

CHAPTER 20

Challenges in Establishing a Top Research University

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INTRODUCTION

The historical development of research universities and their roles in society has been articulated in many articles and documents. Since their inception, distinguished research universities have generated leaders in virtually every field and created scientific and technological advances that have affected the welfare and well-being of humanity. Top research universities have also contributed to creating national wealth through the generation of knowledge, technology innovation, job creation and establishing new business enterprises and public policies. To reap similar benefits, many countries have invested in higher education, but the results have been mixed. For instance, it has been difficult to match the likes of MIT, Harvard, Columbia and Cambridge.

The purpose of this paper is to describe the challenges associated with elevating a university to a world-class university and to present qualitative observations on both the role of government and the influence of the calibre of institutional culture in strengthening and establishing top research universities.

DIFFERENCES IN SUPPORTING HIGHER EDUCATION AND RESEARCH UNIVERSITIES AMONG OECD NATIONS

Typical goals of modern research universities are to generate educated human resources, create basic knowledge, innovate and improve technologies, and promote public service in order to contribute to health, prosperity and welfare in their nations and the world. To achieve these goals, different models and

approaches have been advanced and tried. In many nations, there have been continuing debates on proper and equitable ways of supporting research universities.

In some countries, such as the United States, Korea, Japan and Turkey, two research university systems co-exist: public universities supported by taxpayers and private universities that must secure their own financial support from non-governmental sources. In contrast, many European nations mainly have public universities that are supported by their central or local governments, although some private universities do exist.

Many arguments have been advanced in support of each one of the two models: public universities supported wholly by government versus private universities. When universities receive governmental support, the bureaucracy of government tends to exert control either directly or indirectly, since government operates according to regulations and rules to comply with governing laws. Even private universities that do not receive much public support can be under tight government regulations.

The higher educational system of the United States is an exception in that its two university systems, public and private, function well, serving the public interest without the kind of government control that exists in many other countries, because the Federal government does not fund universities. Many American private universities have long histories of excellence with complete independence, receiving no direct financial support from government. Furthermore, the U.S. research support system for universities is diverse, effective and highly competitive, thanks to the vision articulated by Vannevar Bush in *Science, the Endless Frontier*.

Historically, different countries have a variety of different educational and support systems, some with strong government support. The OECD nations make significant investment in education. On average, OECD nations spend about 4~5% of GDP on education. However, the actual expenditure can be much larger. For instance, in Korea, families spend an extra 2.8% of GDP for education. On average, Korean families spend an estimated 8% of their household budgets on tutoring and after-hours programs for each child. This high cost of education for families is one of the basic causes for Korea's low fertility rate of 1.2 — a potential social and national problem. The investment made in education by Korean families is among the highest in the world. Indeed, the sensitivity of this issue emerged as a major political issue in the 2012 presidential election in Korea. To get votes by capitalizing on the high cost of education, many politicians demanded that the tuition of all universities be reduced by 50%. This simple-minded approach to higher education is emblematic of the political approach to complex problems faced by many nations and their universities.

The large investments made in education in Korea and other Asian nations have contributed to their rapid economic development. For example, Korea's GDP per capita (in terms of purchasing power parity — PPP) is on par with

those of many nations of the European Union. Korea has become a leading nation in many industrial sectors, including shipbuilding, cell phones, consumer electronics, automobiles and steelmaking. This rapid economic development and industrialization have been attributed to its high educational level and its large investment in education.

STRATEGY OF KAIST TO BECOME ONE OF THE BEST RESEARCH UNIVERSITIES IN THE WORLD

The goal we established was to catapult KAIST to the rank of the world's best research universities, à la MIT. Both KAIST and MIT are great universities with similar aspirations and goals, and equally excellent human resources, but there are major differences in governance, financing, history and culture. MIT is the highest-ranked research university in the world per the QS ranking of 2012. It is a private university with rich tradition and a large endowment. It was founded in 1861, 110 years before KAIST was established in 1971. Both institutions are research-intensive, with similar research funding per faculty and an almost equal number of undergraduate and graduate students.

We adopted the following strategic approach: "Solve the most important problems of humanity in the 21st century."

