CHAPTER 8

The Evolution of globalized Higher Education

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INTRODUCTION

This essay is intended to elicit discussion around current thinking about the globalization of higher education (from a U.S. point of view in particular) in the context of proposing a new model we are attempting to develop at the University of California, Berkeley. We begin with a brief narrative of the historical evolution of efforts to internationalize education, from the 17th century to the present day, before providing a schematic outline of efforts to create new models for the global university. It turns out, perhaps not surprisingly, that higher education was global in its origins as well as in its subsequent trajectory. With that said, as in so many other domains, the globalization of higher education has accelerated rapidly over the last quarter century, motivated by a quest for additional revenues (especially in the case of Anglophone universities), a desire for greater international relevance and hence prestige (for all universities, but especially in the case of European and Asian universities), and a desire to provide a foundation for a knowledge economy (especially in the case of Asian universities) (Altbach & Knight, 2007; Wong, Ho & Singh, 2007; Marginson, 2006). This essay will focus on the development of globalization strategies of North American universities — a history that begins with the religious history that drove early educational experiments in the new world that was in more than one way connected to the history of global empires.

PREHISTORY: GLOBAL ENDOWMENTS AND THE COLONIAL PAST

It is well known that many of the early colleges established in colonial America were designed to foster dissenting denominations and to disseminate theological views at odds with what was possible in the mother country (Brubacher & Rudy, 1997; Humphrey, 1972). Less well known, however, is the fact that Yale College — one of the new dissenting colleges — was named after an Anglican, who gave his founding endowment in part to satisfy his (general) missionary zeal, and in part to ensure posterity for his surname after the death of his son David in Madras, where Elihu Yale had been Governor (Viswanathan, 1994). Yale, as was the custom for East India Company Governors during the 17th and 18th centuries, earned his vast fortune through the custom of "private trade", engaging in an activity that ultimately led Edmund Burke to push for the regulation of mercantile capitalism in India (Dirks, 2009). The fruit of global trade — unfortunately in this case the same kind of trade that propelled a new class of "Nabobs" to enter gentry status, acquire huge estates, and buy seats in parliament — played an important role in the foundation of one of America's oldest, and most prestigious, institutions of higher education.

We do not mean to draw perverse analogies between the current push for globalization and this particular history, though admittedly global trade has often been part of the mix for the generation of wealth that continues to be so important for the philanthropic support of higher education. We do mean, however, to suggest that even the most local of educational beginnings were always already quintessentially global. Yet this historical anecdote is not just an isolated example, but also the prelude for thinking through the global relationships of American higher education throughout its history. This history is one that began with England and its role in setting the terms for the fundamental values of higher education, shifting in part to Scotland (and the 18th-century Scottish enlightenment), before migrating across the continent to Germany, which became the most important new influence for U.S. educational institutions in the mid-19th century, especially in the area of research and graduate training. This is also a history that shows how important higher education was for early settlers and then citizens of the new world, while expressing the continued importance of Europe — and its civilizational inheritance — for the emergence of the United States as a new nation. Indeed, education was not just to inculcate religious learning, but also an understanding of and appreciation for the civilizational inheritance that was seen as so critical a base on which the new world was to develop (Marsden, 1994). For much of its early history, American higher education was oriented in relationship to Europe, both as the touchstone and the point of departure.

Europe was also a point of perpetual return. As Edward Gibbon observed in his autobiography, "According to the law of custom, and perhaps with reason, foreign travel completes the education of an English gentleman." (Gibbon, 1900) During the 18th century, "travel became fashionable as a means of finishing the education of youths, as a source of social polish, and as a pleasant and desirable way to spend periods of leisure." (Black, 2003) For English aristocrats, in particular, time spent perusing the (mainly ancient) glories of the continent provided just the right touch of gentlemanly polish (Cohen, 1992). This aristocratic tradition was not lost on settlers in the new world. As students in American colleges studied theology, the classics, and — especially after Jefferson created the University of Virginia — a growing array of new subjects, the Hellenic and Roman worlds remained primary referents, though European civilization as the continuous space for enlightenment was always the ultimate referent. Although sponsoring formal study abroad was beyond the reach of early colleges, the curriculum fed into a desire to replicate the grand tour, if only in theory for most students. Increasingly, however, the new American elite sought to ape the model of the English aristocracy, sending their children not just to college in America, but also to Europe for their own version of the Grand Tour (Rodgers, 1998). (Henry James's fiction, from "Turn of the Screw" to *Portrait of a Lady*, offers a portrait account of what upper-class Americans hoped to achieve by sending their children for a jaunt around Europe — and how often they left disappointed.) Soon this was being institutionalized: by the late 19th century, some American finishing schools for girls began to market themselves in part around the chaperoned travel that they afforded their students — updating the thematic content of the Grand Tour for a new gender dynamic, while also presaging the role that colleges would soon play in funneling new generations to various packaged versions of the Grand Tour, disseminating a patina of refinement to growing numbers of young Americans who coveted cultural capital and, of course, elite status (Ridder-Symoens, 1996).

MODEL I: TRAVELLING

Though collegiate study abroad remained fundamentally a luxury good throughout the Progressive Era, the professionalization of advanced scientific education, particularly in Germany, was spurring fundamental change of a different kind, change that would metamorphose the idea of higher education in the United States. In fact, the first pedagogically serious efforts at international education would begin in the late 19th century, with graduate students from around the world (and particularly the United States) (Ellis, 2013) coming to study at the new breed of German research universities, whose model of scientific training was soon exported back to the United States (and to

Figure 1: The first U.S. foreign study group, sponsored by the University of Delaware, en route to Paris in 1923.

other countries too) (Charle, Schriewer & Wagner, eds, 2004). The desires of students to learn from the best professors in Europe was supported by scholarships designed explicitly to lure top talent from abroad — iconically, the Rhodes Scholarship, which had Oxford hosting foreign students from 1902 on. Up through the Great War, intellectually serious international education remained the province of graduate education.

