



NATIONAL ENDOWMENT FOR THE

Humanities

DIVISION OF PRESERVATION AND ACCESS

Narrative Section of a Successful Application

The attached document contains the grant narrative and selected portions of a previously funded grant application. It is not intended to serve as a model, but to give you a sense of how a successful application may be crafted. Every successful application is different, and each applicant is urged to prepare a proposal that reflects its unique project and aspirations. Prospective applicants should consult the NEH Division of Preservation and Access application guidelines at <http://www.neh.gov/grants/preservation/humanities-collections-and-reference-resources> for instructions. Applicants are also strongly encouraged to consult with the NEH Division of Preservation and Access staff well before a grant deadline.

Note: The attachment only contains the grant narrative and selected portions, not the entire funded application. In addition, certain portions may have been redacted to protect the privacy interests of an individual and/or to protect confidential commercial and financial information and/or to protect copyrighted materials.

Project Title: Celestial Cartography Digitization Project

Institution: Adler Planetarium

Project Director: Jodi Lacy

Grant Program: Humanities Collections and Reference Resources

3. Narrative

SIGNIFICANCE

The celestial cartography digitization project will digitize and make accessible all celestial cartography in the Adler Planetarium collections. The Adler is the only independent planetarium in the world to steward significant collections. The scope and quality of the Adler's holdings rank it among the world's most important science museums.

Celestial cartography was selected for digitization due to the fragility and diversity of the materials, scholarly content and interest, and usefulness in Adler programming for the general public. Dating from the fifteenth through twentieth centuries, the Adler's celestial cartography focuses on European astronomy, but also includes significant examples from China and the Islamic world, as well as an early international scientific collaboration. The materials to be digitized include:

- **227 rare books and atlases, containing over 1,000 celestial maps and star charts.** The Adler's rare book collection contains the most important celestial atlases of the seventeenth and eighteenth centuries, which were the great age of celestial cartography. The collection includes multiple copies of Johann Bayer's influential celestial atlas *Uranometria* (1601), in which Bayer implemented a stellar nomenclature system still used today. Books on comets are another strength. In addition, significant individual maps are found in astronomical and cosmological texts and tables, as well as works on astrology, geography, and navigation.
- **97 works on paper.** Strengths of the works on paper collection include celestial maps as well as comet and eclipse broadsides. One rare example is the Suchow chart, a Chinese star map chiseled into stone in the thirteenth century and passed down via rubbings through many generations. The Adler's nineteenth-century rubbing adds text reflecting Western influence on Chinese astronomy.
- **58 objects from the scientific instrument collection.** Celestial cartography in the instrument collection includes forty-three globes, maps engraved on navigational instruments, and paper star finders. Highlights include a seventeenth-century filigree celestial sphere, engraved in brass with 1,018 star holes and forty-eight constellations, from Lahore, Pakistan; and a 1551 hand-colored celestial globe by Gerhard Mercator.
- **The *Carte du Ciel* collection of approximately 3,750 prints.** The *Carte du Ciel* ("Map of the Sky") was one of the earliest large-scale international science projects and among the first in astronomy to apply photography to map star positions. Some twenty observatories based in Europe, Africa, Australia, Asia, and North America participated from the project's origin in 1887 to its end in 1950. The Adler's collection consists of astrographic charts from the late nineteenth and early twentieth centuries from observatories in Paris, Bordeaux, Toulouse, Brussels, Rome, San Fernando (Spain), and Greenwich.

Fragile and diverse nature of the materials

Celestial cartography is especially suited for this digitization project due to the fragile and varied nature of the materials. Rare books and works on paper may be displayed in exhibition galleries only for brief periods. Because inks can fade, they permit only limited exposure to light. Sensitive organic materials in bookbindings are easily stressed and can degrade, so books can be displayed in an open

position only for a short time. In addition, fold-out maps in books are difficult to display. Digitization will allow the Adler to incorporate celestial cartography in Adler exhibitions and planetarium shows regardless of the length of the program. The maps in the *Carte du Ciel* collection are printed on unstable paper typical of the late nineteenth century. The paper is acidic, with the acidity distributed throughout the paper, making it volatile. Digitization will help preserve the intellectual content of the collection. The three-dimensional objects to be digitized (globes and scientific instruments) include moving parts. The digital photography for these items will be enhanced by animation. These animations will be available to researchers online and offered in an interactive format in the Adler's exhibition galleries.

Scholarly content¹

The intellectual content of the Adler's celestial cartography reaches well beyond the history of astronomy. On the most fundamental level, maps show relationships between objects in space. Just as a terrestrial political map defines arbitrary national borders, a celestial map creates imaginary groupings of stars physically very far apart. In selecting groupings of stars and information for their maps, celestial cartographers reveal contemporary awareness of the universe around them, as well as prior beliefs assimilated into that awareness. With a perspective embedded in time and place, the artist or astronomer understands and portrays the universe based on his surrounding society and culture. Available technologies, dominant religious sensibilities, prevailing philosophical thoughts, and popular artistic styles all influence celestial maps. From antiquity to the present day, maps of the heavens are tools for our understanding of human life on Earth.

Looking up in awe at the sky, all ancient cultures tracked celestial motions, found patterns in those movements, and developed cosmological theories based on their observations and interpretations. All over the world, people independently watched and analyzed the heavens to measure time and to divine the future. Thousands of years ago, many of these astronomer-philosophers left behind a record of tales, texts, tables, maps, and diagrams, each reflecting its time and place.

Ancient Greek science and philosophy laid much of the foundation for astronomy in the Western world, leaving a tradition visible in many of the works in the Adler's collection. Greek philosophers understood the Earth to be round, positing that it was at the center of the universe and was surrounded by a celestial sphere that rotates daily. Around 250 BC, Aratus of Soli wrote his epic poem *Phaenomena*, which recounted ancient constellation myths and laid out many details of the Greek cosmos. Four centuries later, Claudius Ptolemy of Alexandria (ca. AD 100-170) compiled a list of stars in his *Almagest* (ca. A.D. 150). Ptolemy catalogued stars he saw from his location in the Mediterranean, grouping 1,028 naked-eye stars into forty-eight constellations (forty-seven of which are still in use today). The earliest maps of the stars described by Ptolemy took the form of celestial globes, which show the stars as seen from a position outside the celestial sphere.

