The public research university as a complex adaptive system

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Introduction

> "I have been a businessman for over 35 years, and I was a trustee of the University of Massachusetts and chairman of the Massachusetts Board of Higher Education for a total of 12 years. I am, or have been, a director of eight public corporations, and was chief executive officer of a transit system with an annual budget of $1 billion. I have also founded four businesses, in separate fields, that were recognized by *Inc.* magazine for their rapid growth and success. I think I've learned something about management and controlling costs. Never have I observed anything as unfocused or mismanaged as higher education."

This is James Carlin's idea of the university, as expressed in a *Chronicle of Higher Education* article titled "Restoring Sanity to an Academic World Gone Mad" (1999). Carlin is a millionaire businessman and former trustee of the University of Massachusetts and chairman of the Massachusetts Board of Higher Education; in his person come combined the business expert and the political overseer of a public research university.

So much for the view from business. Remarkably, we find a very similar take on the university in the complex systems literature, as expressed by Michael Cohen, James G. March, and Johan Olsen in an *Administrative Science Quarterly* article titled "A Garbage Can Model of Organizational Choice" (1972). They conceptualize the university as

> "a collection of choices looking for problems, issues and feelings looking for decision situations in which they might be aired, solutions looking for issues to which they might be the answer, and decision makers looking for work."

The university-as-garbage-can collects problems, solutions, participants, and choice opportunities and mixes them together, with the result that problems become more or less randomly attached to solutions. Thus, in the organized anarchy that is the university absurd individual behavior flows from absurd collective decision-making processes.

There is no shortage of social scientists seeking to tame the wild university. They can be found in business economics and in some part of public administration that goes by the name of New Public Management.[1] In their minds, organizations and institutions are deliberately designed by humans and controlled top-down by managers to fulfill some purpose efficiently. The university is simply a business to which standard business concepts can and should be applied—concepts such as incentives, managerialism, outsourcing, accountability, quantitative performance standards, profitability, and market competition. Also popular is the idea of unbundling the university—of disaggregating it into its profitable and unprofitable parts and closing down the latter.

I argue, to the contrary, that the research university is a complex adaptive sytem. There are two pieces to my argument.

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[1] See, for example, Collis (1999) and Kettl (2000).

First, the university is "of human action, and not of human design."[2] It is characterized by evolution, self-organization, and emergence. A historical analysis is necessary to understand its design.

Second, the university has a unity, or "wholeness," to it. It cannot be split up or merged at will. A holistic analysis—as opposed to a reductionist analysis—is required to understand its design.

The remainder of this paper is devoted to spelling out these two properties of the university.

Evolution, self-organization, and emergence

The university is "of human action, and not of human design." It is characterized by evolution, self-organization, and emergence. Let me illustrate this property of the university with reference to the university's history.[3]

The medieval university. The university is child of Western Europe and the Middle Ages. Two archetypes emerged in 12th and 13th century France and Italy. Paris offered a free space for the theological debates that prepared the way for the Reformation. Bologna trained students in the legal statutes and reasoning that would come to support increasingly complex political and economic institutions all over Europe.

In both cases, a complex institution cristallized, the result of a decentralized process of annealing. Paris and Bologna were both shaped by the conflict with their environment, and in similar ways, but they ended up at opposite ends of the governance spectrum, Paris controlled by its faculty, Bologna by its students.

Paris attracted students from all over Europe. They came to hear the charismatic Peter Abelard apply the scholastic method to questions of speculative theology, such as whether the bread and wine consumed during mass truly turn into the body and blood of Christ, or only in spirit. In an age permeated by religion, in which any position outside of the pale defined by the Church was considered heresy and heretics were burned at the stake, the *sic et non* (pro and con) exploration of a theological issue was nothing short of daring, and Abelard's students picked up on the fact that he was onto something big.

The University of Paris thus started out as an amorphous group of faculty and students collecting in and around the Cathedral School of Notre Dame, with few norms and no internal organizational structure in place. Over the years, the faculty fought with the Church over rights and entitlements, including in particular the right to appoint new faculty. The pope and the emperor were drawn into these fights, and the faculty played them off against each other.

Migration, boycott, and violence pushed forward the cause of the faculty. It helped that the medieval university had no physical plant—the faculty could threaten to leave for another city and take the university (themselves and their students) with them. On occasion, this threat was realized,

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[2] Friedrich Hayek, in *The Fatal Conceit* (1989), draws on Adam Ferguson's "Essay on the History of Civil Science" (1966 [1767]): "Every step and every movement of the multitude, even in what are termed enlightened ages, are made with equal blindness to the future; and nations stumble upon establishments, which are indeed the result of human action, but not the execution of any human design" (p. 122).

