

UC Berkeley

UC Berkeley Previously Published Works

Title

Inventing Venice:An Urban and Environmental Innovation Model from the Lagoon City

Permalink

<https://escholarship.org/uc/item/75635711>

Author

Hindle, Richard

Publication Date

2023-12-12

Peer reviewed

Inventing Venice: An Urban and Environmental Innovation Model from the Lagoon City

Richard L. Hindle*

Abstract

Innovation in physical urban infrastructure is a vital component of city making in an era of sea level rise, climate change, and rapid urbanization. Venice pioneered an urban and environmental innovation model in the 14th and 15th century, successfully negotiating the city's complex geography and the sociotechnical processes that characterized Renaissance urbanism. A review of early inventor rights issued in the city suggests that the process of patent innovation facilitated urbanization of the Venetian lagoon through development of advanced drainage, dredge, irrigation, and reclamation infrastructure, essential to the city's survival. In addition to granting patents for new inventions, the Venetian government established expert review for proposed inventions, supported prototyping and testing for untried technologies, and used patent rights to attract experts with novel inventions from across Italy and Europe. These processes, in addition to the extensive dossier of patents issued in Venice, substantiate the primacy of innovation in the process of urbanization and reveal an urban innovation model. Patent law later spread along Venetian trade routes through Europe, where they were also employed in economic modernization, and the construction of urban and regional infrastructure. Interestingly, similar process can later be observed throughout Europe and the United States as patent rights were constitutionalized.

*Assistant Professor of Landscape Architecture and Environmental Planning at the University of California Berkeley. rlhindle@berkeley.edu. <https://ced.berkeley.edu/ced/faculty-staff/richard-hindle>.

Contents

Introduction	530
Venice and the Advent of Patent Law – A political, economic, and urban imperative	531
Figure 1: Venetian Patent Statute (1474)	535
Expert Review, Prototyping, and Urbanization	535
Figure 2: Model replica of Galileo Galilei’s patented water pump(1594)	538
Foreign Inventors and Technology Transfer to Venice	538
Figure 3: Cornelius Meijer’s dredge apparatus and vessell(c.1675)	540
A Patent Model Spreads: an environmental and urban perspective	541
Figure 4: James Buchanan Ead’s patent(1875)	544
Conclusion	545

Introduction

Innovation in physical urban infrastructure is a pressing issue as cities face the challenges of climate change, sea level rise, and increasing development pressure from rapidly urbanizing populations. Environmental change and technological innovation are perennial forces in urbanization, making historical precedents valuable as we consider strategies for the next generation of urban infrastructure. A look back at the history of patent law and urbanization reveals that a unique model for urban and environmental innovation was pioneered in Venice in the 13th and 14th century, through the integration of inventor’s rights (i.e. patents) with urban and territorial development. This history obviates a dynamic relationship between sociotechnical processes, urbanization, and environment, that is particularly salient today as we develop the innovative infrastructure of the next century.

Venice is a city built on innovation. The city was founded in the estuarine landscape of the *Leguna Venata* on March 25th, 421 AD. Venice’s watery refuge was defensible, but presented a challenge to conventional land-based forms of urbanism. Prospects of building a thriving metropolis in a dynamic lagoon environment required technological and social innovation to remain competitive in global trade and manufacturing, but also to reconcile the inherent conflict between city building and the environmental contingencies of sedimentation, fluctuating water levels, and miry soils. Robust historical accounts exist of Venice’s ingenious building practices and advances in hydrologic engineering are widely documented; yet many accounts overlook the legal and sociotech-

nical tools employed in Venice to incentivize innovation in industry and physical infrastructure. The coevolution of city building and inventors rights suggest that a distinct urban innovation model was created, and later emulated, as patent rights spread from Venice to Europe and the United States.

