CHAPTER 10

Writing and Secular Knowledge Within Modern European Institutions

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After the collapse of the Roman Empire, the seats of learning moved to Constantinople and Baghdad. With few texts, poorly distributed in Europe, learning was thin and static for over five centuries. Yet within this bleak landscape, the reintroduction of the texts of the world produced institutions, practices, and forces that were to be the basis of modern learning, knowledge production, and scholarly communication that now encompass the globe.

THE EUROPEAN MIDDLE AGES AND THE BIRTH OF THE UNIVERSITY

In the early European Middle Ages, classical knowledge was limited to a few Latin texts and compendia derived from them, such as Isidore of Seville's (560–632) encyclopedic *Etymologies* and Boethius' (ca. 480–ca. 525) Latin translations of Aristotle's works on logic. Some chronicles, most notably Gregory of Tours' (d. 595) *History of the Franks,* documented newly powerful peoples and political structures. Extant texts were housed in monastic and other church collections with only small, sporadically consulted holdings. Beyond the brief accomplishments of Alcuin during the eighth-century Carolingian Renaissance, few institutions supported instruction in these texts, so the vitality of knowledge depended on individual scholars.

Developments in the 11th and 12th centuries increased the available stock of knowledge texts and expanded organized access to them. When Umayyad Islamic culture in Spain met the Christian reconquest, Europe regained access to classic Greek and Roman texts preserved by Islamic scholars. Ptolemy's synthesis of the work of Greek astronomers, for example, became known through its Arabic translation *al-Majisti*, translated into Latin as the *Almagest*. Many of Aristotle's works were recovered, including his works on medicine and biology, as was Plato's *Timaeus*, Euclid's *Elements,* and Galen's medical works. The taste for texts held in the Islamic world led to interest in other texts available in Constantinople as well as the work of Islamic scholars such as Al-khwarizimi's *Algebra* and Avicenna's commentaries on medicine and philosophy.

Scholars translating and studying these works created a vital intellectual life in the monasteries and larger cities of Europe. Students gathered around scholars lecturing on classic texts, usually beginning with a passage following with an interpretation (Ridder-Symoens, 1991). Generally courses focused on works of moral and natural philosophy along with metaphysics. As available texts increased and scholars gathered in greater numbers, teachers and students organized themselves in guild structures to form the bases of modern universities. These universities first formed in the south, in Italy and Spain, with additional centers around Paris and London. By the end of the 12th century, universities existed at Salerno, Bologna, and Reggio, and soon others emerged at Vicenza, Palencia, Paris, Oxford, Montpelier, Arrezo, Salamanca, Padua, and Naples, with around 20 by the year 1300. By 1500, more than 60 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). The universities varied in size from those that could accommodate over 1,000 students simultaneously (such as, at times, Paris, Orleans, Toulouse, Avignon, Bologna, Oxford, and Cambridge) to those that barely accommodated 100. Nonetheless, from the middle of the 14th until the start of the 16th, approximately three quarters of a million students matriculated throughout Europe, as Schwinges (1991) conservatively calculates.

Curricula were soon standardized under Vatican authority, and degrees granted were held to be valid and equivalent throughout Christendom, although certain faculties were recognized as superior. There were four faculties or disciplines at these universities (theology, law, medicine, and liberal arts), although only a few universities had all four. These disciplines were each defined by a list of authorities or standard texts; studies and authors not included in this classification were in most cases excluded from formal study (Verger, 1991).

The mode of instruction consisted of lecture on passages from authoritative texts (in Latin translation) and debate on general propositions conducted on the basis of those same authoritative texts. Consequently, books in Latin were at the heart of the curriculum, and the shared learning was based on the core disciplines of language and interpretation—the liberal arts trivium (composed of grammar, logic, and rhetoric), although logic and grammar at times took a speculative turn into philosophy, particularly as the Greek and Arabic texts were translated into Latin. The new texts also put new life, substance, and interest into the quadrivium of arithmetic, geometry, astronomy, and music, which gained increasing presence in the universities during the late medieval period (Leff, 1991), in response to the availability of new texts (North, 1991).

In addition to the liberal arts of the trivium and quadrivium, medieval universities contained more specialized faculties. The faculty of medicine distinguished its graduates from the many nonuniversity-trained medical practitioners through the study of Greek and Islamic texts translated into Latin, particularly works attributed to Hippocrates and Galen along with the Islamic encyclopedic works of Avicenna, Haly Abbas, ar-Razi, and Albucasis. These were largely taught through lecture and disputation as were the liberal arts, although supplemented with some practice, apprenticeship, and dissection—guided by the same texts. Surgery, using texts of more recent vintage incorporating practical experience along with Galen, was not part of all medical faculties, and was in fact excluded from Paris (Siraisi, 1991).

The faculty of law, teaching both canon and civil law, was also based on commentary of authoritative texts. The authoritative texts of canon law or *corpus iuris canonici* were of more recent vintage, being 12th-century and later summations of church law, decrees, and rulings, supplemented by contemporary additions to church law. The *corpus iurus vilis* was based on Justinian's code, dating from the end of the Roman Empire, which had been in continuous circulation in Europe since then. This was supplemented by more recent constitutions of German emperors and contemporary commentary. Legal works were sometimes translated and taught in the vernacular. Thus law seemed more closely attached to contemporary situations and institutions. Furthermore, as clerics needed to write legal documents, contracts, and the bureaucratic correspondence of the church, training in writing practice through *ars dictaminis* and *ars notaria* became part of the curriculum, at least in some Italian universities. Nonetheless, law remained taught through lecture and disputation, with the logic and organization of the classic legal canon taking priority over any contemporary code operative in the jurisdiction in which the university was located. This system of legal training as a form of scholastic learning remained universal in Europe through the 17th century. In some countries, law is still studied as a form of liberal art and logic through university lecture (Garcia, 1991).