While natural philosophic thought stagnated in early medieval Europe, it blossomed in the Islamic world. Medieval Islamic scientists translated Greek texts as well as Indian, Persian, and Babylonian works of science and philosophy. Al-Sufi (903-986), working in the court in Isfahan (now in Iran) and basing his work on Ptolemy, drew constellation figures around stars of six magnitudes,

¹ For an overview of the history of celestial cartography, see: Deborah Warner, *The Sky Explored: Celestial Cartography, 1500-1800* (A.R. Liss, 1979); Anna Friedman Herlihy, "Renaissance Star Charts" in *History of Cartography, Volume Three: Cartography in the European Renaissance, Part One* (University of Chicago Press, 2007); and Elly Dekker, "Globes in Renaissance Europe" in *History of Cartography, Volume Three: Cartography in the European Renaissance, Part One* (University of Chicago Press, 2007).

symbolized by their size.² Islamic scientists also made significant advances in astronomical instrumentation, improving Greek inventions such as astrolabes and celestial globes. Ulugh Beg (1394-1449) stocked his great observatory in Samarkand (now in Uzbekistan) with enormous instruments and composed a new star catalogue from his observations. When Islamic civilization eventually spread across the Middle East, northern Africa, and through Spain into Europe, Islamic astronomers' retention of, and improvement on, Greek ideas invigorated science and culture in late medieval Europe and the subsequent Renaissance.

Beginning around the twelfth century, European scholars rediscovered Greek texts, including the poetry of Aratus and the more technical scientific work of Ptolemy. Thanks to the improvement of printing with moveable metal type in Germany around 1450, publishers popularized these ancient poems and spread scientific texts throughout Europe. Using woodcut blocks, already known in eighth-century China, printers added illustrations to the texts. The Adler's collection contains many of these early European translations, including Aratus's *Phaenomena* (1488), Abu Ma'shar's *De magnis conjunctionibus* (1489), and Hyginus's *Poeticon astronomicon* (1482). The Hyginus edition contains the first-ever printed constellation figures, representing the bulk of the Ptolemaic constellations. Although based on imprecise star positions, its illustrations served as models for future constellation figures.

The development of the printed book marked a point of departure for a frenzy of astronomical advancement in the sixteenth and seventeenth centuries. Paired with an increasingly literate population, this technology enabled a greater dissemination of information. Printing dramatically improved the accuracy of earlier texts, which had suffered from the vagaries of manuscript copying. Numerous classic scientific texts were published and distributed in relatively accurate editions. Eliminating a scholar's need to travel to libraries for primary sources, readily available reference materials spurred more rapid theorization. Consequently, resulting accounts of new discoveries and hypotheses could be more quickly and more easily publicized within the community of astronomers and natural philosophers, as well as to a scholarly-minded aristocracy and merchant class. A surge of global exploration coincided with innovations in printing and a rebirth in artistic expression. For example, in the sixteenth century, copperplate engravings allowed finer detail in scientific illustration. Texts, illustrations, and maps conveyed recent discoveries and new ideas, reaching more people in greater geographical distribution than ever before.

One of these startling ideas came from Nicholas Copernicus, whose *De Revolutionibus orbium coelestium* (1543) described a sun-centered universe. Decades passed before his idea convinced astronomers, but eventually it did—with support from discoveries enabled by the telescope. Invented in 1608, the telescope dramatically changed the conception of the heavens. Astronomers discovered details on the moon and planets, and consequently adjusted their theories of the universe. Cartographers charted variations of cosmic models, embellishing them with mythic accounts and scientific devices. Seeing farther into the cosmos, astronomers observed more stars, which appeared in the maps of the most recent discoveries. Other astronomers who travelled to places previously unknown to Europeans observed additional stars that cartographers added, along with newly invented constellations, to create the most up-to-date maps. Influential catalogues of new stars included those of Tycho Brahe, John Flamsteed, Edmund Halley, Pieter Dirksz Keyser, and Frederick de Houtman, who featured the new constellation figures created by Jakob Bartsch, Johannes Hevelius, and Abbe

² Stellar magnitude is a star's (or other celestial object's) apparent or measurable brightness. Brighter objects have lower numbers; dimmer objects have higher numbers. With the naked eye, and in the absence of light pollution, a person can see stars to approximately the sixth magnitude.

Nicholas Louis de Lacaille; some of these constellations soon faded out of common usage, but many are still currently used. All of the significant atlases, and each of the new constellations, find extensive representation in the Adler's collections.

As Europeans explored and colonized the globe, astronomy played a crucial role in navigation and exploration. Mariners relied on observations of the stars and the sun to determine their latitude and carried out complex calculations involving lunar positions in order to approximate their longitude. Navigational instruments occasionally included simple celestial charts relevant to the function of the instrument. The Adler's collections contain examples of astrolabe quadrants with charts engraved into brass. Europeans learned much about the southern skies in particular, perhaps best exemplified by Lacaille's southern sky planisphere, also represented in the Adler's collections.

By the early eighteenth century, European celestial iconography was firmly established, but artists were still challenged to creatively render the constellation figures accurately superimposed onto a template dictated by the positions of the stars. Despite the limitations imposed by the basic forms, constellation figures encompass a range of artistic styles, including classical, baroque, and rococo forms. There was even flexibility in the orientation of the heavens to the viewer: the cartographer could present stars from either a geocentric perspective or an external perspective. A procession of figures resulted from the influence of certain cartographers, especially Johann Honter, Johann Bayer, Johannes Blaeu, Johannes Hevelius, and John Flamsteed. For example, Bode based his *Vorstellung der Gestirne* (1782) on Jean Fortin's 1776 edition of Flamsteed's *Atlas* (1729); all are included in the Adler's collections. Balancing the strict constraints of science and the fluidity of art within a celestial chart posed a new challenge to the artist; too much adornment would obscure the positions of the stars, resulting in a beautiful chart with little practical use, while the absence of adornment would create a sterile, unappealing diagram.³

The discovery of more and more stars brought about the decline of the artistic celestial chart. Johann Elert Bode's *Uranographia* (1801) is the last of the great pictorial star atlases to have practical astronomical value. Later pictorial atlases included only stars visible to the naked eye, while scientific atlases abandoned the constellation figures so as not to obscure any of the numerous new celestial bodies that needed to be charted. By the mid-nineteenth century, celestial charts often indicated constellations only as regions in the sky, eliminating decorative illustrations altogether. In the Adler's collections, Henry James's *Charts of the Stars* (1860) provides an excellent example of how the details included in nineteenth-century maps made constellation figures inappropriate and impractical.

In the late nineteenth century, less artistic and more technical celestial maps became even more prevalent. Developments in dry-plate photography led E. B. Mouchez, director of the Paris Observatory, to promote the idea of a photographic star chart of the entire sky, with stellar positions

³ Aside from a few relatively minor examples, the Adler's collections contain what would comprise a short list of every influential star map or atlas from the sixteenth through eighteenth centuries: Ratdolt's *Hyginus Poeticon Astronomicum* (1482), Pisanus's Aratus's *Phaenomena* (1488), Honter's planispheres (1532), Piccolomini's *De le stelle fisse* (1540), Gallucci's *Theatrum Mundi* (1588), Bayer's *Uranometria* (1601), Schiller's *Coelum Stellatum Christianum* (1627), Cellarius's *Harmonia Macrocosmica* (1661 and 1708), Seller's *Atlas Caelestis* (1680), Lubieniecki's *Theatrum Cometicum* (1668), Hevelius's *Firmamentum Sobiescianum* (1690), Pardies's *Globi Coelestis* (ca. 1690), Flamsteed's *Atlas Coelestis* (1729), Doppelmayr and Homann's *Atlas Coelestis* (1742), Bevis's *Celestial Atlas* (ca. 1750), Lacaille's southern sky planisphere (ca. 1756), Goldbach's *Himmels-Atlas* (1799), Bode's *Uranographia* (1801).

determined more accurately than ever before. Over fifty astronomers attended the first planning meeting at the Paris Academy of Sciences in 1887. From observatories around the world, the *Carte du Ciel* would map stars down to the fourteenth magnitude, with a companion catalogue listing stars to the eleventh magnitude.