Venice's urban innovation model can be traced to 14th and 15th century through the antecedents of patent law in which privileges granted to inventors were used to incentivize construction and maintenance of canals, drainage of land, and stabilization of the city, with innovative technology. The *Senato* penned the first patent law in 1474 to incentivize the creative genius of domestic and foreign inventors, and in doing so established one of its most enduring exports – the patent. The impact of patents in Venetian manufacturing and economic expansion is well understood, but patent rights also served as a dynamic tool for infrastructure delivery and urban development, helping to resolve complex issues related to water, sediment, and other technologies vital to Venetian city building. The coupling of urban infrastructure development with patent rights allowed city officials and managers to successfully negotiate the complex geographical contingencies of Venice through technological means. Expert review panels, time allocations for prototyping and testing, a geographically specific scopes of work, incentivized private inventors to create novel machinery, reclamation processes, and technologies that were vital to Venice's economic success and urbanization. This form of public and private partnership allowed Venice to remain at the cutting edge of technology from the every changing geography of the *Leguna Veneta*.

Evidence of a true model for environmental and urban innovation is further substantiated as patent rights spread. Patent law initially extended through the Venetian territories. By the late 15th century legal precedents for patent law had travelled the extents of Venetian trade routes through Europe, where it was readily adopted in the modernization of manufacturing and industry. Patents also became integral to transformation of urban territories, just as they had in Venice. The spread of patent rights through Europe also attracted inventors to Venice, and became an important legal mechanism for technology transfer to the city. When assessed through the lens of urbanization and environmental transformation, it becomes clear that inventor's rights and innovation were instrumental in regional and urban development - a pattern that can also be observed centuries later in America where technological and western frontiers progressed concurrently.

Venice and the Advent of Patent Law - A political, economic, and urban imperative

Venice is the birth city of patent law. Precedents for inventor's rights and early patent law are documented in Venice since the early 14th and 15th century, primarily in the form of privileges and monopolies granted to inventors and manufacturers, but also for the development of public works such as the digging of canals and dredging exiting waterways. These rights and privileges granted

to inventors for public works later served as important precedents for patent law in the city, and are conceptually significant for their emphasis on the *public* aspects of innovation. In this manner, innovation and urbanization became intimately intertwined in Venice prior to the formal codification of patent law in 1474, and continued as the city developed over the next few centuries.

Inventor's rights, or privileges, granted in association with public works may seem antithetical today, yet many have forgotten the public and inherently sociotechnical aspects of patents as they were first conceived. Contrary to contemporary notions of patents relating to items of manufacturing and trade, the early patents often had no immediate commodity associated with them and were conceived in terms of their public and geographical scope. Mario Biagioli, a leading scholar in law, science, and technology summarizes the issue as follows:

It is striking how specific and local the early notion of utility was when compared to the increasingly generic definition we find in today's patent law. In the age of global economies utility seems to have no identifiable beneficiary beyond a generic 'public' situated in an equally unspecified future. By contrast, some of the earliest patents — like those related to the making and dredging of canals in Venice or the drying of swamps in the Netherlands — concerned public works, not privately-owned technological products to be sold on a generic market. Though not many patents were so site-specific, a distinctly local and immediate notion of utility informed all early privileges, especially those issued before 1700.¹

Records of these early patents are striking for their distance from contemporary notions of a patent, but also for their emphasis on public and urban works. For Example, the Maggior Consiglio (The Major Council) issued an "award" to the inventors Leonardo Albizio and Francesco "dalle barche" in 1334 and 1346 respectively for their invention of time saving dredge vehicles, and allowed them to operate the machines in the city. And, similarly in 1371 Hendrigeto Maringon was hired for the clearing of canals using an excavator of his own invention, essentially granting him a monopoly for the machine he created and the geographical scope of work. Agreements, such as these, between inventors and city managers served as important precedents for patent law in Venice, but also established a trajectory of experimentation and testing in urban infrastructure.

