# Section 1.
# The forming of scientific communities

# Church, state, university, and the printing press: Conditions for the emergence and maintenance of autonomy of scientific publication in Europe[1]

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In early modern Europe the multiplicity of competitive political, religious, and economic players created conditions of both support and freedom that seeded the free flow of knowledge, the flourishing of competing knowledge claims, and the growth of science. Yet, surprisingly from a modern perspective, the university was not a central part of this story. When the new state-sponsored research university emerged in the nineteenth century it maintained elements of autonomy for both scholars and scholarly publishers that fostered scientific freedom. It is not clear, however, how the contemporary reconfigurations of what has been called the triple helix of state, industry and science may restrict the university, i.e. science and scientific publication, diminishing its autonomy to support the free growth of knowledge.

In Europe, universities, from their medieval invention through the eighteenth century, had remained largely under church control. Domains of study followed the church regulated traditional faculties of liberal arts, theology, medicine and law. Empirical science was little pursued or studied within university walls. During the seventeenth and eighteenth centuries, scientific research and publication developed largely outside of the university, frequently outside the reach of church or state control. The complex fracturation of power in Europe from the sixteenth through the eighteenth centuries, meant that scientific inquiry and publication could escape the domination of a unified political or religious authority.

As this period developed there was some state patronage for individuals and state charter for scientific societies, but this reflected more the desire of the state to enlist the emerging value and prestige of science rather than to exert authority over it. Rather it was individuals acting as entrepreneurs, privately

1. This essay draws heavily on chapters nine and ten of the Handbook of Research on Writing. I co-wrote these chapters with Paul Rogers, whom I thank for all his assistance and collaboration.

organized societies, and especially printers and publishers who were responsible for the production, communication, discussion and development of sciences prior to the nineteenth century. This independence from large institutions, and especially state or church control allowed the license for exploration and heterodox publication. At the same time this independence allowed scientists and their compatriot publishers to seek patronage and support from multiple sponsors, each of whom saw different values and opportunities in the new forms of knowledge.

Eighteenth century Scotland, Germany, and Sweden, however, foreshadowed a change in university role in the production and dissemination of knowledge, bringing the university into the center of new alliances with the state and publishers. These new alliances, reflecting the value of knowledge to the state rather than the state's fear of the uncontrolled proliferation of knowledge, were accompanied by ideologies and arrangements that fostered academic independence as well as practicality – ideas that would develop in the secular research university of the nineteenth century. These new arrangements changed the character and conditions of scientific publication, as well as the sponsorship of scientists and science.

## 1. The printing press and changing networks of knowledge in Europe

In the early European Middle Ages classical knowledge was limited to a few Latin texts and compendia derived from them. The modern university was born out of a curiosity about texts arriving during the 11th and 12th centuries in Europe through contact with Islamic scholarship held in the libraries of the Umayyad courts of Spain. Scholars in the monasteries and larger cities of Europe began translating and studying such texts as Ptolemy's synthesis of the work of Greek astronomers, known through its Arabic title *al-Majisti* or *Almagest* (Ridder-Symoens 1991). As available texts increased, students and scholars gathering in greater numbers organized themselves in guilds to form the bases of universities. Monastic and commercial copyists were of course important in providing texts for the libraries that were at the heart of these universities. By the end of the twelfth century, universities existed at Salerno, Bologna and Reggio, and soon others emerged at Vicenza, Palencia, Paris, Oxford, Montpelier, Arrezo, Salamanca, Padua and Naples. By 1500 over sixty universities were active throughout Europe: from Uppsala in the north to Catania in Sicily in the south; from Lisbon in the west to Cracow in the east (Verger 1991). From the middle of the fourteenth until the start of the sixteenth century, approximately three quarters of a million students matriculated through-

out Europe (Schwinges 1991). Two forces served to organize and support this movement, shaping its destiny until the reforms of the nineteenth century. The contemporary economic system of guilds provided the internal organization, defining structures of faculty governance, student rights, and protection of the interests of guild members. The church provided sponsorship and curricular regulation – around the four faculties of Liberal Arts, Theology, Law and Medicine.