We identified energy, environment, water and sustainability (EEWS) as some of the most important problems that must be solved in the 21st century. Specifically, we chose the reduction of CO₂ as a major goal. As results of this focused effort, we were able to initiate the R&D effort for the On-Line Electric Vehicle (OLEV) project in 2009. Also at the same time, we created the Mobile Harbor (MH) project. We developed both of these complex systems in two years. OLEV is now commercial.

These two projects are typical examples of the research done at one end of the research spectrum, i.e. technology innovation. The other end of the research spectrum is basic research. This philosophy of emphasizing the two ends of the research spectrum at KAIST is a result of the observation that the research done in the middle of the research spectrum has limited impact.

To achieve the goal of becoming one of the leading research universities, we also decided to increase the faculty size from 400 to 700 in order to reduce the ratio of the number of graduate students per faculty member. Departments were encouraged to hire as many faculty members as they can recruit, provided that they satisfy the highest standard of quality established for faculty. Although government did not fund many of these additional faculty hires, we were able to manage the additional cost. We proved that research universities must fund their operations largely with research funding.

This strategic goal also required the construction of modern physical facilities for research, education, dormitories, sports, health care, international

activities and housing for international faculty. During the period of 2007-2013, we built 14 new buildings. These buildings were financed from a variety of sources, i.e., gifts, government funding and other funds.

One of the most important undertakings at KAIST was the I-4 education, a new format of learning and teaching. Under this new educational format, there were no formal lectures in the classroom. Instead, students would listen to the lectures available on the Internet and come to class to solve problems with their fellow students in a pre-assigned group of six students with the help of TAs and professors. Students learn through discussion with other students while solving assigned problems. I-4 is over-subscribed because of its increasing preference among students.

OBSERVATIONS FROM VARIOUS RANKING OF RESEARCH UNIVERSITIES

In recent years, many universities have begun to pay more attention to rankings of universities by organizations such as the QS World University Rankings and Times Higher Education (THE). Although the specific details of the ranking process are subject to questions and debates, the general trend and the overall comparative picture provided by the rankings may be informative.

The following observations may be made based on the QS World University ranking and other relevant information:

- a. According to the 2012 QS ranking, six private universities in the United States, headed by MIT, are among the top 10 research universities in the world. Four universities of the United Kingdom are also in the top 10. Among the top 20 universities, 13 are U.S private universities. Of the top 700 universities, 130 are in the United States. A distinguishing characteristic of the U.S. universities, including public universities, is that they are mostly free from government control. Although universities have to comply with government regulations when they receive research funding, government control of private universities is relatively minimal. State governments support all public universities except the military academies. A university dependent on funding from a state government may be subject to more control by the state. However, in comparison to the government regulations exercised in other nations, public universities in the United States are relatively free to make most of their own decisions. Also, the U.S. has provided more support for university research than many other nations through such agencies as NSF, NIH, DARPA and ARPA-E. In addition, American universities benefit from the American culture of charitable donations.

- b. Young universities in Asia, founded since 1962 (less than 50 years old), are rapidly rising up in ranking.
- c. There are 19 Asian universities (excluding seven in Australia and one in New Zealand) and 21 European universities (excluding 18 U.K. universities) in the top 100. What is remarkable is the fact that excluding the United Kingdom, only two of the European universities — ETH (13th) and EPFL (29th) of Switzerland — were ranked in the top 30.
- d. If we exclude the U.K. universities, there is only one European university in the top 20 — ETH of Switzerland — and only two European universities in the top 30.
Many of the prestigious European universities are public universities. ETH and EPFL are supported by the Swiss federal government and have more autonomy than other Swiss universities, which are supported by regional governments, the cantons. The cantons regulate their universities tightly, making it difficult for the universities to innovate and transform themselves. The funding for ETH and EPFL seems to be unique. They receive a lump-sum budget from the ETH board.
- e. Most prominent universities in Sweden, Denmark, Norway and Germany are public institutions funded by the central or local governments. In France, there are two kinds of higher educational systems, universities and grandes écoles. Universities are usually public. Grandes écoles, mainly devoted to engineering and business administration, can be public or private. Most prestigious ones are public. One-fourth of research in France is conducted at and through CNRS. Many of these universities seem to be bound by the budgets they get from government and, as a consequence, are beholden to government in pursuing their institutional goals.
- f. Korea and Japan have both public and private universities. In the ranking of Korean universities conducted by the Korean *JoongAng Daily*, KAIST was No. 1 for five years in a row. Some of the best universities used to be public or national universities, but that is gradually changing. Many private universities have been moving up in the rankings.
- g. In Korea, the Ministry of Education, Science and Technology (MEST) controls all national universities tightly and even exerts control over private universities. KAIST has made some independent decisions, which have strained the KAIST relationship with MEST. All administrative staff members of the national universities are civil servants belonging to MEST. Private universities are also subject to control by MEST.

