

Current Trends in Knowledge Production: An Historical–Institutional Analysis¹

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ABSTRACT *Building on the author's recent survey of Western knowledge institutions since antiquity, this article assesses the impact of current trends in information technology, higher education, science, and the environment on knowledge production. Its focus on institutions diverges from conventional histories of ideas, media, and technologies but also from the understandings of knowledge and information prevalent among economists. It instead identifies patterns by which entirely new institutions of knowledge supersede their predecessors, reconceptualizing today's changes around the fitful process by which the laboratory, broadly understood, outgrows the tutelage of the academic disciplines.*

Keywords: knowledge institutions; information technology; higher education; laboratory science; social science; academic disciplines

Introduction

The advent of the Internet has given rise to a widespread belief that the very definition of knowledge is about to change. We once viewed knowledge as a body of learning lodged in books and journals and governed by groups of credentialed specialists. Now, computer networks make a vast panoply of digitized information instantaneously accessible to anyone and everyone. To some observers, user participation, mass collaboration, and reliance on the 'wisdom of crowds' suggest that virtual communities will challenge experts for the power to create and define knowledge.² This democratization of information promises to fulfill longstanding prophecies of a 'knowledge society' in which knowledge-producing capacities are far more widely distributed among organizations and individuals than in the past. Such changes have coincided with a broader set of societal trends. Talk of 'knowledge work', 'cities of knowledge', and the 'knowledge economy' reflects the relocation of many knowledge-producing capacities outside of universities and into zones of private enterprise. Economists now track the movement of knowledge through and among corporations and measure its impact on economic

productivity with increasing precision.³ Management experts seek to harness the talents of knowledge workers roaming among firms in search of lucrative and personally fulfilling employment.⁴ Sociologists document the informal networks of skill and expertise that these workers spontaneously create.⁵

Meanwhile, universities, the traditional bastions of knowledge production, feel pulled in two directions. As research-driven anchors of the knowledge economy, they enjoy commanding influence in channeling new inventions, new workers, and new skills into the private sector, particularly in science and technology fields. But at the same time they suffer from increasing incoherence in their mission as providers of higher education. In the United States, the canon wars and battles over political correctness that shook liberal-arts curricula in the 1990s may have largely subsided, but calls to make liberal education more practical and more marketable have only increased in intensity. Both Anglophone and continental European universities are under mounting pressure to standardize the meaning of their degrees and, by extension, streamline the market in these educational credentials. All this has occurred as new digital media erode inherited forms of textual literacy, critical thinking, and other staples of classical liberal learning. Universities today both benefit from and are threatened by the unmooring of knowledge from its historic institutional monopolies.

Looming over these developments, centered mainly on the West, are others affecting the pursuit of knowledge worldwide. Economic and cultural globalization and the challenges of environmental degradation and resource depletion have now clearly established themselves as dominant trends of the twenty-first century. The formidable ecological barriers to sustainable economic growth and social development will create staggering new demands for knowledge-based solutions and at the same time reshape the institutions that produce these solutions. But it is by no means guaranteed that they will be able to respond with sufficient creativity and vigor. On issues ranging from global warming to the exhaustion of fossil fuels to the lack of clean water, 'science', 'technology', 'research', and 'innovation' may ultimately be insufficient to stave off a profound disruption of lifestyles and a decline in living standards even in the most prosperous parts of the world. And despite the worldwide ascendancy of Western science and universities—a global monoculture in knowledge—the intense cultural frictions that a shared knowledge system might be expected to ameliorate show no sign of dissipating. There is as much reason for concern as there is for optimism as we contemplate the trajectories of knowledge in the future.

The scope, scale, and convergence of these trends invite comparison with past upheavals in the organization of knowledge, reaching in the Western tradition all the way back to the library at Alexandria. In this article I adopt just such a perspective to put today's rapidly globalizing knowledge society in historical context. Drawing extensively on my recently published book, *Reinventing Knowledge: From Alexandria to the Internet*,⁶ I will first propose a model for understanding upheavals in knowledge. My focus on institutions departs not only from conventional histories of ideas, technologies, and media but also from the understandings of knowledge and information prevalent among economists and economic theorists. I will next apply this institutional model to a series of current trends in information technology, higher education, science, and the environment. This analysis reveals that for all the undeniable drama and uncertainty surrounding the fate of the 'knowledge society', reassuring signs abound of a recurrence of familiar patterns of institutional change. The regularity of these patterns throughout

history in fact offers a powerful means of predicting future developments. Among other things, this suggests that if an entirely new institution of knowledge is to emerge, it is likely to form more in response to the threats of environmental degradation than to the opportunities of globalized consumerism.

Institutions of Knowledge in Historical Perspective

Reinventing Knowledge traces the six institutions that have produced, reproduced, and redefined knowledge over the past 2,300 years in the West.⁷ These institutions are, in chronological sequence, the library, the monastery, the university, the republic of letters, the disciplines, and the laboratory. (The republic of letters encompassed early modern correspondence networks, books and journals, museums, and learned academies.) Each institution coalesced in an epoch of profound upheaval, responding to sweeping political, economic, or religious changes that destabilized its predecessor. Each such upheaval gave small but pivotally situated groups of intellectuals a remarkable creative mandate to redefine what knowledge means, how we should pursue it, and how we judge ourselves to have attained it. Such 'reinventions' of knowledge established durable, clonable institutional templates that preserved the same basic features even when they later underwent mid-level modifications like curricular reforms, adaptations to cultures and languages, and even major doctrinal and paradigm shifts.

New institutions also cause their predecessors to be revamped and reformed in their wake. Older institutions are repeatedly recycled and refurbished as, for example, the medieval monastery absorbed the libraries of ancient Rome, remaking the study of classic books around Christianity's new ascetic and devotional practices. So too, what seems today's dominant knowledge institution—the university—has for some five centuries acted as a repurposable shell subservient to its successors, most notably the academic disciplines. What we may now be witnessing is a protracted, ongoing process whereby the disciplines cede hegemony to the last institution in the sequence: the laboratory.

Patterns of Institutional Change

Because the argument of *Reinventing Knowledge* diverges significantly from conventional accounts of intellectual change, it is critical to understand what reinventions of knowledge entail before tracking the story of institutional succession into our own times. Table 1 depicts the development of knowledge institutions since antiquity, matching each one to its epoch of inception, to its original template or prototype, and to the new definition of knowledge it established for later generations.