Evolution of patent rights in Venice is intimately tied to geography. Venetians realized that building a thriving metropolis in a lagoon required legal, social, and technical ingenuity in both industry and infrastructure. It is therefore unsurprising that many archetypal patents have distinct geographical dimensions that site and situate innovation in Venice, both to attract inventors to Venice and deter foreign competition. For example, the rights issued to Ser Franciscus Petri on February 20th 1416 for the manufacture of wool involved

¹Mario Biagioli, *From Print to Patents: Living on Instruments in Early Modern Europe*, 44 *Hist. Sci.* 139, 152 (2006).

the use of a previously known type of Byzantine fulling device for the cleansing of wool. This agreement precluded use of the method by others within a 10 mile radius of Rialto (Venice) for a period of fifty years.² Ser Franciscus Petri's patent was essentially a form of monopoly that prohibited production of similar products within a geographical radius of the city, but did not necessitate that an invention be new - only requiring that it be new to Venice and be operated within its territory. This not only applied to industry, but also to city building. In 1456, Antonio "of France" received privileges from the council to excavate certain channels in the city of Venice using a known technique he brought from France. The council recognized the genius of his proposal though and its usefulness in the city of Venice, essentially granting Antonia 'privileges' for bringing the technique to Venice - a process that today we might call technology transfer.³

The groundwork for patent law was laid in Venice in the 14th and 15th century, however the first modern, or "true", patent is often attributed in the history of law to Filippo Brunelleschi, the eminent Florentine architect, in 1421 for a floating vessel to transport materials for his Duomo di Firenze. Brunelleschi's patent was an anomaly in Florence, where patent law failed to take hold. The patent, however, is significant as it contains all the components of the modern "patent bargain" between inventors and the state, and is therefore considered seminal in the history of patent law.

Initially Brunelleschi withheld dissemination of the invention until he was granted rights by the state of Florence to protect his creation, fearing that his new technology would be stolen. Filippo's father was a prominent lawyer and member of the Lawyers and Judges guild Calimala, which included merchants and shipping elite. At the time of the patent, Filippo was working on designs for the Duomo - a design that necessitated the use of large marbles and massive quantities of brick. Given the constraints of navigation on the river Arno and logistics of the Duomo a new ship was required. Filippo was reluctant to share the invention without legal protection for fear that others would copy his intellectual property.⁴ The Republic of Florence gave Brunelleschi exclusive rights to his invention for a period of three years in exchange for sharing the new technology with the public. The patent's text is vague on details, yet the vessel named the 'Badalone', was built and commercialized by Brunelleschi. It is also striking that the patent was so intricately intertwined with the built environment, as the Duomo of Florence might not exist without the protections granted to Brunelleschi for his invention. The patent states;

FILIPPO BRUNELLESCHI, a man of the most perspicacious intellect, industry and invention, a citizen of Florence, has invented some machine or kind of ship, by means of which he thinks he can easily, at any time, bring in any merchandise and load on the river Arno and on any other river or water, for less money than usual, and with several other benefits to

²Giulio Mandich, *Venetian Origins of Inventors' Rights*, 378 J. PAT. OFF. SOC'Y 378 (1960).

³ROBERTO BERVEGLIERI, *LE VIE DI VENEZIA: CANALI LAGUNARI E RII A VENEZIA: INVENTORI, BREVETTI, TECNOLOGIA E LEGISLAZIONE NEI SECOLI XIII-XVIII* (1999).