Each of the twenty participating observatories focused on a specific zone. With uniform astrographic telescopes, they photographed their zones in a regular overlapping pattern. Each *Carte du Ciel* chart appeared in the same format. Mapmakers exposed a standard grid onto each plate to facilitate measurements, which were left to individual observatories. Using the grid and standardized keys for stellar magnitude, astronomers imposed order upon everything telescopically visible from Earth. Financial complications and two world wars slowed progress on the project. The *Astrographic Catalogue* of stars to the eleventh magnitude was finally completed in the 1960s, with the original *Carte du Ciel* mapping project never fully accomplished; only about half of the observatories published plates. The Adler's collection includes approximately 3,750 charts from observatories in Paris, Bordeaux, Toulouse, Brussels, Rome, San Fernando (Spain), and Greenwich. Although incomplete, the *Carte du Ciel* project was a forerunner of international collaborative scientific projects prominent in the twentieth century. As an early attempt to map the whole sky, its ambition parallels that of the early twenty-first-century Sloan Digital Sky Survey.

In the early-mid twentieth century, the ability to navigate using celestial cartography remained an essential skill for pilots, sailors, and even astronauts. Examples from the Adler's collections include a 1920 navigator's celestial globe and a 1946 star finder used in American, Canadian, and British navigation schools.

With each subsequent advance in technology and ever-more powerful telescopes, astronomers see farther into, and work toward a deeper understanding of, the universe. Celestial cartography documents changes in the exploration of, and theories about, the universe. Combining art and science from the late fifteenth century to the early twenty-first century, celestial maps visually express both humanity's sense of wonder about, and efforts to impose order on, the universe.

Scholarly interest

Researchers can use the Adler's celestial cartography to study subjects related to the history of theology and religion, maritime and navigation history, the history of technology, art history, visual and critical studies, material culture, and the history of printing. For scholarly researchers, the Adler's celestial cartography provides unique opportunities for interdisciplinary research that incorporates art, history, and science.

In recent years, numerous outside researchers have studied the Adler's celestial cartography collection to explore diverse yet specific topics: a history professor consulted bound and loose star charts as background for her examination of a rare Islamic celestial globe in the Adler's collection; a map historian examined the Adler's first edition of Bayer's *Uranometria* during his research on the measurement of longitude in the seventeenth and eighteenth centuries; and a media and technology studies graduate student used rare books, works on paper, and historic scientific instruments for his thesis on "locative media." Artists have used the Adler collections for inspiration, while local and international groups interested in bookbinding and the history of the book have toured the collections. College students regularly visit to enhance their courses on material culture and the history of astronomy.

Digitizing celestial cartography and making it freely accessible to researchers will open new interdisciplinary research possibilities. Contemporary celestial cartography most often uses the internal perspective, showing the stars as seen from Earth. Historical celestial cartography, however, often mapped the stars from the external or God's eye perspective, showing the stars as if the viewer hovers above the celestial sphere. This is true of all celestial globes, but also many flat maps and atlases. Digitization makes reversing the perspective very convenient, allowing researchers to more easily compare the accuracy of star positions, and the fluidity of artistic representations. In addition, scientists can use these maps to learn more about the history of the universe. For example, researchers may be able to compare old and new maps to discover supernova remnants, dying or variable stars. The depth of the Adler's celestial cartography collection should also prove useful to forensic astronomers, who research astronomical references in literature and art. Forensic astronomy has been used to determine dates, locations, and the historical and astronomical context for a variety of notable works, including Vincent Van Gogh's *Moonrise*, William Shakespeare's *King Lear*, Mary Shelly's *Frankenstein*, and Walt Whitman's *Year of Meteors*.⁴ Comets, meteors, and eclipses were a great source of anxiety through the early twentieth century. The Adler's celestial cartography, especially comet and eclipse maps, can provide content and context for forensic astronomers and others studying literature and art history. The Adler's collection of comet maps, second only to the Crawford Library in Edinburgh, makes the proposed project of great significance.

Two under-researched and intriguing categories of star charts are included in the celestial cartography digitization project: pole star charts and charts related to the function of astronomical instruments. The Adler's collection includes singular and typically hard to find examples of pole charts, which map the stars in the region surrounding the north celestial pole. They can be used for wayfinding (providing orientation to the north), helping to determine latitude (by finding the elevation of the north celestial pole), and for timefinding (by tracking the orientation of northern stars, such as the stars of Ursa Major). Many pole charts are found in books not obviously about mapping the sky, but the Adler's rare book collection has strengths in many related areas beyond celestial atlases: navigation, cosmological and astronomical texts and tables, and books on historic scientific instruments. Star charts were used on nocturnals, instruments used for nighttime navigation, on astrolabes, and on compendiums; each had a plausible practical function, and each had associated significant social and cultural functions. Digitization of the pole charts and functional charts on astronomical instruments will provide researchers with a rich, untapped resource unrivaled in any other collection. The Adler's unique collection of rare books, works on paper, and astronomical instruments makes this possible.

One scholarly project in particular will greatly benefit from the celestial cartography digitization project: the Adler's two-volume *Star Charts* collections catalogue. Much of the background research to develop the object list for the celestial cartography digitization project was conducted in

⁴ For forensic astronomy examples, see: Jennifer Drapkin and Sarah Zielinski, "Forensic Astronomy Solves Fine Arts Puzzles," *Smithsonian*, April 2009, <http://www.smithsonianmag.com/arts-culture/Celestial-Sleuth.html> [accessed 17 June 2013]; Dan Falk, "Forensic astronomer solves Walt Whitman mystery," *NewScientist*, 1 June 2010, <http://www.newscientist.com/blogs/culturelab/2010/06/the-forensic-astronomer-donald-olson.html> [accessed 17 June 2013]; Donald W. Olson, Russell L. Doescher, and Marilyn S. Olson, "Dating van Gogh's *Moonrise*," *Sky & Telescope*, July 2003, <https://digital.library.txstate.edu/bitstream/handle/10877/4028/fulltext.pdf> [accessed 17 June 2013]; and Jennifer Ouellette, "'Forensic Astronomer' Solves Frankenstein Mystery," 5 October 2011, <http://news.discovery.com/space/astronomy/astronomy-solves-the-mystery-of-frankensteins-moon-111005.htm> [accessed 17 June 2013].

preparation for a scholarly printed catalogue. *Historic Scientific Instruments of the Adler Planetarium*, an ongoing publication project, documents the collections in a multi-volume catalogue series. In each volume, an established scholar presents introductory essays and detailed descriptions of each instrument in an object category. Technical appendices and bibliographies provide further information. The first two published volumes have appeared: *Western Astrolabes* (1998) by Roderick and Marjorie Webster, and *Eastern Astrolabes* (2009) by David Pingree. *Star Charts*, by Anna Friedman, is among several volumes in progress. Production of the *Star Charts* catalogue will occur after the grant period, but celestial cartography digitization will support Friedman's research and writing, as well as catalogue printing.

