).

measure of the ways in which the university is interacting with and representing our global society. Also, importantly, it includes a measure of the staff-to-student ratio as a rough proxy for learning environment. By looking to a ranking system that includes a wider range of measures, we are pushing to improve not only Virginia Tech's research reputation and prestige but also enhance its overall teaching and learning environment as well.

Although Virginia Tech scores and rankings offer an understanding of how the university fares on a number of measures, it does not give a sense of how far it is ranked from other universities in these measures. We collected the data and averaged the scores for each of the component measures for the top universities listed to get a comparison score. Table 5 presents how Virginia Tech compares to the average scores of the top 400 universities ranked by THE from 2011 to 2014.

Table 5
Virginia Tech Scores Compared to Average of Top 400 Universities on THE World Ranking, 2011 to 2014

	2011-2012		2012-2013		2013-2014		2014-2015	
	VT	Avg	VT	Avg	VT	Avg	VT	Avg
Teaching Score*	36.9	37.8	38.5	41.7	33.7	37.3	40.1	54.6
Research Score	40.4	35.9	44.4	40.8	40.4	35.6	40.0	57.8
Citations Score	30.3	57.3	37.2	65.3	38.7	66.5	40.7	78.2
Industry Score	24.2	46.9	27.9	50.2	42.0	50.8	42.6	50.1
International Score	25.1	51.3	27.8	52.4	27.5	54.3	28.9	45.7

Note. * Component scores are composed of multiple indicators, as described in Footnotes 3, 6, 8, and 11 and Appendix C. Scores are z-scores which "standardizes the different data types on a common scale and allows fair comparisons between different types of data" (Times Higher Education, 2015).

Virginia Tech is in the bottom half of universities ranked by THE. Virginia Tech consistently does better than average in terms of its research score and is only slightly below the average teaching score. The university, however, is far below the average scores for the citations score, industry score, and international score. Virginia Tech's industry score has improved dramatically from 2011 to 2014 going from 24.2 to 42.0. As a result, Virginia Tech is closer to the average in terms of the industry score than it was previously. In the areas of both the citations score and international score, the little improvement in Virginia Tech's score has been mirrored in the improvement of the average score. The combination of the large weight (30%) given to the citations score in THE's ranking and Virginia Tech's low citations score indicate that citations are an area of particular importance to improving Virginia Tech's place in this ranking system.

When compared to 29 benchmark institutions, primarily comprised of SCHEV peers, Virginia Tech ranks second to last according to the 2014-15 THE ranking.[15] Virginia Tech scores below the average of all these benchmark institutions in the categories of teaching, research, citations, industry, and international. The rank is particularly below the average for citations, with a score of 40.7 compared to the benchmark institution average of 78.2.

World university rankings position Virginia Tech in the bottom half to quarter of universities ranked, but Virginia Tech seems to be improving on several measures. The volatility in all of the rankings at the bottom half indicates there is the potential for improvement in ranking.

[15] For the purposes of this study, benchmark institutions included all SCHEV peer institutions plus MIT, Georgia Tech, University of Arizona, and UNC Chapel Hill. See Appendix D for complete information on THE ranking of benchmarks

Moving Forward: Virginia Tech's Visioning Initiative

As Virginia Tech celebrates its 150th and 175th birthdays, it will be a different university than it is today in large part because of the opportunities and challenges facing higher education institutions worldwide. Mass-expanded enrollment, technology, internationalization, and funding patterns will contribute to these changes. In order to prepare for the future, and to secure international recognition, Virginia Tech must act now. One of the ways that this can be done is by inviting constituents to discuss generally the future roles of the global land-grant university, and specifically, the path for Virginia Tech. In this section, we suggest a university-wide process for this work. This initiative will provide the Virginia Tech community an opportunity and charge to truly "Invent the Future" of the institution. It will result in an articulated long-range vision for Virginia Tech bolstered and informed by the university's broad-based constituent groups. This vision will help guide the university forward and serve as an important foundation for future strategic planning processes. We may not be able to predict the future, but we can begin to undertake the necessary work of affirming the values and pursuits of Virginia Tech as a 21st century, global land-grant university.