Table 1. Knowledge institutions since antiquity

Institution	Epoch	Template/prototype	Knowledge is that which can be ...
The library	300 BCE–500 CE	Alexandria	reasoned from texts
The monastery	500–1100	Benedictines	enacted as devotional ritual
The university	1100–1500	Paris and Bologna	structured as disputation
The republic of letters	1500–1750	Copernicanism	legitimated by humanist rhetoric
The disciplines	1750–1900	Classical philology	sanctioned by specialist communities
The laboratory	1900–present	Pasteur's	replicated through experiment

Thus the Library at Alexandria, Egypt, founded ca. 300 BCE by the successors of Alexander the Great, aimed not simply to collect all the known world's books but also to redefine knowledge around written scholarship instead of oral debate. Its resident scholars pioneered modes of textual scholarship founded on critical reading, editing and translation, and synthesis of written materials. Their often pedantic research practices contrasted markedly with the verbal, extemporaneous, primarily non-written philosophizing of Socrates and Plato. But this shift neatly reflected new empire-builders' aims to render Greek culture as portable as books themselves and thereby assert Greek hegemony across the Mediterranean world. Libraries in later empires followed Alexandria's example until—in the fifth-century West, at least—the Roman Empire collapsed and cities declined, leaving Christian monasteries to assume the libraries' function of conserving manuscripts. Early monks, however, starting with the Benedictines, adopted a fundamentally different rationale for keeping and studying texts: reading them for spiritual enlightenment and composing new ones to regulate their lives in devotional community, once literally rubbing out a work by Cicero to recycle parchment for one by St. Augustine. Silent monastic reading dominated the life of learning until Europe's twelfth-century demographic, economic, and urban recovery sparked the formation of new scholarly guilds called universities, first at Paris and Bologna, and eventually throughout Latin Christendom. Abandoning monastic silence, universities revived oral argument through vocal 'disputations', in essence knights' tournaments for scholars. Such rituals cemented fraternity among masters and students working through scholastic conundrums in theology, law, and medicine. Verbal sparring also prepared medieval university students to enter real-world occupations in these fields and join Europe's first knowledge economy.

The West's first three knowledge institutions illustrate how reconfigurations in the practices and rationales for pursuing knowledge invariably conformed to familiar civilizational transformations. In each instance, broad historical changes underwrote a new social contract between scholarly communities and the world beyond which in turn redefined knowledge itself. In contrast to these 'bricks and mortar' institutions, the next two seem more ephemeral, having grown amidst the university-based knowledge system we have inherited from the Middle Ages. But their reinventions of knowledge have been no less profound on that account. Indeed, while external social forces have continued to drive the evolution of knowledge institutions, intellectuals in the last five centuries have become even more successful in establishing autonomous standards of scholarship.

The republic of letters arose during the European wars of religion as an international correspondence network keeping scholars in contact as the medieval universities devolved into ideological bootcamps for one or another rival confession, Protestant or Catholic, often under the political pressure of their ruler-patrons. Besides the handwritten letters of figures like Erasmus and Descartes, the republic also encompassed learned academies, museums, and—above all—printed books and journals. In all of these venues, scholars revived models of humanist rhetoric from the ancient Romans (Cicero, preeminently) to institute greater civility and politeness in their exchanges with colleagues. This enabled them to cope with the many other intellectual challenges and disruptions of the time, such as the discovery of the New World and the Copernican Revolution. Copernicanism in particular showed how new knowledge not sanctioned by ancient texts could be legitimated through recourse to well-crafted humanist rhetoric. Whether in Copernicus' shrewdly deferential *De Revolutionibus* or Galileo's exquisitely polite

epistolary appeals to patrons and colleagues, the republic exhibited a remarkable resiliency in the face of massive ideological opposition and formidable physical barriers to international communication.

By the late 1700s, books, journals, academies, and museums had begun to eclipse universities, many of them by then backwaters of mediocrity, pedantry, and alcoholism. Historians of the Enlightenment often speak of a media revolution, seeing in commercial publishing ventures like the multivolume French *Encyclopédie* a parallel to the massive growth of today's information-rich society.⁸ But in a dramatic reversal, seekers of knowledge, instead of procuring a set of quality encyclopedias and setting forth into the world, streamed back into the universities. This seed of reinvention was sown not in ultramodern France but in backward Germany, among evangelical Protestants who bucked the Enlightenment trend toward 'extensive', promiscuous consumption of print to make Bible study groups the centerpiece of an ever more *intensive* practice of reading and scholarship. A string of largely unsung reformers like J. D. Michaelis and F. A. Wolf made seminaries—later called seminars—the seedbeds of disciplined research and disciplinary specialization, first in Biblical and then in classical philology. Redeeming orality once more, they refurbished the university as a site of face-to-face study one could not find in disembodied print media. After Wolf's disciple Wilhelm von Humboldt founded the world's first research university in Berlin, seminars soon sprang up in a range of fields from philology and history to chemistry and psychology. From these humble beginnings developed the panoply of disciplines we still recognize today. The inception of the disciplines thus offers another surprising instance of a small cluster of intellectuals who reinvented knowledge, fusing disparate cultural resources in unprecedented recombinations as the raw materials of a new institution.

The Disciplines

For all of its hallowed Gothic traditions, the research university was a fundamentally novel institution in being dominated by specialized disciplines. Sociologically, the disciplinary university reflected the emergence of the modern nation-state, the first to insist that culture be made the patrimony of all of its citizens and to create markets in education to produce broad-minded citizens. Disciplines emerged in earnest as nineteenth-century German states constructed systems of public education beginning with compulsory primary schooling and crowned by reformed universities. Competition induced the states of this still-disunited nation to poach professors who freely roamed within the boundaries of the German culture region. Founding their own specialized seminars to train acolytes in new fields and propagate new methodologies, scholars in the disciplines carved out niches at will, from pure curiosity, within a publicly subsidized marketplace of ideas. In classic Smithian fashion, the growing national market in tertiary education drove the division of academic labor, producing far-flung communities of specialists whose individual members inhabited particular universities as part of a larger career trajectory. These disciplinary networks in turn retooled the print media of the republic of letters to make scholarly books and journals into what can still be regarded as an elaborate system of professional calling-card distribution.