During the Middle Ages, the close nexus of the universities, the church, scriptoria, and education for church careers kept universities at the center of the knowledge maintenance, dissemination, and production. The Protestant Reformation and the accompanying religious struggles of the sixteenth and seventeenth centuries, moreover, did not fundamentally change the church-bound character of the universities, although changing some allegiances and disrupting the Vatican's universal curricular authority.

In the fifteenth century, however, knowledge moved out into the world. The moveable type printing press, along with related inventions and social arrangements made books available in increasing quantity (Eisenstein 1979), accelerating and transforming a process that had already begun in the scriptoria (McKetterick 2003). Increasingly, scholars were freed from the university or monastery library and from church supervision. Even more, the printing houses proliferating across Europe no longer came under a single religious jurisdiction and therefore could not be uniformly censored or controlled, nor did they serve a single international organization Separate states had neither wealth nor jurisdictional reach to keep the production of texts subservient to their needs. To underscore the importance of this multiple sponsorship for creating substantial autonomy for printers and scholars, it is useful to compare the European situation to those in the centralized Chinese state four centuries earlier when printing was first invented, but with very different consequences as it became an instrument of state power.

## 2. The centralization of power, knowledge, and printing in China

In China, long before the introduction of printing, the national order was administered by an elite trained in classical learning and its ideals. Knowledge and its production was regulated through a system of rewards and controlled dissemination among government officials. Valued learning was institutionally regulated by the imperial civil service examinations which lasted over two millennia, until the final collapse of Imperial power in the early twentieth century. The Han dynasty (206 BCE–220 CE), to repair the destruction of books by the preceding Qin dynasty (221–207 BCE), fostered bureaucratic expertise

in philology and lexicography through instituting scholarly examinations. For the next two millennia those exams defined the aims of schooling, what texts were valued, and the literate development of every individual seeking power and place. Further, the need for objectivity of evaluation lead to a narrowing of the canon of texts concerned, a formalization of the questions and a ritual patterning of expected answers in the notorious eight-legged essay based on eight matched pairs of opposing concepts. As the most valuable knowledge was that which would provide advantage on the examinations, much scholarly production was summary, commentary and interpretation of the classic texts. Some of these commentaries in turn became part of the examined canon (Lee 2000).

Throughout a two thousand year period, there was great consistency in the ethical, philological, literary and aristocratic knowledge valued in the civil service, the exams and the schools that prepared candidates. Learning in the law, medicine, astronomy, mathematics and military arts was also supported in preparation for appropriate civil service roles for the control and maintenance of the economy and national welfare (Ronan and Needham 1981; Needham and Lu 1970a, 1970b).

However, while these knowledge domains, useful to the state, had some coherent development and expanding literature, other areas of knowledge were sporadic with little organized distribution of texts or institutional support. The many technological advances made in agriculture, textile manufactures, mining, fishing, construction, weaponry, explosives, mechanical and civil engineering, ship-building and other arts and crafts were developed largely by artisans, workers, crafts people or people in the lowest rungs of the state bureaucracy. Higher level administrators trained in the classics had at most a supervisory role in the development of these practical arts. Thus the makers of practical knowledge were neither educated and highly literate nor had they access to the means of publication and text distribution. Practical work tended to be atheoretic and did not depend on the dominant educated thought systems of Confucianism, Taoism and Buddhism. Sometimes inventions and discoveries remained local and sporadic because of the lack of textual transmission. When this practical knowledge did spread it was through objects and practices. It was thus in these concrete forms that much of this knowledge was diffused to India, the Islamic world and Europe (Needham 1970).