Adler programming

The celestial cartography digitization project will enhance Adler exhibitions and planetarium shows that merge science and the humanities. The Adler's mission is to inspire exploration and understanding of our universe. Adler collections play a critical role in providing this inspiration, and a significant one in promoting understanding. Current astronomy and cosmology can be intellectually intimidating even to the most engaged visitor. To achieve our goals, we must first humanize scientific discoveries. In Adler exhibitions and programming, the collections illustrate how scientists of the past and present have utilized instruments to make their discoveries. Moreover, the collections provide social and cultural context to scientific activities and accomplishments, humanizing the often abstract nature of science and enabling visitors to connect with the people and content of science. By showing how people developed the impressive tools and theories of astronomy from careful observation of the night sky, the collections provide a personal and intellectual link between museum visitors and the people of science. Visitors leave with new knowledge, but most importantly, are inspired by their experiences to seek a deeper understanding about our universe and humanity's place in it.

Once the celestial cartography collection is fully digitized, history and art will be more easily incorporated into planetarium shows and long-term exhibitions. The Adler's current featured planetarium show, *Cosmic Wonder*, integrates historic star charts from the collections in the context of human curiosity. Throughout time, humans have connected with the cosmos in an ongoing cycle of wonder, observation, and discovery. The projection of a star chart onto the planetarium dome makes this connection easier to understand because it mimics the sky. Past temporary exhibitions featuring the Adler's collections have addressed diverse topics, including: celestial and cosmological mapping; Asian astronomy; connections between art and astronomy; celestial navigation; changing views of the cosmos; and the cultural uses of astronomy for survival and community building. Whether an exhibition focuses on a historical topic or cutting-edge scientific research, Adler collections provide background, insight, and human context. **Digitization of the celestial cartography collection will allow its use in long-term exhibitions and in new immersive and interactive formats.**

Two specific public programming projects will result from the celestial cartography digitization project: an interactive digital exhibition and a WorldWide Telescope tour. The Adler's Space Visualization Laboratory is a working laboratory where historians, scientists, technicians, artists, and educators collaborate to create new ways for people to explore the universe. The Space Visualization Laboratory provides curators a venue for dynamic presentations to visitors, using technology that allows the public to interact with collections without risking physical damage to artifacts. Digital versions of collections objects also make it possible to add virtual settings and magnification of space and time. As a part of the celestial cartography project, Space Visualization Laboratory team

members will animate globes, star finders, and other moveable objects. Using Open Exhibits (<http://openexhibits.org/>) software, the Adler will create an **interactive digital exhibition featuring celestial cartography**. The exhibition will be displayed in the Space Visualization Laboratory and will be available for download. Focusing on the history of celestial cartography from antiquity to the present, the exhibition will feature twenty-five collections items—including animated three-dimensional objects—and provide unique opportunities for rich interaction with collections materials.

WorldWide Telescope (<http://www.worldwidetelescope.org>) combines imagery from the best ground and space-based telescopes in the world with 3D navigation. Available for free download or as a web-based application, WorldWide Telescope allows users to conduct their own research, import data, and create narrated guided tours. **Using current astronomical images and fifteen historical images, the Adler will create a guided tour for submission to WorldWide Telescope repository.** The tour will be available for free download to the general public, as well as other planetariums seeking to incorporate historical context into their programming.

Related collections

The Adler is the only independent planetarium in the world to steward significant collections. Moreover, the scope and quality of the Adler's holdings rank it among the world's most important science museums. The Adler's strengths lie in its focus on astronomy, rather than a broader history of science; in its collecting a variety of formats such as museum objects, books, and archival collections; and in its in-house expertise in astronomy from antiquity to the present day.

Significant related celestial cartography collections are housed at the British Library, the Linda Hall Library (Kansas City), the Library of Congress, the Huntington Library (Los Angeles), the Crawford Library (Edinburgh), and Museo Galileo (Florence). The British Library houses a collection of star charts, celestial globes, European printed star atlases, and early maps in medieval manuscripts. In the United States, the Linda Hall Library and the Library of Congress both have strengths in celestial atlases and star charts from the seventeenth century. The Crawford Library houses a significant collection of comet maps, and Museo Galileo holds celestial globes among its collection of historic scientific instruments. The Adler's celestial cartography collections are by themselves a rich resource featuring six centuries of celestial atlases, star charts, comet maps, celestial globes, and practical maps engraved on instruments.

HISTORY, SCOPE, AND DURATION

History of the project

The celestial cartography digitization project is a part of the Adler's **Collections Access Initiative**. At an intensive retreat in March 2011, the Adler's Board of Trustees placed a high priority on improving collections access technologies. The resulting Collections Access Initiative is an ambitious five-year (2013-2018) plan to bring Adler collections to the broadest possible audience. The initiative is being implemented in three phases:

- ***Phase I: Stewardship & Staff Access.*** The Adler is implementing an integrated collections management database (Minisis MINT) that provides professional staff access to museum, library, and archival collections. Adler staff are establishing standards for

metadata, data structure, and controlled vocabularies. Currently underway, this phase will be completed in January 2014.

- **Phase II: Scholarly Access.** From October 2013 through September 2014, the Adler will implement the digital asset management system for its backlog of digital images, and design and implement an online public access catalog.
- **Phase III: Digitization & Innovative Access.** Beginning in October 2014, the Adler will focus on collections digitization and visitor access. From October 2014 through April 2016, the **celestial cartography digitization project** will be the first major digitization project. After the grant period, Adler staff will develop additional mobile and interactive applications using the celestial cartography. Other digitization and access projects will follow.

The Adler is committed to raising \$1.5 million for the Collections Access Initiative. To date, approximately \$487,000 has been raised toward this goal. Funds requested from NEH will contribute to the overall budget of the Collections Access Initiative with Adler's cost share for this NEH project supported by institutional operating funds and philanthropic contributions.

Scope and duration

The celestial cartography digitization project has two major goals: 1) **digitization of the celestial cartography** in the Adler's collections, and 2) **accessibility of the celestial cartography**. The grant period will be May 2014 through April 2016, with the bulk of the work implemented from October 2014 through September 2015.

Digitization of the celestial cartography will be achieved through:

- photography;
- scanning; and
- animations of three-dimensional objects.

Accessibility of the celestial cartography will be achieved through:

- descriptive, administrative, and technical metadata;
- the online public access catalogue and digital asset management system;
- an interactive digital exhibition; and
- a WorldWide Telescope tour.