Disciplinary communities soon came to govern the career expectations, intellectual horizons, and identities of practicing scholars elsewhere as well. Many US universities, beginning with Johns Hopkins, adopted the German system wholesale, embedding disciplines in formal administrative departments and linking them to

undergraduate majors in ways that further solidified their almost impregnable role in higher education.⁹ Western European nations (and their overseas colonies) followed a more circuitous route¹⁰ but likewise ended up with a common package of disciplinary practices and sub-institutions, including the PhD, specialized academic job markets, extensive peer review, professional conferences and journals, and other all-too-familiar components of modern academic life. Japan and China, too, had by the turn of the twentieth century embarked upon similar courses in an explicit attempt to develop themselves as nation-states.¹¹ China famously abolished its millennium-old Confucian examination system in 1905 and later instituted research-oriented disciplines at Beijing University under the chancellorship of the German-trained Cai Yuanpei.¹²

At the dawn of the twenty-first century, the only traditional institutional rival to the research university worldwide remains the Islamic *madrasa*, which continues to thrive not only in its now-notorious capacity as a training center for Muslim fundamentalists, but in a host of other incarnations, many of them surprisingly modern and progressive.¹³ Still, research universities and their associated disciplines are unlikely to be supplanted by an alternative, non-Western institution either in the Muslim world or anywhere else. Academic disciplines, housed in the universities they long ago colonized and refurbished, remain in many respects the dominant institution of knowledge in both the Western and non-Western worlds.

The Laboratory

The laboratory emerged from within the disciplines to become what is now arguably a separate institution. Despite its initial containment within the research university, it has long demonstrated an amphibious capability to thrive in non-academic settings as well. In our own times, it has continued to evolve institutionally by generating new knowledge through methods of skilled experimentation.

The treatment of the laboratory in *Reinventing Knowledge* begins with the migration of the scientific demonstrations and experiments of the high republic of letters into the disciplinary seminars of the nineteenth-century university. First in chemistry and later in other fields, the laboratory acted as a conduit for craft skills, hands-on knowledge gained through trial and experiment, which superseded the literary skills even Galileo and Copernicus had to master to persuade fellow scholars of their discoveries. The new seminar pedagogy proved ideal for imparting this tacit or craft knowledge. By no means an uncontested development, the incorporation of natural-science disciplines into the research university was at first resisted by philologically-minded humanists who likened hands-on laboratory practices to artisanal work. But by Pasteur's time, the laboratory had not only secured an undisputed place among the disciplines but also begun to demonstrate an ability to serve other social needs besides those of the higher education system. Improving human welfare by manipulating contained spaces—from anthrax-ridden cattle farms to modern refrigerators containing pasteurized milk—laboratory scientists redefined knowledge around controlled experiments that could be reliably replicated and held out as objective truth by scientific experts. Their achievements also enabled the laboratory to expand its claims in two crucial ways that expand our traditional view of the institution.

First, the laboratory encompasses not just the natural but also the social sciences. Industrialization and urbanization, particularly in the United States,

created entirely novel social spaces whose social scripts and rules of interaction were subjected to study and experimental manipulation by self-styled experts. These spaces included the public school, a site where university psychologists developed mass intelligence testing as a means to track both over- and underachievers; the factory floor, where time-and-motion specialists and other species of management consultants conducted experiments to increase worker productivity; and immigrant slums, where large-scale foundations endowed by robber barons dispensed 'scientific philanthropy' based on social research findings generated by academics sent to do fieldwork among the impoverished. In these and other cases, social scientists aspired to the rigorous protocols of objectivity established by their colleagues in the natural sciences even if they clearly did not meet them in every case. Such technocratic 'scientism' reached its apogee in the urban redevelopment and Third World modernization schemes of the 1950s and 1960s, which made whole cities and countries into spaces for social-scientific experimentation and manipulation, from the planned city of Brasilia to the Strategic Hamlet Program in Vietnam.¹⁴ The subsequent discrediting of large-scale social engineering, while engendering greater humility among social scientists and greater vigilance among their patrons, has by no means led to the abandonment of rigorous experimental attempts to assess and solve social problems, however. Social-scientific methods still assume commanding influence in contemporary schools, hospitals, workplaces, cities, and government policymaking forums of all sorts.

As a second characteristic, already implicit in the examples above, the laboratory bestrides the university and non-university worlds, colonizing the state and in particular the corporation. In our own times, the spectacular successes of entrepreneurial startups in biotechnology, pharmaceuticals, computing, and materials science, often founded in the shadow of nearby universities, provide ready instances of this amphibious capability in the natural sciences. But so too, the social sciences find lucrative market niches and broad societal impact in practices from management consulting to advertising research, instructional curriculum design to health care policy reform, and the activities of non-governmental organizations (NGOs) and development agencies of all stripes. While typically importing disciplinary methods and techniques from academia, laboratory practitioners in these extra-academic settings are not in all instances confined by them. Instead they subject their experiments to the alternative disciplines of the market and the political process.

As a secular trend, corporations have since the 1970s displaced the state as favored spaces for the expansion of laboratory practices and ideologies. Thatcherism and Reaganism in the West weakened governments as sponsors of technocratic social development schemes, while the fall of the Soviet Union revealed history's largest scientific social experiment as an abject failure. Since the 1990s, the experimentalism of the laboratory has comported more readily with the entrepreneurship of the corporation, and is especially congenial to modern liberal-democratic, capitalist-consumerist, technologically-oriented societies. Market economies, whether formally democratic or not, ease the consensual adoption of new products and practices emanating from the laboratory in ways that the technocratic state historically could not. And yet, the colossal financial-market meltdown of 2008 proved that social-scientific engineering is by no means a relic of the past. Fueled in large measure by highly sophisticated risk modeling techniques, some developed by 'quants' who emigrated from academia, the financial crisis demonstrated how an academic disciplinary theory (the efficient markets hypothesis) legitimized the

creation of experimental new practices (like credit-default swaps) whose failure caused tangible dislocation in the economy and in society—ironically enough in a climate of deliberate state deregulation.