The fourth faculty of theology taught specifically religious knowledge, exegisis of sacred texts, and philosophic disputation of questions of religion. Relevant to secular knowledge is that many of the fundamental disputes of theology had to do with whether attention or authority should be given to pagan philosophers or whether theology should proceed only on the basis of the testaments and the church fathers. That tension between sacred and secular texts of course continued through Renaissance humanism and the transformation of natural philosophy into modern science. The place of theology within universities moving to secular sponsorship has been a continuing question, particularly in the United States, where state sponsorship has been accompanied by the legal separation of church and state.

THE PRINTING PRESS AND CHANGING NETWORKS OF KNOWLEDGE IN EUROPE

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. In the 15th century, however, knowledge moved out into the world. The moveable-type printing press, along with related inventions and social arrangements (see chap. 2, this volume), made books available in increasing quantity, no longer tying the scholar to the university or monastery library and freeing the scholar from supervision within church-supported activities. Reformation religious division and struggle did not fundamentally change the church bound character of the universities, although changing some allegiances and disrupting the Vatican's universal curricular authority.

Even more, the printing houses proliferating across Europe, often near university towns, 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, as China had done. Rather, 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.

Multiple copies of books and the ability to compare editions led to textual scholarship to establish definitive editions (Grafton, 1991). The multiplication of contemporary and ancient books led to vigorous debates over the value of classical and contemporary learning in what became known in England as the battle of the books (Jones, 1965; Levine, 1991).

WRITTEN KNOWLEDGE AND PROFESSIONAL PRACTICES: MEDICINE, LAW, AND COMMERCE

Medicine had strong motive to reach beyond the books to incorporate practical knowledge gained through surgery, which had been kept at the margins of universities by its craft nature and the church prohibition of dissection. During the 15th and 16th centuries, university medical studies combined medical and surgical cures, relating books and embodied practice more closely. By the 17th century, the new discipline of anatomy mixed books with skeletons, bodies, and models to give order to discoveries and to become a cornerstone of medicine (Pedersen, 1996). Two centuries later, anatomy was to be brought in relation to knowledge of infectious agents, and shortly thereafter to chemical knowledge of the pharmacopia, biochemistry, and now genetics. Each of these extensions of relevant knowledge recontextualized understanding of the operation and regulation of the body, as seen through textually inscribed orders, principles, and empirical findings. This bookish part of medical education is then reinforced and applied in situ (Lingard et al., 2002); it also organizes and directs the professional vision by which experts come to see the world in knowledgeable ways (Goodwin, 1994). New medical tools, expanding the kinds and amount of inscribed data available, have now combined with electronic manipulatable multimedia texts to bring about new levels of integration between the body and the book. Although anatomy and other studies preliminary to medical practice continued to be taught in the universities, the central site of medical education moved to the teaching hospitals, which mix the book learning, bodies, practice, and formation of new knowledge in the production of research.

As national legal codes elaborated and commercial interests expanded, the faculties of law included more contemporary law in their curricula still dominated by Roman Law (Brockliss, 1996; Pedersen, 1996). In England, however, the adherence to common law and the collection of texts of laws and customs led to a break with Roman Law; legal education left the universities and organized around the courts with their libraries that informed both education and practice. This separation of law from the humanistic and philosophic grounds of the university has led to a substantially separate system of legal knowledge in the Anglo-American world, in both the profession and legal education, reflected in the specialization of law libraries and the limited legal collections in libraries where there is not a law school. There is a separate world of publication, circulation, use, and even radically different citation. Much of legal education has to do with navigating, interpreting, and applying this alternative documentary system for purposes of communicating, staking claims, and adjudicating within this textualized world that regulates rights and obligations in the material and social world of daily life (see chap, 8, this volume).

Commercial growth also made commercial information more valuable. Although the keeping of financial records was as ancient as writing (see chap. 1, this volume), only in 14th-century Italy did the rights of private ownership, volume of trade and capital, and the development of money and financial instruments (see chap. 6, this volume), combined with advances in arithmetic, come together in the new advance of double-entry bookkeeping (attributed to Benedetto Cotrugli and widely disseminated through the 1494 treatise of Luca Pacioli), which is generally taken to be the founding of the accountancy profession (Littleton, 1933). Proprietary financial information generally stayed with the commercial venture or estate of the wealthy person except for government intervention or regulation, particularly with the rise of publicly traded corporate stock in the 18th and 20th centuries. In the last two centuries, to keep track of the complexities of large corporations and geographically dispersed enterprises new modes of knowledge organization (first the pigeonhole desk, then the file folder and the filing cabinet, then electronic storage and retrieval), new means of inscription and reproduction (typewriter, rexograph, and punch card and data entry systems), and new genres (memo, report, corporate charts, and databases) were invented (Yates, 1989, 2005).