[3] My short history of the university draws on Lohmann (2003, 2006).

in which case it led to new university foundings in surrounding cities: mass migration was the mechanism by which the idea of the university, and its emerging structures, spread.

As each bitter conflict was resolved, some protective piece of structure fell into place—one right was awarded here, another entitlement there. Pieces of structure were negotiated to prevent future conflict, or to encourage non-violent conflict resolution, or for damage-control purposes. In this way, over the course of a century, an extraordinarly complex institution emerged brick by protective brick. In a decentralized process planned by nobody, structures evolved that protected the inhabitants of the university from the outside world. Thus, in the midst of the Middles Ages, an era not known for its intellectual tolerance, the university carved out a safe space for scholarly inquiry.

Because it was the faculty who led the fight against the Church, Paris ended up with a governance structure dominated by the faculty: it was the faculty who voted on the issues of the day, staffed the administration, set the curriculum, and appointed new faculty.

As the university became increasingly differentiated into schools and departments, and factions within schools and departments, and factions within factions, it became internally conflicted. The members of a faction tend to reserve the most intense feelings of hatred for their intellectual neighbors rather than for the inhabitants of far-away worlds. This makes it very hard for faculty in the same, or closely related, fields to agree on appointments and curriculum design.

Protective structures followed faculty infighting: strong walls sprang up to separate the departments and schools, and federalist structures emerged. The voting procedures that aggregated the preferences within and across departments and schools became ever more complex. The university thus developed an intricate internal organization to protect the faculty from each other.

Meanwhile, students flocked from over the mountains (the northern and western parts of Western Europe) to study law in Bologna, and it was they who led the fight that created a great university. Foreign students did not have the same rights and entitlements as the citizens of Bologna. They were vulnerable to exploitation by the local townspeople, especially landlords and tradesmen, with no legal recourse. If a drunken student got into a fight and killed a local, he would be judged by a jury consisting of local citizens, and the outcome would not be favorable—hence the students' demand to be judged by their student peers.

The foreign students banded together for reasons of protection. They formed nations, that is, groupings of students with shared geographic origins. Collectively, they fought the Commune of Bologna for rights and entitlements. Here, too, the weapons of choice were migration, boycott, and violence. Once again, in the course of a century a complex institution emerged, loaded with rights and entitlements protecting its inhabitants from the outside world—but now, because it was the students who carried the water, the university ended up with a governance structure dominated by students: it was the students who voted on the issues of the day, staffed the administration, set the curriculum, and appointed the faculty.

The institutional structures that emerged in Paris and Bologna include bottom-up governance, representative assemblies, decentralized federalist structures, complex voting procedures, and institutionalized forms of conflict resolution (the latter snuffed out the violence that used to be an inevitable by-product of conflict).

The idea of the university emerged, manifesting itself in the norms of *ubique docendi* (the right to teach at any institution after graduating from one of the them), open access, open information, and free inquiry. These norms—powerful as they are—ultimately derive their power from the

institutional structures of the university: a norm of free inquiry is not worth much without a structure in place that protects the inquirer from being imprisoned, killed, or (worst of all) excommunicated.

The Middle Ages saw the emergence of complex voting procedures in the Italian city state and of bottom-up governance processes in the medieval guild; but the politics of the city states remained violence-prone, and the guilds did not exactly embrace ideas of open access and open information. The university was unique in the astonishing combination of structures and norms it developed allowing its inhabitants to engage in peaceful intellectual inquiry and protecting them from the outside world and from each other.

And the medieval university did good by its people. In the early Middle Ages, Western Europe was a primitive backwater; a couple of centuries later, we meet upon a sophisticated society with a rich political, economic, and cultural life. It was university-based scholarship in speculative theology and civil law that supported the development of complex institutions.

In its early fighting years, the medieval university was as intellectually vibrant as its structures were pliable. Once its structures, and the associated protections, got locked in, the university ossified intellectually. The scholastic method, wild and wonderful in its early years, matured and joined the establishment, finding its apotheosis in Thomas Aquinas' *Summa Theologica* (the title itself has an end-of-history quality, quite unlike Abelard's title *Sic et Non*, which has an open-ended air about it). The scholastic method degenerated into an ever more refined system of logic-chopping exercises applied in a mindless and mechanical way to questions of great irrelevance, as in, how many angels are there on a pinhead. As the society surrounding the university became more interested in history and language, and more empirically oriented, the scholastic method was doomed.