For good or ill, the laboratory seems poised to outgrow the tutelage of the disciplines and emerge as today's dominant knowledge institution, both inside and outside the university. As an amphibious institution, the laboratory enjoys a potential for expansion not limited by the markets for higher education that sustain but also constrain the growth of disciplines. And yet disciplines and universities show no signs of ceding their central role in the production of knowledge. Here it is important to recall that reinventions of knowledge invariably repurpose older institutions. Throughout history, the same texts, ideas, scholarly practices, buildings, and symbols of continuity and tradition have been so often reused and recycled that it is easy to miss the profound disruptions and discontinuities marking the succession of one institution to another. Signs of the laboratory's hegemony are therefore ambiguous and difficult to interpret but nonetheless dramatic and pervasive. The question confronting us now is how to apply the patterns of past reinventions to an understanding of the present.

Current Trends and Institutional Trajectories

Extrapolating into the future, several scenarios are possible as institutions of knowledge develop further: the cohabitation and partial overlap of the disciplines and the laboratory may continue, the laboratory may reinvent and repurpose the disciplines, or an entirely new institution of knowledge may supersede them both. In this section, I canvass several current trends to determine which of these is most likely.

Information Technology

By the early 2000s, the explosive development of computer networks and new information media suggested to some that physical books and journals are destined to be replaced by the virtual, digital provision of knowledge. The boldest enthusiasts of distance learning hold out the same prospect for university campuses themselves.¹⁵ Ambitious schemes to digitize everything knowable, render it machine-searchable, and disseminate it over networks were already a staple of serious speculation among Cold War engineers and academics, but only the more recent development of services like Google, Wikipedia, and a host of social networking sites has brought their visions to life. Collectively dubbed Web 2.0, these sites rely on continuous user feedback and participation in ways unanticipated by the original architects of the information superhighway. Cyberspace verily teems with social experiments like this, conducted by software engineers and subject to massive continuous referendum by an innumerable body of wired lay contributors. Colossal, consensual, and virtual, cyberspace is the latest of the spaces colonized by the laboratory, and, as a disembodied creation of technology, the one most immune to the deleterious ethical and environmental consequences that previous manipulations of actual physical and social spaces have often entailed.¹⁶ The Internet was born in the Cold War laboratory; its ongoing integration into post-Cold War society represents a significant expansion of the laboratory's practices under the guises of commerce, entertainment, news, and other needs and interests.

And what of its impact on higher education and scholarly research? Consider the ways popular Web 2.0 websites have begun to rupture with the protocols of the disciplines. Google's user-driven page-ranking algorithms exhibit a remarkable ability, independent of credentialed specialists, to push good ideas to the top and screen out bad (or at least unpopular) ones by aggregated unreasoned choices. Wikipedia's decentralized, collaborative forms of editorship and peer review have likewise begun to reveal the collective expertise and surprising rigor attainable by self-selected groups of largely non-academic volunteers.¹⁷ Social networking sites create spontaneous communities around every conceivable interest, from consumer goods to political issues to personal hobbies. Social tagging, indexing, and bookmarking techniques build on real-time user feedback to create folk taxonomies or 'folksonomies' reorganizing information and recategorizing knowledge on an encyclopedic array of subjects, many of them outside the purview of traditional academic disciplines. Everywhere, online texts, whether scanned or born digital, are now trivially easy to cut and paste, recombine, hyperlink, gloss, comment, and blog upon. The authorship, authority, and fixity of texts have become confused as a result, a development potentially threatening to the disciplinary practice of allocating status, recognition, and career advancement on the basis of academic publications with clearly identifiable authors and stable textual forms.

Notwithstanding the hype surrounding the Internet, however, the disciplines are likely to exhibit considerable resilience in the face of these apparent threats. Computers do dramatically improve access to texts and other forms of information, but anyone intent on adding to our store of learning must still expend the same time and effort as before to read, think, and write about them. The standards governing new contributions to knowledge remain those of disciplinary communities: of careful review, critique, and response by peer experts both before and after publication. No alternative means has yet been found of legitimating new knowledge claims and culling sound ideas from the bogus or useless ones pervasive on the Web. Nor is there any inherent reason to fear the degradation of traditional literacy—the silent, individual, isolated, linear consumption of printed books—and its replacement by massively hyperlinked, collaboratively authored, portable e-texts of various sizes, shapes, and formats. The disciplines were, after all, first founded on decidedly painstaking practices of close reading (of the Bible, of the classics) that ran athwart the promiscuous consumption of Enlightenment-era print media. Humanistic scholars have long been accustomed to the problems of information overload and the instability of texts. And even though today's print publishers suffer from diminishing profits and libraries struggle to cover the costs of science journals and university-press monographs,¹⁸ scholars will no doubt find technological work-arounds that preserve the accessibility, permanence, and peer review of texts as the *sine qua non* of scholarly publication. Adapting university pedagogy and scholarly research to today's information technologies in short requires merely mid-level reform of a stable institutional complex, not its wholesale reinvention.

Discipline in the sense of academic specialization has always been yoked to discipline in the sense of behavioral conditioning, meaning that however distracting and destabilizing the effects of computerization may prove in the short term, the changes it heralds are easily absorbable in principle. The growth of cyberspace is unlikely in itself to disrupt the disciplines. The threats to the latter come more from other sources, whereas the real potential of cyberspace to reconfigure

knowledge practices is tied to larger trends within the laboratory. I take up these contentions in the next two sections, respectively.

Higher Education

Coinciding with the networked computer revolution, the world's largest higher education system, that of the United States, endured a series of stinging critiques in the 1980s and 1990s. These ranged from right-wing diatribes against political correctness and the evisceration of the Western canon to polemics on the left decrying the corporatization of the university and the adoption of quantitative metrics of assessing scholarly 'excellence'.¹⁹ Both the left and the right converged around a belief that the disciplines—particularly their original, humanistic core—were under increasing threat from those who saw knowledge in purely instrumental terms, whether as a means of political empowerment (in the view of conservative detractors) or as a key input to economic growth (in the view of some liberals). Both agreed, too, albeit from widely different perspectives, that universities were failing in their traditional function of training broad-minded citizens for modern nation-states. Whether defending the old European classics or extolling their multiculturalist replacements, critics seemed united around the assumption that the disciplines, whatever their specific content, bear a sacred civic responsibility to instill intellectual standards. As part of their historic social contract with the public patrons of higher education, disciplines uphold disinterested intellectualism as the primary mission of the university, a mission now embattled on all sides.