The idea that American universities would actively encourage their own undergraduate students to study abroad first began to take off after World War I, with American universities (led, curiously enough, by the University of Delaware) for the first time actively encouraging their students to consider spending a semester or a whole year at a European university.

Study abroad suddenly seemed a good idea to U.S. university administrators in the 1920s, not only because such an offering promised students a frisson of continental sophistication that echoed the Grand Tour, but also because the strength of the dollar in the post-war years made educating students in war-ruined Europe a cheap alternative to educating them at home. Study abroad in its modern guise began, in part at least, as a price arbitrage play.

If this original idea made good financial sense, it would soon flower into what until recently was virtually the only (and even today remains the modal) model for international collegiate education, namely the iconic "School Year Abroad." Through the 1920s and 1930s, there was a rapid proliferation of foreign study programs at American universities, both public and private, though the total number of students studying abroad remained relatively small at first.

The idea of the school year abroad really took off in the post-World War II years, as a result of a number of factors. First, transportation linkages between continents intensified with the rise of the long-distance air travel, democratizing international travel to an unprecedented and ever-increasing degree.

Second, the rapid expansion of university systems in the United States, combined with great stratification, led many universities to begin to offer school year abroad programs as a "product differentiator". While these programs were often marketed to the students in terms that would not have been unfamiliar to the grand tourists, travel to Europe began to become a marker not just of elite status, but of a new American middle class. Finally, there was also a distinct Cold War imperative behind the push to internationalize post-war higher education in the United States. As Princeton linguist and USIA consultant Albert Marckwardt (1964) put it in 1964:

"Certainly we can grant without further argument that the position of the United States in the world today demands, on the part of everyone who has a share in the decision-making processes through which the country is governed and moved to action, a heightened and sympathetic reaction to the ways of life, the values, and the problems currently facing other areas of the world. As a democracy, we can no longer tolerate the unhappy spectacle of a thirty- to fifty-year lag between the public state of mind and those who must assume the responsibility for our relationships with the outer world, Western as well as non-Western. In fact, it is urgently necessary that the gap be closed at once. Even if we were not one of the powerful nations, the technological conquests of time and space which have occurred would still demand this of us. In the world we are approaching, not even a third-rate power will be able to afford the easy, retreat of isolationism, either in its political thinking or in its social and ethical outlook. How is such a general broadening of the horizons to be achieved? Direct foreign contact, which is becoming a far more common experience than it used to be, still cannot begin to take care of the situation adequately. Moreover, it takes more than a vacation trip or even a school year abroad to work the changes in thinking and outlook that are necessary; if anything, this is only a beginning. Operating on the scale which seems almost inevitable, we can only put the new experiences and the extension of the personal environment into the educational system in this country. In short, we shall have to bring the non-Western world to the student, since we can send only a limited number of students to the non-Western world."

It was in this context that the semester in London or Paris began to seem a normal if not fundamental ingredient of a college education, at least in many private colleges, and a few of the leading public ones too. It was also in this context that study abroad began to include not just the standard European destinations, but some in the "Third World" as well. Japan, India, Latin America and the Middle East all began to be the sites of new interest, propelled not just by the new Fulbright program and the National Defense Education Act (among other federal government initiatives), but sponsored by some of the leading foundations as well, including Ford, Rockefeller and Carnegie (Brooks, 2015; Bu, 1999). Under these programs, students from the

Global South now came to study in the North as much as the reverse. (Less studied is the Soviet Union's sponsorship of parallel student exchange programs for socialist bloc nations, which would significantly influence the political imaginaries of many postcolonial cadres in the later years of the Cold War (Katsakioris, 2014). Although post-war "Area Studies" were predominantly directed towards graduate training and advanced research, the growth of Area Studies faculty and programs led inexorably to increased attention to study abroad as a genuinely global phenomenon.

MODEL II: EXCHANGING

Study Abroad programs began by being sponsored and organized by colleges and associations in the U.S., but increasingly relied on "host" institutions in Europe and elsewhere. As programs became more dependent on these institutions (and in turn, host institutions began to rely on the regular revenue models that went along with them), new kinds of partnerships were established, in order to formalize the curricular and financial aspects of student exchange (even if students moved more in one direction than another) and to curate a student experience that required regulation, oversight and "*in loco parentis*" in multiple global sites. This model commonly involved two universities collaborating to set up a shared pedagogic and/or research program. In some instances, each university would contribute roughly equal numbers of students, faculty and resources to the venture, with none of the resources flowing off campus, and students simply flowing between the campuses. This model worked well for U.S. liberal arts colleges, but worked less well for the more fixed curricula of most European institutions, which nevertheless valued their role in helping to educate American students. In many instances, U.S. programs would be run through associations or consortia that provided structure, housing and some set of curricular guarantees through relationships with host institutions.

The partnering model became the basis for the proliferation of cross-institutional agreements: the ubiquitous memoranda of understanding that began to create dense global networks, at least in theory. Over time, partner universities began to generate new programs at the graduate level as well, increasingly in professional degree programs (especially MBAs) where international exposure also attained major significance. In recent years, a variety of universities have offered dual degree programs that offer students the chance to spend time at the two campuses, allowing them to broaden their international experience, which is seen as particularly valuable for those intending a career in international business or in a globalized industry. This model began to be used in Asia throughout the 1990s as a number of privately owned institutions provided outlets for students to study for foreign degrees in their home

countries (Chen, 2015). These programs were in some ways more precursors for new models of institutional collaboration than the standard study abroad programs of earlier decades.