The medieval university missed the boat come the Renaissance. In Italy, many universities continued to apply the scholastic method for one hundreds years after the society around them had reinvented itself in full. The intellectual underpinnings of the Renaissance were developed in private academies outside of the university. Humanist ideas got picked up by newly founded universities, including universities in Northern Europe far away from the geographic center of Renaissance action.

Around 1500, following the invention of movable type and the printing press, communications across Europe improved. In the mind of management guru Peter Drucker, history offers a lesson for today's electronic communications revolution. "Universities won't survive," he tells us, "it's as large a change as when we first got the printed book."[4] In fact, teaching methods remained largely untouched by the printing revolution; the printed book replaced the hand-copied manuscript, but the classroom experience stayed essentially the same, and the classroom itself turned out to have staying power.

It was not the printing revolution per se, but the Reformation it enabled that turned the universities in Europe upside down. The coming of the printed book, which in its early years was the printed bible, was followed by a century's worth of bitter religious wars pitting Catholics, Lutherans, and Calvinists against each other. The university flourished in the immediate aftermath of the printing revolution, as religious factionalism drove a spate of university foundings.

[4] Lenzner and Johnson (1997), p. 127.

The 17th century saw a war-induced dropoff in the rate of university expansion. The university in Europe sunk into a moribund stupor, the pawn of local princes and religious factions. Remarkably, the 18th century—the age of the Enlightenment and the Scientific Revolution—represents the university's all-time nadir: more universities were shut down than opened their doors. The influence of the university was negligible in the one century, the 18th, in which we might have expected it to shine.

By 1800, the university structures that had served the Middle Ages so well were considered obsolete. Napoleon Bonaparte, as an integral part of his education and civil service reforms, disaggregated the university into specialized research and teaching institutions. His reforms mark the French university system to this day.

The German research university. In Prussia, the 1806 defeat of its army at the hands of Bonaparte served as a trigger for broad administrative reforms. Charged with reforming the university system, Wilhelm von Humboldt rejected the Napoleonic model, choosing instead to breathe new life into the medieval model. The German research university stood for deep specialization in research and disinterested pursuit of truth for its own sake and for the bundling of research and teaching, the latter including liberal arts education and doctoral training.

The German model won out over the French model. The German states started out the long 19th century economically backward and an intellectual backwater. Newly unified, Germany rose to become the powerhouse of Europe. University-based research in the newly emerging basic and applied sciences, ranging from chemistry to forestry science, served as the motor of industrialization. Fueled by the humanistic character- and citizen-building mandate of the university, philosophy and history emerged as the lead disciplines in the project of nation-building.

Therein lay the seeds of the German university's demise. It was the philosophers who served as the obstacle to an all-inclusive university definition by virtue of their dominant position in the philosophical faculty (which at the time included the humanities and the social, life, and physical sciences; today we speak of the College of Letters and Science, or Arts and Sciences, and the philosophers and natural scientists are housed in separate divisions). The philosophers despised Big Science and applied science, that is, basic research in the natural sciences along with applications in medicine and the military.

The inability of the German university to adapt its form and norms to the needs of Big Science served to the endless exasperation of the *Grossindustrie*, that is, Big Business consisting of the chemical-pharmaceutical and military-industrial complexes. Industrialists lobbied for Big Science to be outsourced to a private nonprofit society, and in 1911 their efforts were rewarded with the establishment of the Kaiser-Wilhelm-Gesellschaft—just in time for Big Science to be harnessed to the war effort.

In 1945, the Kaiser-Wilhelm-Gesellschaft shed its war-criminal past by reinventing itself as the Max-Planck-Gesellschaft. Today, the Max Planck Institutes, 95% publicly funded, conduct basic research in the natural sciences, life sciences, social sciences, and humanities, and all of it outside of the German university system; its researchers hold no responsibilities for teaching undergraduate or professional school students, only for doctoral training. Meanwhile, mass higher education is delegated to state universities which struggle to fulfill their research function underfunded as they are, and loaded with time-consuming shared governance and university bureaucracy.

The American land-grant university. And so the university baton passed on to the new country. The states of America, newly reunited after a bitter civil war, were experiencing an industrial revolution

of their own. This was time when human brawn was ceded power to man-made machines; the American economy shifted from agriculture to industry; and the American people moved from the countryside into the cities. There was a demand for more higher education, and for a different higher education.

The American land-grant college met a large part of this demand. It stuck with the medieval idea of keeping all the various concerns under one full-service roof. The land grants enriched the original model with service to the local community, which includes applied and locally relevant research along with professional and extension teaching; accountability to democratically elected politicians, which connects the university to the outside world; and professional university administration, which allows for complex organizational responses to a demanding political and economic environment.