Two decades later, attacks on political correctness have substantially lost their edge while concerns about corporate management and values have only increased.²⁰ With respect to the former, economic globalization has apparently vindicated the need for a decidedly multicultural curriculum and validated, if only as a by-product, the arguments of predominantly left-leaning university academics. But many still fear that the professoriate is experiencing a dramatic decline in status, income, and autonomy as corporate culture continues its march through the academy. Adjuncts, for example, are increasingly replacing tenure-line faculty in universities driven by the bottom line.²¹ The jargon of 'leveraging human capital' for 'comparative advantage' remains ubiquitous.²² Most insidiously, corporate-minded administrators and accreditors have adopted the practices and pretensions of managerial social science to encroach on the prerogatives of traditional faculty. The widespread adoption of 'assessment rubrics' to measure teaching outcomes substitutes external benchmarks for the deeply internalized standards of intellectual judgment professors acquire in being socialized to particular disciplines. Europe's Bologna Process envisions similarly bureaucratic methods to standardize university degrees and enhance the Continent's economic competitiveness. Its American admirers are now striving to 'tune' degree requirements in the United States as well,²³ urging the codification of standards already tacitly enforced by the circulation of scholars and ideas within national disciplinary networks.

Many academics, seeing the writing on the wall, defend the liberal arts and sciences precisely for their economic practicality, touting the utility of broad and flexible training for a post-industrial job market in which the occupations of tomorrow may not yet even exist today. One professor upholds the ancient liberal traditions of rhetoric and persuasion as eminently marketable skills in a modern consumer society overrun by a bewildering array of products and services competing within an 'economy of attention'.²⁴ Another believes universities can thrive

by retooling themselves around interdisciplinary projects—like the study of media, or money, or water—that redeploy discipline-specific methods around questions of more general public import.²⁵ A confusing welter of arguments and proposals for educational reform now crowds public discourse. One common denominator, however, seems to be the elision of national citizenship with participation in a globalized economy. As US President Barack Obama said in February 2009,

In a global economy, where the most valuable skill you can sell is your knowledge, a good education is no longer just a pathway to opportunity. It is a pre-requisite ... because we know the countries that out-teach us today will out-compete us tomorrow.²⁶

The incursion of economic and managerial imperatives into higher education dovetails with another powerful trend, toward more active interfacing between university research and corporate interests. Semi-autonomous university research institutes, technology transfer offices, and various fundraising and outreach opportunities all capitalize on marketable natural- and social-scientific achievements emanating from university labs in applications ranging from nanotechnology and green chemistry to educational testing and addiction counseling. Such endeavors speak to a realignment of interests and personnel bringing laboratory scientists into closer contact with university administrators, venture capitalists and entrepreneurs, and their own scientific counterparts employed in corporate-based labs.²⁷ The density of these contacts has carried universities beyond their traditional economic role as self-contained incubators of useful inventions and discoveries that then function as externalities in being taken up by knowledge-intensive firms.²⁸ Instead, a revolving door of people, ideas, techniques, and organizational practices has now opened between the university and corporate worlds. Many now gladly trade research autonomy for lucrative—and intellectually exciting—positions in industry. Knowledge-intensive firms like Google and Microsoft even offer perquisites like sabbatical leaves and research fellowships to entice those who might otherwise enter academia.

Contacts with the corporate world increasingly distance laboratory practitioners from their erstwhile humanistic brethren under the traditional rubric of ‘arts and sciences’. Their networks may even begin to act as the leading edge of a deeper institutional change.²⁹ Although the successes of such ventures cannot be straightforwardly replicated even in many scientific fields, let alone non-scientific ones, they may yet reach a tipping point where academics’ involvement with non-academic institutions—not only corporations, but also governments, hospitals, schools, or NGOs—becomes the norm, not the exception. Such a development would confound the key principle on which the disciplines were first founded: that the dynamic of scholarly specialization furnishing new disciplinary questions and methods should take place entirely within the ivory tower, in a pristine and publicly subsidized marketplace of ideas placed atop the educational system. Natural and social scientists, while grounded in and loyal to this disciplinary ideal, have long been accustomed to crossover activities serving outside economic and political interests in ways largely alien to their colleagues in the humanities.

Taken together, recent developments in higher education confirm the progressive institutional demotion of the disciplines and a concomitant rise in the influence of the laboratory. To forecast the laboratory’s supersession of the disciplines is

in no way to prophesy that scientists in white coats and safety goggles will commandeer their humanist colleagues' classrooms. Nor does it assume that philosophers, historians, and literary critics will be required to adopt quantitative methods, perform experiments, and test falsifiable hypotheses. Humanists may simply see their research subordinated to their teaching function, an entirely salutary development if it produces fewer unread monographs and more creative pedagogical experimentation inside (and perhaps outside) the classroom. Admittedly, the greater prestige of science disciplines relative to the humanities has spawned many proposals, such as E. O. Wilson's intemperate call for 'consilience',³⁰ to subordinate all fields of knowledge to the scientific method. New interdisciplinary fields like behavioral economics, cognitive neuroscience, and evolutionary biology likewise challenge humanists' claims to better understand rational choice, the mind, or belief in God. In large measure, these salvos amount to internecine academic turf battles with little potential to disrupt the underlying principle of a structural division of labor among fields. Still, as the social contract between university and society is renegotiated, the laboratory's values, practices, and ideology may prove better suited than those of the disciplines to reconfiguring our institutions around economic and political imperatives and changes in the collective cultural imagination.

The disciplines have long relied upon the nation-state as the sponsor and beneficiary of tiered mass education systems and their attendant academic specialties. That function is unlikely to disappear even amidst widespread state disinvestment and its replacement by corporate funding, private philanthropy, and student borrowing that increasingly converts deferential pupils into cost-conscious consumers. But as the laboratory takes the lead in brokering new alliances and affinities among groups both inside and outside scientific disciplines, other constituencies of the university will be forced to adapt or face obsolescence. In an increasingly post-national, globalized world, the laboratory's ideology favoring experiment, entrepreneurship, and social engagement is likely to gain the upper hand—and in the long run, possibly even reassert the value of pursuing knowledge for its own sake against the instrumentally minded.