Process and Timeline

We have conceived this initiative as a facilitated convening of thought leaders and members of the Virginia Tech community. The charge to participants is to wrestle with the complex challenges and opportunities facing Virginia Tech and make recommendations that will guide the institution towards a 2047 future. First, we invite high-profile and world-renowned experts and corporate and alumni advisors to help shape the process and advise throughout the initiative. Second, we convene a steering committee to lead the university-wide initiative from beginning to end, making recommendations to the university community at the conclusion. Third, we invite public input through an idea bank and town hall meetings. Seminars from leading experts in the field of higher education will help educate the university community about the changes facing Virginia Tech and institutions worldwide. Fourth, we charge working groups organized around thematic areas to bring forth new ideas to advance the university. Fifth, we make recommendations and suggest a framework for planning to the BOV and university community. The initiative would take place between May 2015 and June 2016 and be staffed by the Office of the Senior Fellow for Resource Development in consultation with other university departments.

Participants

Invited participants would guide the initiative. Table 6 details these roles. Community members would be invited to participate through an idea bank, town hall meetings, and seminars.

Table 6
Participant Roles

External Expert Advisors, 3-4 members	
Qualifications	--Notable experts in the field of higher education and technology in context of education --Advisers will have a commitment to and interest in advancing Virginia Tech as a global land-grant university

Alumni Advisors, 6-8 members	
Qualifications	--Distinguished alumni active in furthering Virginia Tech's goals --May include donors, retired faculty or administrative personnel, and/or alumni working in organizations of prominence or interest to Virginia Tech

Corporate and Professional Advisors, 6-8 members	
Qualifications	Leaders in government, military, and private and/or nonprofit sector organizations with an interest in advancing Virginia Tech as a global land-grant university

Steering Committee, 20+ members	
Qualifications	--Thought leaders from the Virginia Tech community, including people invested in the university from the state, nation, or world --Representative of different academic disciplines and functional areas of university life (i.e. alumni, colleges, research institutes) and diverse populations important to inclusive thought processes and decision-making

Working Groups, 4 groups of 8-10 members	
Qualifications	--Content experts and thought leaders from the Virginia Tech community --Local/state experts may be included

Public Input and Seminars

Public and Virginia Tech community input is central to the initiative's organizing framework. By design, we plan to invite public comment in advance of and during working group meetings so that this knowledge may inform group discussion. We envision two mechanisms to collect broad public comment: town halls organized around a theme and an idea bank. The Virginia Tech community and others connected to the university throughout the state

and beyond would be invited to attend approximately four open town hall meetings organized around topics of interest to Virginia Tech (i.e. agribusiness, technology). Additionally, seminars offered by leading higher education experts would inform the university community about challenges and opportunities facing the field. These seminars would contribute to an important initiative outcome--broadening understanding of the external environment that will shape Virginia Tech's future.

The idea bank would serve as an electronic method to collect input on the areas of inquiry central to the initiative. Designed as an open forum for input, the idea bank would be semi-structured and include several questions. This design would ensure quality data that would be used to guide formally designated initiative participants.