New commerce also required information about foreign markets and trade at urban centers. The earliest newspapers in England in the early 17th century arose out of letters by agents circulating information about commercial markets to gentry in the provinces (Andrews, 1968; Bourne, 1887; Raymond, 1996). The Fugger family in Europe also had a chain of correspondents to provide commercial news (Sommerville, 1996). From these arose the earliest newspapers (see chap. 13, this volume), and ever since newspapers have had a strong component of business and financial news, whether reports of sailings and arrivals, latest market prices, or corporate restructurings. With industrial and corporate and financial market growth in more recent centuries, a robust specialized financial and industrial journalism has developed, often organized around industries and job categories. Market prices have come to be seen as valuable information. With the need for instantaneous knowledge, such markets have become the sites of the development of new communicative and information technologies, whether the ticker tape of the late 19th century or the Internet a century later.

Knowledge of the specific arts on 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 farming, silkworm production, beekeeping, estate management, home management, and cooking that appeared in the Renaissance (Brockmann, 1998; Tebeaux, 1997). In the medieval period, many of the practical crafts and arts were held as orally transmitted secrets within the guild system. But 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.

Another means of maintaining monopoly was a royal letter of patent, granted to guilds and individuals. In England in 1624, the royal abuse of such grants was restricted, leaving only the possibility of temporary monopoly for the inventor of a new good. This led to the development of the modern system of patent, whereby new inventions are registered and made public in return for a temporary monopoly (now 14 years; Bugbee, 1967; Federico, 1929). By the 19th century, all patents were published and made widely available in national repositories. The archives of the patents have become an organized body of knowledge to be consulted in the preparation of new patents and in litigation involving patent rights. Currently, patent applications include a review of prior art as revealed in the patent archives. During the 19th century, a series of treaties coordinated the patent systems of many countries, culminating in the 1883 Paris Convention for the Protection of Industrial Property and revised periodically since then. It now is signed by 169 nations, with more than 150,000 patents granted annually, over half emanating from the United States.

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. Control is exerted more through a constant flow of new patents than by secrecy. Nonetheless, papers presenting industrially sponsored scientific work that has not yet eventuated in patent ownership often are restricted in publication and distribution. Particularly, the emergence of the biotech industry in partnership with universities has raised questions about restrictions of scientific publication, hampering scientific advance and sheltering embargoed work from peer criticism and evaluation of the work (Etzkowitz, Webster, & Healey, 1998; Lievrouw, 2004).

One final wrinkle on this subject has been the recognition that information and knowledge themselves are commercially valuable commodities, especially as we move into what has been called an information economy. The economic value of texts was established by the extension of patent monopoly to copyright in the 18th century. As the length of the copyright monopoly has been extended, largely under an ideology of author's rights, 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, so that the purchaser may gain only transient use of the purchased knowledge product, the permanent and authoritative copy of which still resides solely in the possession of the owner. We are starting to see the consequences in industry and the academy as a few corporations are gaining ownership of large segments of the knowledge our society depends on.

KNOWLEDGE OF EXPLORATION, COLONIES, AND NATIONS

During the 15th and 16th centuries, other knowledges moved from the universities out into the world. The age of exploration expanded the need for astronomy, the arts of navigation, and map making; geographic documents were spread by the growing print industry (Ruegg, 1996). Exploration and trade also brought natural and cultural wonders from around the world, collected in wonder cabinets, and illustrated and described in volumes (Impey & Macgregor, 1985). Colonial conquest created needs for documentary control of the colonies, with such results as the Archivo General de Indias in Seville becoming the repository for more than 45 million documents from the Spanish colonization of the new world. The colonial archives of the various European empires contained geographical, geological, mineralogical, anthropological, botanic, zoological, agricultural, and economic knowledge, as well as political and legal documents defining the colonial order and economic exploitation. This massive expansion of recorded knowledge of the world, however, was accessible only to ruling elites, of the church, the throne, or commercial organizations.

Within Europe, expanding commerce combined with print images, descriptions, and tales to increase knowledge of the peoples, customs, lands, and arrangements throughout the continent. This knowledge of human, geographic, zoologic, and botanic variety also expanded national and regional awareness (Eisenstein, 1979). Knowledge of national histories and national cultures, including literatures, became important forms of citizenship identification and affiliation (Anderson, 1983; Helgerson, 1992). In the later 19th century and 20th century, such knowledge entered curricula of schooling and universities.

As the publications and knowledge of each nation came to be understood as part of the heritage and vitality (economic, cultural, and spiritual of each region), the language of publication switched from Latin, the previous international language of scholarship, to the local national vernacular. This had been largely accomplished in the 17th century, and was typically followed by a movement for standardization and purification of the prestige dialects of the national capitals used in publication. This once again provided motive and tasks for further development of linguistic knowledge, with a prescriptive intent. In 1612, the Florentian Accademia della Crusca published its *Vocabulario della Crusca,* helping define the Italian language. In 1647, Claude Favre de Vaugelas, an early member of the Académie Française, published his influential *Remarques sur la langue française*. And in 1755, Samuel Johnson's *Dictionary of the English Language* attempted to regularize English. Each established a standard for publication and editorial improvement. The languages became associated with national genius, and knowledge of them became marks of refinement and dedication to the culture so that each nation that wanted to achieve full status would need to produce its monumental dictionary, such as Noah Webster's *American Dictionary of the English Language* in 1828 and the Grimm brothers' *Deutsches Wörterbuch* begun in 1838 but not finished until 1960. Advancement of knowledge of national languages as well as the national cultures and literatures produced within them became a matter for state support (McArthur, 1986). To this day, nationalist movements are often accompanied by attempts to revivify and purify a national language, to spread literacy in it, and to create familiarity with the texts considered the national heritage.