While in Europe the invention of the printing press was to foster novel texts, new communities of knowledge seekers and producers, and new disciplines of learning, in China the much earlier invention of printing (block printing at the eighth century CE or before and movable type circa 1041–1048 (Carter 1955) led to much less diversity. The control of the press remained largely in the hands of the state and monasteries (Luo 1998). As a result most mass-produced and

widely circulated print documents reflected bureaucratic functions of the state, the literary classics and commentaries associated with examination, religious scriptures and government issued paper money. Sometimes leisured elites used the government press for publication of special interest limited-editions of their poetry and avocations, reflecting their educated tastes steeped in the classics. When private printing flourished (often based in private academies), it too was dominated largely by the culture of the classically-based examination system. Only during the Ming (1368–1644) and Qing (1644–1911) dynasties did private printing of vernacular texts (such as popular novels and tales, books on crafts and technology, and gazetteers) appear on a large scale. However, most private printing remained devoted to such ritual artifacts as New Year pictures and funerary money. Thus the printing press largely supported and participated in the same world of knowledge fostered by the government civil service and examinations.

## 3. Learning as a competitive force in Europe

In Renaissance and early modern Europe, however, learning became a competitive force that could enhance the status and power of monarchs, starting with the great merchant princes of Italy who patronized such scholars as da Vinci and Galileo (Biagioli 1993). Monarchs throughout Europe patronized scholars and brought them to court to bring grandeur and luster, if not the vision of a new world, as in the court of Rudolph of Austria (Evans 1973). In the free city of Magdeburg, Otto von Guericke rose to power in part on his demonstrations of learning, which he then turned to the benefit of the state (Bazerman 1993). Printing houses saw themselves as beyond the force of any state and began to fashion themselves as a Republic of Letters, spreading cosmopolitan thoughts and ideals (Eisenstein 1979). Gaining knowledge of each other through books, scholars across Europe engaged in lively correspondence networks.

Science, previously called natural philosophy, has been closely associated with consequences of the printing press, i.e. with easier access to classic texts, with wide and rapid dissemination of new data, observations and theories, with the reproduction of exact descriptions, tables, illustrations and maps that allowed the comparison and aggregation of astronomic, geographic, botanic, zoological and anatomic data, with the impetus to criticism, commentary, taxonomy and theory based on the access to multiple sources which then could be compared to new results, and with the impetus for improved maps, illustrations, tables and taxonomies to meet the book-buying market (Eisenstein 1979). Publishers were instrumental in creating cultures of trust that allowed readers to

rely on the authority of editions untainted by piracy and other forms of immorality and amorality (Johns 1998). While universities, scriptoria and monasteries formed communities of trust within which books could be selected, shared-interpreted and evaluated, the proliferation of copies of printed books seemed to set them free of social context, which needed to be re-created around the networks of publishers, authors, collectors and sponsors. These new communities of knowledge, communicating across national and religious boundaries, challenged the authority and legitimacy of at least one state, England, in the seventeenth century (Jacob 1976; Shapin and Schaffer 1985), The restored monarchy in England needed to position itself warily with respect to natural philosophic inquiry, which it sequestered apart from public discourses of faith and royal legitimacy. In the eighteenth century new philosophy, knowledge and rationalism formed the ideology of American and French revolutions, the Napoleonic empire, and the consequent nineteenth century remaking of the European political/administrative landscape.