Science

At the same time that the laboratory has begun to enjoy increasing autonomy beyond the discipline-dominated research university, it has also evolved new institutional features partly transcending disciplinary frameworks, often in reaction to external pressures. Citizens, activists, and entrepreneurs have in recent decades challenged monopolies of disciplinary expertise, responding both to the successes and to the notable failures of science, medicine, social engineering, and marketable technologies. Thriving in widely varying incarnations as 'impure science', 'citizen science', or 'mode 2 science', the 'post-disciplinary' laboratory mobilizes a range of new constituencies not only to monitor its production of knowledge but in many cases to redesign its innermost practices. What one might also call the 'participatory' laboratory maintains as an inherited institutional feature a cardinal emphasis on technical skill, experimentation, and the value of objectivity as defining components of knowledge creation, but it increasingly dispenses with strictly disciplinary protocols of peer evaluation in enlisting the participation of those it formerly treated either as test subjects or as external patrons and clients. This development signals a seismic shift in institutions potentially more consequential

than changes in information technology and higher education. Still, it ultimately amounts to merely mid-level reform, cementing rather than undermining the laboratory's broader ascendancy.

Impure Science. Among the best illustrations of the post-disciplinary laboratory is offered by Steven Epstein's study of gay activists in the development of treatments for AIDS—a paradigmatic example (and perhaps still the sole successful one) of what he calls 'impure science'.³¹ Epstein shows how initial conflict led to eventual compromise between scientists wanting to maintain pristine research protocols and groups like ACT UP clamoring for quicker results from clinical trials. Activists exploited their contacts with the gay community to provide biomedical researchers access to and knowledge of their patient population. Drawn from a relatively affluent and well-educated demographic, activists also proved adept enough at self-education to gain a 'seat at the table' alongside disciplinary experts, able to hold their own in discussions ranging from cellular biochemistry to protocol design. Researchers responded by modifying their standards in ways not strictly sanctioned by their disciplinary peers, but that nonetheless qualified as objective experiments requiring technical skill to test clear hypotheses. These collaborations hastened the discovery and testing of new therapies for AIDS as a panoply of stakeholders united around the specific goal or project of curing HIV.

Citizen science. This denotes experiments that rely on dispersed non-expert volunteers to gather data, whether to track bird migrations, search for extraterrestrial intelligence, or monitor climate change.³² Citizen science is still quite limited in its impact and in its suitability for rigorous scientific projects, but it betokens a fascinating revival of the predisciplinary practices of the republic of letters, which relied pervasively on dispersed correspondents to collect and interpret data on meteorological and astronomical phenomena and natural history. The appetite for discovery and growth in baseline education found in modern knowledge societies may enable citizen science to expand in other ways, spawning forums not only for amateur curiosity, but also for monitoring more complex scientific experiments with tangible social, environmental, and political consequences. One can easily imagine a range of applications from medical therapies to green energy to the study of traffic patterns, all capitalizing on informed decentralized scrutiny of the self and of the local environment.

Risk. Yet another context where post-disciplinary practices have emerged in the laboratory concerns science involving high medical, technological, or environmental risk. Risk assessment and risk management have in recent decades moved from the prosaic technical domain of engineers and accountants to the very center of social theory. Modern society is increasingly prone to disasters and setbacks as the complexity of our technological systems outstrips our ability to model, anticipate, and correct for systemic vulnerabilities.³³ Dramatic disasters like the Chernobyl meltdown and the explosion of the USA's *Challenger* space shuttle have pointed up the dangers of what Sheila Jasanoff calls 'technologies of hubris'.³⁴ These must be countered, she argues, by 'technologies of humility', involving formal participation by citizens and other stakeholders and an 'extended' practice of peer review encompassing quality control and deliberative, open-ended risk assessment procedures. Purely disciplinary standards, Jasanoff observes, entail 'peripheral blindness' both toward the negative societal impact of spuriously 'objective' scientific findings and toward purely scientific questions that happen to lie outside the frame of investigative analysis—as in the case of toxicity studies focusing on one drug at a time, in isolation from other biochemical interactions. A more inclusive, participatory

process of discovery does not necessarily dilute and may in fact increase the quality, validity, and objectivity of laboratory-generated knowledge.³⁵ Jasanoff focuses largely on the hard sciences, but her analysis applies with even greater force to the hubris of social-scientific experiments, from inner-city housing projects with their massive unintended social consequences to the supposedly fail-safe risk modeling paradigms that helped cause the financial crisis of 2008.

The knowledge economy. One can hardly envision a better illustration of laboratory-like experimentation outside the disciplines than the free competition of knowledge-based firms under post-industrial capitalism. The production of knowledge-intensive goods and services may seem out of place on a list of participatory practices focused mainly on ethical and political conundrums, but this is only because modern liberal-capitalist economies enshrine as an ethical and political principle the freedom of entrepreneurial firms to harness knowledge for profit, subjecting them largely *ex post facto* to regulatory oversight, legal constraint, and citizen monitoring. In fact it is in private industry that the social dispersion of knowledge-producing capacities typical of the post-disciplinary laboratory has advanced the furthest. Economic theory once conceptualized knowledge as a public good, either assuming new technologies and discoveries to be unproblematically accessible to all, or treating their production in research universities as an externality, a free gift from pure-minded disciplines to the profit-oriented marketplace.³⁶ This view has been completely overturned by economists' renewed appreciation for the local, highly technical knowledges produced by corporations, not just in their formal R&D departments but pervasively within increasingly fluid organizational hierarchies. Whether crystallized as a form of intellectual property that can be patented and protected, or treated as a more diffused capacity of networks of skilled knowledge workers, knowledge now flows in and among firms as a species of the tacit skill central to the laboratory since its very inception. Not merely encompassing the hands-on facility to construct an assembly line or design a solar panel, such knowledge emphatically includes, for example, the social-scientific marketing research that systematically incorporates consumer feedback. It also encompasses organizational leadership techniques descending directly from the first social-scientific management consultants in the early 1900s. The famed knowledge-society guru Peter Drucker even exalts the manager's ability to lead knowledge-intensive organizations as the noblest of intellectual pursuits, on a par with the humanities themselves.³⁷

Mode 2 knowledge. As we seek some coherence in what might seem a scattered set of developments, the theory of 'mode 2 knowledge' recently developed by a group of European social theorists proves especially useful.³⁸ Though short on specifics and employing a deliberately vague rubric to avoid imposing a premature label on an embryonic phenomenon, their analysis nonetheless offers a compelling framework for understanding the post-disciplinary laboratory. Mode 2 knowledge production occurs, first, in a 'context of application', not of impractical curiosity-driven discovery. It draws its problems from real-world non-academic concerns and not the specialized interests of disciplinary communities. Second, mode 2 science brings together interdisciplinary teams to work on well-defined projects on a transient or temporary basis, unlike the decades- or even lifelong commitments typical of disciplinary scientists' careers and research agendas. The portable skill sets typical of today's knowledge workers are more valuable in such contexts than the deeply arcane expertise of dedicated academics. Finally, mode 2 effaces hierarchical divisions between pure and applied science, theory and technique, disinterested knowledge and public or commercial application. Reflexivity is its hallmark: theories are adapted quickly

in response to practical successes and failures, and scientific products and inventions are then assessed with an eye toward quality control, profitability, impact assessment, and rigorous accountability toward economic, social, political, and environmental interests and imperatives.