Access to texts of the classical world inspired visual, architectural, and verbal arts on ancient models as well as provided models for the political revolutions to follow in the 17th and 18th centuries. Starting with the Puritan Revolution in England, formation of states became increasingly based on philosophic grounds. 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 that 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 thought was fostered in an international climate of freedom and exchange, this movement 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 the natural sciences (see e.g., Guerlac, 1981). Furthermore, insofar as scholarship remained international, competition ensued to be the leading language in any area of study, with French and German each having domains of dominance until the general dominance of English from the middle of the 20th 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 United States) needed familiarity with several European languages. This expectation still resides in undergraduate and graduate language requirements, though now reinterpreted through business and cultural-diversity motives.

PRINT AND THE FORMATION OF SCIENCE

Science, previously called natural philosophy, is closely associated with consequences of the printing press: easier access to classic texts; wide and rapid dissemination of new data, observations, and theories; the reproduction of exact descriptions, tables, illustrations, and maps that allowed the comparison and aggregation of astronomic, geographic, botanic, zoological, and anatomic data; the impetus to criticism, commentary, taxonomy, and theory based on the access to multiple sources that then could be compared to new results; and 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). Although 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 17th century (Shapin & Schaffer, 1985), and the restored monarchy needed to position itself warily with respect to natural philosophic inquiry, which it sequestered apart from public discourses of faith and royal legitimacy (Jacob, 1976).

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 (http://www.scholarly-societies.org) has identified 30 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 20 years until shut down by ecclesiastical opposition. Among the other early scientific societies was the Accademia dei Lincei in Rome (1603–1630), Accademia degli Investiganti (ca. 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. 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*. Although the earliest journal issues carried the trappings of letter correspondence, this was to rapidly evolve into distinctive authored articles. An illustrated overview of the history of scientific journals can be found at http://www.fathom.com/course/21701730/index.html (see also Kronick, 1976, for a catalog of early scientific journals). By 1790, more than 1,000 scientific journals had appeared, at least briefly, of which three fourths presented original contributions and/or were society proceedings (Kronick, 1976). Currently the Scholarly Societies Project indexes more than 4,000 societies.

The interest in nature was coupled by 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 (Slaughter, 1982). Bacon 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 that could be used to record and organize all knowledge in its true form—the best known of which is Bishop Wilkins's *Essay Towards a Real Character and a Philosophic Language*. Bacon's 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 (Pera, 1994; Pera & Shea, 1991), but the grounds of the argument were to shift to accounts of empirical experience (Bazerman, 1988; Dear, 1985). 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 publicly contestable only years later in new books. Further books contained such a myriad of details and claims that it would be difficult to focus a specific disagreement across books. At society meetings, such as at the Royal Society, however, the heart of the argument was a physical demonstration of an empirical reality. As such, much effort went into the creation of apparatus that could experimentally demonstrate phenomena (Shapin & Schaffer, 1985). Issues of detail could be directly debated. Furthermore, 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 people who were to assist in the evaluation, criticism, and selection of the articles in what emerged as a system of referees by the mid-18th century. These social changes were accompanied by transformation of a more gentlemanly style for a more overtly contestative and professional one (Atkinson, 1999; Gross, Harmon, & Reidy, 2002), expressing evaluations through facts, use of the literature, and irony, rather than overt first-person judgments (Gunnarsson, 2001; Myers, 1989, 1990a). This professional discourse had unique features that set it apart from languages in other social domains and made it increasing difficult for nonspecialist and amateur reading (Batalio, 1998; Halliday & Martin, 1993). Differing historical, social, cultural, and economic circumstances in different countries led to distinct kinds of journals and forms of articles (Gross et al., 2002; Gunnarsson, 1997).

Controversy was to erupt on the pages of the journal 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 18th 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 (Bazerman, 1988; Merton, 1973). 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 and the periodic scandals and calls for self-policing indicate how much hangs on the reliability of the system threatened by such acts (Broad & Wade, 1982; LaFollette, 1992). The current increasing alliance among government, industry, and science presents challenges to the kind of open communication of results and debate that is at the heart of scientific evaluation.

The systems of publication and authorship grew hand in hand with the formation of modern science: Emerging forms of journal publication focused and directed the work of scientists aiming to contribute; roles of editors, critical readers, and referees emerged around journal production; communal values became formulated around the publication process; and the 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 to be granted credit and reward arose along with accountability for claims (Merton, 1973), although authorship is now being transformed through the emergence of large collaborative science (Biagioli & Galison, 2003). Furthermore, within the social organization of reviewing, criticism, publication, and uptake, even the singly authored article is a social accomplishment (Myers, 1990b).

As sciences expanded and proved useful for many activities, in the late 18th and early 19th centuries, scientific specialties, societies, and journals proliferated, at first in England. The Society of Civil Engineers was founded in 1771 and became the Institution of Civil Engineers in 1818; the Entomological Society, 1806; the Geological Society, 1807; the Royal Astronomical Society, 1820; the Zoological Society of London, 1826; and the Chemical Society of London in 1841. Specialized societies on the continent soon followed. The membership of these societies was military engineers and officers, other government employees, and employees of industry. The proliferation of these societies continues to this day, although since the late 19th century membership has shifted to academics. Johnson (2006), using as example the charcoal iron industry in the United States between 1760 and 1860, examines the process by which embodied technological practices become professionalized by written technical communication.