Thematic Areas of Inquiry and Working Group Organization

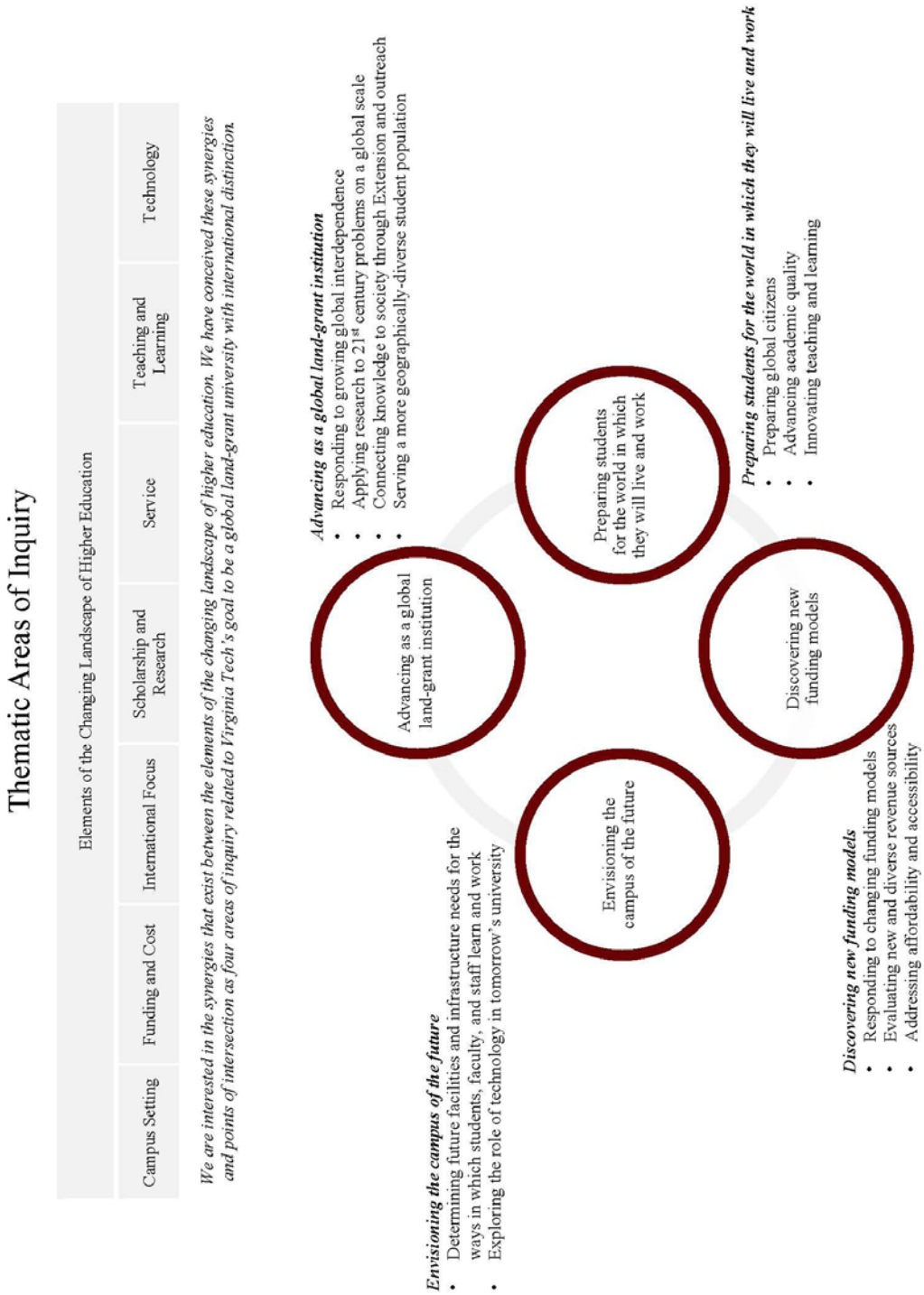
As per the aforementioned description of participant roles, Working Group members would be charged with addressing specific areas of inquiry, subtopics, and complex questions. Table 7 suggests ways in which each of the elements of a changing landscape of higher education could interact with each of the others. As such, this waterfall-style table shows the dyadic relationships between each element. Certainly, discussion is not limited to these interactions; the table and subsequent questions are provided as a suggested starting place to organize what will surely be complex and overlapping conversations. The interrelatedness between two or more elements will be at the heart of the questions asked of the working groups.

Table 7.
Dyadic Relationship between Elements of a Changing Landscape of Higher Education

	Funding & Cost	Technology	Teaching & Learning	Scholarship & Research	Service	International Focus	Campus Setting
Funding & Cost	· Impact of funding changes on VT · Creating new revenue opportunities						
Technology	· Capital expenditures on new technology · Cost containment opportunities	· Using and creating technology					
Teaching & Learning	· Affordability and accessibility · Attracting and retaining the best	· Technology changing learning environment	· Comprehensive institution · Improve academic quality				
Scholarship & Research	· Outside funding for research · Support for non-outside-funded scholarship	· Technological investments to support research trajectories	· Support undergrad scholarship and research · Include professors' ongoing S&R to enrich classroom learning	· VT's research objectives · Supporting scholarship & research across the institution			
Service	· Effect of funding changes on *Ut Prosim* · Partnering to further service mission · Funding to meet service mission	· Using technology to solve 21st c. challenges · Technology as a mechanism for land-grant mission	· Use land-grant mission to facilitate experiential learning through service and outreach · Incorporating service components in the classroom	· Addressing 21st c. challenges and meeting land-grant mission with S&R	· Identify service priorities · Explore how to address 21st. C. issues		
International Focus	· International funding opportunities · Resources for expanding reach	· Technology needed to expand the university's focus	· Create global citizens ready to interact with an increasingly globalized world	· Expand research into global arena · International research opportunities	· Service to a global community	· Understanding what a growing international focus would look like for Virginia Tech	
Campus Setting	· Funding capital projects and addressing staffing concerns	· Impact of technology on classrooms and residence needs	· Learning environment of the future	· Impact of S&R priorities on facilities needs	· Use of facilities to accomplish land-grant mission	· Infrastructure to support a greater international focus	· Capital projects and staffing needs