Entrepreneurs, consultants, managers, marketers, consumers, social workers, public watchdogs, government regulators, and the media all have potential roles to play in mode 2 knowledge production. Most important, though, are the new functions assumed by both higher education and information technology. The social distribution of knowledge-making capacities marks yet another incursion on the prerogatives of the disciplines to determine the questions, methods, and standards driving the pursuit of knowledge, but the staffing of mode 2 projects relies heavily on a steady stream of highly educated workers and other stakeholders that only universities can provide. Equally crucial, the 'knowledge society' depends on citizen-workers able to question and critique their own specialized training by situating their inevitably circumscribed economic roles amidst wider civic concerns. Training citizens to act as scientifically informed, verbally articulate participants in mode 2 knowledge production: this is what a higher education system repurposed by the ascendancy of the laboratory might (and perhaps has already begun to) look like. Such a role is entirely consonant with the moral tutelage universities have always exerted, but that under the disciplines has been dissipated by the inculcation of a plethora of field-specific work ethics.

Mode 2 science potentially creates a new use, too, for Web 2.0 online communities beyond their current roles as forums for entertainment, commerce, and social networking. The same technologies that now organize online chess tournaments and high school reunions may easily be recoded to gather feedback and orchestrate pushback among the widely dispersed constituencies affected by scientific projects. Online networks provide a ready-made 'context of application' for the rollout of new therapies, inventions, products, and policies for subsequent experimental cycles of improvement and adjustment. Cyberspace can also offer a powerful model of self-organization to inspire practices of collective experimentation within other institutions like hospitals, schools, neighborhood groups, governments, and NGOs.

Pressures on the post-disciplinary laboratory to integrate ethical, political, social, economic, and environmental concerns through the active participation of new constituencies no doubt undermine the autonomy of disciplinary 'pure' science, but even such profound changes are unlikely to threaten the tacit knowledge, practices of objectivity, and experiment-driven methodology that remain the core components of the laboratory as an institution. They may instead help correct tendencies toward scientistic, technocratic overreach that have plagued the laboratory since its inception, thereby removing the last obstacle to its attaining the truly comprehensive influence enjoyed by its predecessor institutions.

The Environment

If any truly epochal trend threatens the laboratory's ascendancy, it is the confluence of economic globalization with the degradation of the natural environment. As living standards rise in rapidly developing economies like China, India, and Brazil, billions more consumers will enter the global marketplace, competing for ever scarcer resources and accelerating destructive environmental processes from climate change and fuel shortages to water pollution and pandemic disease.

Decades may elapse before, say, the lifestyle expectations and resource demands of the average Chinese worker approach those of her American counterpart, but only the most optimistic (or myopic) analysts believe that Westerners themselves will in the long run be able to escape major, disruptive changes in their consumption of energy, food, water, and material goods. The question is whether the laboratory, in its broadest institutional incarnation, can sustainably address these problems on the technical-scientific as well as social-cultural fronts. For it to do so would require a series of technological breakthroughs from abundant clean energy to safe genetically modified foods; a variety of social-scientific policymaking and management techniques allowing these breakthroughs to be introduced within an economically liberal, politically multipolar global order; and a host of cross-cultural participatory forums—possibly aided by online social-networking technologies—to facilitate this process and compensate for the inevitable risks, inequities, uneven impacts, and unanticipated consequences it will entail.

But even that might not be enough. One need not imagine that the relatively harmonious economic and political order that has succeeded the Cold War will experience apocalyptic disruption or collapse into an anarchic ‘clash of civilizations’ to envision a future world of straitened circumstances, difficult choices, and intensified rivalries. Widespread lifestyle revisions, both upward and downward, are therefore likely to nurture challenges to the Western ideologies and worldviews sustaining globalization. This cannot help but have adverse consequences for a global knowledge monoculture founded on the supremacy of Western universities, disciplines, and laboratories. Such situations have historically bred the conditions for fundamental, not just incremental, institutional upheaval.

The skeptic’s view holds that liberal capitalism as practiced in the West is globally unsustainable and that its modification will require more than mid-level revision to the laboratory. ‘Liberal’ capitalism need not be understood here to entail a democratic political order founded on individual citizenship rights and limited government. It merely connotes a culture that prizes competition among individuals, firms, and nation-states as an optimal means of allocating resources. Liberalism also enshrines tolerance, pluralism, and non-interference as a means of reducing social and political conflict both nationally and internationally. Such a system, fully ascendant in the West but only partially so in the robust economies of East and South Asia, must be able to tolerate and materially sustain the huge amounts of waste, redundancy, duplication, and Schumpeterian creative destruction that free competition entails. Illustrations are ready at hand. Affluent, well-educated students dither in search of careers well into their twenties while migrant and sporadically employed workers churn through series of jobs. Venture capitalists invest in multiple failed startups before finding the one that pays off. Politicians defer large-scale remedies to social and environmental problems until crises force their hand.

Liberal-capitalist societies already aim to educate skilled citizens flexible and resilient enough to adapt their careers and life expectations to personal setbacks, economic recessions, and the other inescapable cycles of creative destruction on both the individual and societal levels. Their knowledge institutions reflect and reinforce these values as part of their larger social contract. Under the laboratory’s hegemony, the limitless trial and error endemic to liberal-capitalist economies indeed finds its analogue in the processes by which knowledge itself is created: as that which can ultimately be shown to ‘work’ through repeated experiment. The husbanding of technical skill to generate objective knowledge through experimentation stands

as the laboratory's defining practice—its most central and abiding feature, beyond its origins in university disciplines and beyond its tentative evolution toward post-disciplinary, participatory characteristics. And experimentation relies upon a principled commitment to endure failure and waste resources in the pursuit of replicable breakthroughs. While largely unavoidable in manipulations of the natural world, this principle has never applied with equal success to the spaces of human social interaction to which the laboratory has also historically laid claim, in workplaces, schools, cities, and beyond.