Whereas since the early years of printing in the West, the new knowledge being published was to some degree read by more popular audiences than it was intended for (Chartier, 1987), in the 18th century reliance of industry and social progress on science created a substantial popular audience for the dissemination of knowledge and self-improvement. Encyclopedias and other reference volumes began being written for this audience (Darnton, 1979; see also chap. 11, this volume). In the mid-19th century, with decreasing print and paper costs, nonspecialist and industry journals presented the latest in science and technology along with basic instruction, such as *Scientific American* founded in 1845. Bazerman (1999) documents such developments in the United States around the telegraphic and electrical industries. The fields of popular science writing and science journalism have thrived since then and now have their own societies and forms of professional training, including specializations in medical and health writing, nature writing, and environmental writing. Also, many divisions of technical and professional writing have developed to serve the internal needs of knowledge-reliant disciplines (see chap. 14, this volume).

In the 19th and early 20th centuries, specialized knowledge became important for public-policy decisions, corporate and financial planning, and analysis of social problems accompanying urban industrialization. Quantification became useful for representing projects, problems, and various aggregate states of affairs. Writing about economics, markets, bureaucratic policy, public works, insurance, and social problems took on an increasing statistical and mathematical character. Ted Porter (1986, 1995) argues that quantification was a persuasive rhetorical tactic, giving an appearance of objectivity to controversial policies and advancing the authority of forms of expertise.

MILITARY KNOWLEDGE

The military has long seen knowledge as providing strategic advantage and has long been producer and consumer of knowledge. In ancient India, veterinary science developed to treat militarily important horses and elephants. Egyptian documents, in another example, list logistic support for specific campaigns (Gardiner, 1964). Manuals of military strategy date back at least to Sun Tzu's *Art of War* (ca. 500 BCE), with other notable Chinese martial manuals being Chiang Chi's *The Myriad Stratagems* (ca. 225 CE), Li Chüan's *Manual of the Martial Planet* (759 CE), and Tsêng Kung-Liang's *Collection of Military Techniques* (1044 CE). In the West, histories such as of Thucydides, Caesar, and Tacitus contained information on tactics and strategy, as well as glorification of the leaders and forces. Dedicated manuals of war in the West date back to Frontinus' *Strategemata* from the latter part of first century CE and Arrian's *Ars Tactica* in the early second century.

Although much military technology was embodied in unwritten and secret craftwork, the political conditions of Europe in the latter Middle Ages and Renaissance encouraged the production and distribution of military knowledge. Nations in frequent conflict on economic, national, and religious grounds created a distributed market for military books. The first printed book on fortifications (e.g., Albrect Durer's 1527 *Etliche Unterricht zu Befestigung der Stett, Schloss und Flecken Nürnberg*) arose within the highly contested world of Germany. Italy was also a site of fortification technology. Treatises on shipbuilding technology, of importance for military and colonial conquest, date from Mathew Baker's work circa 1580. Gunnery and ballistics was a strong motive in the development of mechanics from the time of Galileo and Thomas Harriot in the early 17th century, although useful practical calculations that incorporated air resistance were not available until the 20th century.

As science demonstrated its military potential, governments began to enlist it to produce new weapons, as when the bureaucracy of the French revolutionary government in 1793 authorized the chemist Claude Louis Berthohellet to develop secret explosives (Gillispie, 1992). This case exemplified several of the features of texts that were to recur in the alliance of government and science. First, government and bureaucratic documentary systems intersected with science in the authorization, funding, and accountability for the project. Bureaucratic texts authorized the initial allocation of resources for facilities and materials, and granted permission for scientists to go forward. Routine meeting minutes, policy statements, injury reports, and descriptions of employees were documented. Letters within the government, between ministers and ministries, and with Berthohellet, were crucial in project development, administration, and monitoring. Tests, reports, diagrams, and descriptions of accomplishments all flowed from the researchers back to the bureaucracy. Second, the projects were initiated by scientists, in the initial scientific papers and communications with the government about military potential. Third, much of the crucial information was kept secret: that concerning government decisions and operations; substance of the scientific advance; details of the technology design, operations, and testing; and deployment. Fourth, public access to knowledge was limited or delayed, though some scientific papers and patents resulted. Descriptions of new tactics made people aware of the existence of the knowledge and its consequences but not the detailed substance, with a consequence for perceptions of security, fear, and national strength. This limited knowledge also restricted the open scientific advance. Over time, more information became available through declassification of documents, personal accounts, and the science advancing to the point where the technology became more obvious. Fifth, a further series of documents arose concerning use and maintenance of the technology, much of it remaining secret within the military. Sixth, documents tied industry to both the government and scientists, defining financial arrangements for manufacture, knowledge of the technology, and procedures of production. Finally, the massiveness of the undertaking and its bureaucratic organization meant that it required regular government attention.

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. Engineers became important members of the military, with military education often leading engineering education and the formation of professional engineering societies, as in the founding of the British Society of Civil Engineers in 1771 (Watson, 1989), its successor Institution of Civil Engineers in 1818, the Royal Swedish Academy of War Sciences in 1796, and the British Society of Telegraph Engineers in 1871.