We suggest four working groups based on these seven elements. The drivers underlying each area of organization follow Figure 1.

Figure 1. Elements of the Changing Landscape of Higher Education as Areas of Inquiry



Outcomes

Priority outcomes for this initiative include strategically visualizing Virginia Tech's future, gaining an understanding from voices throughout the Virginia Tech community, and suggesting a framework for planning that will help guide the institution through the challenges and opportunities it may face through 2047. Certainly, all of the potential outcomes and benefits of this proposed initiative are unknown. But by thoughtful discussion, analysis, constituent input, and internal and external leadership, the initiative will aid the university community in addressing the complex questions it must face on its path to becoming an internationally recognized, global land-grant institution.

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Appendix A: SCHEV Peers

Cornell University
Iowa State University
Michigan State University
North Carolina State University
Pennsylvania State University
Purdue University
Rutgers, The State University of New Jersey
Texas A&M University
The Ohio State University
University at Buffalo
University of California, Berkeley
University of California, Davis
University of Colorado Boulder
University of Florida
University of Illinois at Urbana Champaign
University of Maryland, College Park
University of Michigan
University of Minnesota
University of Missouri
University of Pittsburgh
University of Southern California
University of Texas at Austin
University of Washington
University of Wisconsin-Madison
Virginia Polytechnic Institute and State University

Appendix B: Benchmark Institutions

Cornell University
Georgia Institute of Technology
Iowa State University
Massachusetts Institute of Technology
Michigan State University
North Carolina State University
Pennsylvania State University
Purdue University
Rutgers, The State University of New Jersey
Texas A&M University
The Ohio State University
University at Buffalo
University of Arizona
University of California, Berkeley
University of California, Davis
University of Colorado Boulder
University of Florida
University of Illinois at Urbana Champaign
University of Maryland, College Park
University of Michigan
University of Minnesota
University of Missouri
University of North Carolina at Chapel Hill
University of Pittsburgh
University of Southern California
University of Texas at Austin
University of Washington
University of Wisconsin-Madison
Virginia Polytechnic Institute and State University

Appendix C: Comparison of International Ranking Systems: THE World; QS World; ARWU; US News and World Report

	Area	THE	THE	QS	QS	USNWR	USNWR	ARWU	ARWU
		%	Indicator	%	Indicator	%	Indicator	%	Indicator
Reputation	*Global research reputation*	18%	Research reputation	40%	Academic reputation	12.5%	Global research reputation		
	Regional research reputation					12.5%	Regional research reputation		
	Teaching reputation	15%	Teaching reputation						
	Employer reputation			10%	Employer reputation				
	Award winning alumni							10%	Award winning alumni
	Award winning staff							20%	Award winning staff
Learning Environment	*Student-to-faculty ratio*	4.5%	Staff-to-student ratio	20%	Student to faculty ratio				
	Per capita performance							10%	Per capita research performance
Citations	*Citations per faculty*	30%	Number of times a university's published work is cited by scholars globally	20%	Citations per faculty	10%	Normalized citation impact		
	Highly cited research					10%	Percentage publications among the top 10% most cited	20%	Highly cited researchers in 21 broad subject categories
	Total citations					10%	Total citations		
Research	*Research income*	6%	University research income scaled against staff numbers						
	Research output	6%	Publications			12.5%	Publications	20%	Publications
	Doctoral to bachelor degree ratio	2.25%	Ratio of doctoral to bachelor's degrees awarded						
	Doctorates awarded	6%	Number of doctorates awarded scaled against size			5%	Number of doctorates awarded per academic staff		
	Doctorates awarded (Raw)					5%	Number of doctorates awarded		
	Publications in Nature and Science							20%	Numbers of papers published in Nature and Science
Internationalization	*International faculty ratio*	2.5%	Ratio of international to domestic staff	5%	Proportion of international faculty members				
	International student ratio	2.5%	Ratio of international to domestic students	5%	Proportion of international students				
	International co-authorship	2.5%	Proportion of internationally co-authored publications			10%	Proportion of internationally co-authored publications		
Income	*Industry income*	2.5%	Industry research income						
	Institutional Income	2.25%	Institutional income						

