On the LAM:
Library, Archive, and Museum Collections in the Creation and Maintenance of Knowledge Communities

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Introduction

People have been gathering things into collections for a long time. The resulting collections might be informal, but when they are institutionalized and sustained over time, they are typically referred to as libraries, archives, and museums. There are good reasons why libraries, archives, and museums have evolved on separate paths, but the information age arising around new information and communications technologies brings them together as never before. The objective of this paper is to disentangle libraries, archives and museums in historical context to show the key commonalities of *collecting* in the creation and maintenance of the knowledge communities that enabled the Renaissance, the Enlightenment, and the Industrial Revolution. The focus then turns to the changes in the concept of collection in the emerging information age, and the challenges facing the traditional patrons of collecting. Throughout the paper we refer to the broad world of library, archive, and museum collection by the abbreviation LAM. The use of this acronym as a plural proper noun is intended to highlight the commonality of these remarkably separated worlds of work, even as we trace the pathways of their separate evolutionary development. Ultimately, we argue that the differences among the separate worlds of libraries, archives and museums should be subordinated to the emerging need to strengthen what we call the *epistemic infrastructure of the knowledge-based economy* through a new view of collecting and collections.

The motivation behind this argument lies in what Bowker (1994 calls "infrastructural inversion," or the excavation of the underlying infrastructure of social and technical components that makes possible phenomena often seen in the modern world.[1] It is commonplace for deep infrastructure to remain invisible until it breaks down. [2] When deep infrastructure requires attention in order to preserve its capacity to deliver its benefits, waiting for breakdown is ill-advised. An effort must be made to see the role of deeply hidden infrastructure precisely in places where people are disinclined to look. Few people consider the cozy worlds of the LAM to be the critical infrastructure of the knowledge–based economy because the LAM have worked so well as to be nearly invisible in contemporary society. Moreover, there is a notion abroad that new information and communications technologies might obviate the need for such institutions in the future. After all, the story goes, once everyone and everything is on the

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[1] Bowker, 1994
[2] Star and Ruhleder, 1996

Internet exchanging intellectual property in a universal cyber-marketplace, the quaint old LAM will no longer be needed.

Our investigations into the contributions of the LAM to economic and social progress over the past half a millennium refute this view. The following sections begin with the establishment of a conceptual frame for understanding the fundamental role collections play in managing the social construction of practical as well as abstract knowledge. We the review the rise of libraries, archives and museums in the 17th through 19th centuries, paralleling the enlightenment and industrial revolution. Third, we examine institutionalized collecting as a mechanism that provided the stability, comprehensiveness, and access needed by a rapidly expanding, knowledge-dependent socioeconomic realm. Finally, we reflect on the continued importance of systematic collection in as epistemic infrastructure in the information age, and the potential of leveraging new information and communications technologies to capitalize on the value of such collection.

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Rising from the Renaissance

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The achievements of the modern world are a direct consequence of coming to know and understand the world. Coming to know the world has required systematic creation of order from confusion. We see order in the maintenance of civil society, in the transport of people and cargo, in the maintenance of currency and credit, in the global network of communications. Nevertheless, there is still much confusion to testify to the emergent nature of knowledge. Confusion arises at the intersection of the known and the unknown, and is an essential feature of the expanding frontier of knowledge. Knowledge is created by managing the ambiguity inherent in the unknown. The more effectively ambiguity is managed, the more rapidly and effectively knowledge is acquired and progress is sustained.[3] Ambiguity in the creation of knowledge arises when one doubts or is uncertain regarding the interpretation or meaning of some piece of information. The centrality of ambiguity in knowledge creation is evident throughout the history of epistemology, but it can be seen in stark clarity through the work of key individuals in the late Renaissance who leveraged the institutions of their time to frame what we now recognize as modern scholarship.

This essay is far too short to recount the history of western intellectual development, but a few key points are worth noting to frame our discussion of the role of the LAM in building the knowledge-based world we know today. The essential elements of the story are the slow departure of western philosophical thinking from the tradition of scholasticism that dominated intellectual development for centuries. The scholastic

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[3] By progress in this paper we are concentrating mainly on the material welfare of the human population. We recognize that material welfare extends to other kinds of welfare, and the line separating the different forms of welfare is sometimes difficult to draw. In addition, we recognize that material welfare is not the only kind of welfare that might be considered. Our focus on the knowledge-based economy is a policy-based focus, aimed almost exclusively at the question of what infrastructural components are required to sustain economic progress in the coming century.

construct was built on the writings of Aristotle and elaborated through the patristic writings of the western Christian church. A key point in this departure was the work of Thomas Aquinas in the 13th century. Aquinas adopted the view of the12th century Arabian scholar Ibn Roschd (Averroes) that Aristotle's philosophy required the separation of religion and philosophy into two different spheres of mental endeavor.[4] In intellectual inquiry reason must prevail in exposition of faith. Aquinas argued successfully that intellect is a legitimate force in the construction of theology, and by extension, all vital realms of human endeavor. This argument sowed the seeds of the Renaissance by establishing intellectual inquiry as a kind of piety, even when the inquiry appeared to challenge prevailing religious beliefs . The importance of this breakthrough is seen directly in the work of two philosophers of the early 17th century, Rene Descartes and Francis Bacon, who helped lay the foundations of modern scientific inquiry.

Descartes' 1641 *Meditations Concerning First Philosophy* was addressed to the faculty of theology at the University of Paris. Descartes dwelt at length on Aquinas' arguments regarding the need to exercise reason in theology, but went beyond to argue that use of reason in addressing *all* problems of knowledge was a kind of worship that must not be suppressed in ill-considered defense of the faith. In the realm of ideas, Decartes' major contribution was a refutation of the particularist effort to build general epistemic understanding from *prima facie* intuitions about particular items of knowledge.   He argued that *prima facie* intuitions are unstable and unreliable, and recommended instead the use of method to develop settled and reflective intuitions that would allow credible claims about particular knowledge. The resulting Cartesian revolution vaunted reason as the means to resolve ambiguities that arise when empirical facts do not match *a priori* assumption. Descartes' work is remarkable in that it survived the scrutiny of the Church even as the Church was reeling from the revolution begun by Martin Luther at the turn of the 16th century. Paris in the early 17th century was in the grips of the counter-reformation led by Francis de Sales and Vincent de Paul. It is clear that Descartes was well aware of the gravity of his endeavor. His *Meditations* was actually a letter to the Church hierarchy presenting a meticulous apology for importance of preserving reason above all in the work of the pious scholar. His success in this opened the door for the triumph of the rational in the Roman Catholic realm following the Reformation, and in so doing, established a common scholarly bond with the Reformed realm.

Francis Bacon's 1623 work, *The Great Instauration or Renewal of the Sciences,* was also addressed to church leaders who might regard it as a threat to the faith, but his tack was fundamentally different from that of Descartes. Bacon worked from an England already swept by the Reformation, and the introduction to Instauration reads very much like Descartes' introduction to his Meditations. Bacon takes great care to show that the scholarship and science he advocates are in the service of God and not a threat to faith. Unlike Descartes, however, Bacon argued that fundamental questions about the nature of the world could not be explained through rationality alone. Moreover, he explicitly links

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[4] Aquinas viewed key ideas of Averroes as heretical, but treated the core ideas with great respect. Following Aquinas' death Averroes was deemed an "arch enemy of the faith" by the Church hierarchy, but the influence of the Muslim scholar on western philosophical development is undeniable.

his philosophy to Aristotle's logic, naming the second part of his *Instauration* the *New Organon,* after Aristotle's *Organon*. Bacon argued that ambiguity in understanding of the material world could only be resolved through systematic empirical investigation, and through the application of what would in time be called inductive reasoning. While Bacon's philosophy never achieved the status of Descartes in the realm of the mind, his work had a profound practical influence on the conduct of scholarly inquiry. This is especially true in what we now call the natural sciences, where Bacon was arguably the most powerful advocate of getting out and looking at things instead of only ruminating about them.

An essential contribution of both Descartes and Bacon was the recognition that knowledge could only be achieved by the application of *method*, a systematic protocol abstracted from the effort to understand any given thing, but applicable to the effort to understand many things. The methods of reason and empiricism are complementary and are often used iteratively on the path to knowledge. The quest for ultimate knowledge is the establishment of concrete, global understanding from the evidence of the particular. The effect of the Cartesian and Baconian traditions was the separation of the realm of faith from that of knowledge, and the establishment of systematic method using reason and investigation as the tools by which knowledge is created. The LAM played a critical role in the evolution of these traditions from the early 17th century onward. In time, they became fundamental institutional mechanisms facilitating knowledge creation and sharing. The LAM provided a distributed and consistent mechanism whereby the important questions of the time could be exchanged among scholars, and the means for answering those questions would be made accessible.

We do not mean to imply that the LAM were nonexistent prior to 1600. Archives, for example, are an ancient phenomenon. The American Heritage Dictionary of the English Language (fourth edition) defines an archive as "a place or collection containing records, documents, or other materials of historical interest. Often used in the plural: *old land deeds in the municipal archives.*" The retention of "old land deeds" and similar records related to property characterizes archives from the earliest eras. It has been a practice for millennia record upon birth an individual's given name and location of birth, usually accompanied by attributions of parentage, each person born into a locale. Property and identity records are needed to maintain the social order. Nevertheless, the LAM as we know them today emerged mainly during the Enlightenment and the Industrial Revolution. Equally important for our story, the modern LAM were *causes* of the Enlightenment and the Industrial Revolution, and the subsequent material progress the world has enjoyed as a result. The next section recounts the formation of modern LAM during this period.

The Rise of the Modern LAM

We combine the history of libraries and archives for our investigation of the rise of the modern LAM. We begin with museums because they are most directly tied to the revolution in thinking of the early 17th century as illustrated above. We then extend this discussion to libraries and archives to illustrate the depth of institutional embeddedness

with which the LAM have become epistemic infrastructure in the knowledge-based economy.