During World War I, the military, both axis and allied, became interested in applications of new technologies, and industry saw potential profit in producing new means of war. In the United States, this alliance of industry, science, and the military manifested itself in two new government civilian agencies: the Naval Consulting Board and the National Research Council (Hughes, 1989). The chemist Haber persuaded an initially reluctant German military to pursue chemical weapons, but once the military understood the character of trench warfare, it became committed to the weapon, as did all the major axis and allied powers. By the end of the war, more than 1,500 university-trained scientists and around 4,000 scientists with lesser qualifications were engaged in chemical warfare-related research on all sides. These researchers generated “an enormous mass of paper on the details of offensive warfare” (Haber, 1986, p. 107). The complex production of documents followed much as in the gunpowder case of a century before, with a few new wrinkles. First, the massiveness of the project meant greater planning and centralization with the formation of several large government-sponsored laboratories, which themselves required management and planning documents. Second, industry was drawn into the planning, production, and secrecy processes. Third, a closer communication between technologic knowledge and its field uses developed, with a consequence that field experience identified specific knowledge needs the scientists needed to fulfill. Fourth, scientists saw that the development and funding of military technology would not be of benefit just to the nation but to the general funding of science. As the size and complexity of the project grew, the aggregation of existing knowledge in literature reviews also identified application opportunities and needs for knowledge. Finally, the production of knowledge became so extensive as to make useful the production of secret bulletins and journals that circulated among the scientists on each side; in fact, these journals fell into the hands of enemy counterparts, so that there was a scientific literature known to the military scientists of both sides, but secret from the public and nonmilitary-engaged scientists.

From the beginning of World War II, both sides invested heavily in technological development. Nuclear weaponry, which both sides worked on, was the most dramatic, with its realization marking the end of the war. Major advances also occurred in aviation and rocketry, aerial bombing, motorized vehicles and tanks, radar and other telemetry, encryption, and computing. The last three specifically concerned the production, communication, and management of information, laying the groundwork for many postwar developments in information technologies. All these technologies involved massive research, development, and design operations with the same kind of documentary support seen in the earlier instances of explosives and chemical warfare. Furthermore, like chemical warfare, all except the most secret operations of nuclear weaponry and cryptography involved major industrial partners. The two exceptions involved major collaboration between the military and academic scientists. At the war's end, academic scientists had achieved higher status in the eyes of governmental and industrial leaders, and money poured into university-based research projects, which would coalesce in the ensuing years as a military–industrial–academic complex. In U.S. President Eisenhower's farewell address, his well-known warning about the military–industrial complex, it should be noted, is immediately followed by a warning about scientific research becoming beholden to government contract (Eisenhower, 1961). Currently, most academic research in the United States is funded by the federal government, with about 60% of it, on average, being 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).

The American Vannevar Bush's engagement with these developments is iconic. After serving during World War I on the National Research Council, Bush became a professor of electrical engineering at the Massachusetts Institute of Technology and was a cofounder of the electronic equipment manufacturer, the American Appliance Company, soon renamed Raytheon after its first successful product. In 1939, as war broke out in Europe, he was named chair of the National Advisory Committee on Aeronautics. The year after, he became chair of the National Defense Research Committee, and in 1941 the director of the Office of Scientific Research and Development, which oversaw wartime scientific research, including the Manhattan Project to develop the atomic bomb. Out of that war experience of managing such massive knowledge-based projects, he wrote two documents making proposals that were to fundamentally change the production and distribution of knowledge. First, and most directly, "Science, the Endless Frontier," a 1945 report prepared at the request of President Roosevelt, articulated the role of scientific development in both national security and industrial prosperity, and led to the formation in 1950 of the National Science Foundation (NSF). The second, an article "As We May Think" in the June 1945 *Atlantic Monthly,* proposed a device for managing microfilm information called the Memex, which inspired the development of hypertext and underlay the design of the World Wide Web.

In the ensuing cold war, continuing relationships among science, the military, and industry became institutionalized. Whereas previously military engagement with science had been limited to wartime mobilization, a state of permanent warfare made the military an enduring partner with science. Furthermore, as scientifically based military technology was produced by private manufacturers, this system of knowledge production became deeply intertwined with the interests of corporations. At the end of the war and as the cold war emerged, secrecy issues surrounding nuclear weaponry came to a head in the United States. Scientists argued that all wartime restrictions imposed on the communication of scientific knowledge should be lifted and all discoveries be made part of the open scientific literature, both to support scientific advance and to allow informed civilian democratic decision making over the future of nuclear weaponry. The military and government argued for continuing secrecy in the name of national security. The resulting compromise provided only limited public access and civilian oversight through the Atomic Energy Commission. Public stakes in access to knowledge became evident as concern grew in the early 1950s over fallout from hydrogen bomb tests. In response to the government not providing sufficient details to satisfy citizens' concerns, a popular movement was initiated by the St. Louis Citizen's Committee for Nuclear Information to develop independent scientific information in the public interest. Out of this movement grew networks of scientifically based publications directed toward issues of public concern, around which advocacy movements have formed, including environmentalism (Bazerman, 2001). Issues of community access to independently produced knowledge as well as to the knowledge produced and used by governments have become heightened as more aspects of the information society are viewed as matters of national security.

THE MODERN RESEARCH UNIVERSITY

Although some creators of knowledge in the 15th through 18th 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 studying 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, several 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. The largest exceptions were the 18th-century Scottish universities, with secular charters and the dissident academies in England (although not fully accredited universities) that provided practical education for emerging business classes. Also, some higher education for practical professions developed in the service of governments, as with the British military academy at Sandhurst.