The land grant colleges were huge institutions by the standards of their time as they sought to accommodate the emerging need for a mass, in place of an elite, system of higher education. In the 20th century, backed up by sheer size, they easily integrated Big Science, medical schools, and much else that caught their fancy.

Public universities, which include the land grant colleges, are far from the only game in town. In the 19th century, public universities co-existed with private teaching colleges, including women's colleges, and private universities styled along the lines of the German model. In the 20th century junior and community colleges joined the mix, and the end of the 20th century saw an influx of for-profit universities. The result is a system of higher education marked by distributed political control, institutional diversity, and market competition.

As public and private research universities competed with each other, there was a certain convergence in form and norms, though the two remain distinct different institutions in two respects, namely funding sources and governance structures.[5] The result of this convergence process is the public research university, which includes the land grants, but which also picked up, via the private research universities, features of the German university, which in turn has its roots in the medieval university.

Greatness and unity go together; excellence implies a centre[6]

The university has a unity, or "wholeness," to it. It cannot be split up or merged at will. Let me spell out why the university is necessarily a bundle of concerns.

The unbundling of the university. The research university is the ultimate generalist, bundling as it does a huge number and variety of research and teaching activities. Today, for-profit research firms are cream-skimming the profitable parts of the research enterprise. For-profit higher education firms are cherry-picking the profitable parts of the teaching enterprise. What follows for the viability of the university's business model, if you want to call it that, of joint production and cross-subsidization?

David Collis exemplifies the business school take on the higher education industry as he compares it with industries that suffered deregulation (telecommunications, energy), new technologies (pharmaceuticals, computers), and foreign competition (steel, autos). Industries fragment when

[5] Veysey (1965).
[6] Newman (1872), p. 16.

competition increases because entry barriers fall; because a substitute product improves its appeal; or because a more economical way is found to produce a similar product. Firms pull back, spin off many of their functions, and focus on their strengths. They become more specialized and less vertically integrated. Thus, in higher education specialized providers will challenge the traditional integrated provision; already are.[7]

The prescription is to disaggregate, and it is applied indiscriminately to the university. What is especially pernicuous about this prescription is that it contains an powerful kernel of truth even while the prescription as a whole runs counter to all the university stands for.

As a provider of higher education, the research university is a hideously expensive and wasteful institution. If the goal is to teach business and accounting to students who will reliably graduate and find employment, the job is better done, and at a lower price, by for-profit universities that do nothing else but. For-profit universities also offer a home to the low-income students who are chronically underrepresented in non-profit universities, public and private alike. At the opposite extreme, let us say the goal is to offer a traditional high-quality liberal arts education, price no object. In this case, the liberal arts teaching college is a superior vehicle.

Pick any purely educational enterprise, and it turns out that the research university is outperformed by specialized teaching institutions on price or quality, or both. Fundamentally, it is always going to be more expensive and less effective to use a research university as a delivery mechanism for teaching than an institution that is specialized on teaching. The reason is not simply that research university professors are paid well; enjoy light teaching loads; and are selected and rewarded to emphasize research over teaching, to the detriment of the teaching enterprise. The reason is that the research university requires forms of governance and administration that are inefficient and wasteful from a teaching perspective. Utilizing the form and norms of the research university to run a teaching enterprise has all the cost-effectiveness of burning a barn to roast a pig.

The justification for the research university lies in the research enterprise, obviously. The university is vulnerable, however, even on its own ground. It regularly loses out to specialized providers, which are more nimble and efficient in the category that matters to the outside world: applied research of obvious and immediate usefulness. A pharmaceutical company can run drug trials in an academic health center; or it can get better service, at lower cost, by hiring a for-profit firm that will test the drugs and shepherd them through the complex Food and Drug Administration approval process; or it can get bargain prices by going abroad. If the goal is to work out a needle exchange program for heroin addicts, a specialized non-profit is an excellent vehicle. And if we wish to Do Good for the state economy, building a great research university is not the most effective way to go about it—a non-profit institution with a more narrowly focused mandate will cost less and do more for the state. True, this institution won't be a member of the prestigious Association of American Universities, but who cares?

The research university is on the defensive. Can its unlikely norms and complex structures justify their expensive existence?

Can't business be more like the university? Even as the business world calls upon the university to become more like business, in an ironic twist of fate business is becoming more like the university.[8]

[7] Collis (2000).
[8] Lohmann (2004).

The organizational struggles of the multinational corporation in particular serve to remind us that we would be well-advised not to shed the university too quickly.