⁴Frank D. Prager, *Brunelleschi's Patent*, 28 J. PAT. OFF. SOC'Y 109 (1946).

merchants and others; and that he refuses to make such machine available to the public, in order that the fruit of his genius and skill may not be reaped by another without his will and consent; and that, if he enjoyed some prerogative concerning this, he would open up what lie is hiding, and would disclose it to all

Venice penned the world's first patent law in 1474. The Venetian Statute came into existence through a complex coupling of industry, innovation, engineering, commerce, competition between states, and the unique geography, law, and social structure of Venice. The lagoon city literally and metaphorically created a fertile ground for innovation. A primary factor was the relative strength of the Venetian state and relative weakness of the guilds. In Venice it is observed that the guild defined the boundaries of the craft but did not have complete control over the details of production. This idiosyncrasy allowed for craftsmen, and inventors, to innovate within the framework of the guild instead of the guild fixing the methods of a specific craft, essentially providing space for innovation.⁵ All Italian Renaissance cities were innovative in their own right, though only Venice promoted patent law. In Rome, the church and papal privilege controlled the cities development and economy, and patents had little relevance. Conversely, in Florence, strong guilds controlled the modes of production and the processes of innovation. Accessing the Florentine guilds was accomplished through birthright, wealth, and/or protracted periods of training. This provided little room for early patent rights to flourish. However in Venice, the radical urban waterborne outpost, inventors could acquire patent rights for new inventions irrespective of class and bring inventions to the city from distant regions. This highly democratic, or egalitarian, form of sociotechnical innovation helped Venice remain competitive. As the power and territorial ambitions of Venice reached its zenith, so did the geographical scope of Venetian patent law and riches of inventors, craftsmen, and the state.

Venetian Patent Statute of 1474 was conceived as a public/private partnership designed to promote individual innovation and the advance the state. The Law was adopted to promote the creation of new devices and businesses through legal protection of patents and establishment of the rights of inventors.⁶ Sociotechnical, public, and urban aspects of the law cannot be understated or ignored. The act reads:

1474, March 19

WE HAVE among us men of great genius, apt to invent and discover ingenious devices; and in view of the grandeur and virtue of our City, more such men come to us every day from diverse parts. Now, if provision were made for the works and devices discovered by such persons, so that others who may see them could not build them and take the inventor's honor away, more men would then apply their genius, would discover, and would build devices of great utility and benefit to our commonwealth.

⁵Craig Nard & Andrew Morriss, *Constitutionalizing Patents: From Venice to Philadelphia*, 2 REV. L. ECON. 224, 243 (2006).

⁶Giulio Mandich, *Venetian Patents (1450-1550)*, 30 J. PAT. OFF. SOC'Y 166 (1948).

Therefore:

BE IT ENACTED that, by the authority of this Council, every person who shall build any new and ingenious device in this City, not previously made in our Commonwealth, shall give notice of it to the office of our General Welfare Board when it has been reduced to perfection so that it can be used and operated. It being forbidden to every other person in any of our territories and towns to make any further device conforming with and similar to said one, without the consent and license of the author, for the term of 10 years. And if anybody builds it in violation hereof, the aforesaid author and inventor shall be entitled to have him summoned before any magistrate of this City, by which magistrate the said infringer shall be constrained to pay him hundred ducats; and the device shall be destroyed at once. It being, however, within the power and discretion of the Government, in its activities, to take and use any such device and instrument, with this condition however that no one but the author shall operate it.