The Rise of "Wonder" and the Creation of the Modern Museum

It seems obvious to the modern observer that the public display of interesting items has great value in the education and enlightenment of the population. That was not evident prior to the Enlightenment. The museum as we know it today grew out of a form of entertainment that slowly evolved into a deliberate practice of collecting. The recognition of the scholarly utility of collecting was contemporaneous with the revolution in thinking illustrated by Galileo, Erasmus of Rotterdam, Descartes, Francis Bacon, Newton, Spinoza, Rabelais, Montaigne, Voltaire, Rousseau, Locke, Hume and others. Nevertheless, the roots of collecting arose not from the realm of philosophy or natural philosophy, but in the practical quest for novelty and utility in agriculture and medicine.

A useful case for illustrating the rise of the modern museum is found in the history of the Ashmolean Museum, part of Oxford University since the late 17th century. The museum is regarded as the oldest in the UK, and it might well be the oldest surviving museum in the world. However, its antiquity is only part of what makes the Ashmolean useful as an example. The history of the Ashmolean traces the very concept of the museum from the tradition of the private collections of individuals that arose in the 16th century.   The Ashmolean arose from the collection of the John Tredescants, a father and son both named John who built their collection between 1610 and 1662. Both Tradescants were master gardeners by profession, and their most extensive collecting was done in the realm of plants. The elder John's service as gardener to various noblemen required him to make numerous journeys to Holland and France to collect plants. His service to Edward, Lord Wotton, at Salisbury House near Canterbury, also brought him into contact with global traders and promoters of settlement in the recently established British colonies. He entered the service of Sir Dudley Digges of the East India Company, in whose employ he made a trip to Russia in 1618 and accompanied the British fleet in its mission to quell the Barbary pirates in 1620. During these missions he began collecting artifacts and recording information about his collections in a journal.

Tradescant's fortunes changed dramatically in 1622 when he became gardener to the powerful George Villiers, First Duke of Buckingham, and began landscaping New Hall in Essex. Tradescant collected in earnest on behalf of Buckingham, at one point directing Edward Nicholas, Secretary of the Navy, to instruct all merchants engaged in trade in the New World to be on the look out for a long list of rarities, concluding with the admonition to bring "any thing that is strang." Tradescant also began aggressive collecting for himself, and by the time of Buckingham's assassination in 1626, had amassed one of the best collections in Europe. Shortly after Buckingham's death, Tradescant was appointed gardener at the royal palace at Oatlands in Surrey, which further established him in the upper echelon of royal society. He also established residence in South Lambeth, across the Thames from London at Westminster. Several rooms of his Lambeth House were dedicated to display of his collection, which became widely known as John Tredescant's Rarities. Tradescant opened his collection to the

public under the name The Ark, and apparently charged admission. On his death in 1638, his son John took over as gardener at Oatlands, and also became the keeper of the collection. The younger Tradescant expanded the collection significantly, and personally visited the Virginia colonies to acquire artifacts.

In 1850 the younger Tradescant met Elias Ashmole, a successful lawyer who had studied a variety of subjects at Oxford and had grown attached to the institution. Ashmole was one of the most learned astrologers and alchemists of his time, and had written an historical anthology of alchemy that had gained him renown. He was also an early member, and some argue a founder, of The Royal Society, and was fascinated by the emerging practice of scientific discovery. Through Ashmole, the younger Tradescant obtained service as gardener of Oxford's medicinal garden. Ashmole grew close to the Tradescant family, and recognized the importance of the collection. In the early 1650's, with Tradescant's consent, Ashmole and a colleague, Dr. Thomas Wharton, began documenting the entire collection. The document was published as the *Musaeum Tradescantianu*m in 1656. The end of the document names over 100 contributors to the collection, providing a fascinating picture of the Tradescants' social networks among the most learned people of England at that time.

By 1559 the younger Tradescant was concerned about the future of the collection. He had no heir, and no obvious means of keeping the collection together after he and his wife died. In fact, he was forced to close The Ark in 1661 under pressure from a corrupt and grasping courtier named Sir Henry Herbert, the King's Master of the Revels, who attempted to tax the establishment as an entertainment. Under the influence of Tradescant's friends, the King reversed the order, but The Ark never reopened. John Tradescant the younger died in 1662. In a series of disputes with Tradescant's widow over various versions of wills her husband left, Ashmole managed to gain legal control over the entire collection. He obtained the full physical collection by the early 1670's and was showing them to learned colleagues, although not to the general public as the Tradescants had done with The Ark. In 1683 Ashmole dedicated the entire collection to Oxford University, whereupon it evolved over the next century into the Ashmolean Museum.

The evolution of the Ashmolean was not a unique event. Throughout Europe from the middle of the sixteenth century onward a remarkable synthesis began in which gardeners active in the collection of plants expanded their collecting to include other natural creations and man-made artifacts. The movement first took shape in Italy in the collections of Francesco Calceolari, Ulisse Aldrovandi, Michele Mercati and Ferrante Imperato. None of these collectors were from the aristocracy, but rather were learned members of the emerging middle class who had climbed the social ladder through the apparatus of the university. Calceolari and Imperato owned pharmacies and depended on botanical medicines that they grew; Mercati was a physician and keeper of the medicinal garden in the Vatican; Aldrovandi was a professor of natural philosophy at Bologna and keeper of its medicinal garden. Two of these collections were meticulously documented: Calceolari's by 1584 and Aldrovandi's by 1594. The resulting catalogs were shared

among collectors in manuscript form, creating a discourse independent of the physical specimens, but nonetheless grounded by the specimens.

The practice of collecting expanded in Italy through the collections of Manfredo Settala, Lodvovico Moscardo and Ferdinando Cospi, each with published catalogs that were widely circulated. The travels of the aristocracy, many of whom were taken with these collections as a kind of entertainment, spread the word on collecting throughout Europe. Collecting became a popular activity resulting in what became known in German as Wunderkammeren, or Wonder Cabinets.[5] By the early 17th century Wunderkammern were becoming common in the Netherlands, and often contained exotic specimens drawn from the rapid expansion of Dutch exploration. Among the most important Dutch collections were those of the brothers Jan and Gerard Reynst and of FrederickRuysch, both in Amsterdam. Ruysch's collection, in particular, was important because it contained the most extensive set of preserved human and animal organs and body parts yet assembled. Olaus Worm's collection in Copenhagen was also a vital anatomical collection, and with Ruysch's, had a significant influence on the development of anatomical medicine.

Universities played a key role in the rise of the modern museum. As already shown in the case of the Tradescants, it is likely that their collection would have been dissipated and destroyed had it not been acquired by Ashmolean and given to Oxford. (As it happened, Oxford itself treated the collection badly and lost much of it before realizing what a treasure it had in the late 18th century.) But the role of universities had already emerged clearly in the rise of the medicinal gardens and the focus on the collection, identification, classification and testing of plants in medical treatment. The first known medicinal garden in Europe was in Pisa, established in 1543. By the end of the century the Pisa garden was accompanied by a gallery for display of preserved specimens and a growing collection of interesting artifacts brought back from the orient by travelers. The University of Leiden established a gallery attached to its medicinal garden and another attached to its anatomy laboratory by the late 16th century. The establishment of collections in universities spread quickly through the 17th century, but many of these were haphazard affairs that were not systematically documented or preserved.

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[5] The Wunderkammer were natural object versions of the Kunstkammern, or Art Cabinets of man-made objects that already become popular among the European aristocracy. By the late 16th century important Kunstkammeren had been created by Archduke Ferdinand II in the Tyrol, Emperor Rudolf II in Prague, Peter the Great in St. Petersburg, Bacilius Amerbach in Basel, the Elector Augustus in Dresden, Albrecht V in Munich, Gustavus Adolphus in Uppsala and others. In most cases, these cabinets were rich in jewels and other precious artifacts one would expect in the possession of aristocracy, the display of such treasure was old by the time the era of the Kunstkammer arrived. Some wealthy collectors expanded their Kunstkammern to include natural objects, and many of the Wunderkammern that contained mainly natural objects expanded to include man-made objects. The confusion about what belongs in what kind of museum remains with us today. For example, assuming we could remove them, would the ancient cave paintings from Lascaux or Chauvet-Pont-d'Arc belong in a natural history museum or an art museum?

The evolution of the modern museum for scholarly inquiry was also inspired by a society of learning that called upon the "invisible college" of scholars distributed throughout the world to collaborate through meetings and correspondence. This was The Royal Society of Great Britain, established by Robert Boyle, John Wilkins, John Wallis, John Evelyn, Robert Hooke, Christopher Wren and William Petty, most of whom were affiliated in some respect with the Tradescants' collection. The Royal Society created what it called a "Repository" under the supervision of its Curator of Experiments (Robert Hooke at the time) in 1663, built largely around the cabinet of Robert Hubert. By 1665 the Repository had a printed catalog. Though a smaller collection than the Tradescants', it was almost entirely devoted to natural objects. Most significant for our purposes was The Royal Society's decision in 1669 to collect all natural objects to be found in the British Isles that were not yet contained in the Repository, and the subsequent decision to use the Repository as the chief resource in constructing a universal taxonomy of natural objects. Although the effort to create the universal taxonomy failed, it established within the society the goal of systematically building a coherent natural science that remains the mission of The Royal Society that continues to this day. The subsequent life of the Repository itself was less glorious. It became a burden on the Society and its maintenance suffered steadily over the decades until the residual collection was given to the British Museum in 1779.