In urban areas where new learning thrived outside the walls of universities or government, societies of learned people formed to share their readings, thoughts, and discoveries, as well as to support and criticize their new claims to knowledge. These societies, often enjoying patronage of rich families or royalty, became the centers of learning. The Scholarly Societies Project (www.scholarly-societies.org) has identified thirty such societies prior to 1600. The earliest that specifically turned its attention to natural philosophy appears to be the Accademia dei Segreti founded by Giambattista della Porta in 1560 in Naples and lasting twenty years until shut down by ecclesiastical opposition. Among the other early scientific societies was the Accademia dei Lincei (1603–1630 in Rome), Accademia degli Investiganti (circa 1650–1670 in Naples), and the Accademia del Cimento (1657–1667 in Florence). In 1660 the Royal Society of London, the oldest scientific society in continuous existence, was organized from a series of informal meetings. As the first in Scandinavia, the Royal Society of Sciences at Uppsala (Kungl. Vetenskapssocieteten i Uppsala) was founded in 1710 and the Royal Swedish Academy of Sciences (Kungliga Svenska Vetenskapsakademien) in Stockholm in 1739. At first communication among scientists across Europe was facilitated by active letter writing with some individuals becoming the centers of correspondence, such as Marin Mersenne (whose correspondents were to form the basis of the Académie Royale des Sciences) and Henry Oldenburg (who was secretary of the Royal Society of London). Out of these two networks were to form in 1665 the first scientific journals *Journal de Scavans* and the *Philosophical Transactions of the Royal Society*. While the earliest journal issues carried the trappings of letter correspondence, this was to rapidly evolve into distinctive authored articles.

By 1790 over 1000 scientific journals had appeared, at least briefly, of which three quarters presented original contributions and/or were society proceedings (Kronick 1976). Currently the Scholarly Societies Project indexes over 4000 societies.

The interest in nature was coupled with a desire for language appropriate for communicating about nature. The wide availability of detailed descriptions and illustrations of botanic species, for example, vexed prior taxonomy, as principles were needed to aggregate and organize these many species in collections. Bacon (1603), in *The Advancement of Learning,* argued that we often mistake words for things and lose sight of the things themselves: words come to us filled with unconsidered and unsubstantiated associations, and words sometimes name things that do not exist or that are ill-defined. Bacon expressed a desire for a method of notation that would not be deluded by what he called the Idol of the Marketplace. His critique inspired projects for universal languages which could be used to record and organize all knowledge in its true form – the best known of which is Bishop Wilkins *Essay towards a Real Character and a Philosophic Language*. Bacon's (1620) description of Solomon's house in the *Novum Organum* set out a communal project for the gathering, inscription and interpreting of knowledge of nature that inspired the Royal Society. Thomas Sprat's (1667) hyperbolic description of *The History of the Royal Society* sees language purification at the heart of the society's project. Despite hopes for a language that transcended rhetoric, scientific writing was always to remain persuasive and argumentative, but the grounds of the argument were to shift to accounts of empirical experience. A plainer style, less reliant on ornaments, was to influence pages of the new scientific journals. Nonetheless, figures of speech and thought (such as antithesis, series and repetition) were to remain an essential part of scientific writing (Fahnestock 1999).

Journal publication and society meetings created new forums for scientific arguments that had previously been published in books that were only publicly contestable years later in new books (Bazerman 1988). Further books contained such a myriad of details and claims that it would be difficult to focus a specific disagreement across books. At Royal Society meetings, however, the heart of the argument was a physical demonstration of an empirical reality (Dear 1985; Shapin and Schaffer 1985). Issues of detail could be directly debated. Further, the rapid response available in journals allowed for controversies to be argued with many rounds of responses. But as journals could contain only accounts of demonstrations, to be read by distant audiences, the credibility of the witnesses and the impressiveness of the described apparatus carried persuasive value. At first, credibility drew on earlier social resources for gentlemanly credibility, but, over time, scientific expertise became the source of credibility (Shapin 1994).

Credibility also came to be enhanced by the scientific credibility of the editor of the journal and the persons who were to assist in the evaluation, criticism and selection of the articles in what emerged as a system of referees by the middle of the eighteenth centuries. These social changes were accompanied by transformation of a more gentlemanly style for a more overtly contestative and professional one (Atkinson 1999; Gross et al. 2002), expressing evaluations through facts, use of the literature and irony rather than overt first-person judgments (Gunnarsson 2001; Myers 1989, 1990b). This professional discourse had unique features that set it apart from languages in other social domains and made it increasing difficult for non-specialist and amateur reading (Halliday and Martin 1993; Battalio 1998). Differing historical, social, cultural and economic circumstances in different countries lead to distinct kinds of journals and forms of articles (Gunnarsson 1997; Gross et al. 2002).