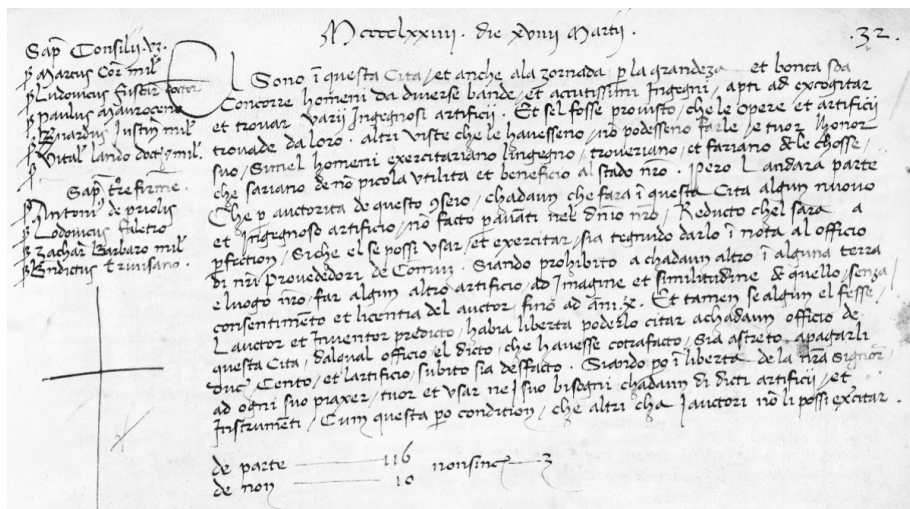


Figure 1: The Venetian Patent Statute (1474) formalized the relationship between inventors and the state, and is a seminal document in the history of patent law.

Expert Review, Prototyping, and Urbanization

Venice is defined by its relationship to water. The city was founded in the estuarine landscape of the Venetian lagoon on March 25th, 421 AD. The environmental imperatives of the *Leguna Venata* necessitated invention, establishing a trajectory for the city that continues into the present day as rising seas and subsidence threaten the city. Many of the first buildings constructed in the lagoon

utilized lightweight timber frames to remain elevated. In 639 AD, Torchello Cathedral was constructed of stone supported on wooden piles driven into soft sediment, marking not only the permanence of the city, but also the willingness of the Venetian to reinvent building systems and the lagoon landscape using novel methods. By 814 work had begun on the first Doge's Palace, requiring the appointment of a commission of three men to oversee the digging of canals, shoring up of islands, and preparation of building sites.⁷ In the 13th century a permanent panel of experts was established to guide the development of Venetian waterways.⁸ Shortly thereafter, a special commission was established by Doge Giovanni Dandolo to void and override years of disparate plans and technical work conducted over the last centuries in order to establish a single legislative structure to manage waterways. At this time, the canals and waterways also became part of the public domain, collectively constituting the shared thoroughfares of the city. Claiming the canals, waterways, streams, and shores of Venice as public placed the burden of construction and maintenance on the state. Numerous public/private partnerships were initiated to execute the work, and in these partnerships we see an emphasis of innovation that carried forward into patented works and processes a century or so later.

In the 13th century waterways cut and excavated through Venice were dug with rudimentary dredge boats in a slow and laborious manner using human or horse-powered implements to dislodge and raise sediments. Acknowledging the need for improved technology, privileges for new techniques were granted by Venetian Government to expedite the process of building public waterworks and canals. Experimentation was a vital component of these early agreements between private inventors and the state. As mentioned previously, the privileges granted to inventors Leonardo Albizio (1334), Francesco "dalle barche" (1346) and 'Hendrigeto Maringon' (1371) all had elements of experimentation and testing embedded within their terms, and this tradition continued as patent law was established. For instance, the mechanical patent issued in 1492 (18 Years after the patent statute of 1474) to Nasimben from Fontanell and Vielmo from Lime, for the extraction of mud from canals and create terra firma, granted the pair a six month experimental period to verify novelty of their methods before a fifty year "privilege" for use of the device was granted.⁹

A bureaucratic process of technological review and evaluation coevolved with plans to build and maintain canals in which new inventions of merit were given experimental periods to prove their viability, and eventually legal rights to the intellectual property and scope of the work to be conducted. Between 1474 and 1788, the Venetian government issued 1,904 patents. Of these patents 197 were issued for devices and process for the reclamation of lagoons channels, stabilization of ground, and various digging machines. An additional 43 patents were issued for hydraulic pumps for use in land drainage and irrigation.¹⁰ Proposals for new inventions radically outnumbered those that were

⁷ JOHN JULIUS NORWICH, *A HISTORY OF VENICE* 5 (1982).

⁸ BERVEGLIERI, *supra* note 3.

⁹ BERVEGLIERI, *supra* note 3.