In reflecting on the emergence of the Wunderkammer as precursors to modern museums, we see three crucial elements in the rise of modern science and scholarship. The first was the essential role of collections in stimulating efforts to comprehend and understand the natural world. Collecting, to use Lugli's term, was a form of inquiry: a means of creating a didactic resource that not only made sense to the collector, but that could be shared among collectors to create a common knowledge. This new knowledge revealed in graphic terms the inadequacies of the Aristotelian accounts of the natural world. It began a protracted effort of clarification and correction of that record, and its expansion to previously unknown realms. This was a vital step in the abandonment of scholasticism and the rise of modern scholarly and scientific inquiry. Through the existential act of placing natural objects on display, the observer was required to try to explain the existence of such a thing in light of old beliefs. The initial purpose of these collections was simply to elicit wonder, but the act of wondering led soon to inquiring and theorizing. In a way, Master of the Revels Henry Herbert was not far wrong in attempting to cast The Ark as an entertainment. Wonder at the objects in The Ark spread its fame, and it was entertainment that eventually established museums as a public educational experience.

The political and social ramifications of this merger of entertainment and public education were soon seen in the displays of the skeleton of the dinosaur *Iguanadon*, discovered in 1822 in southern England. The museum patron was compelled to ask where such a thing came from, since it obviously was not like anything anyone had seen. The display of dinosaur skeletons over a quarter of a century to untold numbers of British citizens paved the way for widespread alarm at the publication of Darwin's *Origin of the Species* in 1859. Darwin put the idiosyncratic fossil record square in the path of the

literalist version of Creation from Judeo-Christian tradition, and offered instead a mechanistic model of the emergence and diversification of life. It seems doubtful that Darwin's work would have elicited the public reaction it did had the stage not been set by tradition of the Wunderkammern.

The second element of the Wunderkammern was their role in the rise of systematic method in the sciences. To move beyond naïve inquiry and into deep understanding of complex relations among natural objects requires careful, repeated observation. The collections evolved from being somewhat haphazard and random, following the fancy of the collector, and toward a much more focused and systematic pursuit of all examples of the class. This was particularly true in the case of the collectors of natural objects, who increasingly sought to obtain as many different kinds of birds, beetles, shells or whatever objects of collecting caught their attention. When the collections became large enough to permit careful comparison of morphology among the specimens, the first efforts at taxonomy construction and classification got underway in earnest. A lively trade in travel among collections by collectors emerged, permitting first-hand comparison of specimens and argument over classification. This practice shifted the discussion of the natural order away from the scholastic reflection on God's intention in the creation and the moralistic medieval ascription of anthropomorphic traits to animals, and toward the empirical facts resident in the specimens themselves. Science was no longer driven by how the investigator thought things ought to be, but rather by things as they clearly are in the state of nature.

The third major element of the Wunderkammern was the corollary documentation of the collections, as in the Musaeum Tradescantianum. These catalogs allowed the collections to circulate in a kind of virtual form, greatly aided by the advent of printing. Scholars in disparate places could compare their local collections with the catalogs of other collections, identifying discrepancies and questions that could be resolved through further correspondence, discussion, and examination. In this way the effort to identify, classify, and compare all of nature first took shape and moved forward. As the experience of The Royal Society's universal taxonomy revealed, the problem was larger and more difficult than it appeared. Nevertheless, books based on collections, especially when illustrated, played a major role in moving forward what became in time systematic biology. The effort to systematically classify natural objects went back to Aristotle, but little progress was made on the matter until the advent of systematic collecting and documentation in the 17th and 18th centuries. Martin Lister's 1686 *Historia Conchylorium* systematically compared over 1,000 mollusk shells rendered in plates, and Georg Rumphius' 1711 *Thesarus Cochlearum* expanded on that effort. These and other illustrated catalogs of collections of natural objects laid the groundwork for the masterpiece *Systema Naturae* first published in 1738 by Sweden's Carl von Linné (Linnaeus), upon which all subsequent biological taxonomy was built. The Wunderkammern were thereby the progenitors of scholarly and scientific collaboration on which knowledge required for the industrial revolution was built.

The details of the processes by which the Wunderkammern became the institutionalized museums of today are beyond the scope of this paper, but a few indicators are useful. The

British Royal Library founded in 1471 was combined with the newly purchased Sloane, Harleian, and Cotton libraries in 1753 to become the nucleus of the British Museum. The museum added collections of artifacts and natural objects in the ensuing decades, and became a major institution of learning by the time its key buildings were completed in the 1830's. The Royal Botanical Gardens at Kew originally were private gardens of the monarchy, similar to those tended by the Tradescants at Oatlands, but took on new importance for science under the direction of the avid naturalist Sir Joseph Banks in 1772. Although the gardens suffered major decline following Banks' tenure, they were revitalized and turned into a major center of learning with the establishment of the garden's department of economic botany in 1847. The French Jardin des Plantes, founded as a medicinal garden by Louis XIII in 1626, expanded greatly under the direction of Georges-Louis LeClerc (Comte de Buffon) between 1739 and 1788. LeClerc raised funds for the garden and, following the initial publication of his influential *Histoire Naturelle* in 1749, began a number of large collections that became the French National Museum of Natural History. By the turn of the 19th century the museum was an internationally important center of study, engaging figures such as Jean-Baptiste Lamark, Bernard Germain (Comte de Lacepede) and George Cuvier who had a great influence on the evolution the natural sciences.

The 19th century was the golden age of museum expansion and stabilization. Philadelphia's Academy of Natural Sciences opened in 1812. The Peale Museum opened in Baltimore in 1814. The National Museum of Denmark was established in 1816. The ethnographic museum of the Academy of Sciences in Petrograd opened in 1836. The Smithsonian Institution got going in 1846. The British Great Exhibition of 1851 had a major influence on the relationship between display of collections and emerging industrial enterprise. Harvard University established museums for botany, zoology, and anthropology between 1858 and 1866. The Deutsches Museum opened in 1903. Since that time, museums have become common fixtures in all developed countries and can be found in many developing countries.

Many museums today are major centers of research, but they also play an important role in shaping social discourse regarding contemporary controversies. Part of this influence occurs through the very act of selecting what will be displayed, and how those displays will be presented. Most museums have collections far larger than their space available for display, so what gets displayed can make a statement. For example, a display of artifacts of Southern Pacific island societies might be read as a statement about what has come to be called "Polynesia." This kind of labeling is more explicit in instances such as the US National Museum of the American Indian or the numerous Holocaust Museums. The very idea of the "American Indian" originates with a mistaken assumption by early European explorers who thought they had reached India, and extends to the lumping together of a large number of highly specialized cultures who were as different from one another as Danes and Italians. Similarly, the vast majority of the holocaust museums understandably place the extermination of Jews in the foreground, even though Nazi cruelty extended to other classes such as the mentally ill and the politically rebellious. Museums, almost without intending to do so, provide a political context for their collections that affects public perception.

The contextual commentary included in the narratives about displays offers yet another means by which museums affect the public's understanding of collections and what they mean. A museum of technology such as the Deutsches Museum in Munich can display a combination of train locomotives, trucks, and automobiles to signify forms of land transport (a focus on functionality), or to signify progress in the design of propulsion technology (a focus on the means by which the functionality is achieved). Only the explicit guidance of the curator will construct a consistent frame of mind in the visitor. Such explicit guidance often escapes notice because the underlying disputes are not in the public consciousness. However, from time to time the commentary can cause extraordinary controversy, as in the case of the Enola Gay exhibit at the Smithsonian Institution's National Air and Space Museum in the mid-1990s commemorating the dropping of nuclear weapons on Japan in WW II. In one of the most celebrated public fights over a museum exhibit in US history, curators found themselves locked in a struggle between those who wished to foreground the difficult choices to be made in the bombing, and those who wished to commemorate the heroism of those whose efforts brought the US victory over Japan. As Tom Crouch, curator of the museum put it, "Do you want to do an exhibit intended to make veterans feel good, or do you want an exhibition that will lead our visitors to think about the consequences of the atomic bombing of Japan? Frankly, I don't think we can do both." In the end, Crouch was proved right, and the exhibit was constructed to make veterans feel good.

Museums provide a good example of the emerging discussion of the construction of "narratives" in collection and display. Narratives are the means by which artifacts are pulled into the foreground or pushed into the background in ways that create a story for the visitor that cannot emerge simply from the presence of the artifacts themselves. As in the case of the Iguanadon, the narrative did not need to be more than the simple display of the artifact. The emerging tension between strictly biblical accounts of creation and the apparent contradictions of the geological record was evident to all who saw the exhibit. The Iguanadon skeleton was unavoidably a gauntlet thrown at the feet of the strict creationists, with the challenge, "Explain *this*." Explanation was not easy. The ready response that the fossil bones were merely those of some great creature destroyed in the biblical flood of Noah's time raised questions about why Noah did not rescue such creatures along with all the others recounted in the story of the Ark. There was nothing fictional about the fossils. Their concreteness threw into ambiguity the accepted narrative of the time. Similarly, the Enola Gay exhibition at the National Air and Space Museum queried whether it was possible to have a master narrative that could speak simultaneously to multiple audiences, enlightening all and offending none: could the master narrative be controlled in an "objective" manner, or was it inherently subjective and perhaps overtly biased? The facts of the Enola Gay, the war, the bombing, and the aftermath were never in dispute by any of the antagonists. At the heart of the argument was the question of what it all *means*. In other words, the difficult challenge was to wrap up the iteration between the unambiguous and the ambiguous in a manner that yielded knowledge acceptable to the observers.

We close our discussion of museums with the observations of Susan Leigh Star and Jamie Griesemer from their study of the museum of systematic biology at the University of California, Berkeley. They recognized the museum as a site very much dedicated to the generation of knowledge, but they also noted that the key participants in the museum world – collectors, curators, and the scientists who used the museum – each saw different purposes for the museum. They coined the phrase "boundary object" to denote the role of the museum, which was explicitly to bring together a highly heterogeneous group of people around a shared interest in flora and fauna that constituted a knowledge community. Boundary objects are concrete to each specific user, but plastic enough to be interpreted differently by different users. They are devices for mediating the disagreements that lie at the heart of the role of LAM in the realm of knowledge.