Assuming some sort of post-liberal social and ideological order will result from the combined effects of environmental distress and global leveling, the laboratory will remain necessary yet insufficient to meet these sweeping new external demands—a pattern entirely consistent with prior reinventions of knowledge. The laboratory undoubtedly still harbors tremendous potential to generate astonishing results that comfort and inspire, that open up new horizons while rendering our existing practices more sustainable. It may even come to rely systematically on civic participation, risk and impact assessment, and other socially robust practices of mode 2 knowledge production. But the laboratory cannot in itself effect the personal changes in consciousness and behavior needed to bring about the large-scale cultural transformation that a post-consumerist society would require. Not even the most totalitarian, scientistic, technocratic social engineering schemes of the twentieth century succeeded in this respect.

The next knowledge institution, whether it takes decades or centuries to emerge, is therefore likely to incorporate some kind of personal ethical or even spiritual component. Subjectivity, not objectivity, would be its watchword. This may engender something like a revival of the devotional practices enabling monasteries—the West's second knowledge institution—to govern their denizens' daily habits and remold their ethical horizons at the most intimate level. More likely, however, is a milder and more ecumenical alternative, one not limited to a specific religious tradition but instead founded on cross-cultural translation and cultural mediation. Cross-cultural translation will certainly become central to resource management and coordinated response to ecological change at the global level of nation-states and international policymaking bodies. So too, it will remain an essential task at the middle level of NGOs and multinational corporations, with their simultaneously local and global knowledges. Its most fundamental impact, however, is likely to occur at the level of individual lifestyles. One can only fantasize about what this might entail—radical ecotourism, lifelong periodic study abroad, mobile kibbutzim, living off the grid. But the choices and changes individuals must make, to adjust their diet, health and hygiene, to modify their patterns of work and leisure, and to reshape their lived environments—from the suburbs and highways of the American sunbelt to the sprawling megalopolises of Asia and Latin America—will come to rely on modes and rationales for seeking knowledge that are wholly alien to the laboratory in any of its contemporary guises. Eventually these changes may coalesce into the prototype for a wholly new institution.

Conclusion

As we contemplate the future prospects for a true 'knowledge society'—whatever the term may entail—the framework offered by *Reinventing Knowledge* is useful in at least three respects. First, it helps us to distinguish fundamental from mid-level institutional change, offering a series of historical comparisons by which to gauge

whether today's upheavals together amount to a true reinvention of knowledge. Second, it helps us to predict the probable course of transformations already well underway, illuminating the subtle processes by which ideas, practices, and edifices of knowledge are recycled and repurposed as one institution supersedes its predecessor. Third, it helps us to group together seemingly disparate phenomena inside and outside knowledge institutions, identifying the core, abiding redefinitions of knowledge that establish a new social contract between knowledge-seekers and society. By all these benchmarks, the ongoing shift from the disciplines to the laboratory is itself dramatic and destabilizing enough to account for many of the diverse and unsettling trends that surround us. Let us review these trends now.

First, for all the dazzling possibilities opened up by cyberspace and the Internet, the advent of new media and information technologies does not in itself portend radical institutional change. Like all tools, these technologies conform to the larger purposes dictated for them, in this case by knowledge institutions. Thus the disciplines are likely to adopt the best practices of new communications technologies while retaining whichever traditional methods of collecting and analyzing texts and information are appropriate to each field. The laboratory may co-opt cyberspace more vigorously, forming new online communities promoting the adoption of participatory, post-disciplinary experimental forms—again, however, on its own institutionally-determined terms.

The crisis in higher education, a second trend, reflects the eroding autonomy of tertiary education in an era when states retrench in their financial support of universities and, together with citizenries and corporate interests, demand more practical services from them. Specialized curiosity-driven research will certainly survive but in a form subordinated to larger societal problems, concerns, and agendas that increasingly displace the self-perpetuating questions, methods, and foci of particular disciplinary communities. Far from presaging a devolution of higher learning into a purely utilitarian or instrumental enterprise, however, such a development would powerfully vindicate the umbrella ideology of the laboratory—with the knowledge society itself becoming the space of experimentation.

Among the forums where post-disciplinary models of skill and experimentation are most prevalent are those at the interface between science and society, where knowledge-producing capacities are now pervasively dispersed among non-academic scientists, entrepreneurs, workers, citizens, and other groups and organizations. These 'mode 2' forms of knowledge production, together constituting a third trend, cement the hegemony of the laboratory as it graduates from an institution once lodged within the academic disciplines to one that is increasingly self-sustaining. Though historically prone to disastrous overreach in technocratic engineering projects, the laboratory now exhibits a newfound potential to integrate these external groups into its experimental protocols, maximizing profit and social utility while avoiding undue risk and unethical consequences.

No institution of knowledge has ultimately thrived without marrying the ideology and values of its host society to the standards of intellectual activity produced by knowledge-seekers themselves. As we confront a fourth major trend—the intertwining of globalization and ecological decay—it is this issue that will ultimately make or break the laboratory as an institution. Barring a miraculous series of technical breakthroughs enabling the sustainable universalization of current Western living standards, resource competition and environmental degradation may eventually undermine the liberal-capitalist social order on which the laboratory's experiment-driven practices ultimately rely. If and when this ever occurs, a new

institution may crystallize around practices of individual lifestyle reform in a deeply cross-cultural setting.

Looking into the future, much depends on how far along we find ourselves on the cycle of institutional reinvention. The length of these cycles has steadily contracted over the last two millennia, and a mechanical extrapolation of this trend suggests that a new institution is just around the corner. But there is no reason to assume this will automatically be the case. The twentieth century in particular witnessed a prolonged institutional stalemate as two rival versions of the laboratory—the Soviet totalitarian-technocratic and the Western liberal-capitalistic models—remained locked in competition. The era since the 1970s has been dedicated in large part to confronting the technocratic defects of the Western version itself. Now that a new set of opportunities and anxieties has replaced those of the Cold War, we now face the question of how the laboratory will adapt to a fresh set of challenges.

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