Controversy was to erupt on the pages of the journals as natural philosophers questioned each other's results. More detailed accounts of the conditions and actions that led to the results soon followed, as did quantification and precision in reporting the results. More extensive reasoning connecting theory and research design and results led to theoretical claims being supported through experimental and other methodologically focused empirical evidence (Bazerman 1988). Changing ideological beliefs about the value of collective experiences along with the mounting accumulation of empirical results led to the development of modern practices of citation and reviews of literature in the latter part of the eighteenth century (Bazerman 1991). Many of the rewards and values associated with participation in science developed in conjunction with journal publication and served to reinforce participation within the journal system (Merton 1973; Bazerman 1988). Recurrent violation of these values in terms of misrepresentation of parts of the experiments and results, plagiarism, lack of supervision, collusion, or self-delusion serves to illustrate how strongly rewards are tied to values. The periodic scandals and calls for self-policing indicate how much hangs on the reliability of the system threatened by such acts (Broad and Wade 1982; LaFollette 1992).

The systems of publication and authorship grew hand in hand with the formation of modern science. The work of scientists to contribute to knowledge was directed and focused for publication in the emerging journals. Scientists adopted roles of editors, critical readers, and referees as they became engaged in journal production. Communal values of criticism, shared production of knowledge, and objectivity became formulated around the conflicts of the publication process. And the published literature came to stand for the accumulated accomplishment of the sciences. Within that simultaneously cooperative and agonistic social system, the concept of the individual scientific authorship and credit

for discoveries arose as a reward along with accountability and responsibility for claims (Merton 1973), although authorship has in recent decades been transformed through the emergence of large collaborative science (Biagioli and Galison 2003). Further, within the social organization of reviewing, criticism, publication, and uptake, even the singly authored article is a social accomplishment (Myers 1990a).

## 4. Systems of worldly knowledge

Although the emergence of modern science is seen as paradigmatic of the growth of knowledge, many other systems of knowledge were also developing in the renaissance and early modern Europe, including commercial, journalistic, technical, colonial governmental and military. Each of these developed somewhat separately from the other. Each had their own documentary systems, different uses for print media, and restrictions on the free flow of information. Eventually, however, they were all to find common interest in the modern research university, ultimately putting pressures on what the university should be producing and how its knowledge should be circulated or restricted in access.

Commercial information was and remains in large part proprietary financial information maintained through the Renaissance technologies of accounting (Littleton 1933). As commercial enterprises grew and became geographically dispersed, particularly in the last two centuries, new technologies from typewriter and filing cabinets to electronic storage and computing were invented to produce and keep track of the growing information needed to manage (Yates 1989, 2005). Expanding commerce also required information about foreign markets and trade – giving rise to newspapers, market reporting, financial and industrial journalism, and other databases that are part of business decision making (Raymond 1996; Andrews 1968; Bourne 1887; Sommerville 1996). Financially valuable market and commercial information particularly motivated information technologies, whether nineteenth century telegraphy or current internet.

Knowledge of the specific arts upon which commerce was based also became of great value. The origins of technical writing have been traced to the printed books of instruction in practical arts such as silkworm production, beekeeping, and cooking that appeared in the Renaissance (Tebeaux 1997; Brockmann 1998). Some of the arts were so complex as to require extensive documents closely held among the adept, such as apothecaries and herbalists, lens makers, and alchemists. Today's technological enterprises are even more deeply tied to the production and use of new knowledge. Patents and their publication

(Federico 1929; Bugbee 1967) were until recently a knowledge system carried out almost entirely separate from the university. With the industrial revolution and the formation of large corporations technological and industrial development became closely intertwined. (Currently about 85 % of patents are granted to corporations.) Recent partnerships between universities and corporations, particularly in the biotech industry, however, have raised questions about restrictions of scientific publication, hampering scientific advance, and sheltering embargoed work from peer criticism and evaluation of the work (Lievrouw 2004; Etzkowitz, Webster, and Healey, 1998).