After the grant period, the Adler will develop additional projects and programs related to celestial cartography. Digitized celestial cartography will be readily available for scholarly research and use in Adler exhibitions, planetarium shows, publications, and educational programs. Specifically, the Adler will produce the printed scholarly collections catalog, *Star Charts*. In addition, the Adler will submit an NEH Digital Humanities Start-Up grant to plan a "Citizen Science" project to catalog—according to scientific classifications—astronomical objects in the Adler's celestial cartography, and to develop an interactive mobile application that incorporates a smartphone's GPS, historical celestial cartography from different cultures, and the current night sky.

METHODOLOGIES AND STANDARDS

The celestial cartography digitization project will create approximately 5,300 digital images of star charts from nearly 400 items in the Adler's collections. The physical material to be digitized includes

a variety of sources: maps, books, works on paper, globes, and historic scientific instruments. All objects are fragile but stable; items are assigned a conservation priority by a curator when accessioned and those in need of conservation either have received treatment or are currently being conserved. During digitization, only staff trained in proper handling of museum objects will handle original materials, ensuring appropriate measures are taken to do no harm. Materials will require minimum handling overall.

The Adler will adhere to best practices for digitization and metadata. The descriptive metadata created for this project will be based on National Information Standards Organization (NISO) recommended Simple Dublin Core, utilizing controlled vocabularies from Library of Congress and Chenhall nomenclature when appropriate. Preservation metadata will follow the Preservation Metadata Implementation Strategies (PREMIS) data model. Maintenance and preservation of the physical storage for the digital assets follow industry best practices, including redundancy in the system and scheduled backups. The Adler continues to establish a long-term preservation plan for the digital assets and aims to reach and maintain at least Level 3 of the National Digital Stewardship Alliance's Levels of Digital Preservation.

The majority of the materials to be digitized date from 1500 to 1850, and are now in the public domain. All photography will be created as works-for-hire; the rights for images of three-dimensional objects will belong to the Adler and be released under Creative Commons licenses. All assets created for the celestial cartography digitization project without copyright restriction will be openly available as well. See the *Dissemination* section for more information on the Adler's commitment to open access.

Technical specifications and workflow

All hardware and software used in this project is expressly selected to streamline workflow, increase efficiency, and create high quality digital representations of objects. The Adler has already invested in much of this equipment for ongoing digitization efforts, with the exception of the Indus Book Scanner 9000. Designed specifically for fragile books and documents up to 18x24", the Indus Book Scanner 9000 scans from above, significantly reducing stress on book bindings. Photography of books often presents challenges in terms of lighting, distortion, and post-processing. The book scanner will allow for efficient production of consistent and optimal results.⁵

Hardware and software

- Epson Expression 11000XL flatbed scanner
- Indus Book Scanner 9000⁶
- Nikon D800 camera
- Nikon CL-M3 lens
- MacBook Pros running OS 10.7.5
- Adobe Creative Suite 6, particularly Bridge and Photoshop
- Minisis Trusted Digital Repository (TDR)⁷ or alternative digital asset management system

⁵ Other institutions in the Chicago area have similar equipment, and there may be potential for collaboration. However, the costs associated with packing and transporting rare books for scanning at another institution would rival the cost of purchasing a book scanner for in-house use. In addition, the Adler intends to use the Indus Book Scanner 9000 for future digitization projects.

⁶ The Indus Book Scanner 9000 will be purchased using grant funds. For specifications, see the *Appendices*.

⁷ The Minisis Trusted Digital Repository (TDR) is currently in development. The Adler will implement the trusted digital repository or another digital asset management system in fall 2013.

- Minisis MINT database application hosted on virtual Microsoft Windows server 2008 created in VMware VSphere environment
- IMB XIV storage array
- Backup storage on external four terabyte drive

Digitization workflow

The Adler's digitization workflow is developed from the Federal Agencies Digitization Guidelines Initiative's *Digitization Activities: Project Planning and Management Outline*. The project team will collaborate to prioritize digitization efforts and to decide the best method of digital capture, photography or scanning, on a case-by-case basis. All images will include Kodak Color Control Patches and scale regardless of the method of digitization. The goal will be to fully digitize 120 images per week, with the understanding that the rate per week will vary based on the type of material processed. For a general timeline, see the *Work Plan* section.

Digitization specifications will use the National Archives and Records Administration's *Technical Guidelines for Digitizing Archival Materials for Electronic Access* and the Federal Agencies Digitization Guidelines Initiative's *Technical Guidelines for Digitizing Cultural Heritage Materials: Creation of Raster Image Master Files* as guidelines. Master image parameters will, at minimum, be:

- 8 x 10" or smaller:
 - Pixel array: 4000 px on long side, excluding mounts and borders
 - Resolution: 8x10" = ~400 ppi, 5x7" = ~570 ppi, 4x5" or smaller = ~800 ppi
 - Dimensions: 100% of original
 - Bit depth: 48-bit RGB.
- 8 x 10" to 11x17":
 - Pixel array: 6000 px on long side, excluding mounts and borders
 - Resolution: 8x10" = ~600 ppi, 11x17" = ~430 ppi
 - Dimensions: 100% of original
 - Bit depth: 48-bit RGB.
- 11x17" or larger:
 - Pixel array: 8000 px on long side, excluding mounts and borders
 - Resolution: 11x17" = ~570 ppi
 - Dimensions: 100% of original
 - Bit depth: 48-bit RGB.

The master files will be saved as uncompressed, lossless TIFFs.

Books will be digitized as PDFs, in order to use automatic optical character recognition (OCR) tools as possible. Master PDF parameters will, at minimum, be:

- Documents where the smallest type is less than 1mm high:
 - Should be scanned at 100% original size, 600 ppi
 - Longest side should be at least 6000 px
- Documents where the smallest type is greater than 1mm high:
 - Should be scanned at 100% original size, 400 ppi
 - Longest side should be at least 4000 px

All individual master files will have unique, descriptive file names that will identify the object by accession number. The file name format will remain standard for all images created by the Adler, even beyond this project for consistency within the system.

A digitization process specialized for projection mapping will be used for the forty-three globes to be captured. Technical specifications and workflow will enable the images to be mapped to a virtual sphere, as well as “flattened” for the two-dimensional perspective. Because of the planned animations, lighting will be arranged to omit shadows and hot spots as much as possible. For the WorldWide Telescope portion of the project, Adler staff will process the scanned maps into multi-resolution image pyramids and register them on the sky.

Once digitization is complete, metadata will be added to each master file via the trusted digital repository, using batching if possible. All images will be given a unique and persistent URL, assuring that images will be accessible over the long-term, as well as allowing for file authentication. Metadata will follow the same schema Adler uses for its collections management system, including additional photography fields when necessary. Prior to digitization, pre-existing metadata for the objects will be collected and entered or, if imported from the collections management system, confirmed by the digital collections assistant. The curatorial consultant will enter additional descriptive metadata. Library and archival specific metadata will be MARC and encoded archival description (EAD) compliant, respectively. Descriptive and administrative metadata will use the Dublin Core schema, utilizing controlled vocabularies when appropriate, including Library of Congress name and subject authorities and Chenhall nomenclature. Adler-specific controlled vocabularies will also be utilized to maintain consistency with the collections management system. The digital collections assistant and the digital collections manager will enter additional administrative and preservation metadata. Preservation metadata will follow the PREMIS data model. All metadata will be embedded into the image files using extensible metadata platform (XMP) or comparable technology. An external file of all metadata will also be created as a backup.