Libraries and Archives

We combine the history of libraries and archives for our investigation of the rise of the modern LAM. Although archives and libraries often are used for somewhat different purposes and are commonly separated institutionally, they are fundamentally similar in their objectives. From the perspective of an epistemic infrastructure of knowledge communities, the similarities between libraries and archives are more central to our argument than are their differences. We argue that the articulation of libraries as collections of published works and archives as repositories of unpublished primary sources is a relatively recent aberration that developed as a consequence of industrial rationalization and specialization and that is increasingly difficulty to sustain in light of the potential for digital convergence.

The origins of libraries and archives are intertwined with the emergence of writing, the development of commerce and accounting, the establishment of the rule of law, and the genesis of scholarly discourse. The earliest physical evidence of repositories of clay tablets in the Near East suggests that documents were created, collected, and stored to serve pragmatic purposes. Records commonly found in ancient archives include the laws of the land, evidence of administrative transactions, financial and accounting records, and documents that enforced ownership and control over property and people, reflecting constants in records creation regardless of the nature of governmental, religious, and economic institutions.[1] Recent scholarship suggests that written documents from the ancient and classical period, as well as the institutions that housed them, served many purposes beyond bureaucratic accounting.[2] Stone tablets inscribed with laws and proclamations were erected in public places to inform citizen/subjects of their rights and responsibilities. Inscriptions on pottery and bronze may have played a role in deification, religious practice, and commemoration.[3] Ancient collections from the seventh and eighth centuries B.C.E. contain a mixture of administrative, spiritual, and literary texts.

We can only speculate about the reasons why ancient and classical societies assembled collections of documents and artifacts and built temples to house them. Most scholars agree that ancient libraries and archives were intended to assemble documents in central locales where their owners, and in some cases a broader public, could consult, analyze, and compare multiple texts. As collections grew in size and complexity, their custodians

developed methods for organizing and managing large bodies of texts, using titles to readily distinguish one text from another, creating inventories and catalogs to keep track of what was in the collections, and imprinting documents with seals to assert authenticity. Collections were housed in purpose-built structures or in fortified portions of royal palaces to protect them against fire, theft, and pillage.[4] Libraries and archives also served as commanding symbols of authority and power. The legendary Library of Alexandria fulfilled more than the purpose of assembling all the world's known texts in a single monumental structure. By acquiring ancient texts and then translating them into Greek, ancient scribes and curators contributed to the hegemony of the Greek language, culture and worldview. As O'Donnell argues,

> In an ancient context, that particular library enshrined a consciousness of community spread across time and space. To seek out all of the books in the wider world showed a consciousness of that world and a sense of meaningful communication within it.[5]

The later Roman achievement was even greater, spreading Roman culture and law over a much vaster territory with lasting effects on language, social organization, and politics.

Nevertheless, we have to deal with the fact that the Alexandrian Library was destroyed, that no library of Greek or Roman antiquity survived, and that the tradition of assembling collections and imposing order on them disappeared for nearly a millennium. In the canonical interpretation of the history of Western civilization, the loss of organized institutions to collect, preserve, and share written texts equates to "the Dark Ages" -- a period of primitive orality and personal autocratic rule enforced by might rather than the rule of law. Were it not for the "molding of Christian monasticism around the preservation and veneration of the written word," most ancient texts -- both sacred and secular -- would have vanished from human knowledge.[6] During the Middle Ages a veritable industry of salvaging, copying, and translating texts flourished in the monasteries of a Catholic Western Europe awakening from centuries of intellectual impoverishment.[7]

Historians of writing and literacy find many connections between the introduction of printing, the spread of Enlightenment thought, and the scientific revolution. Elisabeth Eisenstein treated the printing press as "an agent of change" in early modern Europe and attributed to new modalities of communication that enabled both the Reformation and the Scientific Revolution.[8] Although subsequent historians have questioned the extent to which Eisenstein ascribes causality to the technology of printing, her basic contention -- that the availability of multiple, identical, and relatively inexpensive copies of texts had a profound impact on the circulation of ideas -- remains largely unchallenged. In ways that we are only beginning to appreciate fully, the circulation of printed works fundamentally altered the transfer of knowledge between religious and secular cultures, from expert to novice, from academy to academy, from scientists to artisan, and across generations. Latour refers to these knowledge-bearing objects as "immutable mobiles" which have the properties of being mobile but also immutable, presentable, readable and combinable with one another.[9] Latour is less interested in the impact of printing technology on the

history of ideas *per se*, than in the ways that scientists and bureaucrats manipulate texts, documents, and objects to convince and mobilize others to see the world the same way they do. The advantage of the printing press for philosophers, scientists, and clerics was that it provided a means for those who were successful at mobilization to circulate their ideas and dominate on a larger scale.

Latour's notion of immutable mobiles as knowledge-bearing objects that can be mobilized to spread ideas helps to explain the emergence or re-emergence of libraries, archives, and museums in the modern era as social projects intended to persuade and convince ever-expanding publics to perceive the world as coherent and knowable. Libraries, archives, and museums, with their increasingly sophisticated systems for organizing and classifying monographs, scholarly journals, administrative documents, manuscripts, and physical specimens emerged as critical institutions, not only for collecting and organizing knowledge-bearing objects, but as sources for innovation and new ideas and vehicles for enhancing the circulation of ideas. These were not the only institutions that engaged in scientific inquiry and humanistic endeavors. Libraries, archives, and museums grew hand-in-hand with the private publishing and the book trade, the emergence of modern the university, the maturation of scholarly societies, and the rationalization of the administrative apparatus of modern states. These forces worked together to further accelerate the production of books, administrative documents, maps, journals, reports, and the like and the collection of physical evidence that flowed into private and public collections.

The quest for a universal library was reinvigorated during the 17th and 18th centuries, not as an end in itself, but as a means of unearthing collections from private, princely, and ecclesiastical libraries and assembling all known works as the foundation from which new knowledge could be generated. In one of the earliest books on library design (1627), Gabrial Naudé stressed the value of a comprehensive library containing all the principal authors who have written on a diversity of subjects and arranged for use of the public. Naudé's *Advis pour dresser une Bibliothèque* was addressed to the president of the Parliament of Paris, himself a great book collector. Naudé's *Adivis* took aim at the cabinets of curiosity or *cabinet chosi,* distinguished mainly by their small collections of rare and precious works that nobles and wealthy aristocrats collected and assembled for display and personal satisfaction.[10] Naudé argued that

> It is more useful to and necessary to have, for example, a great quantity of books well bound in ordinary fashion than to fill only some small, pale, gilded, decorous room or cabinet enriched with all matter of little oddities [*mignardise*], luxuries, and superfluidities."[11]

During the eighteenth and nineteenth centuries, libraries and archives grew in number and scope using a variety of means to assemble vast collections. Private collectors, who had gradually opened their "cabinets of curiosity" for viewing by privileged elites and for research by qualified scientists, began donating collections to fledgling libraries and archives in universities, major municipalities, and provincial towns. Progressive monarchs donated their private libraries to the citizens forming the early instances of

royal libraries. During the French Revolution, the *Bibliothèque du Roi* became the *Bibliothèque Nationale*, vastly expanding its holding by adding an estimated 250,000 books, 14,000 manuscripts, and 80,000 engravings that were confiscated from the Church, emigrants, and the former nobility.[12] By 1800, national libraries existed in 20 different countries, including the United States which passed legislation establishing the Library of Congress that year. Most library and archival institutions built up their holdings by acquiring pre-existing collections through purchase, donation, and legal decree. During the 19th century, libraries and archives not only expanded their collections, they were transformed into modern institutions and instruments of industrialization, modernization, knowledge generation, and civic engagement.

The establishment of the *Archives nationale de France* immediately following the Revolution offers one particularly compelling example of the transformation of archives from private and parochial to public and national. Within a day of the storming of the Bastille on July 14, 1789, the municipal government of Paris dispatched guards to protect the prison archives from looting and pillage, beginning the long process of building a national collection of documentary sources. Within a year, the National Assembly began planning for a universal bibliography of every book in every depository in the country. By 1793, the government had confiscated thousands of ecclesiastical libraries and archives and seized the archives of exiled nobles, convicted counter-revolutionaries, the academies and scholarly societies of the Old Regime, and pre-revolutionary estates. The amassing of vast collections of books, archives, and manuscripts from pre-revolutionary institutions immediately raised questions about the purpose, value, uses, and organization of archives and libraries.

Successive regimes in France between 1790 and 1870 proposed new approaches to the organization of French archives and libraries and questioned the purposes to which they ought to be put. Throughout the 1790s, revolutionary leaders debated whether the archives of the Old Regime should be preserved as evidence of false ideas, as common heritage, and as rich treasures to be enjoyed by the citizens of the Republic; or whether they should be purged because they were no longer useful and risked poisoning the French citizenry with traitorous ideas. According to historian Lara Moore, whether revolutionary leaders favored destruction or preservation of the pre-revolutionary archives they agreed on two key points: that "the bibliographic and documentary legacy of the Old Regime was strongly connected to the French national identity . . . [and] that national collections ought to be publicly accessible."[13] But just what did accessible to the public mean? This question took decades to resolve, not only because of the turmoil caused by successive changes in government, but because the notion of "publicly accessible archives" was so novel.

By 1839, it was obvious that simply confiscating archival and library collections and distributing them in to system of repositories did little to make the collections usable or useful. Early efforts to select critical documents, establish their authenticity, transcribe, translate and then publish them in documentary editions failed primarily because of the chaotic condition of pre-revolutionary archives and ambivalence on the part of public officials about opening the collections to the public. During the late July Monarchy (ca.

1838 to 1848) the focus of attention shifted from detailed analysis of small corpora of documents to the organization of entire archives and libraries. Departmental archives were the central focus of organization and classification activities guided by instructions from the Royal Archives that introduced a new principle for classification of archives, *respect des fonds,* or the principle of provenance. A *fonds* is the "whole of the records, regardless of form or medium, organically created and/or accumulated and used by a particular person, family or corporate body in the course of that creator's activities and functions."[14] *Respect des fonds* implores archivists to maintain aggregations of documents based on the person or entity that accumulated the records or to restore such order if it has been lost.