MODEL III: BRANCHING

Though the first international "branch campus" opened in the 1920s, when Parsons Fashion School in New York launched a location in Paris, the fashion capital of the world (Lane & Kinser, 2015), few universities followed Parsons's suit until the 1990s, when all of a sudden a welter of universities began to consider building full-blown extensions of their home campuses overseas (Wagner & Schnitzer, 1991). Over the last 20 years, few ideas have been more popular with ambitious university administrators: According to the Cross-Border Education Research Team (C-BERT) at SUNY-Albany, as of May 2015, there are a total of 235 international branch campuses in operation worldwide. Universities in 32 different countries have "exported" campuses, including 51 U.S. universities (with a total of 81 branch campuses) and 26 British universities (with a total of 34 branch campuses). Conversely, there are a total of 73 "importing" countries, including United Arab Emirates (with 33 branches), China (28), Singapore (14), Qatar (11), and Malaysia (9) (http://www.globalhighered.org).

The motives behind the establishment of international branch campuses are multifarious, ranging from a desire to unlock new sources of revenue for the university, to offering faculty and students of the home campus with a more comfortable environment for international engagement (Wilkins & Huisman, 2012). While many different models have been attempted, the common idea is to replicate the academic and other experiences of the home campus, while injecting appropriate local flavour into the mix. Sometimes this entails building a stand-alone campus, with NYU-Abu Dhabi as perhaps the most famous example, whereas sometimes it involves building a bilateral joint venture, e.g. Yale-NUS, Technion-Cornell (which bleed into Models IV and V, see below) (Olds, 2007).

Depending on where these campuses are set up, such international branch campus are often bold (and risky) experiments, introducing various American styles of education (including the liberal arts) where they did not previously exist, creating new levels of investment in and collaboration with partner universities, and opening universities to global forces that are fundamentally new and different. Yet they also create a thicket of operational complications for the institutions involved, ranging from financing, to convincing the professors of the home institutions to participate, to ethical questions concerning labour practices and academic freedom (Altbach, 2013). To be successful, the managers of higher education institutions who embark on branch

campus ventures need to understand the cultures and business practices of the countries they are entering. The greater the cultural distance between the two countries, most importantly including differences in the institutional understandings of the role and function of higher education, the greater the chances something will go awry. So far, the most successful experiments have been those where partner universities already shared faculty cultures of research and teaching. Exciting though many of these experiments are, however, the downside risks are enormous: even leaving aside losses of prestige or "face" should the venture go awry, financial losses from failed joint ventures have been known to run into the tens of millions of dollars. Despite these risks, for most universities this model remains the state of the art in terms of global institutional ambitions.

MODEL IV: MODULARIZING

Some universities, tempted though they have been to build branch campuses, decided to take a different strategy in developing their global "footprint". At Columbia University in the early 2000s, for example, we decided to build a global network of "consular" offices to provide a limited, yet discrete, physical presence in various global centres. Our thinking was that these offices would be free-standing (that is, not linked to any particular university), enabling the development of partnerships and collaborations with multiple institutions, and yet capable as well of developing links to and programs for faculty, students and their parents, and alumni, while also handling local legal, political and fundraising issues of relevance to the university. We believed that these "centres" or offices (some very small, some larger, depending on local funding and resources), would significantly advance our global activities, encourage faculty and students without significant global experience or expertise to become more global, while minimizing risk and, for that matter, upfront investment (most of the resources were raised from local alumni pleased to have an opportunity to "give back" to their alma mater while doing so locally). Columbia began by opening offices in Beijing, Paris, Amman and Mumbai, soon expanding as well to Istanbul, Nairobi, Rio de Janeiro and Santiago. So far, these centres have steadily established themselves as important resources and generated new activity, from different forms of study abroad, to new faculty research, to the generation of new grants to support research in areas such as global health and environmental policy.

The Columbia model has been followed by a number of other universities, usually with a focus on key areas of the world. Stanford, for example, has opened an impressive new centre in Beijing, and though it has done so on the Peking University campus, it has not restricted the centre's activities to specific collaborations with PKU. Like Columbia (and to some extent

deliberately following its example), the University of Chicago has opened a number of global international centres, in Beijing, Hong Kong, New Delhi and Paris. The list of universities that have opened some set of consular office is growing almost exponentially, and this is true for universities all over the world. For example, the Freie Universität of Berlin has seven global centres (New York, São Paolo, Paris, Cairo, Moscow, New Delhi and Beijing), explicitly establishing for itself the model of a global network university. If offering your students the opportunity to study abroad has become table stakes for any major university, the "Consular Office" model remains the most popular for universities with bigger ambitions about "going global".

MODEL V: NETWORKING

While various global centres, most notably Dubai, Abu-Dhabi and Qatar in the Gulf, and a myriad of cities in China (e.g. Souzhou), have established new university research parks, inviting global universities to take advantage of land, proximity to other new research and educational ventures, shared use of infrastructure, the promise of growing and talented student populations, and often major infusions of resources, to date only a few of these research parks have been sponsored by highly ranked research universities themselves. Where top-ranked universities such as Stanford have built research parks, the goal most often has been not to partner with foreign universities, but rather with industrial partners, with the aim of lubricating the process commercializing technology and other intellectual property. This process has typically been kept quite intentionally distinct from the process of partnering with other universities, if only to lessen potential legal and operational complications.

The only important exception in this regard is the National University of Singapore. NUS has made major partnership agreements with a whole slew of foreign universities including Duke, Carnegie-Mellon, Australian National University, University of North Carolina, Cambridge, King's College London, Waseda University, and perhaps most significantly with Yale, providing land and facilities on or near their main campus with the express purpose of developing new kinds of international partnerships to drive innovation and enhanced global collaboration. Each of their educational collaborations has been bilateral, although some research ventures have been multilateral (e.g. CREATE). In both of these areas, NUS has been pioneering a new model for a global university, what might be described in the language of "insourcing."