In the quest to juggle a global strategy with country-specific concerns, the multinational corporation has been experimenting with its organization form for over a century.[9] After cycling for the longest time between centralization and decentralization, it eventually settled on an intermediate matrix form. Thus, an employee who sells Proctor and Gamble detergent in Japan reports to two managers, one manager who is in charge of Japan and a second manager who is globally in charge of detergents.

Today, the matrix form is under attack for failing to cope with a market environment that has become furiously complex. Customers are asking for differentiated products and demanding the same low price they used to pay for standard products. Frequent changes in local tastes and government regulation require fast and flexible responses. Technological innovations in one market must instantly find application in other markets.

The solution is for the multinational corporation to transform itself into a knowledge-sensing organization.[10] The organization must draw on pockets of knowledge scattered across local markets, and it must move local knowledge from one part of the organization to another, local to local, or local to central to local.

Sensing knowledge is a high-risk high-payoff enterprise. Most of the time nothing will come out of it, and indeed nothing may come out of it for a very long time; but when something comes out of it, the payoff can make or break the firm. In this situation, short-term and high-powered incentives are counterproductive. Human resources management must be patient and tolerate failure—not an easy job for an American-style incentive system. Indeed, the imperative of incentivizing people is losing its luster. The Next Big Thing in human resources management is to select the right *types* of people and give them the free space to act out their types. A knowledge-sensing organization must hire, promote, and reward playful explorer types who respond positively to space and recognition rather than financial reward.

Multinationals must develop a culture that thinks local and acts global, and an organizational structure that backs up such a hybrid culture. Once local knowledge has been successfully sensed, it must be mobilized so it can translate into new products, services, or production processes. Moving knowledge is not easy when the knowledge in question is situated and thick, and thus hard to communicate. When knowledge is stuck in people's heads, the prescription is to move people rather than to move information disconnected from people. Multinationals thus need to mix-and-match people, which means co-locating people temporarily and then moving them on.

Recently, the international management literature has sighted a new corporate form, variously called transnational, metanational, geocentric, wired, holographic, heterarchical, horizontal, transcontinental, multidimensional, multi-center, integrated global, integrated players, integrated network, dynamic network, differentiated network, network-based, N-form, and individualized enterprise.[11] The new corporate form supports the proliferation of small, independent, and highly specialized units. It aggregates decisions from the bottom up, rather than allocating resources and devolving responsibilities from the top down. Middle management is key for it creates the

[9] Alarik (2000).
[10] Doz, Santos, and Williamson (2002).
[11] Pihl (2003), p. 1.

horizontal linkages that connect the independent locals to each other and to the global corporate purpose.[12]

The transnational company seeks to combine global scale economies with gains from global specialization and local market adaptation. The hard part is "to have your cake and eat it," or to square the circle. To this end, the new corporate form centralizes and decentralizes selectively and fluidly. The parent company stays in control of some activities to exploit scale economies; protect core competencies; and infuse international managers with a shared organizational purpose. Other activities are delegated to specific local subsidiaries to create centers of excellence or exploit local comparative advantage. Most activities are devolved to the various local subsidiaries to enable flexible and rapid responses; allow for the application of local knowledge; and insure the firm against exchange rates movements.

Leif Melin takes a rather more jaded view of the supposed new corporate form. A cross-national learning organization would be in constant danger of fragmenting, he warns us, and its organizational complexity would obstruct learning. At a minimum, such an organization would be extremely hard to manage, and top management would have to be extremely skillful and powerful to support local diversity and flexibility even as it builds shared vision and commitment.[13] Christian Berggren goes so far as to question whether such a cross-national learning organization, as it has been described in the international management literature, exists in reality: "The truly transnational corporation … is a slippery animal to catch."[14]

It turns out that such an organization exists; it is called the university. The ancient form of the university, like the new corporate form in international management, is complex because it is the solution to an impossibly hard problem. We can find a useful analogy in the mathematical problem of squaring a circle. One of the three geometric problems of antiquity, it was perhaps first attempted by Anaxagoras and proved to be impossible by Ferdinand von Lindemann in 1882. But then Jeremy Gray in 1989, using transcendental rather than rational numbers, demonstrated that while the circle cannot be squared in Euclidean space, it *can* in Gauss-Bolyai-Lobachevsky space.

And so it goes with the university. If a simple university will not solve the problem, then a complex university is called for, and we will have to go hunting for it in some strange-dimensional space that is home to transcendental organization forms. But first we need to define the problem.

What is the problem to which the university is the solution? The university is the institutional home of science. This is where the disembodied global scientific networks touch the ground and cosmopolitan scientists turn into members of academic departments; the place where faculty are hired, promoted, and rewarded; the place where faculty have "a room of their own"—an office, a library, a laboratory; the place where faculty train their doctoral students.[15] What can we say about the social organization of such a place?