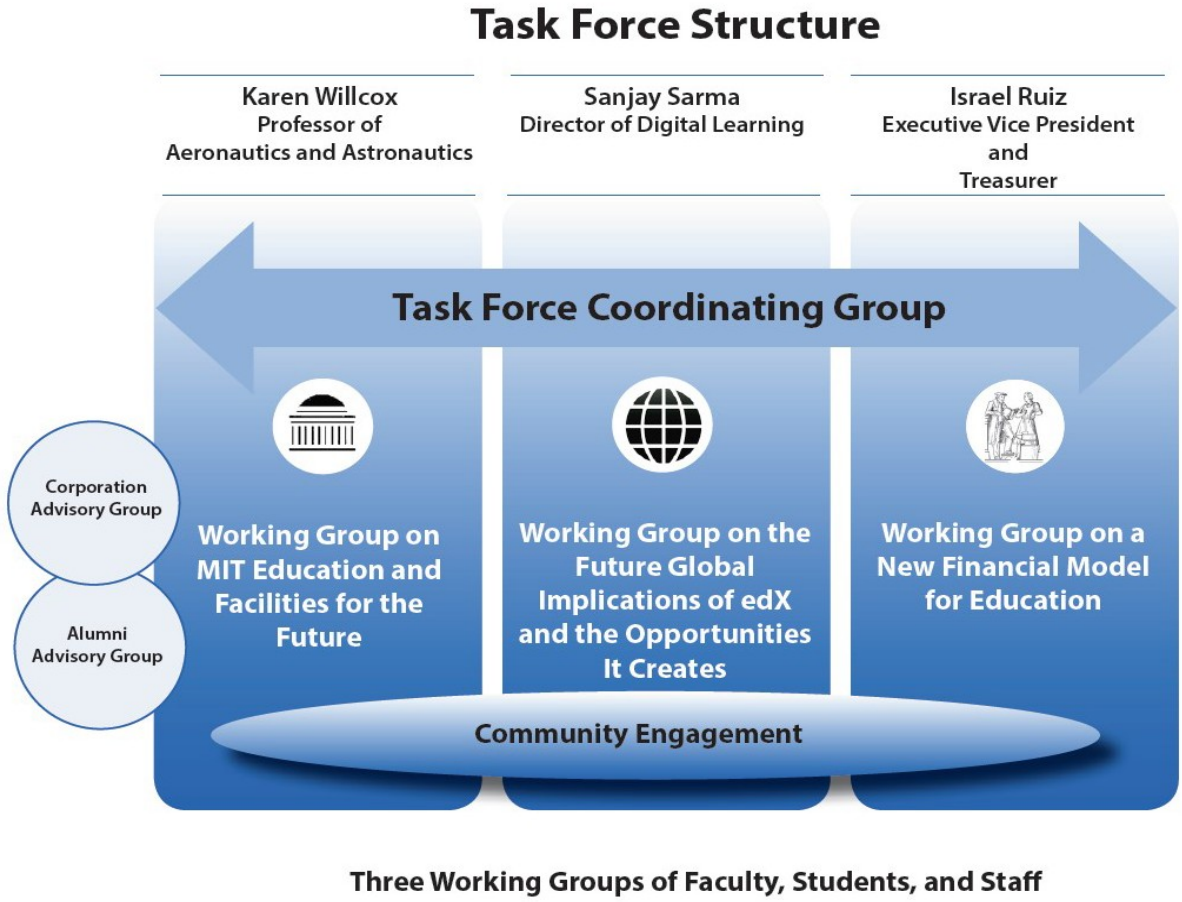
Appendix D: Times Higher Education World Ranking and Scores for Benchmark Institutions, 2014-15