This is a model we at Berkeley are ourselves developing, especially since we were recently cleared to develop a new campus — 134 acres on the San Francisco Bay formerly known as the Richmond Bay Field Station — less than 15 kilometres to our north. As we have considered different options for

extending our global reach and establishing a real global network for ourselves, we have been mindful of the successes (and failures) of other ventures, as also of our public mission, in particular our obligations to the region of northern California and more generally to the state of California itself. We have also been mindful of the fact that while we all have seen how global centres can exert powerful incentives for partnership and collaboration, no U.S. university has initiated a similar kind of "insourcing" strategy as begun by NUS, and indeed (viewed in a wider context) developed by a number of countries in the Middle East and Asia. The most direct example of U.S. "insourcing" might be said to be the initiative undertaken by New York City, at the instance of Mayor Michael Bloomberg, when he invited universities from across the world to compete for money and land with direct access to the myriad of resources represented by an institutional presence in one of the greatest global centres. The winner of this much-heralded competition, of course, was a partnered proposal by Cornell and Technion, an Israeli university, and this new experiment in global collaboration is currently under construction (Kiley, 2011).

At Berkeley has taken and elaborated these ideas and examples to propose a new model, in effect that our new campus be labelled as the Berkeley Global Campus (BGC) at Richmond Bay, separate from but inexorably and deeply connected to the home campus. We are in the process of recruiting international and local partners — universities as well as private corporations, government agencies as well as non-governmental organizations — to join us in designing an integrated global network of activities, programs and enterprises. The goal of this new campus will be to provide our students, faculty and staff with an unparalleled global experience and education, as well as to generate and to sponsor global research and entrepreneurship that will benefit both our campus and the entire region of northern California.

BGC will create a unique global footprint, involving a multilateral consortium of universities from across the world (along with other public and private institutions), who will partner with UC Berkeley in the establishment of a global centre for research, teaching and practical engagement in the East Bay. BGC will bring global resources to bear on the construction of the campus, while at the same time opening up the entire Berkeley community to global opportunities. Building on our strengths in engineering, computing and technology, climate science, global public health, big data, entrepreneurship, law, social science, humanities, the arts and design (as well as leveraging our developing partnerships with UCSF on the other side of the Bay, for example in the field of personalized medicine, as well as the Lawrence Berkeley National Lab, in energy biosciences, computing, etc.), we propose to establish a global campus that will extend out from our Berkeley base while inviting global universities to partner with us in a wide range of activities that align with the

university's core academic priorities and take full advantage not just of our resources but of our location in the world's leading centre of innovation.

This bold idea initially emerged as we began to consider and evaluate a wide range of issues and risks associated with a potential UC Berkeley presence in mainland China, either through the establishment of a "consular" office or by setting up joint educational and research ventures. Along with some of the challenges in areas related to academic freedom, there are complicated regulatory and political issues, as well as local concerns about ensuring wide participation across the Berkeley campus for a venture of this kind. While we will proceed on a parallel track with the planning for global centres not just in China, but in critical world locations, we will commence the development of a global strategy by establishing a central node in the form of a new global campus close to the home campus.

The proposal inverts the usual model whereby U.S. universities establish themselves in sites all around the world, and instead proposes to invite the world's leading universities to come to join us at Berkeley. BGC represents a model of educational globalization that is sharply distinct from the "commensalist" models of academic globalizations outlined above. These models of global engagement are all in one way or another premised on the educational analog to a "special economic zone," creating autonomous campuses that purport to be somehow "in" but not "of" the country in question. What Berkeley envisions in BGC, by contrast, is a "mutualist" model: rather that sallying forth to conquer the world, we wish to invite the world not just to partake of the benefits of our campus and region, but to establish a genuinely global network of activities. BGC will be host to the research and educational facilities of a small set of elite partner universities from around the globe, as well as P3 research facilities. All of these facilities will be formed in partnership with specific research initiatives (both ongoing and new) that are taking place at Berkeley and in partner universities. As the BGC grows, we believe it will increasingly draw in the most resources and talents of people from around the world, thus acting as a sort of tractor beam for drawing in the brightest lights from across the world into California.

The real innovation of BGC will be to create a new hierarchical network structure to transnational academic collaboration. This pushes it one step beyond the admirable work that Singapore has done in making multiple bilateral arrangements with foreign universities in order to turn the city-state into an "Educational Hub". In other words, where Singapore has been building a brilliant hub-and-spoke model, what we hope to do is to create a true *network* — a "Star Alliance" for international higher education. To put it somewhat technically: whereas the topology of higher education has always been scale-free, our aim is to formalize the clustering among the world's top educational brands by creating an altogether new global structure.

CONCLUSION: THE GLOBAL PUBLIC AND THE PUBLIC UNIVERSITY

As we embark on this new venture, we will also provide new opportunities for our extraordinarily diverse student body to become not just citizens of California — the original charter of the land grant university — but of the world. We take this challenge quite literally, as we have decided to place at the core of the global campus a College of Advanced Study that will take on issues related to global governance, global ethics, global citizenship and global relationships more broadly. The goal here is two-fold: the first, that universities represent the most successful experiments in global institution building; the second, that if universities work together to build global curricula and global platforms, for research and teaching, they might provide models and ideas that will predicate new ways of engaging — and reimagining — globalization itself.