The university fulfills two functions, governance and funding. It supports scientific networks by supplying the necessary governance structures, and it funds the scientific gift economy, which after all has no money of its own. To fulfill these two functions, the university necessarily takes the form of a bundle, or an aggregation of concerns. The university combines basic and applied research; it

[12] Bartlett and Ghoshal (1993).
[13] Melin (1992).
[14] Christian Berggren quoted in Melin (1992), p. 36.
[15] Virginia Woolf's 1929 novel is titled *A Room of One's Own*.

houses all the departments of knowledge in one place; it intermingles research with teaching and service; and it merges the governance of science with faculty governance, university administration, political oversight, and market competition.

On the curious nature of the university, at once open and closed. Let me touch on the governance function of the university first and examine its funding function second. There are three constituent ideas of the university, which I attribute to the philosopher Immanuel Kant, Cardinal John Henry Newman, and U.S. Senator Justin Smith Morrill, respectively.[16]

The first idea describes the university as an internal variety of basic and applied scholarship protected by walls within and without. The walls within prevent the inhabitants of the university from killing each other (only up to a point, obviously); the walls without prevent the outside world from disturbing the circles of scientists at work, or at play (ditto).

The second idea defines the university as a physical space that brings together all the departments of knowledge in one place, thereby creating intellectual ferment and inspired learning across the departments. Key is the face-to-face encounter, which builds trust and supports imitation, alongside the serendipitous encounter, which encourages the mixing and matching of ideas.

The third idea envisions a university "of the people, by the people, and for the people."[17] The university must attend to the concerns of local and global constituencies in the outside world; it is accountable to the people; and it must grant access to the sons and daughters of toil.

The first idea is about "protecting people from each other and from the outside world so they can develop their ideas in peace," the second, about "mixing and matching people's ideas," the third, about "spilling out people's ideas to the outside world." If the merger of these various ideas sounds like a contradiction, the answer is: it takes a complex organization to implement a contradiction.

A global public good and the free-rider problem. Let me turn to the funding function. The world-wide system of scientific networks produces knowledge which everyone can download and use for free. The world-wide system of universities is the mechanism by which this global public good is funded.

Public goods are generically hard to fund because of the free-rider problem. Why should California support a great research university if Illinois is willing? Why should business pay the bill if the U.S. taxpayer will fund the universities? If it is impossible, or undesirable, to exclude people from benefiting from a public good, and if people can reasonably expect that someone else will foot the bill, then people will have an incentive not to contribute to the public good and instead free-ride on other people's contributions.

The scientific gift economy comes with several features that make it an especially hard public goods "sell." People are not generally perfectly egoistical; they will contribute to local communities that are small enough so that their contribution will make a difference, and they will also contribute to communities they feel good about. The larger and the more diffuse is the group that benefits from a public good, the more severe is the free-rider problem. Global public goods are marked by the most severe free-rider problem of them all. True, if the survival of the human race is threatened

[16] Lohmann (2006), Kant 1979 [1798]), Newman (1872).
[17] These words are drawn from Abraham Lincoln's Gettysburg Address of November 19, 1863.

by enemies from outer space, as in the movie *Independence Day* (1996), people on Earth will readily band together; but this does not exactly happen every day.

Even if scientific networks taken as a whole are an asset, it is impossible to tell in advance whether any given research project will yield a benefit. People's willingness to contribute to a public good is dampened by uncertainty. Why would anybody pay to support research on zebrafish? Today we know that zebrafish offer an excellent animal model for the study of human diseases and heritable disorders.[18] But life scientists did not know that from the outset—they studied zebrafish out of curiosity, and because they study everything, and it just so happened that their zebrafish findings amounted to something useful.

Then again, some research projects are all too likely to yield benefits for some people and impose costs on other people. It is often the case that the benefits are spread diffusely, and the costs are concentrated. The beneficiaries will then be uninformed and inactive, and the opponents will be informed and active. For example, research on environmental health and safety standards is likely to benefit large numbers of blissfully ignorant voters even as business firms know all too well that environment health and saftey standards will cost them dearly, and so business firms will oppose research that cuts into their profits, and there will be nobody standing up for research on the other side.

Lastly, people will hardly contribute to a public good they do not understand. People have different ideas what a university is for, and close to nobody conceptualizes their local university as part of a world-wide system of universities that supports the world-wide system of scientific networks. Indeed, most voters believe that the purpose of their state universities is to educate their sons and daughters, and some voters believe that the purpose of state universities is to improve the competitiveness of local agriculture and business.