In France, the Enlightenment, Revolution, and Napoleonic reorganization, abolishing the colleges of the *ancien régime,* created conditions for new secular professional schools. Research was, nonetheless, supported in nonuniversity institutes and centers, such as the botanic and zoological gardens. This model of reform held some influence over mid-19th-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. Whereas 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 unification, as well as to Austria, Russia, and the rapidly expanding educational system of the United States. By the turn of the 20th century, it influenced the more traditional systems of England and southern Europe, as well as the French bureaucratic system (Charle, 2004; Ruegg, 2004).

The research university provided an institutional framework for the university to be again associated with the forefront of knowledge. Professors of theology such as Friederich Schleiermacher and Georg Frederich Creuzer turned to philology and textual studies, soon to be directed at classical texts and to contemporary languages and literatures, in part motivated by ideas of national heritages embodied in cultural works. Leopold Ranke, appointed to a professorship at Berlin in 1825, espoused a history grounded in archives, taking advantage of the new national archives being established, and set the terms for the foundation of the academic discipline. It should be noted that both philology and history, two of the core founding disciplines in the university, were founded on the study of texts. Furthermore, the pedagogic innovation of the seminar associated with the research university brought with it a disciplinary-based writing to learn pedagogy in the form of the seminar paper (Kruse, 2006).

Philosophers of political economy, society, human nature, and language also found employment in universities and turned their philosophical inquiries into empirical social sciences. German chairs in national or political economy were established in the mid-19th century, and by 1895 the London School of Economics was founded. Whereas Auguste Comte (1798–1857) was a public philosopher and never obtained an academic position, by the time of Durkheim (1858–1917), sociology was an academic profession and he was to found the first French academic journal in sociology in 1898. Wilhelm Wundt, appointed to a professorship in philosophy at Leipzig in 1875, laid the groundwork for academic experimental psychology, founding the first psychological experimental lab and the first journal of experimental psychology. In the 20th century, linguistics, anthropology, and political science were also to define themselves as modern scientific disciplines with distinctive networks of departments, societies, journals, and publications.

The French and German universities provided a particularly welcoming environment for mathematics and sciences. The French concern for practical arts led to large infusions of mathematics, chemistry, physics, and astronomy into university curricula. However, in France, much of the biological sciences research remained at nonuniversity government institutions, such as museums, gardens, and academies, where both Claude Bernal and Louis Pasteur were to work. The German research model fostered university sciences more broadly, fostering the careers of major researchers such as Franz Neumann, Gustav Kirchoff, Herman von Helmholtz, Max Planck, Justus von Liebig, and Robert Wilhelm Bunsen. The British and Scottish universities adopted a research focus in the latter half of the 19th century, with the institution of new professorships and laboratories—but not in time for such greats as Charles Darwin, Charles Lyell, and James Hutton, who supported and published their science privately. The initial debates over Darwin's theories were carried out in the public sphere, where they still in part remain, despite the robust growth of academic biology, which carries out a distinctively different discussion. Engineering education, fostered by industrial dependence on technology, was to be established within university curricula across Europe in the latter half of the 19th century. Scientific and technological journals also became increasingly professional throughout the 19th century.

WESTERN UNIVERSITIES, TEXTS, AND KNOWLEDGE GLOBALLY

As Europeans colonized the New World, they brought for themselves (although not for indigenous populations) traditional universities. The earliest colonial universities in the Spanish Americas were on the model of and chartered by the University of Salamanca, with the University of Santa Domingo founded in 1537, Lima in 1571, and Mexico City 1595—all run by the Dominican order. By the early 19th century, about two dozen universities in the Spanish Americas educated clergy and elites. Only in the second half of the 20th century were Latin American universities to evolve more practical and research-based missions.

Anglophone North America took its models from Cambridge, with Harvard founded in 1636 and chartered in 1650, William and Mary founded in 1693, and Yale chartered in 1745, with others soon thereafter. After the American Revolution, these universities stayed much the same until the latter half of the 19th century, when two changes transformed them. First, in 1862, the Morrill Act granted states land to establish publicly funded secular universities aimed at advancing practical arts and industry. This widened access to higher education and established more practical ends of education (Veysey, 1965), creating different curricula and career paths for students related to agriculture, manufactures, and engineering. Second, the German research university model was enthusiastically imported along with the research-oriented PhD, and a redefined role of professor as publishing researcher. As faculties were reorganized along disciplinary departmental lines, researchers formed national organizations, published journals, and constituted research communities. The sciences also gained strength from engineering education, which required their courses. Economics and other social sciences, as well, formed as areas of professional expertise removed from amateur engagement in social-improvement projects (Furner, 1975). The humanities also reorganized along disciplinary lines, with a focus on philology and literary studies, leaving behind the practical concerns for communication and rhetoric (i.e., text production) that had previously dominated the humanities (Graff, 1987; Parker, 1967). Disciplinary majors, graduate degrees, and advanced specialized courses created markets for advanced specialized texts. After World War II, university student access again expanded, so that currently more than 15 million students are enrolled in higher education at any time and about 30% of the population has completed a 4-year degree. The accompanying expansion of the research enterprise, in large part funded by federal national security initiatives, has made U.S. universities the leading producers of international scientific publications.