This mutualist vision of the globalized university is rooted in a fundamental assessment of the inexorable direction of the global future, which is increasingly knitted together not just around a single global research enterprise, but also of the changing social and economic role of a preeminent research university like UC Berkeley in the 21st century. In contrast to the "high modernist" vision of the state university as a machine whose output would be knowledge workers contributing to the state economy — the apotheosis of which was the California Master Plan for Higher Education that Clark Kerr developed during the 1960s — *BGC represents the first-class research university as a focal point for enabling the state and its citizens to engage the world*, connecting Berkeley scholars and local industry with researchers and innovators worldwide, and drawing human and financial capital from across the globe into the state. Rather than the cloistered space envisioned by the traditional inward-looking campuses, BGC will be a site for the flow of ideas, information, money, technology and people — moving not only between Berkeley and foreign universities, but also between the private and public sectors, with increasing velocity as they pass through.

By acknowledging the irreversible force of global trends, the extent to which no local challenge is disconnected from global issues, and the powerful role that our universities — both within the United States and across the world — can play, we seek to establish a new kind of global presence that is fully in concert with our public mission. Berkeley is seeking to enable the renewal of its core ethical and political commitment to remaining an elite institution that enables the best and brightest Californians from all backgrounds to gain access to the highest echelons of research and opportunity. In sum, BGC offers what we hope to be a fundamental reimagining of the role of the state university in the age of globalization, and the role of the public university in an age of privatization.

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CHAPTER 9

University Research comes in many Shapes

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In "The Usefulness of Useless Knowledge", written in 1937, (Flexner, 1955) Abraham Flexner described a conversation with George Eastman: *"I ventured to ask him whom he regarded as the most useful worker in science in the world. He replied instantaneously, 'Marconi'. I surprised him by saying: 'Whatever pleasure we derive from the radio or however wireless and the radio may have added to human life, Marconi's share was practically negligible."*

I shall not forget his astonishment on this occasion. He asked me to explain. I replied to him: *"Mr. Eastman, Marconi was inevitable. The real credit for everything that has been done in the field of wireless belongs, as far as such fundamental credit can be definitely assigned to anyone, to Professor Clerk Maxwell, who in 1865 carried out certain abstruse and remote calculations in the field of magnetism and electricity. Maxwell reproduced his abstract equations in a treatise published in 1873. Other discoveries supplemented Maxwell's theoretical work during the next 15 years. Finally, in 1887 and 1888, the scientific problem still remaining — the detection and demonstration of the electromagnetic waves which are the carriers of wireless signals — was solved by Heinrich Hertz, a worker in Helmholtz's laboratory in Berlin. Neither Maxwell nor Hertz had any concern about the utility of their work; no such thought ever entered their minds. They had no practical objective. The inventor in the legal sense was of course Marconi, but what did Marconi invent? Merely the last technical detail, the now obsolete receiving device called a coherer, almost universally discarded.' Hertz and Maxwell invented nothing, but it was their apparently useless theoretical work which was seized upon by a clever technician and which has created new means of communication, utility and amusement by which men, whose merits are relatively slight, have obtained fame and earned millions. Who were the fundamentally useful men? Not Marconi, but Clerk*

Maxwell and Heinrich Hertz. Hertz and Maxwell were geniuses without thought of use. Marconi was a clever inventor with no thought but use."

How knowledge created by science converts into material benefit for society became an explicit and pressing question as the 20th century ended. It is not that before then an expectation that science would create wealth, well-being and power, did not exist. It did, and the perfect testimony to that was Vannevar Bush's "Science: The Endless Frontier" report (Bush, 1945). Somehow, both the public and their representatives, accepted the idea that there is a connection between science and development, and were most of the time happy to see science advance, counting that this would bring benefits to society in the future.

The Bush report is a good starting point to discuss and understand the ways in which research can be classified. He presents a definition for both Basic and Applied research:

Basic and Applied research — **Basic research** is performed without thought of practical ends. It results in general knowledge and an understanding of nature and its laws. This general knowledge provides the means of answering a large number of important practical problems, though it may not give a complete specific answer to any one of them. The function of **applied research** is to provide such complete answers.

Presently NSF (National Science Foundation) has a slightly updated definition, that in addition defines Basic and Applied research independently of each other (NSF, n.d.):

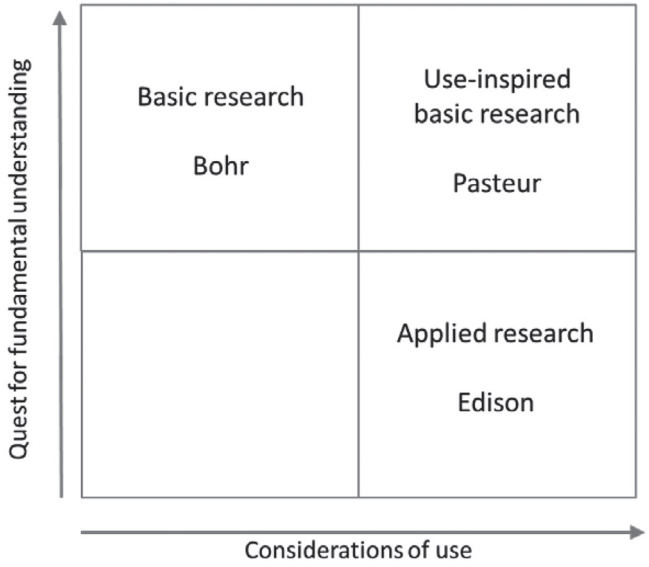
Basic research — systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind.

Applied research — systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.

Universities, governments and funding agencies around the world have been using Bush's definition or the updated NSF definition to classify research activities, and this classification has helped the development of knowledge for many decades. However, its use presents some challenges. One immediate difficulty is the fact that the definition depends on guessing what is in scientists' minds when they decide about the topic they will study. In addition, there are situations in which obtaining *fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts* might be enough *to determine the means by which a recognized and specific need may be met*, which would make the research in question both Basic and Applied.