Specific care will be taken when handling the metadata associated with image rights. Adler staff will research copyright on every object being digitized. Copyright will be attributed to the best of the institution’s ability. If an image is identified as being in the public domain, a Creative Commons Public Domain (CC PD) mark will be applied. If the Adler is identified as the copyright holder, a Creative Commons Attribution-Sharealike (CC BY-SA) license will be applied.⁸

In order to increase the ability to use the images in a variety of ways, Adler will also include metadata fields beyond Dublin Core. Astronomy visualization metadata standards, as defined by the Virtual Astronomy Multimedia Project, standardize the description and delivery of astronomical images. Endorsed by the International Virtual Observatory Alliance, this metadata schema is currently in use by the Spitzer Space Telescope, ESA/Hubble, and Chandra X-Ray Observatory. Developers such as Microsoft’s WorldWide Telescope, California Academy of Sciences, and the American Museum of Natural History are exploring ways to use astronomy visualization metadata in a variety of applications. The Adler will use parts of the schema in this project in order to define key

⁸ The Adler will apply Creative Commons (CC) copyright licenses appropriately to all images generated by this project in order to clearly indicate to the global community how images can be used. Images in the public domain will receive the CC PD mark, indicating that they are free of restrictions. Images for which the Adler holds the copyright will be given a CC BY-SA license. This means that although the image is free for use, the end user must give appropriate credit to the Adler, and allow others to modify their work on the same terms. All metadata will be released under a CC0 license, indicating the information can be used without restriction.

elements of identification of the star charts in fields specifically generated for astronomical images, including observational and coordinate data. By using defined fields, this specialized information will stand alone and will therefore be more searchable as well as useful for astronomical applications of the data, including visualizations.

The minimum sets of metadata to be recorded include:

- ***Descriptive***: Title, Creator, Subject, Description, Date, Format, Identifier, Source
- ***Administrative***: Date, Source, Relation, Identifier, Language, Type, Format, Rights
- ***Preservation***: Checksum identifier, Format, Type, PREMIS rights, Provenance, PREMIS events
- ***Astronomy Visualization Metadata***: Specific astronomy visualization metadata fields used will be established with Adler astronomers, but will likely include Subject.Category, Subject.Name, Distance, Distance.Notes, and appropriate Spatial fields.⁹

Throughout the project, metadata will be assessed and refined using tools such as OpenRefine.

Confirmation of clean data will allow for:

- Better search functionality for all users, beyond historians and scientists
- Obvious articulation of image rights, eliminating confusion about how an image can be used
- The ability to connect to other Linked Open Data sets
- Better preservation of assets over the long term

After metadata is applied, the digital collections assistant will make a production version of the file by cropping out scale and color bars, doing moderate color correction using Photoshop, and saving the image as a lossless, compressed TIFF (LZW), 16-bit RGB. Production versions of files will have a file name related to the master file name, but will make clear that the file is the production version. All metadata will remain part of the image file.

Access to master files will be limited to a select number of staff, including the digital collections manager. Production files will be handled in a similar fashion, with a select number of staff allowed direct access to the files to ensure the integrity of the images by exposing the original files for manipulation as little as possible. Master and production images will be stored on the Adler's server, an IMB XIV storage array with RAID¹⁰ backups, as well as on an offsite drive, per industry best practices. All files will be ingested into the trusted digital repository, which will create distribution formats of the images from the production file on internal or external user request. When a request is made, the user will be asked to provide some pertinent information about themselves and image use. The trusted digital repository will generate a report from this information that can be accessed by Adler staff, allowing for analytics.

During digitization, the digital collections manager will establish a schedule to review random assets created by the digital collections assistant for quality control purposes. The digital collections manager will review the image quality and metadata for each archival information package and work

⁹ Astronomy visualization metadata (AVM) field definitions can be found here:

http://virtualastronomy.org/AVM_12_ref_table_rlh02_print2.pdf. Many of the astronomy visualization metadata fields are already covered by the descriptive, administrative, and preservation metadata fields established, so this project will use astronomy visualization metadata only for information that does not align with these schema.

¹⁰ RAID (redundant array of independent disks) drives, used frequently on servers, are a category of disk drives that employ two or more drives in combination. RAID stores the same data redundantly (in multiple places) in a balanced way to improve overall storage performance.

with the digital collections assistant to address any concerns with either image quality or metadata in the archival information packages. A rough outline of the draft plan is as follows:

The digital collections manager will complete a random check of 10% of digitized images at 100% magnification. The check will include but is not limited to:

- Structure and ID number of file name correct
- File format correct
- Compression correct
- Resolution and long dimension correct
- Bit-depth and color correct
- Reasonable color match to original
- Orientation correct
- No cropping, digital artifacts, or physical matter present
- Pages in correct order (if applicable)
- Metadata completely recorded and correct
- Linked appropriately with Minisis MINT and other applications as necessary

The digital collections manager will establish an “audit trail” in order to track each object’s digitization and percentage of completion. Finally, the assets will be associated with the physical object record via the trusted digital repository and Minisis MINT collections management system.

End use

End use will be driven by the trusted digital repository and Minisis MINT systems. Interconnections between the MINT virtual server and the IMB XIV storage array are via high-speed parallel fiber channels, and other portions of the network utilize infiniband connections, making the server room infrastructure extremely fast. Adler’s network utilizes 10gb fiber backbone to interconnect various telecommunications closets throughout the building, from which one or ten gigabyte connections are distributed to end-users, making for a very fast high-capacity distribution system. Access to MINT will be available for researchers throughout the world, as well as be tapped to deliver content directly to museum and web exhibits for onsite visitors. Assets will be presented in several ways:

1) *Minisis MINT and Trusted Digital Repository*

The Adler’s new collections management database, Minisis MINT, will be completed in January 2014. Minisis MINT is an Object-relational database management system that allows the Adler to combine its records for objects, books, and archival collections into a single database. The Minisis trusted digital repository (TDR) adheres to the IAS and ISO 16363 standards and will allow both for preservation of assets, as well as access to the assets by end-users.

The digital assets will be available to Adler staff primarily via MINT and the trusted digital repository. They will have an immediate impact on research assistance and publication development, as well as in applications across the museum including public programming, education, advancement, and marketing.

2) *Online Public Access Catalog*

The digital assets will be available to the public via an online public access catalog, to be completed in fall 2014. Minisis, Inc. will build the online catalog according to Adler

specifications, and Adler staff will work with the Minisis team to utilize elements for effective indexing and search engine optimization.