¹⁰ ROBERTO BERVEGLIERI AND ISTITUTO VENETO DI SCIENZE, *INVENTORI STRANIERI A VENEZIA (1474-1788): IMPORTAZIONE DI TECNOLOGIA E CIRCOLAZIONE DI TECNICI ARTIGIANI INVENTORI: REPERTORIO34: memoria presentata dal s.c. Maria*

granted patents. Expert review panels evaluated models and working prototypes to evaluate the efficacy of an invention, leading to a rigorous process of peer review. During this period, patent innovation in reclamation, drainage, and dredge technology rivaled that of other sectors of technology, including textiles and scientific instrumentation. This fact is not coincidental, as “mud” technologies were not only instrumental in development of Venice’s waterborne transit network, but also in environmental and urban transformations of the lagoon. Hybridizing patent innovation with infrastructure and public work was essential in Venice; as the city was raised from the lagoon by dredge machines and water pumps that were necessitated continuous invention.¹¹

Patent law incentivized a tech-boom that sparked the imagination of Venice’s creative class. Between 1474 and 1550, more than 100 patents were issued, creating a new class of inventors in the city.¹² Even Galileo Galilei, the famed astronomer and polymath, was caught up in the fervor of invention related to Venice’s hydrologic infrastructure. Galileo invented and patented an improved form of water pump that he reportedly prototyped and demonstrated to a panel of experts at the Contarini Villa, in Padova. Galileo’s patent was issued in 1594 while a professor of mathematics (1592-1610) at *l’Università di Padova*.¹³ Galileo states of his invention “ I, Galileo Galilei, have invented a machine for raising water and irrigating land with small expense and great convenience, which, with the motive power of a single horse, will continuously discharge water through twenty spouts.” Galileo’s irrigation pump was built and tested in the gardens of the Contarini Palace, though exact technical details of the invention remain unknown.¹⁴ A scaled model of Galileo’s pump, showing two horses instead of one, is archived at *Museo Fisica e Scienze Naturali Firenze*.

Francesca Tiepolo nell’adunanza ordinaria del 21 maggio 1994.

¹¹SALVATORE CIRIACONO, BUILDING ON WATER: VENICE, HOLLAND AND THE CONSTRUCTION OF THE EUROPEAN LANDSCAPE IN EARLY MODERN TIMES 38 (2006).

¹²Nard & Morriss, *supra* note 5 at 236.

¹³P. J. Federico, *Galileo’s Patent*, 8 J. PAT. OFF. SOC’Y 576 (Aug. 1926).

¹⁴JOHN JOSEPH FAHIE, GALILEO HIS LIFE AND WORK 42 (2015).