Although a detailed discussion of the application of the principle of provenance is beyond the scope of this paper, the significance of this new classification approach should not be underestimated. It not only helped archivists overcome a variety of pragmatic problems that had plagued previous attempts at classifying French archives; by the late nineteenth century it emerged as the core principle for organizing modern archives and it remains the basic tenet of archival science today. Previous efforts to organize and classify French archives had used a variety of approaches; such as time periods or epochs (historical, revolutionary, administrative), subject matter, strict chronology, author, location, and even size, shape and color. Not only was it impractical to sort large caches of documents by analyzing each of them separately, such classification schemes were considered arbitrary and often controversial. The principle of provenance, in contrast to earlier criteria, was considered a reflection of the natural order of things. By keeping archives together as the originator has organized and used them, archivists preserved a larger context for their future interpretation and use. This approach to organizing archives spread to other parts of Western Europe, North America, and regions of the world under colonial domination.[15]

If we credit French archivists with developing an epistemic regime for archives, then we have to turn to the Library of Congress to find the origins of systematic classification standards for library materials. The Library of Congress was established in 1800, when the seat of government was moved from New York to the new capital city of Washington. In 1802, President John Adams approved an appropriation of $5,000 to purchase "such books as may be necessary for the use of Congress." The first books, ordered from London, arrived in 1801 and were stored in the U.S. Capitol. The collection consisted of 740 volumes and three maps. After Washington was burned by the British during the War of 1812, Thomas Jefferson reestablished the Library by selling his own personal collection of 6,487 volumes to Congress in 1815. At the time, Jefferson's library was considered the finest in America. When Jefferson sold his multifaceted, multilingual collection to Congress, he felt the need to defend its diversity by stating that there was "no subject to which a Member of Congress might not have occasion to refer", establishing a precedent for a comprehensive national collections. [16] Progress toward the comprehensive collection that Mr. Jefferson had favored was interrupted in the middle of the nineteenth century. In 1851 a fire in the Capitol destroyed 35,000 volumes of the 55,000 in the collection at the time, although Congress responded quickly by appropriating the funds to replace the lost books. The fire was followed in 1859 by a

repeal of the law providing for copyright deposits at the Library. U.S. copyright activities became centralized at the Patent Office, which meant that LC and the Smithsonian Institution no longer received copies of the books and pamphlets deposited for copyright under the 1846 law providing for the enrichment of library collections through copyright deposit. Efforts to build the collection resumed in the 1860s. For example, the Library acquired the 40,000 volumes from the Smithsonian's library in 1866. And by 1870, Congress had passed laws establishing the U.S. Copyright Office as an arm of the Library, thereby centralizing all copyright activities. As in other countries with mandatory deposit of copyrighted works, the U.S, copyright laws were intended primarily to help the Library develop a comprehensive collection of printed books.

The influx of materials following the creation of copyright deposit laws in 1870, required both more space to refine ways of managing its collections. In 1896, just before the actual move to the new Jefferson Building, the Joint Library Committee held hearings about "the condition" of the Library and its possible reorganization. The hearings provided an occasion for a detailed examination of the Library's history and present functions and for a review of what new functions the Library might perform once it occupied the spacious new building. The American Library Association sent six witnesses, including future Librarian of Congress Herbert Putnam from the Boston Public Library and Melvil Dewey from New York State Library. Members of Congress listened with great interest to the testimony of Putnam and Dewey, who argued that the national services of the Library should be greatly expanded. Dewey felt that the Library of Congress now had the opportunity to act as a true national library, which he defined as "a center to which the libraries of the whole country can turn for inspiration, guidance, and practical help, which can be rendered so economically and efficiently in no other possible way." In 1897, when the new Jefferson Building was occupied, the staff increased from 42 to 108, and separate divisions were formed for serials, maps, music, manuscripts, and graphic arts.

Although the Library of Congress is most renowned for its large and diverse collections, its key role during the early twentieth century in the area of cataloging is most germane to our analysis of LAM. By the end of 1901 the Library of Congress, the first American library to reach one million volumes, had started organizing its enormous collections of recorded knowledge for public service. Library classification schemes were a nineteenth century invention. Sir Anthony Pazinni, a librarian at the British Museum from 1831 to 1867 developed his 91 rules for cataloging in 1832. Jewett, 1853; Cutter, 1876 Melvil Dewey introduced the Dewey Decimal System in 1876 while he was librarian at Amherst College and expanded it at the New York State Library. In 1901, the Library of Congress published its first volume of a completely new classification scheme, based on the Library's own collections. The LC classification scheme, was not so much a methodological innovation in the field of library cataloging as a precursor for the development of uniform standards for organization and classification of library materials. This was accomplished in part through the development of the Library's card distribution services that sold and distribution of printed catalog cards to other libraries. By 1900, there we xxx university libraries, xxx public libraries, and xxx other special libraries in the US which could purchase preprinted library cards for their catalogs rather cataloging their collection according to idiosyncratic and institution-specific practices. For two-

thirds of a century the cataloging system was supported with the distribution of printed cards. In the late 1950's LoC began investigating the application of computers to library cataloging and eventually led the development during the 1960s of the machine-readable cataloging (MARC) format for identifying and exchanging information about bibliographic materials, which became a national standard in 1971. During the 1970s, new inter-institutional consortia, such as OCLC, began to offer competing services for distribution of on-line cataloging services.

The extension of the Library's classification and cataloging schemes to the rest of the nation led to a uniformity of cataloging across libraries subscribing to the service and some structures to support standard cataloging procedures. This epistemic infrastructure became further refined during the mid-twentieth century when LoC developed standard classification schemes and cataloging rules for subjects, names, titles, and an expanding variety of new media types. As part of a consortium that included the American Library Association and British participants, it helped develop the Anglo-American Cataloging Rules (AACR), first published in 1967, and eventually leading to a broader international agreement on uniform bibliographic description under the auspices of the International Federation of Library Associations (IFLA).[17]

Discussion of classification: [This will be a discussion of the kind of epistemological framework that this type of classification imposed (e.g. encyclopedic, rational, universal, Anglo-American, "scientific."]

Although we tend to take the distinction between libraries and archives for granted and assume that libraries acquire and circulate printed resources while archives collect and preserve unique unpublished documentary sources, this distinction has never been that sharp. The distinction between libraries and archives evolved gradually as popular and public libraries emerged to support and channel the reading interests of an increasingly literate working class and archives defined themselves as repositories for the scholarly and scientific study of the past. Public libraries, with small collections of recent and popular collections, and national archives, with large holdings of administrative documents accumulated by modern bureaucratic states, lie at two extremes of the archive-library spectrum. Along this spectrum, however, are many hybrid institutions that hold books, serials, manuscripts, maps, and archival collections. The book collection at the Library of Congress is the largest in the world, but it comprises only a portion of the total holdings which includes million of maps, photographs, motion picture films, newspapers, and manuscripts. The manuscript division holds 50 million items in 11,000 different collections. The papers of many of the nation's founding fathers, including George Washington, Thomas Jefferson, and James Madison were transferred from the State Department archives to the Library's Manuscript Division in 1903 in part because the United States did not establish a National Archives until 1934. The British Library was part of the British Museum until 1962. Most major university libraries maintain not only general collections of books and serials used for teaching, but also many special collections for exploitation by researchers.

Collecting as Learning and Knowing

The foregoing histories of the LAM provide strong evidence that collections played a crucial role in the establishment of knowledge communities. No better summation of this can be found than Francis Bacon's own musing on the essential apparatus of the gentleman scholar in his 1594 *Gesta Grayorum*:

> First, the collecting of a most perfect and general library, wherein whatsoever the wit of man hath hitherto committed to books of worth, be they ancient or modern, printed or manuscript, European or of other parts, of one or other language, may be made contributory to your wisdom. Next, a spacious, wonderful garden, wherein whatsoever plant the sun of diverse climates, out of the earth of diverse molds, either wild or by the culture of man, brought forth, may be, with that care that appertaineth to the good prospering thereof , set and cherished ; this garden to be built about with rooms to stable in all rare beasts and to cage in all rare birds, with two lakes adjoining, the one of fresh water, the other of salt, for like variety of fishes. And so you may have in small compass a model of universal nature made private. The third, a goodly huge cabinet, wherein whatsoever the hand of man by exquisite art or engine hath made rare in stuff, form, or motion; whatsoever singularity, chance, and the shuffle of things hath produced; whatsoever nature hath wrought in things that want life and may be kept, shall be sorted and included. The fourth, such a still-house, so furnished with mills, instruments, furnaces, and vessels as may be a palace fit for a philosopher's stone. Thus, when your excellency shall have added depth of knowledge to the fineness of your spirits and greatness of your power, then indeed shall you be a Trismegistus, and then when all other miracles and wonders shall cease, by reason that you shall have discovered their natural causes, yourself shall be left the only miracle and wonder of the world."

Two centuries after Bacon wrote his laundry list of scholarly needs the world had undergone profound changes that brought previously unimaginable individual opportunity and wealth. The rise of the institutionalized LAM paralleled both the Enlightenment and the Industrial Revolution. Daniel Webster captured the power of this change and the centrality of knowledge in the change in a speech given on June 17, 1825 at the groundbreaking for the Bunker Hill monument in Massachusetts.

> A chief distinction of the present day is a community of opinions, and knowledge, amongst men, in different nations, existing in a degree heretofore unknown. Knowledge has, in our time, triumphed and is triumphing over distance, over differences of language, over diversity of habits, over prejudice and over bigotry… The whole world is becoming a common field of intellect to act in. Energy of mind, genius, power, wherever it exists, may speak out in any tongue, and the world will hear it. There is a vast commerce of ideas. There are marts and exchanges for intellectual discoveries, and a wonderful fellowship of these individual intelligences, which make up the mind and opinion of the age. Mind is the great lever of all things; human thought is the process by which human ends are

ultimately answered; and the diffusion of knowledge, so astounding in the last half century, has rendered innumerable minds, variously gifted by nature, competent to be competitors, or fellow-workers, on the theatre of intellectual operation. From these causes important improvements have taken place in the personal condition of individuals. Generally speaking, mankind are not only better fed and better clothed, but they are able also to enjoy more leisure; they possess more refinement and self-respect.