Australia and New Zealand in the latter half of the 19th century, although still sparsely populated, also established British-style universities. Education in colonies other than these outposts of English and Spanish emigration, however, was not sponsored to the level of university. The single exception was in India, where the strong interest in Western education by Indian mercantile classes was satisfied by the founding of three universities (Calcutta, Bombay, and Madras) in 1857, only in the wake of the political unrest of the Indian Rebellion of that year. For the most part, students from the colonies had to travel to the Europe for access to higher education, at a cost prohibitive to all but the highest elites (Shils & Roberts, 2004). Only in the closing years of colonialism did the European powers who ruled through Africa, the Middle East, and South and Southeast Asia make any but minimal gestures to providing higher education or bibliographic and archival resources. Even those late and limited gestures lacked the resources to foster serious research.

Nor for a long time did countries independent of European domination show more than limited interest in Western knowledge. China had contact with modern science, but undertook no fundamental institutional changes in education until the early 20th century. The Ottoman Empire banned the printing press from the 15th until the early 20th century, and in Istanbul a university was established only in 1900. Until the mid-19th century, Japan remained closed to the West, but founded Tokyo University in 1869 and the Imperial University of Kyoto in 1897 in a self-conscious process of modernization (Huff, 2003).

The mid-20th-century independence of former colonial nations marked the growth of national university systems throughout Asia, Latin America, the Middle East, and Africa with some attempt to expand access beyond elites. Though serving educational needs of these countries, these new universities have also provided the beginnings of research infrastructure producing knowledge of local value and expressing non-European perspectives, particularly in the social sciences and humanities, where disciplines are more closely tied to regional experiences (see Hayhoe & Pan, 2001; Porter & Ross, 2003).

KNOWLEDGE AND WRITING AT THE START OF THE 21ST CENTURY

The expansion of research universities worldwide in conjunction with the increasing reliance of all social domains on the production of knowledge has accelerated the growth of knowledge along disciplinary lines. The Web of Science currently indexes a selected sample of almost 10,000 significant journals across the arts and humanities, social sciences, and sciences. The relations among disciplines have become matters of issue, and interdisciplinary publication has become a major force in the last several decades (Klein, 1990), although disciplinary reintegration is limited (see e.g., Bazerman, 2005; Ceccarelli, 2001).

This rapid growth of scholarly and scientific publication has been accompanied by specialized genres and discourses, often obscure to educated people in other disciplines (MacDonald, 1994; Swales, 1998, 2004), and has increased the literacy demands of undergraduate and graduate students (Blakeslee, 2001; Prior, 1998), as the Writing Across the Curriculum movement and the related scholarship on writing in the disciplines has addressed (see chap. 22, this volume; see also Bazerman et al., 2005). Researchers in various fields have also critically examined their fields' writing practices. Anthropology, for example, has analyzed the legacies of colonialism in ethnographic writing and has been redirecting its discourses accordingly (Clifford & Marcus, 1986; Geertz, 1988). In economics, Weintraub (2002) has examined the mathematicization of discourse, and McCloskey (1985) has questioned whether that mathematicization has obscured argument over policy issues. Psychologists have come to question the role of language in framing psychological categories and the psychological subject (Graumann & Gergen, 1996; Shotter & Gergen, 1989; Soyland, 1994).

In the latter half of the 20th century, English became the dominant language of science and scholarship (Benfield & Howard, 2000), as well as the medium of instruction at many universities in countries where English is not the first language (Wilson, 2002). This has placed additional obstacles in the way of scholarship and learning in the non-Anglophone world and also challenges the development of other languages as vehicles for intellectual thought (Flowerdew, 1999; Swales, 2004). However, there are some indications that non-native English speakers are gaining support and presence in Anglophone journals (Flowerdew, 2001), and that scholars are making strategic and disciplinary choices about which work is of regional interest and best published in the local language (Peterson & Shaw, 2002).

Economic inequalities of nations that do not support the conditions necessary for the production of knowledge also challenge full participation in and access to knowledge (Canagarajah, 2002). Rising costs of commercially produced research publications have also affected access in both developing and developed worlds (Wellcome Trust, 2003). At the same time, desktop publication and the Internet are making possible new means of distribution of knowledge, crystallized in a movement for free, public, open access to scholarly publications (Chesler, 2004; Velterop, 2004). This is a period of ferment, and it is unclear what the system of scholarly publication and distribution will be within a few years. The electronic revolution has also increased the incorporation of graphic, audio, and other data, including dynamically accessible databases within research publications (Kostelnick & Hassett, 2003). This is leading to a changing definition of both the form and substance of contributions to knowledge, requiring new skills for writing and reading such texts, as well as sorting out and selecting from the mass of available information. Understanding and making strategic use of organizing tools, search engines, and selective interfaces are likely to be crucial research skills.

The greatest challenge to knowledge, its inscription, and its circulation may the great value that it has come to have. On one side is the recognition of its value by powerful institutions with interests in controlling production and access. As governments and military see knowledge and information as crucial to national security and as universities are increasingly supported by corporate providers with their own proprietary concerns for information secrecy and ownership, the texts bearing significant knowledge may not be available for public circulation, examination, and use. On the other side is the emergence of the modern university and the associated scholarly networks devoted to the open production and circulation of knowledge. Accordingly, people in the university community tend to hold values for knowledge, its evaluation, and use that are to some degree independent of political, governmental, economic, religious, national, or military concerns. To the degree the university as a research and educational community is able to maintain some autonomy, it will provide an alternative means to know the world and evaluate human actions, partisan only in its commitment to the advancement and distribution of knowledge.

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