- h. Most universities in Europe and the U.S. charge tuition. ETH Zurich charges 1,160 CHF for two semesters, plus 128 CHF for other fees. At KTH in Sweden, undergraduates pay as much as 145,000 SEK (about \$21,300) per year. The tuition at the Technical University of Berlin is US\$1,000 per year for E.U. students and as much as US\$15,000 per year for international students. The cost of education at private American universities can be substantial, as much as \$50,000 a year for tuition alone. At the state universities the tuition is less, around \$3,000 per year.

ROLE OF GOVERNMENT IN THE DEVELOPMENT OF TOP RESEARCH UNIVERSITIES

Universities should not be treated as a “regulated business”

Most governments are under pressure from taxpayers and politicians to be impartial and fair in distribution of financial resources to universities, which often translates into uniform and equal funding. As a result, in many countries with many national universities, the available financial resources are equally divided among all national universities, taking away the incentive to be more competitive. The faculty and administrators get used to the comfortable life that comes with the tranquil environment when there is no need to strive to be the best.

When governments administer universities as “regulated business” like the postal service or public transportation, great universities cannot exist. A solution to this problem is to allocate most of the educational and research funds of the nation in special agencies (e.g., foundations, research projects agencies, etc.), after providing minimum support to its national and public universities to cover the basic cost of operations. These agencies should create competitive grant systems.

Governmental regulation of universities

In countries still in development phase, a limited control of universities by government may be necessary to maintain a minimum standard for higher education. However, for OECD nations, governmental regulation may hinder the emergence of outstanding research universities. Government should provide sufficient room for competition, while guaranteeing a minimal level of support for public research universities.

There are many ways governments regulate universities. One common method is requiring government approval of decisions made by the university administration. The approval power often covers personnel appointments, budgets, purchasing, regulations, the number of faculty members, the number

of students who can be accepted, tuition charges, etc. Another method of control is the creation of rules and regulations. Under this system, even sub-standard universities will survive regardless of their quality and great universities cannot emerge. This tendency towards the mean is the current situation in many countries.

Lump-sum support of the base budget of universities

It appears that the Swiss model of lump-sum support of ETH and EPFL by the federal government of Switzerland is the ideal model for public research universities. However, Switzerland is an exception.

At KAIST, the basic budget provided by the government pays for the minimal expenses of a tuition-free institution. Such support has been essential for KAIST's development and achievement of its current status. However, now that KAIST has to make another quantum leap to be among top 20 of the world's best universities, KAIST needs much greater financial resources and institutional freedom. The government should simply guarantee a minimum lump-sum support to KAIST to cover the basic operational cost. KAIST should raise the rest of its budget from other sources.

Maximum Freedom to Achieve the Primary Goals of the University through Competitiveness and Self-Determination

A research university must establish its goals and missions clearly. The goals are typically related to the primary mission of the university: education, research and public service. Then it must establish explicit strategies, policies and tactics to achieve the stated goals. In this process, the university should not be encumbered by extraneous factors that are not related to its primary missions.

The Board of Trustees and the Retention of the Power of Approval

One of the prerequisites for a strong research university is an independent board of trustees, free from political influences. A good example for a public university is the University of California system. Under the California constitution, its Regents, who have "full powers of organization and governance" subject only to very specific areas of legislative control, govern the university. The governing article states "the university shall be entirely independent of all political and sectarian influence and kept free therefrom in the appointment of its Regents and in the administration of its affairs." At the University of California, there are 26 Regents, 18 of whom are appointed by the governor of the state for 12-year terms to insulate the board from political influence.

A leading research university should have a large number of board members selected from those who have valuable administrative experience (e.g., former

presidents of universities, corporate CEOs), major donors (because donors help fund the university), alumni, leaders in science and technology, and international leaders. The board members should be appointed for at least five years to provide continuity and independence for the board. Many private universities in the United States have boards of trustees with more than 50 members, led by a small executive committee consisting of about 10 members.