The free-rider problem is a problem for all systems of higher education, and especially for decentralized systems, such as the American system. In a centralized system, national policymakers may well act in the interests of the nation, if not necessarily in the interests of the world. In a decentralized system, the university's local stakeholders will hardly attend to the good of the nation, let alone the world. We should not conclude from these remarks, however, that centralization is a Good Thing. The historically great university models—the medieval university, the 19th century German research university, and the 20th century public research university in the United States—all emerged in federalist systems marked by political and economic competition. What does follow is that in decentralized systems of higher education, even more than in centralized systems, there is an urgent need for an institutional solution to the free rider problem.

The solution consists of a business model that combines joint production with cross-subsidization. The university attracts subsidies for those parts of the research and teaching enterprise that the outside world likes to support and cross-subsidizes those parts towards which the outside world is indifferent or hostile. To this end, the university supports a joint production of monstrous complexity. Multitudes of inputs connect in elaborate criss-crossing paths to multitudes of outputs. Some of the criss-crossing paths are determined by production concerns, others by funding concerns. Some number of inputs and outputs attract subsidies, and contributions are often made in kind or come with strings attached to them.

[18] Kanki (2004).

It should hardly surprise us that university budgets are a zoo. Management and cost-control systems from business will not work in the university. Robert Birnbaum, in *Management Fads in Higher Education* (2000), describes how waves of management and cost-control systems have swept through the university: Planning Programming Budgeting System, Management by Objectives, zero-base budgeting, strategic planning, benchmarking, Total Quality Management, and Business Process Reengineering. The typical life cycle of a management and cost-control system consists of a honeymoon period, in which the system seems to be working, followed by a divorce period, in which the imperfections of the system become glaringly apparent.

Management and cost-control systems from business are designed to fail in the university because they are too simplistic relative to the complexity of the university's joint production and cross-subsidization scheme. Interestingly, management and cost-control systems don't seem have much staying power in business firms either, if we are to believe John Micklethwait and Adrian Wooldridge's *The Witch Doctors: Making Sense of the Management Gurus* (1996). The problem, it seems, lies not with the university or with business firms, but with management science.

Management and cost-control systems from business will not work in the university for yet another reason. Cost intransparency and organizational slack are considered a Bad for business, but they are a Good for the university.

Universities don't really know what is going on inside their decentralized structures, and truth be told, they do not really want to know. Cost transparency would render unviable the university's cross-subsidization scheme. There is a some amount of deception involved when universities encourage people to fund some part of the university only to move the funds to some other part of the university. Opaque budgeting practices protect this solution to the public goods problem.

In the same vein, the university is an economy of waste. Universities keep things even after things have outlived their immediate and obvious usefulness. They keep things in part because they have weak processes to set priorities and get rid of things; and they have weak processes because strong processes would destroy the free spaces of the university. Universities keep things in other part because things might come in handy down the line. University-based natural history museums store stuffed animals and dried plants, and today it turns out that their collections are chockful of useful DNA.

The bundling of research and teaching. In the complex joint production and cross-subsidization scheme of the university, one cross-subsidy stands out. Let me turn to a discussion of how undergraduate teaching cross-subsidizes research.

Among research faculty, the happy myth persists that teaching needs research. In fact, research needs teaching more than teaching needs research precisely because undergraduate teaching cross-subsidizes research. Liberal arts colleges offer excellent undergraduate teaching even though—or rather, precisely because—they do not support deeply specialized research. In comparison, undergraduate teaching in the research university is notoriously compromised.

It turns out that the precise way in which undergraduate teaching cross-subsidizes research is extraordinarily convoluted, and so we need to work out the details step-by-step.

The federal government subsidizes research systematically and generously through the National Science Foundation, the National Institutes of Health, the Department of Defense, and other agencies. Private foundations and corporations chip in rather more erratically. And yet all of these

funding sources together do not reimburse universities in full for the actual cost of the research enterprise.

Unreimbursed research expenses include the start-up packages provided to scientists and engineers for their laboratories.

They include the university's waste economy, that is, all those dormant people and fields which the university keeps around just in case they might come in handy, and because it is too much trouble to get rid of them.

They include the doctoral programs that train the next generation of researchers. The university invests tens of thousands of dollars in a given doctoral student and then releases them to a position of employment with a competing educational institution, possibly even in another country, with no expectation of a return-on-investment to the institution. No wonder doctoral programs operate at a loss.

They include the governance and administration of the university and the governance of science. Faculty sit on all sorts of university committees; they write referee reports and tenure letters; they serve as editors of journals and officers of professional associations; they serve as department chairs and academic deans and university presidents. Faculty are expected to produce many of these services as an integral part of their job, and on company time. The university relieves some number of faculty from teaching altogether and awards them an unusually high salary so that they have the time and inclination to make a career for themselves in university administration.