Today information and knowledge themselves are commercially valuable commodities. The economic value of texts was established by the extension of patent monopoly to copyright in the eighteenth century. As the length of the copyright monopoly has been extended, more extended ownership of the knowledge instantiated in texts has been made possible, and ownership has aggregated in publishing houses. As modern society has become more dependent on knowledge, the economic value of many sorts of information, and the texts that bear them, has increased, particularly with the advent of electronic communication and the internet. This means that the purchaser may only gain transient use of the purchased knowledge product, while the permanent and authoritative copy still resides solely in the possession of the owner. The consequences of these arrangements has tempted a few corporations to try to gain ownership of large segments of the knowledge our society depends on, knowledge now largely produced by the university.

Another related driver of knowledge production that is now influencing the future of the university has been national interest. At first national interest was expressed through exploration and colonialism, then through nationalism and national identity, and in the twentieth century through military technology and national security concerns (Ruegg 1996). During the period of exploration and colonialism, knowledge of the resources and economies of foreign holdings and the internal wealth of the home nations became matters for internal circulation within governments and more broadly within society as entrepreneurship and citizen patriotism became part of the enterprises (Eisenstein, 1979). By the eighteenth century knowledge of standardized national languages and then a century later knowledge of national literatures became means and markers of participation in the enterprises of the nation (Anderson 1983; Helgerson 1992; McArthur 1986). Texts of political and social philosophy became widely circulated controversial documents, as societies sought for the grounds of order outside church doctrine or monarchical authority. Hobbes, Locke, Hume, Montaigne and Rousseau, among others, pervaded a new public sphere which sought explicit rational justifications and designs for their constitutions, most

notably during the American and French Revolutions. Each of these new political formations created institutions for the advance of knowledge, as well as the collection and distribution of texts (Fliegelman 1993; Warner 1990). Though this age of political thoughts was fostered in an international climate of freedom and exchange, this movement towards cosmopolitan democratic rationalism was to become fractured by national identities and national languages. Consequently, distinctive national traditions, affecting what scholars were likely to read, developed in philosophy, humanities, and social thought – and even to some degrees in the natural sciences (see, for example, Guerlac 1981). Further, insofar as scholarship remained international, national languages competed to be the dominant in each area of study, with French and German each having domains of dominance until the general dominance of English from the middle of the twentieth century on. This language situation, in turn, led to an expectation that any person of learning (even in areas of little language contact, as in the U.S.) needed familiarity with several European languages. Gradually in the nineteenth century, the universities began to accommodate their curricula to include more instruction in contemporary foreign languages, in the local vernacular and in local history and culture, particularly as the Napoleonic and Humboldtian reforms reorganized universities and new subjects and disciplines.

The military has long seen knowledge as providing strategic advantage, but only in the middle of the twentieth century has the university been seen as a provider of that knowledge. Treatises on military knowledge were produced in ancient China, India and Rome. At the time when printing emerged in Europe, however, the political conditions were particularly unstable with nations in frequent conflict on economic, national, and religious grounds. These conditions created a rich market for technical military books on fortifications, shipbuilding, gunnery and ballistics. As science demonstrated its military potential, governments began to enlist it to produce new weapons. Over the ensuing centuries, advances in cartography, communication and transportation (such as telegraphy and rail), propulsion (steam and internal combustion), armaments (such as the machine gun) and shipbuilding (ironclads and steampower) were of military interest. Chemistry, physics and information technologies were central to the efforts of both sides in the two world wars of the twentieth centuries. Aeronautical and aerospace engineering along with bio- and nano-technologies were added to the mix in the latter part of the century. The knowledge produced in developing each of these military technologies was a complex of secret, bureaucratic, field operational and open scientific knowledge, with increasing involvement of the university as the century progressed. Currently most academic research in the United States is funded by the federal government. (On average, 60 % of it is, defense related.) Much of those funds are administered by the Department

of Defense, which has developed an elaborate congressionally-regulated system for developing projects, calling for and receiving proposals, and forming contracts with academic and industrial vendors. This system forms tight communicative relations among universities, corporations, and the military (Van Nostrand 1997), and exerts a strong though quiet influence on the growth and operations of universities.