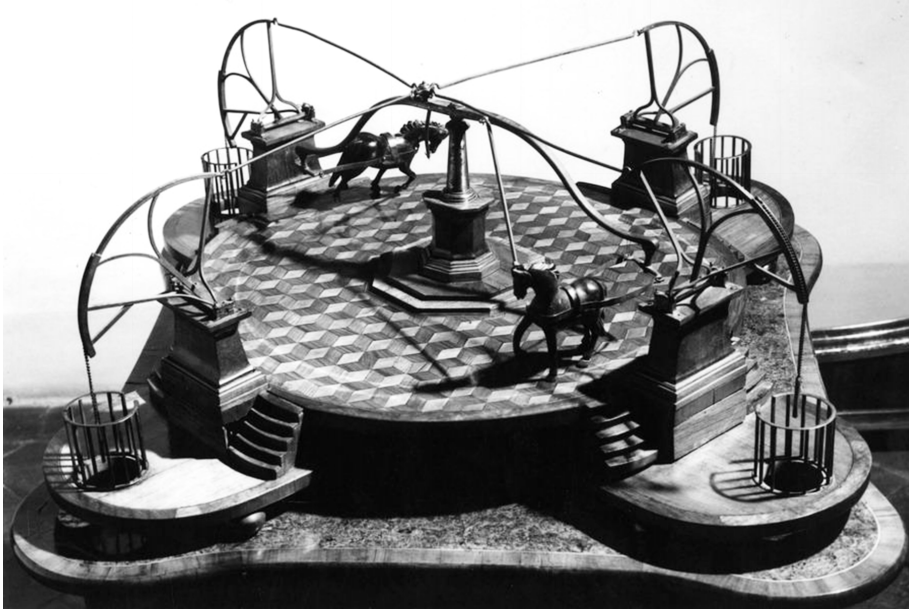


Figure 2: A model replica (20th century) of Galileo Galilei's patent (1594) archived in the *Museo Fisica e Scienze Naturali Firenze*. The pump was invented to raise and distribute water. Galileo prototyped the system at the Contarini Villa, though it was never commercialized.

The model recreates the quadripartite arrangement of the four wells around a central axis and pivot, harnessed to horses that drive the mechanism. Although Galileo's foray into water infrastructure was never commercialized, and is probably the lesser of his inventions, it is emblematic of a process of innovation in physical infrastructure that defined Venice for centuries.

Foreign Inventors and Technology Transfer to Venice

From 1474-1788, one thousand nine hundred and four (1,904) patents were issued in Venice for everything from the production of cereals, paper, and textiles, to the extraction of minerals, construction of weapons, and stabilization of the lagoon. The granting of Venetian patents granted to foreigners is particularly telling, as foreign expertise was vital to remaining competitive in industries as diverse as glass making, textiles, medicine, and city building. Ten and half percent (10.5%) of all patents issued in the city were issued to foreign inventors, linking Venice to innovations from across Europe.¹⁵ Dutch, French, and English inventors brought new technologies to the city, including methods to dredge, drain, and stabilize terra firma.

¹⁵BERVEGLIERI & ISTITUTO VENETO DI SCIENZE *supra* note 10.

Circulation of technical knowledge became vital to European cities in the early modern period, and patents played an important role. City leaders often tapped international markets for technical know-how, and in this context, patent rights were very active to craftsmen and inventors skilled in various types of manufacturing and technology. For example, in the 1660's Venice actively attempted to recruit English specialists in textiles, and in the eighteenth century sent emissaries to Florence to recruit silk manufacturers, promising economic riches and patents. This type of aggressive recruiting led to similar efforts in other cities. In 1662, the city of Turin planned to strengthen the local manufacture of silk by acquiring the knowhow to build a Bolognese-style hydraulic silk mill. And, in 1554 the Republic of Lucca established a special office, the *Offizio sopra le Nuove Arti*, to undertake the task of "examining the ways of introducing new 'arts' to the city, by searching for and finding men who were able and expert in these."¹⁶

In Venice the circulation of knowledge and technology transfer was often related to "mud" technologies for drainage and dredge infrastructure exchanged with countries such as the Netherlands.¹⁷ Precedents for patent innovation and technology transfer in mud technologies are important components of Venice's model for urban in environmental innovation. For example, Ambrosio Bizozero from Milan, was issued a patent in 1569 for his new invention, and granted a 2-year period to test and evaluate the process. Bizozero's process involved the raising of water, draining of swamps, construction of embankments, making of caves, and the transportation of earth. The *Senato* was impressed by his invention, and granted him a 50-year patent to operate his invention on certain public lands. Similar rights were granted to foreigners who migrated to Venice. Gerardo Reighemberg, from the Netherlands, became a voluntary subject of the Venetian state in 1670. His migration was incentivized by prospects of patent rights for a "wheel dredge" that could dig channels up to twelve feet in depth with a continuous motion. Reighemberg agreed to reduce the invention to practice at his own expense in exchange for the legal rights of patent, and charter the vessel to the republic for a period of 25 years.¹⁸ Interestingly, the Netherlands developed their own codified patent law in 1817, though they issued patents for centuries prior based on precedents from Venice. And, the evolution of Dutch hydrologic engineering can also be traced through innovations in patents.¹⁹

Among the most interesting and well-documented foreign inventors who travelled to Venice is Cornelius Meijer who arrived from the Netherlands in 1674, bringing with him news of a mighty chain dredger. The chain dredger described by Meijer amazed the Venetians, and he received a patent for the device in 1675. Although chain dredgers are claimed to have been invented in

¹⁶ Carlo Belfanti, *Guilds, Patents, and the Circulation of Technical Knowledge: Northern Italy during the Early Modern Age*, 45 *TECH. & CULTURE* 569 (2004).