Who pays? The answer is undergraduate education. At first blush, how this works is a mystery, for undergraduate education itself is subsidized. Gordon Winston, in "Subsidies, Hierarchy, and Peers: The Awkward Economics of Higher Education" (1999), spells out how at elite liberal arts colleges and research universities the production cost of an undergraduate education exceeds tuition by thousands or even tens of thousands of dollars. These institutions in effect pay their undergraduate students a wage consisting of the difference between the production cost and tuition. Indeed, some students get financial aid and pay less than the full sticker price of the undergraduate education; the wage they effectively get paid for attending college routinely exceeds the median taxpayer wage.

In the case of the research university, how can undergraduate education, which itself is subsidized, subsidize research? The subsidy for undergraduate education is an artifact of the high production cost of the undergraduate education. The production cost is high not because the research university offers a high-quality undergraduate education. The production cost is high because undergraduate education is produced jointly with research. As a by-product of producing an undergraduate education, the university produces research. The subsidy for undergraduate education is effectively a subsidy for research.

Who subsidizes undergraduate education? Here we need to distinguish between private nonprofit universities and public universities in the United States, which share in common the basic problem of funding a public good but historically have evolved different business models.

The starting point for the business model of the privates is an interest-bearing endowment, often the gift of a 19th century robber baron or the cumulative result of past alumni giving. The privates are experts at encouraging alumni and corporate giving. Buried in here is a government subsidy. The non-profit status of the privates allows alumni and corporations to deduct their gifts from their taxes, and it helps alumni avoid the estate tax. Another source of funding is tuition. Federally subsidized student loans and financial aid flow to students paying large tuition bills, and so the

student subsidies effectively end up in university pockets. The federal government also offers direct financial support for institutional development. Special interest politics will be special interest politics, and so the richest universities are showered with government subsidies while the poor come up relatively empty.

Public universities rely on some of the same subsidies. Since their alumni give less, however, the publics have less to gain from the tax deductibility of alumni gifts. Since their tuition rates are lower, the publics have less to gain from the government subsidies that are channeled through student loans and financial aid. The distinguishing feature of the public research university budget is the state subsidy for undergraduate education. To fix ideas, let us take a look at the University of California System, which these days sucks up one third of the higher education budget of the State of California and educates one eighth of the students. The remainder of the budget and students go to the California State University and Community College Systems. The State of California, by awarding the University of California a greater per-student subsidy, is in effect subsidizing a great research university.

Why would undergraduate students be eager to attend research universities in which the undergraduate teaching enterprise is compromised by the needs of the research enterprise? Elite research universities are selective institutions; the admissions process is hyper-competitive. Universities sell to their students not only an education but also a degree that signals to the world that the student was admitted to a highly selective institution. The students also benefit from peer group effects; the select students learn from each other, and not only, or even primarily, from their professors. The students further enjoy the benefits of alumni network effects; the select students bond with each other and help each other out after graduation.

So it all comes together very nicely.

Conclusion

The public research university in the United States embodies the core structures of the university, "the idea of the university" if you so will, and these structures do some very heavy lifting. They support specialized and creative inquiry; the mingling of basic and applied research; the mixing and matching of scattered ideas, methods, and evidence to generate new insights; the collective vetting, pooling, and cumulation of research efforts; and the sharing of research findings on a global information commons. They teach the liberal arts and thereby leak new "ways of seeing" into the larger society. They ground professional practice in research and link research to the concerns of the professions. They protect the university from the outside world and the inhabitants of the university from each other. They connect the university to a local community, which is motivated for local reasons to fund a global public good—the upkeep of scientific networks that have no money and no physical infrastructure of their own. They allow the outside political world to reach into the university, thereby preventing research and teaching from ossifying. They are embedded in a market ecology which combines competition and diversity and thereby supports the dissemination of innovations. They enable the scientific process and, at their best, create scientific progress and disseminate its fruits to the people.

The research university is an extremely hardworking and fantastically productive institution. It is not to be thrown away lightly, for it is destroyed so much more quickly than it can be re-imagined. It took about one century for the institutional template of the university to evolve in the Middle Ages in Europe (actually, if we include false starts, such as Athens and Alexandria, it took a couple of thousand years), and it took another couple of centuries for the institutional template to find refinement in 19th century Germany and America. Three times in history, social forces joined

together to assemble the university bundle. Two times, social forces combined to disaggregate it, and the third time is in the making today.

Unbundle the research university, and it will die.

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