CONSTRUCTIVE AND ETHICAL CULTURE: PREREQUISITES OF RESEARCH UNIVERSITIES

A distinguishing characteristic of a top research university is the culture of the university, which takes many years to establish. It is embedded in the beliefs, ethics, aspirations, fears, attitudes and expectations of faculty, students and staff. Culture is transmitted through people — professors, staff and students — over many generations. For young institutions, it is important to start establishing the right kind of culture from the beginning, because it is difficult to transform a well-established culture.

There are many common attributes of a constructive university culture: a high standard of ethics and honesty, respect for colleagues and for their achievements, sharing of the value system that enables scholars to make their intellectual contributions, and open discussion with colleagues to elevate the overall level of understanding. Such a culture does not tolerate unethical behaviour such as the fabrication of data, plagiarism, fabrication of misleading stories to attack a target, sexual harassment or other unjust actions. In many universities, most people possess the qualities that are worthy of a great university. However, a small group of people who do not share these basic qualities can poison the culture of the university. A great university must also maintain a culture that promotes, rewards and respects diverse views. A great university is one where those who have made outstanding scholarly and professional contributions are respected. Without these qualities, a great university cannot survive the test of time. If the faculty is led by those who have not made significant scholarly or professional contributions, but are engrossed in campus politics, the culture of the university will become politicized and eventually deteriorate.

Scholars should compete primarily with history, striving to emulate and surpass the intellectual giants who have affected the history of their fields and, in some cases, the history of humankind. A culture that allows creative and unorthodox scholarship, free from coercion of any kind, must permeate throughout the university for serious inquiries to proceed. Such a culture is a prerequisite of a great university.

Perhaps more than in any other institutions, academic culture tends to prize aspects of the status quo. It resists any change that affects the professors

themselves. This alone can be good in some situations but also harmful, depending on the issues involved and whether one is the proponent of a change or the subject of the proposed change. One must expect major resistance when proposing a change. Once again, this aspect of the university culture is neither good nor harmful, but how people react to and deal with proposed changes is an important element of the culture. The desirable culture is one in which changes are rationally discussed and debated.

The changes proposed at universities should be considered in the larger context of the institutional needs. However, this practice is not always the case. When the author proposed that the Department of Mechanical Engineering at MIT broaden the discipline of mechanical engineering from a physics-based discipline into a discipline that is based on other scientific fields and design in addition to physics, some senior faculty members strongly objected. As a testament to the strength of the MIT culture, the board of trustees (called the MIT Corporation), the upper administration and the department faculty handled the difficult transition constructively. The author's experience at the U.S. National Science Foundation was similar, although the transition there involved the large community of the United States. In recent years, KAIST has gone through more significant transitions — a much stronger tenure policy, a department-centric system, increasing faculty size by 50% without departmental quota, a new research structure, instruction in English, etc. All these transformations at MIT, NSF and KAIST yielded positive results, although they were difficult changes.

RECIPE FOR DEVELOPING A GREAT RESEARCH UNIVERSITY

A great research university is created — not born — through many decades of effort and hard work by many who toiled for long hours. To become such a university, there are a few pre-requisites that one should consider.

Requisite 1: Goals

The mission and goals of a research university should be clearly stated and articulated. As discussed earlier, at KAIST, the goal was to “become one of the top research universities in the world” by solving some of the most important problems of humanity in the 21st century. We identified these problems to be “energy, environment, water, and sustainability (EEWS)” and four years later we added healthcare, education and defence (HED) to the original list.

Requisite 2: Strong faculty

KAIST hired 350 new faculty members without getting full government support. By hiring outstanding faculty, the overhead they brought in generated

enough revenue to pay the research expenses and salaries. The lesson is that research universities must generate revenues based on outstanding research. Tuition paid by students cannot and should not pay the research expense.