## 5. The modern research university

While some creators of knowledge in the sixteenth through eighteenth centuries were university trained and held university posts, the main advances occurred outside universities and were largely disseminated outside university networks. Galileo is a case in point; although he studied medicine at the University of Pisa, he left without a degree to study mathematics under a military engineer. He then taught mathematics, astronomy, mechanics and fortification in the cities of Siena, Pisa and Padua, but only in part at universities. He left universities entirely when he gained the patronage of the Medicis.

Gradually some universities made some curricular adjustments and hosted chairs in new specialisms (such as the Lucasian Chair in Mathematics that Newton occupied at Cambridge). Yet the university curriculum generally remained conservative, aimed at the moral formation and intellectual discipline of leadership classes, principally clergy, lawyers and physicians. The Reformation did not bring secularization, autonomy, or research to the university, but only changed the religious auspices, to which national sponsorship was sometime added. Sweden only in part followed this model. At Uppsala the pro-chancellor was regularly the archbishop of Sweden, and at other Swedish universities at Abo (Turku) and Dorpat (Tartu) clergy also were pro-chancellors (Ridder-Symoens 1991). Nonetheless, the Swedish royalty also seemed to understand the relationship between free knowledge and the prosperity and power of the state. King Gustav II Adolph appointed his personal advisor Johan Skytte, chancellor of Uppsala in 1622, only two years after a generous Royal gift put the University on solid financial grounds (Ridder Symoens 1991). Skytte was also to be appointed Chancellor at Abo and Dorpat. He apparently took an active role in the administration of these universities. Gustav Adolf took a strong interest in all of the Swedish universities, including the philosophic curricula, and he provided a large donation to expand the library. Linnaeus, (according to Rausing 2003) saw his botanic project as part of a Christian economy and stewardship of nature, placing his work at the intersection of church and state – making it a candidate for sponsorship within the Swedish university. Sweden

also forged a novel arrangement among crown, university, and the printer Lars Salvius. Swedish academic interest in the intersection of scientific and practical knowledge distinguished it from the more clerical concerns of most European Universities. This practical interest made the 18th century Swedish Universities in some part similar to the Scottish Universities that with secular charters were the most overt exceptions to academic traditionalism during that period.

Of course in the next century major university reforms in France – in the wake of the Enlightenment, the Revolution and the Napoleonic reorganization – abolished the colleges of the *ancien régime*, and forming new secular professional schools. Research was, nonetheless, supported in non-university institutes and centers, such as the botanic and zoological gardens. This model of reform held some influence over mid-nineteenth century universities elsewhere in Europe. Prussia, following the ideas of Kant, Fichte, Schliermacher and Humboldt, developed another model of university reform at Göttingen, Halle, and Berlin, based on scholarly research professorships and advanced research seminars and degrees. While the professorships initially were in philosophy and theology, these soon became differentiated into philology, history, economics, and the sciences. This model spread to the rest of Germany, particularly after its unification in the nineteenth century, as well as to Austria, Russia and the United States. By the turn of the twentieth century the German model influenced the more traditional systems of England and southern Europe, as well as the French bureaucratic system

Even though universities had become the primary center of scientific research by the end of the nineteenth century, scientific publishing had remained largely in the hands of the independent printers and publishers of books and journals. As societies formed and published journals, they also worked with commercial publishers and printers. The few existing university publishers such as Cambridge and Oxford were devoted to history, the humanities and theology. With the rise of the research university, by the turn of the twentieth century, university presses became more common, often with a special responsibility for the work of their faculty.