Fifty-two years later, Donald Stokes (Stokes, 1997) came to help, bringing a different view. He classified research in a two-dimensional diagram, considering in one axis the relevance of the research to the advancement of

Figure 2: Stokes' quadrants for classifying research (Stokes, 1997).



fundamental understanding, and in the other the considerations related to the use of the research results. To help the reader, Stokes classified the quadrants in the resulting diagram, as shown in Figure 1 (being a kind person, he did not name any scientist for the quadrant where there is no fundamental knowledge and the results are not of any use).

To my knowledge, Stokes' was the first formulation that lifted the opposition by definition that existed between Basic and Applied research. Moreover, it came in an interesting epoch, when many knowledge-related organizations in the world were feeling the pressure to produce more useful results, or results with higher and immediate impact.

THE ORGANIZATION OF NATIONAL RESEARCH SYSTEMS

Starting after World War II, many countries took action to build systems to support science, research and higher education. The basic idea was that by enhancing its science base, a nation would create ideas and train people, and these two actions would be determinant in creating development. In many places, the recipe worked for some time, until the economic difficulties at the end of the 1970s started to take a toll on government spending.

Searching for a more effective connection between science and societal needs

Most people would agree that knowledge drives development. Still, the fine mechanics of how knowledge leads to development is a subject of intense debate, more so in recent years, especially after the advent of the IT revolution brought by the invention of the transistor, integrated electronics, the personal computer and, later, the internet and the World Wide Web. Some time around the second half of the 1970s, the life sciences joined the engineering and physical sciences branch of the knowledge revolution. In both branches, the subsequent boom of start-up companies, some of which grew at a fast (or extremely fast, in some cases) pace, made clear to taxpayers and their representatives that there was an opportunity ripe to be exploited: how to create wealth from knowledge at a much faster pace than had been done before.

Governments and society in most countries started an intense debate about the "knowledge-revolution", or the "knowledge-based-economy", searching, in a much more explicit way than had been done before, how to optimize the connections between universities, government and the economy, for the public benefit.

The Bayh-Dole Act of 1980 was especially relevant as it raised the bar for the standards of intensity in university-industry interactions. It had an effect in many countries, as they emulated the U.S. initiatives trying to obtain more impact from university research. In Brazil, an "Innovation Law" was enacted in 2004. On the institutional level, researchers, mostly European, came up with the concept of "National Innovation Systems" (OECD, 1997). A large effort in the measurement, modelling of, and understanding of the institutional interactions ensued, as can be seen in the ever-growing series of OECD reports on Science, Technology and the Economy.

The rising cost of research, increasing the demand on governmental funding agencies and on the taxpayer, also contributed to favour the move towards applications and short-term impact. It must be remembered that members of governments, national congresses or state senates go through the budget tables with the cost of public universities and funding agencies several times each year. However, they seldom find time to pay attention to the news (when it exists) about the benefits of these organizations, which reach the decision-makers in a scattered and non-systematic way throughout the year. On top of this, universities and funding agencies are often not completely effective in transmitting to the public, and to their representatives, the information about its successes.

As a result, the national and regional policies were readjusted, changed or reinvented, to obtain more impact, which usually implied redirecting research to more applied objectives, or altogether to the creation of "innovation".

Themes like university-industry interactions, small-business research support, measuring the impact of research results, and intellectual property protection/licensing, became more and more common in the agenda of funding agencies, universities and research institutions. Among the consequences, there was an intensification of the debate on how research should be organized to bring maximum societal impact.

ORGANIZATION OF RESEARCH IN THE BEGINNING OF THE 21ST CENTURY

Looking for higher impact of the research, funding agencies and universities came up with new ways to classify the research objectives or the way research should be performed. Impact is a broad concept, and it might be useful to think of it along three dimensions: intellectual impact, economic impact and societal impact.

Transformative research

Intellectual impact relates to the way research results will contribute to the advancement of knowledge. The category of Transformative Research, as defined by the National Science Foundation, addresses this dimension (NSF, 2007):

Transformative *— Transformative research involves ideas, discoveries or tools that radically change our understanding of an important existing scientific or engineering concept or educational practice or leads to the creation of a new paradigm or field of science, engineering or education. Such research challenges current understanding or provides pathways to new frontiers.*

Other organizations use different names for activities similar to this category, such as Frontier Research, High-impact and High-reward. Fostering transformative research does not imply abandoning incremental research. The NSF report makes a point on this by starting with:

Science progresses in two fundamental and equally valuable ways. The vast majority of scientific understanding advances incrementally, with new projects building upon the results of previous studies or testing long-standing hypotheses and theories. This progress is evolutionary — it extends or shifts prevailing paradigms over time. The vast majority of research conducted in scientific laboratories around the world fuels this form of innovative scientific progress. Less frequently, scientific understanding advances dramatically, through the application of radically different approaches or interpretations that result in the creation of new paradigms or new scientific fields. This progress is revolutionary, for it transforms science by overthrowing entrenched paradigms and generating new ones. The research that comprises this latter form of scientific progress, here termed transformative research, is the focus of this report.

The challenge here is that transformative research opportunities appear less frequently and, depending on the methods and processes used for the selection of proposals, transformative proposals might find a harder time in a selection process. Transformative research might also be adversely affected by the incentives used for rewarding researchers, as professors involved in transformative projects, that might take longer to show results, might be bypassed in career progression processes.