These two excerpts illustrate the profound shift from Bacon's inquiring gentleman to Webster's broad marketplace of ideas. In the relatively short time between these statements the pursuit of knowledge had emerged from the pastime of the curious individual and into the widespread creation of knowledge communities vital to society. Moreover, the industrial revolution had emerged from trial-and-error experimentation in the tradition of artisans and entered an era in which scientific and engineering knowledge was being systematically applied to accelerate the pace of progress. By Webster's time this had already resulted in the refinement and application of the steam engine to ship and rail transport, the start of mechanistic agriculture through the cotton gin, the discovery of vaccination against viral disease, and the use of artificial fuel coal gas in the lighting of cities. Within the next fifty years Henry Bessemer revolutionized the making of steel, the railroad industry invented operations management, the telegraph was in regular use, Pasteur pioneered profound changes in human health, and warfare reached a harrowing level of carnage through new weaponry such as the machine gun. On the social side, by the time of Webster's speech the world had seen the weakening of the British monarchy in favor of Parliament, the American and French revolutions, and the establishment of what would become modern democratic institutions. Within the fifty years following Webster's speech slavery was abolished and compulsory education was established in the industrializing countries of North America and Europe, a in the U.S. the Morrill Act and the establishment of the Land Grant tradition created a radical expansion in availability of higher education.

As previously noted, the nineteenth century was the golden age in the evolution of the LAM. This period saw the creation of nearly all of the world's great museums of natural history, art, and culture, the rise of the great state libraries, the establishment of many academic libraries, and the beginning of the public library systems. Industrialization, urbanization, and mass literacy added to functions to the LAM, and created further pressures to transform private collections of information and artifacts into public goods. During the latter half of the nineteenth century, private benefactors founded and provided resources for countless museums, galleries, historical societies, and libraries so that a broader public could appreciate and learn from collections of treasures that had accumulated over the centuries.[18] These institutions often were steeped in a broader mission that went beyond building collections and preserving knowledge. Many benefactors and the rapidly growing staffs of professional librarians and curators embraced the social mission of supporting universal education, providing citizens with the information and tools to make informed decisions, and teaching new urban residents how to make intelligent use of their leisure time.[19] Libraries, historical societies, and museums also contributed to nation building by assembling documents and artifacts that

provided a basis for a shared sense of the past and a common national and cultural identity.

During the industrial era, libraries, archives and museums assumed a series of functions that extended beyond simply collecting and organizing books, documents, and objects. These institutions brought together objects and specimens that could be examined side-by-side, and amassed large collections that were more valuable in the aggregate than they were dispersed in their natural environment. Experts in organization, classification, and taxonomy imposed an epistemic order on collections, explicitly for efficient management and tacitly to mobilize collections in the service of scientific discovery, an enlightened citizenry, and aesthetic discrimination. Specialization and selection were the hallmarks of professionally managed institutions. During the industrial age, bibliographers, archivists, museologists, and scholars developed highly refined notions of physical formats and intellectual forms to distinguish publications from manuscripts and to separate documents from three-dimensional objects. These forms and genres defined the natural home for different types of cultural artifacts. Works of art belonged in art galleries, three-dimensional objects belonged in museums, books belonged in libraries, and unpublished, original documents belong in archives.[20] Libraries, archives, and museums further specialized by country, language and region, by topical area or discipline, and by audience. Within these specialized domains, classification systems and taxonomies drifted from idealized notions of organized universal collections of knowledge to highly refined collections tuned to particular audiences or user communities. The counter trend was the parallel development of the great national libraries, museums, and archives that attempted to collect comprehensively by building national bibliographies and erecting monuments for national treasures.

Whether collections were highly refined or comprehensive, selection was instrumental in establishing institutional identity and ensuring the quality and legitimacy of sources. The imprimatur of an established library, museum or archives bestowed on its contents a mark of authenticity, legitimacy, and authority. The naturalist seeking physical specimens, the historian searching for documents, or the private citizen looking for uplifting fiction could trust these institutions to provide the best evidence and the highest quality resources. Libraries, archives and museums also provided a means to accumulate and preserve knowledge over time. As sources for continuity, their function emerged as the accumulation of knowledge and its perpetual, care even when knowledge-bearing objects had become obsolete, outdated, or irrelevant. The preservation function reinforced a conservative ethos in libraries, archives, and museums and forced them to balance continuity with change. Libraries, archives and museums often became reluctant to change their practices for classification and exhibition of objects, and tended to resist pressure to discard or limit access to information deemed subversive, dangerous, or unpopular politically.

Despite the pull toward conservatism in collection development and practice, libraries, museums and archives adapted to a variety of social, cultural, and economic pressures during the post-war period. On the social and cultural side, established institutions faced dwindling audiences for exhibits that were viewed as elitist and shrinking communities of

users for collections that reinforced conservative, nationalistic, and bourgeois master narratives. From the late 1960s to the 1990s, many museums redefined their role and image from a temple for passively viewing clearly interpreted objects to a forum for interaction, learning, and open-end interpretation.[21] Public libraries built new facilities in rapidly growing suburban areas, actively targeted young readers, and expanded services such as outreach programs and organized events that helped to integrate libraries into neighborhoods and communities.[22] In response to a growing interest in social history, local history, and genealogy, many archives reassessed their collecting policies and aggressively sought materials on women, ethnic and linguistic minorities, popular culture, and social movements. At the same time, minority communities began to form their own cultural centers to support research, exhibition, and teaching, and to reinforce a mutual sense of identity. Often poorly funded and staffed by volunteers, these new institutions, nevertheless, emerged as vibrant catalysts for community formation and as competitors to conservative, established institutions.

Economic pressures also forced changes in policy and practice. Facing declining public subsidies and rising costs, cultural institutions, especially museums, have been compelled to assume more market-oriented strategies such as increasing admission prices, introducing museums shops and cafeterias as profit centers, and seeking corporate sponsorship for capital campaigns and high profile exhibits. In response, critics have questioned whether corporate sponsorship exerts undue influence over the themes and interpretations in museums and whether revenue-generating requirements force curators to produce exhibitions that are popular and trendy rather than critical and thought-provoking.[23] It is also worth noting that museums, which emerged from the Wunderkammern entertainment tradition, then evolved in to efforts to collect and organize physical evidence for scientific research with limited public display, reversed course and began to place most of their emphasis on exhibition, outreach, and education.

Libraries and archives have faced similar economic constraints of rising costs and declining public revenues, but both tradition and practice have limited their market-oriented options. Requiring patrons to pay for services that traditionally have been free runs counter to both users' expectations and professional goals of mitigating disparities in citizen's access to information. Libraries and archives have responded to economic constraints primarily through internal structural changes. Research libraries, under the pressure of rising acquisition costs for books and scholarly journals, have reduced acquisitions and began to develop networks for sharing expensive, but little used, items.[24] Archives have also adopted more focused and judicious criteria for selecting material for long-term preservation. They have turned increasingly to private foundations and competitive public funds, such as the Andrew W. Mellon Foundation and the National Endowment for the Humanities in the United States, the Heritage Lottery Fund in the United Kingdom, and the Riks Bank Jubileum Fund in Sweden, as sources for "venture capital" to support innovation.

The LAM in the Knowledge Economy

The LAM are arguably the oldest examples of knowledge organizations. Societies have built and sustained institutions to collect, organize, preserve, and provide access to knowledge-bearing objects for more than two millennia. It would seem that these quintessentially knowledge-based organizations would serve as models for other organizations making the transition to a knowledge-driven economy. In fact, the LAM are facing a period of deep uncertainty at the dawn of the new era due to economic pressures, competition from alternative service providers, changing expectations from consumers of their services, and a fundamental shift in their material base from tangible objects to digital representations. These factors are difficult to distinguish from one another, and we will attempt to do a point-by-point assessment of them. Instead, we will raise a number of emerging conditions that illustrate the interwoven nature of the challenges, and that raise central questions about the missions and continuing relevance of the LAM and their core functions.

The challenges facing the LAM are not new; they have been evolving as part of a larger constellation of changes for some time. However, some contemporary conditions bring the challenge facing the LAM into sharp focus. The advent of the World Wide Web (abbreviated here as the Web) has amplified the long-standing role of radio and television in the competition for attention, and has extended it into competition for information access in ways heretofore impossible. Through the Web, the LAM are facing serious competition from alternative service providers, possibly for the first time in their history. The Web can be thought of as a global substitute for the LAM because it allows a globally distributed population to publish and access information easily. Of course, the Web is weak on some traditional strengths of the LAM, such as legitimation and authentication of information, and in the persistence and structure provided for information access. Nevertheless, there are some striking stories to tell about the Web's competition with the traditional LAM. For example, the on-line bookseller, Amazon.com, has an extensive on-line database, not unlike a library catalog, listing several million book titles, 250,000 CD titles, and data about 250,000 motion pictures and entertainment programs from 1891 to the present. Amazon probably compares well in the ranking of research libraries conducted by the Association for Research Libraries. For some kinds of information, the Amazon databases are more comprehensive and more current than the on-line catalogs of large libraries. Moreover, Amazon competes with other on-line booksellers by adding services that mimic some of the selection and legitimating functions that libraries traditionally performed, such as alerts and recommendations based on user profiles and past purchases, and opportunities for readers to post and read book reviews. It seems reasonable to ask whether Amazon represents a first step in the migration of traditional LAN functions into a new model based on a commercialized Web infrastructure.