2014-15 Rank	Benchmark Institutions	Teaching (30%)	Research (30%)	Citations (30%)	Industry (2.5%)	International (7.5%)	Overall
6	Massachusetts Institute of Technology	89.1	88.2	100.0	95.7	84.3	91.9
8	University of California, Berkeley	84.2	96.7	99.1	44.8	58.5	89.5
17	University of Michigan	77.0	86.5	88.9	55.7	49.8	80.9
19	Cornell University	71.6	83.8	91.5	33.7	59.0	79.4
26	University of Washington	64.5	68.9	95.0	44.7	47.9	73.2
27	Georgia Institute of Technology	62.5	71.2	85.8	72.3	68.9	72.8
28	University of Texas at Austin	64.3	72.0	91.5	58.1	33.1	72.3
29	University of Illinois at Urbana Champaign	67.7	79.0	77.8	51.7	43.9	71.9
29	University of Wisconsin-Madison	67.7	71.3	87.7	53.3	33.6	71.9
46	University of Minnesota	59.9	64.7	82.9	-	33.8	65.9
46	University of North Carolina at Chapel Hill	57.9	58.6	91.0	40.5	35.3	65.9
55	University of California, Davis	54.4	59.7	80.4	55.4	52.9	63.7
58	Pennsylvania State University	54.6	64.8	76.0	60.4	37.4	62.9
68	The Ohio State University	54.0	51.1	80.4	46.8	51.5	60.7
75	University of Southern California	55.2	44.6	81.3	34.4	42.7	58.4
82	Michigan State University	51.1	49.4	74.0	31.7	55.0	57.3
86	University of Arizona	44.9	51.4	74.0	99.6	38.8	56.5
91	University of Pittsburgh	45.2	46.3	84.4	38.5	32.2	56.1
97	University of Colorado Boulder	35.0	38.3	97.4	-	39.1	55.1
102	Purdue University	47.8	50.5	62.2	-	64.3	54.0
126	University of Florida	49.8	52.1	62.2	-	32.2	52.5
132	University of Maryland, College Park	36.5	39.1	83.6	33.2	44.8	51.9
141	Texas A&M University	46.2	51.9	55.1	49.6	49.1	50.9
144	Rutgers, The State University of New Jersey	40.5	45.3	71.0	35.2	34.3	50.5
191	University at Buffalo	40.1	39.8	57.5	39.6	57.0	46.5
193	Iowa State University	36.4	30.9	72.0	54.4	40.6	46.2
276-300	**Virginia Polyte chnic Institute and State Universit**	**40.1**	**40.0**	**40.7**	**42.6**	**28.9**	**39.4**
351-400	University of Missouri	31.7	22.0	46.6	31.2	29.6	33.1
-	North Carolina State University	-	-	-	-	-	-
	Range (Max)	89.1	96.7	100.0	99.6	84.3	91.9
	Range (Min)	31.7	22.0	40.7	31.2	28.9	33.1
	Average	54.6	57.8	78.2	50.1	45.7	61.8

Appendix E: Process Comparison and the Task Force on the Future of MIT Education

As part of a review of peer institutions, we sought to know about institutions that had a university-wide initiative aimed to plan and prepare for changes in the higher education landscape. We began by looking at long-range plans and then further pared down the peer group to reflect only those institutions that had a university-wide initiative aimed to plan and prepare for changes in the higher education landscape. We examined their areas of focus, associated committees, overall process for developing indicators, and mechanisms for communication and community input.

Of these schools, initiatives at MIT and Michigan State University (MSU) appeared to be most similar to the one that Virginia Tech hopes to undertake. Michigan State began its effort in 2005. More recently, MIT undertook the Task Force on the Future of MIT Education over the 2013-2014 academic year. MIT's well-documented design and processes have greatly influenced our thinking about a similar initiative at Virginia Tech.[16]



[16] See the Institute-wide Task Force on the Future of MIT Education, http://future.mit.edu/