In Brazil, the São Paulo Research Foundation (FAPESP) has been working to foster high intellectual impact research. This has been done by emphasizing programs for funding long-term projects (5 to 11 years) by fostering international collaborations and long-term industrial cooperation, and by requiring universities to offer institutional support to the Principal Investigators (PIs) and their projects. In Brazil, unlike what happens in most countries, funding agencies contract the projects directly with the PIs. The reasons for this relate to two facts. First, historically, back in the 1960s it was in the interest of the development of a merit-based science system to award funds directly to the investigators to single them out within their institutions bypassing the non-meritocratic power-structure in the universities, thus making sure the funds would get to the right persons. Secondly, due to arcane legislation regulating the use of public funds, contracting with the PIs removes some hurdles. As the values of the contracts increased, the time burden on the PIs also increased. Thus, having institutional support through a Grants Management Office became essential to allow PIs to direct their time to science and training of students.

Translational research

Another category that appeared in the last 20 years is Translational Research, mostly used in the Health Sciences. This one belongs mostly to the economic, and the societal, impact dimensions I outlined above. The definition given by the NIH National Center for Advancing Translational Science specifies Translation and Translational Science as (NIH National Center for Advancing Translational Science, 2015):

1. **Translation** — The process of turning observations in the laboratory, clinic and community into interventions that improve the health of individuals and the public — from diagnostics and therapeutics to medical procedures and behavioural changes.
2. **Translational Science** — The field of investigation focused on understanding the scientific and operational principles underlying each step of the translational process.

In the U.K., the Medical Research Council (MRC) uses a slightly different definition (MRC, 2015):

- **Translation** is the principle of turning fundamental discoveries into improvements in human health and economic benefit. MRC's translational aims — to drive innovation, speed up the transfer of the best ideas into new interventions, and improve the return on investment in fundamental research — and objectives are outlined in the MRC Strategic plan.

In both cases, it is clear that the focus is on applications of science to improve human health. It is striking that both definitions are unidirectional, from fundamental (or laboratory, clinic) discoveries to the patients or the public — from bench-to-bedside is a common buzzword. The possibility of motivating basic research from the needs of the patient/public — or doubling back from the bed-to-the-bench, does not appear emphasized, even though it has been raised by prominent scientists (Ledfort, 2008). That might have happened because the origin of the translational idea seems to have been affected by the consideration that NIH had been lending too much support to Basic Research (Butler, 2008). It should be noted that, regardless of the formal definitions, several research centres around the world are using the concept of "bench-to-bedside-and-back" to redefine the way they connect, bi-directionally, basic research to applications in the health sciences.

Research applied to societal needs

A generalization of the concepts behind Translational Research brings us to "Research applied to societal needs", which would describe the bi-directional connection between Basic research and societal needs. This is an encompassing category that can include any field of knowledge, from Anthropology to Zoology. It includes, of course, Environmental Science and there are several international efforts geared towards connecting the community in the social sciences to the physical and life sciences communities in topics related to global climate change (or global change, in the broader version). Sustainability is also a topic with growing relevance.

Curiosity-driven research

This is a favourite of academic researchers. More important, there is a breadth of works demonstrating how curiosity-driven research brought essential contributions to the stock of knowledge, leading to several instances of innovation and creation of benefits for society. Lasers, semiconductors, atomic physics and nuclear energy, modern biotechnology, are some of the examples that come to mind (Braben, 2004).

Many times, curiosity-driven research is a favourite target of politicians and the public, when they want to criticize universities for being disconnected from the public interest. In many ways, curiosity-driven research is a twin of academic freedom, so important for the advancement of knowledge. Interestingly enough, curiosity-driven is not a quality that implies the uselessness of the research. It assumes only that the investigator chooses the theme or topic. Investigators choose themes and topics today taking into account the chances they have for obtaining the necessary funding to perform the research. At the same time, researchers many times want to create ideas relevant for society that will be recognized as such.

I do not believe anyone would defend the idea that there should be absolutely no support for curiosity-driven research[1]. The trouble comes when deciding about supporting research with taxpayer money, as the decision translates into defining how much societal needs should define research topics and how much should be left for the researchers to choose, according to their qualification and curiosity.

In the heated debate, most times the first line of defence for curiosity-driven research is to argue that discoveries will lead to economic development (or to curing diseases, or making the poor richer) in due time. Flexner used this argument in his exchange with Eastman. It might work sometimes, but this argument leaves out a large and relevant set of knowledge that might never be translated into wealth. Think of what is learned from studying philosophy, the humanities, astrophysics or particle physics. It seems difficult to make an argument that we need (or want) to learn the age of the universe because this knowledge will bring economic development. Some things must be learned just to make humankind wiser, and university research is (also) about this. Some might argue that it should be mostly about this.

HOW THE RESEARCH IS DONE

University-industry collaborative research

The collaboration in research between universities and industry has been recognized for some time as desirable for both organizations and potentially beneficial for the economy. Industry can use university research to mitigate scientific risks, to have access to highly qualified researchers and sophisticated research facilities, and to have privileged access to students and post-doctoral

1. There might be exceptions to this. For example, the then Governor of California, Ronald Reagan, famously said in 1967, "There are certain intellectual luxuries that perhaps we could do without"… [Taxpayers] "should not be subsidizing intellectual curiosity." (Bennet, 2015)

fellows that can be hired in the future. Universities look for joint research with industry as it brings research funds and creates a visible contribution to the economy. University researchers often value the scientific challenges they can find in problems brought by industry.

In the North the intensity of interaction can be measured in terms of the relative participation of industry funds in the support of research. In the U.S. this percentage has been between 5% and 7% in recent years. Among OECD countries, the participation of the business sector funds in the total university research expenditure (OECD, n.d.) ranges between 2% and 10%, with Germany being an outlier at 14%.