The changing nature of the university also affected the role and collections of the university libraries. The early medieval university was mainly devoted to the study of the classic canonic, and the purpose of the university library was to make canonical texts available to faculty and students. But libraries changed and took on a new importance as science developed into a highly intertextual, cooperative system in the late eighteenth and nineteenth centuries, moving hand in hand with the development of modern citation practices. Libraries needed to collect the most up-to-date material and not just be a storehouse of canonical texts. Thus today, a researcher cannot publish in science without positioning

you're his or her work against a rapidly evolving literature, knowledge of which requires an up-to-date library, or now its virtual extension. Again in Sweden there seems to have been a productive relationship among crown, scientists, and university and national libraries.

Sweden's and Scotland's unusual eighteenth century arrangements of worldly and knowledge institutions were in some ways precursors to the general university reforms and scientific reorganizations of the nineteenth century. They might now be worth looking at afresh to find clues as to how to maintain a degree of independence of knowledge in the face of forces reconfiguring the power, interests, and alliances surrounding scientific and university institutions.

The success of the university in producing and disseminating knowledge has increased the value of that knowledge as well as the interest of its sponsors in wanting more direct benefit. Higher degrees of political and economic organization have exposed the university to increasing external influence even as its success has increased its size and resources. The clients of university-produced knowledge are willing to pay very high prices for knowledge valuable for commerce, medicine, military, law and other practical uses. These clients do not necessarily share the view of knowledge as a public good to be shared internationally; for various competitive reasons they are just as happy to keep knowledge flow restricted. These same clients have entered into tighter relations with research universities so as to foster the kinds of knowledge they perceive as most useful and to gain proprietary edges against competitors, again with pressures for the restriction of knowledge to the higher paying patrons.

The publishers at the same time have been taken up in larger corporate conglomerates and have replaced the traditional ideology of the publishing industry which was culturally aligned with the university and other knowledge institutions with the monopolistic financial logics of mega-corporations. They are aware that information and knowledge are valuable commodities with customers willing to pay the cost.

The value of information has also fostered new technologies for its dissemination that are disrupting traditional routes of distribution, access and storage. These new technologies change the function of the university libraries, which from the beginning had been the central collecting place and local distribution point for the knowledge essential to the university – whether in the traditional church or the modern research version. The core collections now can reside in servers owned by the external providers rather than in the physical copies held in the library. The corporate publishers are taking the opportunity of this moment to restructure the market in their favor basing their pricing on their highest paying clients, and putting the squeeze on the vulnerability of the university library in transition. Insofar as they succeed, they limit the flow of knowledge

(maintaining its high price) and hamper the cooperative enterprise of knowledge production and restrict the wide distribution of knowledge for the public good, including those forms of knowledge aiming at social reform that are not of interest to the higher paying clients.

These same technologies that are providing this commercial monopolistic opportunity, however, provide low cost opportunities to bypass the marketplace logic of the most well-heeled clients and the conglomerate sellers. That is the story of the growing open access movement.

All these forces are creating tensions and destabilizations within the current models of university-based scientific knowledge production and distribution. All threaten the independence of knowledge production carved out in a complex landscape of fractionated power over the last six centuries. While the more stable and unified world that has been emerging in the last half-century is a great blessing, the forces of centralization through alliances of capital and government threaten to harness knowledge production and dissemination more directly to the needs of state, national security, and economy, as was the case in the stable, hierarchical Chinese empire whose knowledge evolved only slowly for two thousand years.

The conditions for autonomy of scientific publication in early modern Europe have clearly changed but they have left a remarkable legacy of secular inquiry and open distribution of knowledge. The wonder of the modern research university is transient and fragile – a conjunction of historical forces. The independence and dynamic growth of knowledge depends on creating new arrangements that allow and even encourage scholars and students to pursue new truths that do not seem to have immediate pay-offs for the state, military, and industry who pay the bills – truths that may even seem heterodox to the sponsoring powers. Looking back to the earlier configurations and the forces that led to our current arrangements is more than a matter of historical celebration, it is a matter of understanding what our world has been constructed of so we can continue in its constant reconstruction.

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