The advent of commercial services such as Amazon causes a subtle but important shift in the political and economic ecology of the LAM. For most of the last two centuries the LAM have operated as a kind of public good in which a patronage structure of universities, governments, and non-profit philanthropies provided funds, and the LAM carried out their missions as best they could. This arrangement never required a very robust means for judging the economic value of the LAM. To the extent that the

measurement of value-added was attempted at all, it tended to be built around a crude input/output model in which the raw materials of the LAM (papers, books, objects) were considered inputs and the outputs were the number of patrons served or the number of reference questions answered.[25]   Several important factors were missing from the middle of this model. For one thing, there was very little cost accounting to show how the LAM functions of selection, organization, curation, content delivery, and so on contributed economically to the services delivered.   For another, the model provided no way to determine the value of the actual work being done by the users of the LAM's materials. It was therefore not possible to determine how any particular input led to any changes in a user's welfare. This was fine as long as the patrons accepted the idea that the LAM were an important public good and they had to be funded at the appropriate level. The rise of examples such as Amazon call that idea into question, and the LAM have no useful measures of costs and benefits to fall back on.

Amazon provides proof that something like a library can be built and provided on a commercial basis. This proof can refocus the discussion of the social welfare provided by the LAM in a critical way. The welfare model of the traditional LAM started with the aggregate welfare of society and worked backward. As Webster's quote above suggests, the benefits of the "vast commerce in ideas" was the society at large – mankind, to use his term. Of course, the specific contributions that create these benefits were individual in origin, but the appropriate focus was not on the individual. In the traditional LAM, especially as they evolved in the 19th century, individual contributions arose through the provision of socially organized affordances. The society provided the LAM for use by individuals, and at least some individual users leveraged those affordances into important new discoveries or creations that benefited society. Prosperous societies had robust LAM infrastructure, and any society that wanted to be prosperous should create such infrastructure through collective action. Amazon offers a fundamentally different economic model in which the starting point is individual welfare. Individuals perceive a need for LAM-like services, and individual investors put up the resources and create the capacity to meet that demand. The individual users pay for the services, and presumably (under the assumptions of microeconomics) receive the welfare they paid for. As the welfare of individuals rises from use of the services, social welfare rises as well. In the realm of knowledge such as provided by Amazon, society might also benefit from the discoveries or creations of individuals who were able to leverage the knowledge they gained from the services. Amazon, simply by its existence, raises the question of why the society should support the LAM when the services provided by the LAM might be had through private enterprise using the Web as infrastructure.

Fortunately for the traditional LAM, such questions are not yet challenging the heart of the enterprise. But the questions suggest that the LAM cannot depend indefinitely on the rationales that have held their patronage structures together for the past two centuries. While some strict traditionalists within the LAM world might try to hold back the tide of changing arising from the Web, many are beginning to follow their user community into the Web world in order to leverage the power of the Web in ways constructive to the traditional LAM. A study of the online habits of 2,000 American college students conducted by netLibrary found that:

- 82 % of the students surveyed own a computer and virtually all of them use the Internet
- 93 % claimed that finding information on-line makes more sense than going to the library
- 83 % said they were frequently unable to get the materials they need for the library because of limited library opening hours
- 75 % said they do not have enough time to go to the library
- 75 % liked the convenience and 71 % liked the time saved by finding information on line any hour of the day.[26]

Another recent study amplifies on the importance of these data: "[b]ecause of easy access to the Web, undergraduates are using library collections and services less than in the past and, in the absence of quality information and tools on the surface, they may imperil the quality of student learning."[27] A transformation is already under way among users of the LAM, but it is not yet clear how social welfare will be affected by the trasnformation. Those who care for the traditional LAM are challenged to decide whether and how they will try to shape that transformation. That challenge should begin in recognizing that the LAM and the Web cannot substitute for one another. They are complementary, and must be developed in a complementary manner. We see four areas in which key complementarities appear: access, information quality, social memory, and information property.

Access

An important complementary role of the Web and the LAM is in improving effective access to information for all strata of the population. The "digital divide" usually refers to disparities in access to Information and Communications Technologies (ICTs). People without access to ICTs have few opportunities to participate in on-line discussions and debates, to use e-mail to communicate with friends and family, or to post their own content on the web. ICTs alone are only part of the problem, however. Equally important is the development of the information and skills infrastructure necessary to exploit the availability of ICTs [Dutton, OECD]. Libraries have long served as equalizers in disparities of access to information by providing free access to materials that individuals cannot afford to purchase, and most have extended their efforts to providing computers with Internet access and licensing access to databases on behalf of their users. Libraries are still relatively new at this, and they are finding that their service provision models based on circulating physical items such as books do not map neatly to the demands of a the digital environment. Users can take a book home and use it at their leisure, but those who do not have a computer and an Internet connection can gain access at a library facility only during its opening hours. Nevertheless, libraries are providing a vital complementary role in leveraging the Web among those who would otherwise not have access at all.

An equally vital complementarity of the Web and the LAM is in the co-location of physical collections and the information necessary to learn from them. Museums can be

used to illustrate this in two ways. The consolidated physical location of a museum's collections is beneficial for those who can visit the museum in person, especially for an extended period of time. Unfortunately, the same consolidation makes the museum's collections inaccessible by anyone unable to visit. Using the Web a museum can make significant portions of its collections available to distant users through images of objects and text information about the objects. Of course, there is much lost in the experience of seeing a photograph of a dinosaur skeleton compared to actually being there to walk around and look at the skeleton. Still, even limited access can be far better than none, especially for scholars who have intimate knowledge of the class of objects being studied and who have need to review items spread across a large number of collections. Even if some on-site investigation is required, preliminary reviews of on-line collections and commentary can dramatically narrow the search space and provide structure to the study. Another way the co-location of objects and information becomes valuable is in the provision of information at varying levels of depth at the location of the physical object itself. For many museum visitors the information contained on a plaque next to the exhibit is sufficient. But for many visitors, the ability to gain deep access into the records on a given object can be essential for study. Such access is usually provided for scholars by museum staff allowing entry into areas of the museum not permitted to regular visitors. With Web based technology, the entire holdings of information on each object could be made available at will to any visitor using a hand-held wireless device like a PDA. In this example of a museum it is possible to see that the LAM are a source of the authenticated information available to a distributed audience over the Web, and the Web provides unparalleled access to information about museum collections for visitors on-site at the museum.

Information Quality Assurance

Taken together, the LAM and the Web permit easy access to authenticated information. The Web is easy to use and provides fast access to a vast amount of information. Unfortunately, it is inadequate for teaching and research where definitive and high quality information resources are instrumental for critical analysis, innovation, and new knowledge generation. A great deal of the information in the Web is not accessible through the large search engines, and thus is not available to most Web users. Recent studies of the architecture of the Web distinguish between the surface Web and the deep Web, or what is also called the dark or hidden Web.[28] Search engines index mainly the surface Web of unrestricted, static Web pages, and no single search engine indexes more than 16 % of the surface Web. All of the search engines combined are estimated to index less than half of the surface Web. The "deep" Web is estimated to be 500 times larger than the size of the surface Web, and it is growing faster. There is no question that the Web makes huge amounts of information accessible, and for many applications this is a genuine boon. However, the Web and search engine package currently available falls short of the infrastructure required by knowledge communities now provided by the LAM.

A more serious quality assurance problem with search engine dependence on the surface Web is the comparatively substandard quality of the information there. The deep Web's

resources are typically superior in quality, organization, and structure to surface Web resources. Deep Web resources tend to be curated, meaning they have been selected, indexed, and controlled for quality and authoritativeness by subject experts or editors. Deep Web resources tend to be narrower and richer in content than surface Web sites, and oriented toward specific domains or disciplines. Scholars who rely on Internet search engines might locate substantial information in the surface Web while remaining completely unaware of the better content in the deep Web. Even if their search skills and their ability to judge the comparative quality of resources available are highly developed, they will miss much of the best information. At the very least, this constitutes a major opportunity loss.

The co-evolution of the objects, data, and meta-data of the LAM was not accidental. It was an integral and necessary part of the knowledge communities that evolved with and were sustained by the LAM. The full utility of collections of objects and documents was unattainable until the full set of complementary assets was available. Those complementary assets were the experts on the content in the collections – the librarians, archivists, and curators – and the tools they developed over time in the form of meta-data tools such as indices, catalogs, and reference works. The vital need for those assets was made strikingly evident shortly after the heroic success of the expansion of the US public library base with the Carnegie library endowments. Most of the XXXX Carnegie libraries had been built by 1920, but the benefits were as yet elusive. The Carnegie foundation commissioned a report by XXX Williamson to investigate the matter. In 1923 Williamson's report argued that the investments in bricks and mortar and collections would never pay off until many more professional librarians were deployed to manage the collections and help the public use them. Most US schools of librarianship were established in the decade thereafter, and their graduates made the public library an essential part of the nation's epistemic infrastructure. In a similar vein, the Web and associated tools such as search engines will not be adequate by themselves to achieving the full potential of the emerging epistemic infrastructure. Librarians and other professionals of the LAM provide essential expertise in information management quality assurance that is badly needed in the world of the Web.

The complementary nature of the traditional LAM and the emerging Web is illustrated by the LAM-like services increasingly available on the Web. These services are tied to large LAM collections, and the services are managed by LAM experts who know the collections intimately. The public's interaction with the collections is intermediated by LAM professionals, providing substantially greater benefits than non-expert users could hope to gain on their own. A good example of this is seen in the experimental on-line library services such as the Internet Public Library (http://www.ipl.org). The IPL began in 1996 as a student experiment to create an on-line service providing features of a public library. Since that time the IPL has demonstrated that essential library services such as reference can be provided on-line to a globally distributed user base from a globally distributed set of reference specialists. The primary user base of the IPL is now students in elementary and secondary school who use the collections and reference services to do assist with their schoolwork. The IPL infrastructure and concept has been extended to the American Indian Higher Education Council Virtual Library (http://www.aihecvl.org)

that has made it possible for a number of tribal community colleges to achieve accreditation for programs that was previously denied due to lack of library resources. The key to such services is their information quality: the content is authenticated by experts who know both the subject matter and the patterns of user demand for the content. The IPL and the AIHEC Virtual Library marry the traditional strengths of the LAM with the distributed access benefits of the Web to create a cost-effective form of epistemic infrastructure not possible before. These examples can be augmented by many others, and suggest that the future of the Web intersects with rather than departs from the traditional LAM.