In the South there is not much information, but recent data for the state of State of São Paulo, Brazil, shows a percentage around 5%. A relevant difficulty in the South is that industry does not have a strong tradition of having internal R&D. In Brazil, for example, for some time, there was an illusion that universities would be the R&D labs that industry did not have. After a few successes and many more failures, the three sides learned that there is R&D that must be performed in industrial R&D labs, there is research that fits well for university labs, and there might be some smaller part that might be performed by both. Recent legislation in Brazil, passed in 2004, created many incentives for joint university-industry research, and facilitated the licensing of IP created with taxpayers' money to the private sector.

University research and start-up companies

Start-up companies are another way in which university research can be translated to economic and social benefits. A few universities in the world are well known for their successes in this endeavour, and many more work hard to facilitate their occurrence, stimulated by the successful examples. In South America start-up creation is more and more frequently mentioned as an important goal, but few universities can display large numbers, either in the quantity of companies, or in the size of the larger ones. An especially successful university in the region is the University of Campinas (Unicamp), one of the three state universities in the State of São Paulo. Unicamp displays a list of 254 start-ups initiated by its students or professors in the last 25 years that sustain more than 16,000 jobs. Some of these became international companies in software, photonics and optical communications. Around the Aeronautics Technology Institute, in São José dos Campos, again in the state of São Paulo, a sizable cluster of airspace and defence companies has developed since the 1960s, the main one being Embraer, which is the third largest aircraft manufacturer in the world today.

SOCIETY EXPECTS MORE ECONOMIC AND SOCIETAL IMPACT FROM UNIVERSITY RESEARCH

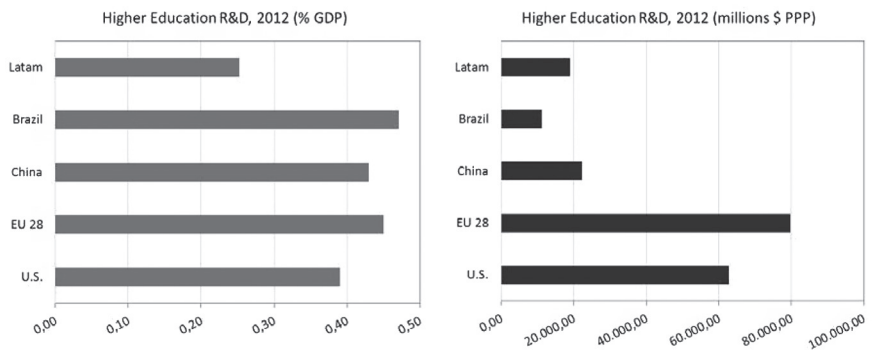
The message is clear: society continues to expect intellectual impact from university research, but now society has added to the charge more economic and societal impact. On top of this, it is also fundamental to consider that the value of scientific research includes not only economic and social impact, but also intellectual or cultural (knowledge that makes humankind wiser).

Research in higher education represents an important part of the R&D expenditures in the world (Figure 2) at a value above $PPP 200 billion in 2012.

Universities have been listening to the message and acting accordingly. A major challenge is how to listen and use society's expectations for more and faster impact while avoiding the trap of short-termism for research objectives. Relevant portions of society forget that the technology achievements of today occur because there was a lot of patient and continuous effort towards discovery in the past. This is a point well analysed in Mariana Mazzucato's *The Entrepreneurial State* (Mazzucato, 2013) in a parallel situation: the role of the state in creating or subsidizing the creation of knowledge that involves high enough risk.

In the Northern Hemisphere, it is easy to notice that universities are directing their research strategies towards Pasteur's Quadrant (Figure 1). An important part of the challenge seems to be how to figure out a way to give larger weight to use considerations, while still fostering the curiosity-driven concept or the value of fundamental research. An illustration of this behaviour is the growth in the quantity of new problem-oriented research centres created in universities in the last 10 years, as compared to the previous period.

Figure 3: Dimension of higher education research expenditures in selected regions/countries, as a percentage of regional GDP and in $PPP (values for Latam region estimated by author).



In the South there are some differences worth mentioning. Universities and their communities often lack conviction about their commitment to advancing knowledge and educating students. On the other hand, governments (and society) are quick, especially in times of scarce resources, to reach the conclusion that excellence is a luxury we perhaps can do without, to paraphrase Ronald Reagan. That applies to excellence in education and in research. In Brazil there is an interesting cyclical evolution around the year: when the international university rankings appear, society criticizes universities for not being excellent enough as Brazil appears with few names among the best 200. Then comes the season when the university entrance exams happen, when society criticizes the universities for being too demanding on excellence, requiring high qualifications to approve candidates and leading to the exclusion of those who have not had access to good middle education. Then someone in the media or government will criticize the high expenditure per student in the public universities (which are the ones that have research activities in Brazil). Then, after a few weeks, the same government (but another department) will criticize universities for not graduating enough engineers and other STEM that are necessary to maintain the competitiveness of the aircraft industry, or agriculture production, or energy generation. In doing that, they forget that, to a large extent, the cost of educating internationally competitive professionals is not set by how much money one wants to spend but by an international standard of excellence and quality.

CONCLUSION — THE SEARCH FOR MORE IMPACT AFFECTS AND IS AFFECTED BY FUNDING AGENCIES TOO

Finally, universities can and have been taking action to connect investigator-initiated research to impactful applications and applied research, while striving to maintain their fundamental contribution to increasing the stock of fundamental knowledge. It must be added that the success of the initiatives depends also on having access to research funds provided externally. Achieving all these goals might be impossible if government agencies direct most of their funds to short-term applied research. It must be remembered that the same kind of pressure that afflicts universities in this matter affects government research funders. For this reason, it is essential that research-funding agencies strive to maintain a balanced portfolio of programs that supports (GRC, 2015):

- Basic research and applied research
- Curiosity-driven and mission (or use)-oriented research
- Research executed by individual investigators and centres of excellence
- Non-thematic and priority areas.

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