Users will be able to download high-resolution images for any asset that is assigned a Creative Commons Public Domain mark or Creative Commons Attribution-Sharealike license. Images with copyright restrictions will appear in the online catalog at thumbnail size (approximately 250x300 pixels) as recommended by the Association of Art Museum Directors. Additionally, the online catalog will eventually drive public access within the museum, as it will serve onsite visitors via gallery interactives.

3) *Open data*

Any digital assets with Creative Commons Public Domain, CC0 (no rights reserved), or Creative Commons Attribution-Sharealike licenses will be uploaded to open data repositories such as Wiki Commons. The Adler will investigate opportunities to partner with various digital libraries, including the Minnesota Digital Library (the Midwest region's Digital Public Library of America Services Hub) in order to establish a presence for its open assets, including its metadata. The approach to metadata in this project will also allow for future connections to the linked open data community, in places like DBpedia and Freebase.

SUSTAINABILITY OF PROJECT OUTCOMES AND DIGITAL CONTENT

The decisions made throughout the term of the celestial cartography digitization project will always reflect on the long-term preservation strategy for its assets. The Adler is dedicated to maintaining the digital elements of the collection and includes costs related to its preservation and longevity in its annual budget. The information technology infrastructure in place provides long term, stable storage for digital assets across the institution. As a part of the Collections Access Initiative, the Adler recently added a full-time salaried position, the digital collections manager, who is directly responsible for the management of the digital assets, including ensuring their long-term preservation.¹¹

Digital assets related to the Adler's collection are stored on a dedicated four-terabyte RAID volume, with the ability for significant expansion. Access to this volume is controlled via user login. For assets generated by this project, the Adler will follow the "3-2-1" best practices for digital backup: three copies, two media types, and one copy offsite. Currently, one backup copy is stored on an external RAID volume, and a second backup copy is stored offsite. After the digitization phase of the project is complete, a second media type will be introduced. Backups of the drives will occur on a regular schedule determined by the Adler's information technology department to avoid catastrophic data loss.

Throughout the grant period, the digital collections manager will continue to refine training materials to codify data standards, workflow, and specific processes related to digitization as well as technical documentation in order to maintain its integrity over time. This will include quality control, instructions for ingestion into the digital asset management system, and fixity checks and checksums to confirm that files are not altered or corrupted. Regular fixity checks on master and production files will rely on MD5 algorithms created at ingest. Training materials and processes will help staff

¹¹ For information about the Collections Access Initiative, please see the *History, Scope, and Duration* section.

identify file corruption as well as allow the Adler to anticipate hardware, software, or file format obsolescence and have a plan in place for migration or emulation once those steps become necessary.

DISSEMINATION

The Adler is committed to providing open access to its digital assets when possible. Digital assets include images, audio, video, metadata, and other digital materials related to the collection.

The Adler follows the OpenGLAM¹² principles to the extent we are able:

- Releasing metadata under Creative Commons Zero waivers
- Keeping public domain works in the public domain by not adding new rights to them.
- Making explicit our expectations about reuse and repurposing when publishing descriptions, data collections, and subsets of the collection
- Using machine-readable open file formats
- Engaging audiences virtually in appropriate and novel ways

To this end, the Adler is committed to determining accurate copyright and securing permissions for digital assets in and related to Adler collections in order to release as many of these assets as possible for a wide variety of uses.

After completion of digitization, the Adler will seek out partners to expose the metadata generated by this project, including the Digital Public Library of America and the Open Knowledge Foundation. The Adler plans to release as many available images as possible to open source digital repositories such as Wikimedia Commons.

Products

Three products will disseminate the Adler's digitized celestial cartography. First, the **online public access catalog** and digital asset management system will provide access to the celestial cartography. Using descriptive, administrative, and technical metadata to connect with the Adler's collections management system, the online catalog will provide researchers with advanced searching and in-depth details. Second, the **interactive digital exhibition** will use twenty-five images to tell the story of celestial cartography. Displayed in the Adler's Space Visualization Lab, the exhibition will be geared toward Adler audiences who are interested in the historical context behind current astronomical mapping projects. In addition, because the exhibition will be developed in Open Exhibits software, it will be available for free download to the general public as well as museum professionals. Finally, the **WorldWide Telescope tour** will integrate fifteen historical images with current data from the world's most advanced telescopes. The WorldWide Telescope tour will be available for free, and will appeal to astronomy enthusiasts and planetarium professionals. WorldWide Telescope is a trusted resource within the astronomy community.

Sharing Results

After the grant period, the Adler will promote the availability of the celestial cartography in the online public access catalog, the interactive digital exhibition, and the WorldWide Telescope tour. These resources will be announced to the general public and Adler audiences through the Adler

¹² OpenGLAM (openglam.org) is an initiative run by the Open Knowledge Foundation that promotes free and open access to digital cultural heritage held by Galleries, Libraries, Archives and Museums (GLAM).

website and social networks, including Facebook and Twitter. The project team will use conferences, listservs, and newsletter announcements to advertise resources to professional groups such as the History of Science Society; the Historical Astronomy Division of the American Astronomical Society; the Scientific Instrument Commission of the International Union for the History and Philosophy of Science; the Special Libraries Association; Reaching Across Illinois Library System (RAILS); Chicago Area Archivists; DOME-L (a listserv for planetarium professionals); H-NET; and other local and national professional networks. In addition, Adler staff will propose a case study presentation at an American Alliance of Museums (AAM) conference.

WORK PLAN

The grant period will be May 2014 through April 2016, with the bulk of the work implemented from October 2014 through September 2015. The celestial cartography digitization project has two major goals: 1) **digitization of the celestial cartography** in the Adler's collections, and 2) **accessibility of the celestial cartography**.

Digitization of the celestial cartography will be achieved through photography, scanning, and animations. Accessibility of the celestial cartography will be achieved through descriptive, administrative, and technical metadata; the online public access catalog and digital asset management system; an interactive digital exhibition; and a WorldWide Telescope tour.

Adler staff will include Jodi Lacy (project director), Lauren Boegen, (digital collections manager), a digital collections assistant, Jennifer Brand (collections manager), Jill Postma (librarian), Marvin Bolt (vice-president for collections), Mark SubbaRao (director of space visualization), and Julieta Aguilera (associate director of space visualization). In addition, a curatorial consultant and a photography consultant will be hired.

May – September 2014

- Purchase and install Indus Book Scanner 9000 (Boegen).
- Finalize handling procedures (Brand and Boegen).
- Finalize digitization work plan (Boegen).
- Hire digital collections assistant (Boegen and Lacy).
- Object handling, digitization equipment, and software training for digital collections assistant (Brand and Boegen).
- Finalize digitization object list (Lacy and curatorial consultant).
- Prioritize the digitization object list for historical significance and animations (Lacy and curatorial consultant).

October 2014

- ***Begin scanning, photography, and metadata creation*** (digital collections assistant and consultant photographer).
- Develop preliminary object list and storyline for interactive digital exhibition and WorldWide Telescope tour (Lacy, SubbaRao, Bolt, curatorial consultant).
- Bi-monthly digitization quality control checks (Boegen).