Social Memory

The LAM provide socially vital core functions that are largely invisible and that cannot be provided by existing Web-based collecting and dissemination mechanisms. A key function in the knowledge-driven economy is the integration of widely distributed objects and collections. This requires a rich set of knowledge and skills in organization and classification, as well as a critical eye toward the epistemic regimes that systems of knowledge organization impose on the worlds they describe. That skill has been built up over two centuries, and is a key part of the role of the LAM in the global epistemic infrastructure. The Web in its current (or immediately foreseeable) form cannot provide this infrastructure. The Web provides access to a global user base, but custodianship of information in the world of the Web is largely in local communities, specific disciplines, and private content providers. This is good in the sense that the most intimate expertise resides at such levels, but over-dependence at this level reinforces parochialism and limits the potential for knowledge integration across space and over time. The LAM are not free from such parochialism: the institutional distinctions between libraries as sources of published works, archives as repositories of unpublished documents, and museums as storehouses for three-dimensional objects is artificial and inhibits knowledge generation. But at least across the subdivisions of the LAM a rich ecology for maintaining integrative knowledge has evolved. Libraries cooperate closely with one another through shared cataloging and other mechanisms, and similar cooperative arrangements reinforce the shared missions of archives and museums. Effective knowledge integration requires a careful balance between local, subject, and domain knowledge as well as broader principles for rich representation. This remains a challenge for both the LAM and the world of the Web, but the LAM are much farther along than the Web in developing the means to achieve the right balance.

An essential function of the LAM is the accumulation and preservation of knowledge that might someday be of vital importance. Libraries, archives, and museums maintain collections over the course of centuries. The LAM are the most important form of long-term social memory. Preservation experts in the LAM fight a constant battle to maintain documents and objects from destruction and deterioration in the belief that losses inhibit future potential. This tradition is well established, and has found a respected place in all advanced societies. The Web reveals another side, in which loss of information is massive and routine. No social institutions equivalent to the LAM currently take responsibility for collecting and preserving digital objects. Many of these objects are

generated without much consideration beyond their first-order uses, and in complete disregard for their long-term potential for manipulation and repurposing. They are seldom collected and organized the way paper documents have been for the past centuries, and in some cases it is not clear whether anyone is going to keep them at all. This represents a major departure from the past, in which the physical and economic realities of publication made it more likely that knowledge would be collected and preserved. And even in the print world, the idea of "comprehensive collection" has largely disappeared. No single library on Earth collects everything that is published, and it is virtually impossible to ascertain the fraction of total global titles held in all the libraries taken together. It is almost certain that a large amount of material disappears forever each year, even as librarians and archivists presume that other libraries are preserving those items. There is no way to tell whether the material being lost is of long term value.

The situation in digital information is much more problematic because there are almost no reliable standards or technologies for long-term preservation. A number of publishers provide full text digital databases made from content they physically own and manage. Libraries purchase access to this content, but they do not actually store or preserve it. Even if copyright laws and license agreements permitted such replication, most libraries would not do so because they figure the publishers will preserve their digital content in perpetuity. But publishers are not in the business of archiving and preserving they content they produce, and there is no reason to assume they will assume this responsibility. Libraries and publishers have not come to sustainable agreements regarding digital archiving responsibilities. Some publishers pledge to preserve their digital into the foreseeable future; others do not. In any case, it seems that libraries, and especially legal deposit libraries, would be better equipped to perform this function over the long run. In most countries, laws covering mandatory deposit of published work ensure that the majority of published material at least has a chance of preservation. Legislation regarding mandatory deposit of published digital works varies widely from country to country, and the deposit libraries are not yet ready to accept and manage such works. Many Web documents are critical sources of information and important cultural artifacts, but there are few tools to capture and preserve these documents and almost no market incentives for Web archiving even in the surface Web. Long term preservation is one of the important areas in which the traditional LAM and the Web must depend on each other.

Information Property

One of the most challenging but important areas of complementarity between the traditional LAM and the Web is information property management. The LAM are expert on copyright laws and conventions that have evolved over the past two centuries. Copyright was designed originally to provide authors with a limited monopoly as an inducement to creativity, but it has expanded in scope and duration and placed constraints on alternatives to purchasing items or leasing access.[29] The digital realm provides many new challenges for copyright. Laws and licensing agreements usually permit libraries to provide access to authenticated or on-site users, but they strictly prohibit wholesale

downloading of entire databases. They also limit the number and future uses of copies of individual articles, and forbid manipulation of digital objects to create extracts or derivative works. Content providers are beginning to use encryption and digital rights management software to prevent duplication of content and access by users who do not purchase an item or pay to view it.

Some scholars such as Lawrence Lessig argue that copyright restrictions on digital content have become so draconian that they are counter-productive to innovation and knowledge generation.[30] The Internet was once seen as a neutral platform that encouraged the free flow of content. Legal constraints on intellectual property are rapidly eroding that nascent tradition, with considerable downside possibilities for knowledge communities. Corynne McSherry contends that the "propertization" of knowledge is transforming key knowledge communities such as universities from "gift" economies to "market" economies. The effects that such a shift might have on high-quality scholarship, academic freedom, collaboration, and creativity are unknown, but it is clear that these knowledge communities have deeply developed and productive traditions that might be damaged in this process. The information objects that circulate in academic communities are "gifts" where the donor (usually an author) relinquishes knowledge to the larger community as a contribution to that community's larger mission of producing science, knowledge, or truth. In return, the scholar receives recognition and enhanced reputation that enhances the value of the scholar's future work.[31]. The scholar's personal economic welfare is tied only indirectly to this process, through promotion and improved marketability to more prestigious universities that compensate better. Only in rare circumstances does a specific contribution contribute directly to the scholar's economic welfare. This has been the fundamental social contract of university for several hundred years, and has produced universities that are the envy of the world. No for-profit equivalent has ever materialized. In principle, it is possible that propertization of knowledge might produce new knowledge communities that rival universities in content and quality. But it is more than likely that propertization of knowledge within universities will encourage petty squabbles over attribution and revenue sharing that erode content and quality.

Fortunately, the Web does not require the propertization of knowledge to be effective. Alternative strategies for evaluating and distributing intellectual property on the Web are evolving along the lines of the "gift" model. An early project initiated by physicists to submit and deposit "pre-prints" of journal articles electronically has mushroomed into a much larger movement for digital deposit and open archives for scholarly communications. The open archives movement retains many of the community-oriented value-added functions of a "gift economy," especially peer review and editorial oversight for quality control. It replaces the strict intellectual property rights enforcement regime of publishers with "rules of the road" and community norms for attribution and re-circulation of ideas that appeared earlier in published works.[32] Lessig and others advocate the development of "knowledge conservancies" where owners of intellectual property voluntarily place their works in the public domain either to contribute to the larger social good, or in exchange for tax incentives that partially compensate donors for foregone royalty payments. An important example of an alternative is SPARC (the

Scholarly Publishing and Academic Resources Coalition), an alliance of more than 200 universities, research libraries, and organizations in North America, Europe, Asia and Australia to innovate in the scholarly communications system.[33] It provides for incubation of competitive alternatives to current high-priced commercial journals and digital aggregations. It also publicly advocates fundamental changes in the system and culture of scholarly communication. SPARC education campaigns are aimed at improving awareness of scholarly communication issues and supporting expanded institutional and scholarly community roles in and control over the scholarly communication process. It remains to be seen whether open archives, knowledge conservancies, or coalitions such as SPARC will fundamentally change the parameters of information property or create a fundamentally new means for valuing and distributing knowledge. But experiments of this kind are important to developing the complementarity between the LAM and the Web most likely to bring benefits in the future.

Conclusion

In arguing that collection development, classification, and preservation are important functions with transcendent value, we are not advocating that all information should be captured, organized and preserved, nor do we believe that archives, libraries and museums are the only institutions that should be engaged in these processes. Selection and quality control are more important than ever, even with very cheap and rapidly declining storage costs, because of the vast quantities of data and raw information generated by knowledge-intensive processes. The selection processes that professional librarians, archivists and curators carry out are essential filtering mechanisms, based on professional norms and standards, subject and domain knowledge, and attentiveness to the needs of user communities. Collection development within an institutional context also builds trust in resources which is especially important for digital information that lacks clear indicators of quality, authoritativeness, and authenticity.   We also contend that institutions devoted to knowledge organization and accumulation, not only support education and research, they have the potential to become important sites of research and teaching in their own right. Here we turn to lessons from the nineteenth and early twentieth century where some of the most significant tools for knowledge management, such as library and museum classifications systems and standards for sharing bibliographic information, were based on research in libraries and museums in order to respond to pragmatic problems. Clearly, knowledge-driven societies need new tools but we believe that archives, libraries, and museums are likely sources for innovations in knowledge management. Likewise, these institutions can become important sites for teaching information literacy and developing skills in information retrieval and evaluation.

We also contend that archives, libraries, and museums will continue to fill a broad social need to decrease disparities between "information haves" and "information have-nots" especially as skills in acquiring, evaluating, manipulating, and generating information become more fundamental to individual and social well-being. Libraries, archives and museums need not replace master narratives of nationalism, natural hierarchies, or local

chauvinism. It is doubtful that they could do so in any case. On the other hand, they need not and should not be dismissed or subsumed by vapid platitudes of one global village. They constitute one of modern society's most vibrant and effective mechanisms for dealing with the extraordinarily challenging and conflicting demands to preserve parochial local perspectives in the service of identity formation, cultural preservation, on one hand, and the pressing need to find improved mechanisms for establishment of civil society within and peaceful relations among disparate communities. LAM must work at the center of epistemological frameworks that are simultaneously coherent and destabilizing, for there is no alternative mechanism for progress in knowledge.

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