Requisite 3: Strong Governance and Organizational System

a. Department-centric system

In a complex research university, the power to make important decisions should be delegated to those who best understand the issue. This philosophy requires a department-centric system, in which a department head is in charge and makes important decisions on personnel, finance, space and academic programs in consultation with the faculty. Sometimes the decisions made by the department head may not necessarily be based on the majority opinion of the faculty, since the department head may have information that is not generally available to others. In this system, the department head should be the boss.

b. Asymmetric decision-making process

To enable the department head to exercise his/her decision-making power, the upper administration should not force the department head to reverse a decision in the negative (e.g., not to hire a particular candidate). However, the upper administration must review the department head's affirmative decisions, since their implementation may have campus-wide ramifications.

c. Faculty Hiring

At most universities, the central administration assigns a fixed number of faculty positions to each department mostly based on past history. However, such a system has shortcomings. The department may perpetuate itself by filling vacancies that were created by retirements with professors who have similar traditional backgrounds to the professors just retired. Under such a personnel policy, the departments may not hire to staff newly emerging fields. Furthermore, the field-specific hiring in a given department may overlook the best-qualified person who happens to be in another field. Therefore, an alternate way is to open up the hiring process so as to hire the best-qualified professor who can open up new frontiers of knowledge.

d. Tenure policy for faculty

Top research universities must have a fair and strong tenure policy. Tenure policy is needed to protect both the professor and the university. A strong tenure system is also required to attract the most qualified faculty to the university.

At KAIST, a stringent tenure system was introduced in 2006. Some of the professors were denied their tenure under the new policy,

which was a new practice in Korea, because previously most professors had received tenure once they were hired. Because about a half of the professors at KAIST did not have tenure, this new tenure policy — a process that allows a maximum of eight years to acquire tenure — has created a great deal of tension on campus, as well as opposition by the faculty “union”. However, this process is now firmly in place at KAIST.

e. An ideal ratio of graduate student/faculty

Often there is a debate within universities about the right size of the graduate and undergraduate student bodies. The answer depends on institutional goals. At a research university, an ideal ratio of undergraduates to graduate students seems to be about four to six. The optimum number of graduate students per faculty member in science and engineering seems to be about six so as to allow the professor to be engaged in research with the student.

f. Admissions policies to offer opportunities to those with limited chances

One of the major tasks of a research university is to admit the most qualified undergraduate and graduate students among those who apply for admission. The research universities also have an obligation to admit the “unpolished rough diamond”. At KAIST, we accepted up to 150 freshmen from rural and deprived regions based on the recommendations of the principals of their high schools (only one recommendation per high school), oral examinations and interviews. About 80% of the students admitted through this process performed as well as those from the highly selective science high schools, but the last 20% could have done better if KAIST had offered remedial courses before enrolling them to the regular freshman class, a lesson learned.

For a research university to be competitive, it must also attract the brightest and most capable students globally. Research universities in English-speaking countries have a clear advantage in attracting foreign students. With the ease of migration, the countries that can attract the brainpower will have competitive advantages in many fields of human endeavour, especially in science and technology.

g. Elections for presidents, deans and department heads by the faculty

Many universities elect their presidents, vice presidents, deans and department heads by vote of the faculty. This practice has many shortcomings. It leads to inbreeding of hiring only their own graduates, splits the faculty and creates a continuing battleground for next election. It is unproductive. It works against the idea that universities must serve the public by bringing the best scholars and professors

regardless of their background. The board of trustees should select the president through a search process and the president should appoint all vice presidents and deans.

h. Merit-based compensation system

To attract the most qualified professors and do justice to those who contribute the most to a university, the compensation system must be merit-based, recognizing the difference in supply and demand of professors in different fields. When market forces are ignored, universities either underpay or overpay their faculty members, practices that are ultimately unfair from the viewpoint of those who actually pay the cost of maintaining a university.

i. Generation of gifts for new buildings and faculty chairs

Universities are not profit-making organizations. Universities need benefactors who are willing to support special activities with their private wealth as a way of repaying what society did to nurture their own success.

Requisite 4: Academic and Research Programs

a. Interdisciplinary collaboration across departments

Many research universities emphasize interdisciplinary and trans-disciplinary research. One way of achieving these goals is to conduct large-systems interdisciplinary research projects that involve the design of complex systems, which necessitates collaboration among colleagues with diverse backgrounds.