November 2014 – April 2015

- Continue scanning, photography, and metadata creation (digital collections assistant and consultant photographer).
- *Complete photography and metadata creation for three-dimensional objects* (digital collections assistant and consultant photographer).
- *Finalize object list for interactive digital exhibition and WorldWide Telescope project* (Lacy and SubbaRao).
- Begin scanning, photography, and metadata creation for interactive digital exhibition and WorldWide Telescope project (digital collections assistant and consultant photographer).
- Bi-monthly digitization quality control checks (Boegen).

May – June 2015

- Continue photography, scanning, and metadata creation (digital collections assistant and consultant photographer).
- Complete scanning, photography, and metadata creation for interactive digital exhibition and WorldWide Telescope project (digital collections assistant and consultant photographer).
- Develop animations and models of three-dimensional collections objects (Aguilera).
- Bi-monthly digitization quality control checks (Boegen).

July –August 2015

- Continue photography, scanning, and metadata creation (digital collections assistant and consultant photographer).
- Develop interactive digital exhibit for the Adler’s Space Visualization Laboratory (SVL), including finalizing image selections and writing and editing text (Lacy and SubbaRao).
- Bi-monthly digitization quality control checks (Boegen).

September 2015

- *Complete scanning, photography, and metadata creation* (digital collections assistant and consultant photographer).
- Finalize text for interactive digital exhibit for SVL (Lacy and SubbaRao).

October 2015

- *All celestial cartography available in online public access catalog* (Boegen and Lacy).
- *Finalize interactive digital exhibition*, display in SVL, launch on Adler website, and make available as Open Exhibits download (Lacy and SubbaRao).

November 2015 - February 2016

- Develop WorldWide Telescope collaboration, including finalizing image selections and writing and editing text (Lacy and SubbaRao).
- Prepare maps for WorldWide Telescope collaboration (SubbaRao and Aguilera).

March - April 2016

- *Finalize and submit WorldWide Telescope tour* (SubbaRao and Lacy).

STAFF (*alphabetical*)

Julieta Aguilera is **Associate Director** in the Adler's Space Visualization Laboratory. She holds an M.F.A. in Graphic Design and Electronic Visualization from the University of Notre Dame and the University of Illinois at Chicago respectively. She is currently pursuing a Ph.D. in Interactive Arts at the Planetary Collegium Program based in Plymouth, UK. She collaborates with astronomers, historians, and educators in the design and production of immersive interactive pieces for sky shows and research-oriented exhibitions. For this project, she will assess scanned imagery, create animations for globes, and design and implement interaction for other three-dimensional models. In each year of the two-year grant, Aguilera will spend 5% of her time on this project.

Lauren Boegen is the **Digital Collections Manager** in the Adler's Webster Institute for the History of Astronomy. Boegen is responsible for the management and preservation of digital collections. She holds an M.A. in Museum Studies from the George Washington University, and a B.A. in History and American Studies from Illinois Wesleyan University. For this project, she will develop and maintain procedures for digitization, assist the consultant photographer, supervise the digital collections assistant, monitor workflow and metadata creation, and participate in the dissemination of results. In each year of the two-year grant, Boegen will spend 25% of her time on this project.

Marvin Bolt is **Vice President for Collections** in the Adler's Webster Institute for the History of Astronomy. Bolt earned a Ph.D. in History & Philosophy of Science from the University of Notre Dame. For this project, he will advise on descriptive metadata, the interactive exhibition, and the WorldWide Telescope tour. In each year of the two-year grant, Bolt will spend 3% of his time on this project.

Jennifer Brand is **Collections Manager** in the Adler's Webster Institute for the History of Astronomy. Brand holds a B.F.A. in Art History and a B.F.A. in Metalsmithing from the University of Illinois. She has over ten years' experience at the Adler in all aspects of collections care and management. As collections manager, Brand is responsible for the documentation, care, and preservation of physical Adler collections. For this project, she will develop handling procedures, train the digital collections assistant on object handling, advise on preservation issues, and monitor the movement of three-dimensional objects and works on paper. In each year of the two-year grant, Brand will spend 3% of her time on this project.

The Adler will hire a **Curatorial Consultant** with content expertise related to the celestial cartography. The curatorial consultant will advise on descriptive metadata, create descriptive metadata for his area of expertise, and advise on the interactive exhibition and WorldWide Telescope tour.

The **Digital Collections Assistant** will support the digital collections manager and will scan works on paper and books under 18"x28", create metadata, and edit images. The Adler will hire the digital collections assistant for a one-year (October 2014 – September 2015), full-time NEH-funded position. The digital collections assistant will spend 100% of their time on this project. A job description is included with the staff resumes.

Jodi Lacy, Archivist & Digital Projects Manager in the Adler's Webster Institute, is the **Project Director** for the celestial cartography digitization project. Lacy holds an M.A. in Public History from Loyola University Chicago and a B.A. in History and English from Marquette University. She is

currently pursuing a Digital Archives Specialist certificate through the Society of American Archivists. Lacy has successfully managed major collections-related projects, including the publication *Eastern Astrolabes*, the establishment of professionally managed archival collections, and the exhibition *Mapping the Universe*. She is also the author of the exhibition catalogue, *Mapping the Universe* (2007). For this project, she will manage the project schedule and budget, co-curate the interactive exhibition and WorldWide Telescope tour, monitor the movement of the archival *Carte du Ciel* collection, and participate in the dissemination of the results. In each year of the two-year grant, Lacy will spend 5% of her time on this project.

Steven Pitkin (Pitkin Studios) is the **Consultant Photographer**. He received a B.F.A. from Rockford College and opened Pitkin Studio in 1987. Pitkin's experience includes advertising and assignment photography, as well as numerous museum exhibition catalogues and books. For nearly twenty years, he has photographed the Adler's collections for publications and other projects. Please see www.pitkinstudio.com for examples of his work. Pitkin will provide technical expertise on photographing three-dimensional objects, oversize works on paper, and oversize rare books.

Jill Postma is the **Librarian** in the Adler's Webster Institute for the History of Astronomy. Postma holds an M.L.I.S. from Dominican University and a B.A. from the University of St. Francis. She is involved in several professional organizations, including the Special Libraries Association. At the Adler, Postma is responsible for over 6000 books. For this project, she will advise on metadata for the rare books and monitor the movement of books. In each year of the two-year grant, Postma will spend 3% of her time on this project.

Mark SubbaRao is the **Director** of the Adler's Space Visualization Laboratory. SubbaRao holds a Ph.D. in astrophysics from Johns Hopkins University. At the Adler, he develops scientific visualizations that allow museum visitors and the general public to explore and understand current astronomical data. For this project, SubbaRao will co-curate the interactive exhibition and WorldWide Telescope tour, and prepare the maps for submission to WorldWide Telescope. In each year of the two-year grant, SubbaRao will spend 5% of his time on this project.