The OLEV and MH projects at KAIST required the expertise of many professors and researchers from many disciplines. They also needed participating companies to defray costs that were in several tens of millions of dollars over two years. What these projects have demonstrated is that research universities can conceive major technological innovations that are large and complex, and successfully execute them in a relatively short time. These projects demonstrate that theory-based design of large complex systems and implementation by building actual systems can be done at leading research universities.

b. Creation of interdisciplinary education and research for better education

It is reasonable to assume that education will undergo a significant transformation because of technology. There is no need for so many professors to teach the same subjects every term. In theory, the English-speaking countries need only one professor of, for instance, physics to teach freshman physics. Students can listen to the lectures stored on the Internet. Then education can be tailor-made for each student — mass customization of education. At KAIST, we have

initiated the I-4 Educational Program to change the educational system to a learner-centric system from a teacher-centric system. Currently, the number of applications of students to enrol in I-4 exceeds its capacity.

Requisite 5: Cultural issues related to creativity and ethics

The culture of a university is the most distinguishing difference between the top research universities and others. Among the many elements of a university culture, two important ones are related to creativity and ethics.

Perhaps the most convincing argument that the university culture matters in nurturing creativity is the observation that the same individual can become more or less creative when the person goes to another university. It may be attributed to the fact that in top-tier universities there are more incidences or occasions that stimulate and inspire creative thinking because of its institutional dynamics, quality of human interaction, respect for creative achievements of their colleagues and history of successful creative activities.

As noted before, ethics at top research universities may be equally or more important than creativity. The absence of ethics in a university can be corrosive over a period of time, permeating the entire university and affecting the core of a university system. At a university, there should be no room for plagiarism, plotting to hurt others, bias, prejudice and slander. Everyone should be treated equally irrespective of religion, national origin, school background, family and regional ties, race, etc. Furthermore, there should be genuine respect for those who have made major scholarly contributions.

Requisite 6: Relationship with Government

A strong government is needed. All universities must respect government policies, since they are concerned about the overall welfare of a nation. Governments deal with much larger issues than a university does and must satisfy many different constituents. That is the reason people in democratic countries have delegated so much power to their governments, since in such a government the people ultimately hold the power.

Universities also have their own responsibilities and obligations, which must be respected by politicians and governments. Universities are legal entities created to fulfil special needs of society and serve the long-term welfare of a nation and humanity. In many cases, universities need government support and government needs strong universities to achieve national goals. Under normal circumstances, there should be a symbiotic relationship between universities and government.

In some countries, government tends to dictate its terms to universities, because government is more powerful and authoritative than universities. Governments control financial resources and can dole out special favours to

interest groups, if they choose to. In some countries, government controls the board of trustees by appointing many civil servants as the trustees and by limiting the number of non-government trustees. They even remove those who have made major financial and intellectual contributions from the board so as to control the board of trustees.

CASE STUDY TO TEST THE THEORETICAL FRAMEWORK FOR A LEADING RESEARCH UNIVERSITY

The development of KAIST since 2006 is a prototype of a case study for development of a major research university. Its world ranking has gone up from 196th to 63rd, and to 24th in engineering and IT. In several fields of engineering, it is in top 20, which is a remarkable change. However, to confirm the theoretical framework discussed in this paper for a top research university, it will be interesting to conduct more case studies.

CONCLUSIONS

- a. Leading research universities have made major contributions to the development of human resources, generation of the knowledge, major technological innovations and economic growth of their countries.
- b. While the importance for strong research universities is clear, the actual establishment of high-quality research universities has been difficult in many countries for a variety of reasons. The best universities feature outstanding faculty, the staff and highly competitive students who can generate and implement creative ideas to solve important problems of humanity. Equally important are the financial resources to attract talent and create state-of-the-art facilities that enable innovative research.
- c. Concurrent with the need to satisfy the requirements for a leading research university, there are two important issues that have not been articulated as much as the others in the past. The first is regulation of universities, either directly or indirectly, by government. Many universities under tight government control have not reached the top ranks, and often they are not competitive in attracting the most knowledgeable and forward-thinking faculty and staff. The second issue is the culture of a research university. Leading research universities create a culture that directly respects and rewards accomplished scholars and professors, dedicated staff and outstanding students for their intellectual and scholarly contribu-

tions. They also create an environment where unethical behaviour is not tolerated.

- d. Leaders of the best universities must articulate a shared vision and clear goals, and create collaborative teams to develop detailed strategies for success. They also must identify multiple financial sources, and, in the case of public universities, gain governmental and societal backing. Leaders must then bring out the very best qualities in the community members that comprise their universities, encouraging dedication, teamwork and innovation.

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