¹⁷ CIRIACONO, *supra* note 11 at 164.

¹⁸ BERVEGLIERI, *supra* note 3 at 100.

¹⁹ GERARD DOORMAN, *PATENTS FOR INVENTIONS IN THE NETHERLANDS DURING THE 16TH, 17TH AND 18TH CENTURIES, WITH NOTES ON THE HISTORICAL DEVELOPMENT OF TECHNICS* (1942).

Holland a century prior, they were new to Venice and the patent was granted.²⁰ In an ironic twist, a Venetian known as P. Venturino appears to have originally patented the chain dredger in Holland a century earlier in 1561. Irrespective of this chronology, Meijer was issued a patent and promptly assigned his invention to a Venetian citizen who would execute the plan as per Meijer's specification.

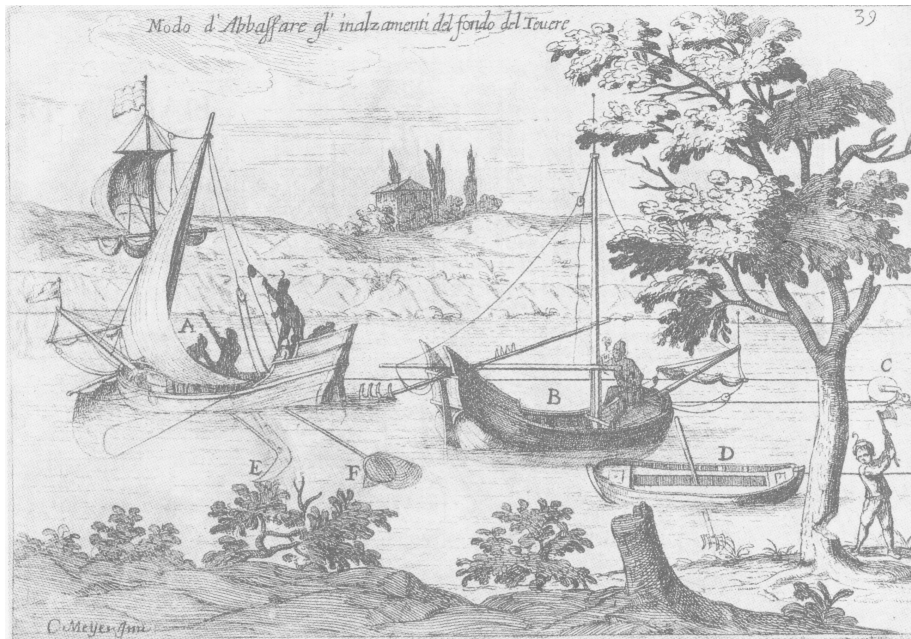


Figure 3: A perspectival representation of a new invention, by Cornelius Meijer (c.1675), showing a dredge apparatus and vessel clearing a waterway. Arriving in Venice, Meijer became famous for his ingenuity and artistic capabilities.

For his invention, Meijer was awarded the official title of “engineer” in Venice. Later, he used this title to solicit projects in his adopted home of Rome, including work on the Tiber River under the patronage of the pope. He used his artistic and technical abilities to his advantage, securing patents and projects with his etched drawings, eventually gaining the favor of powerful elites in Italy.²¹ As a point of comparison, Meijer's work in Rome took a very different turn. Rome, at the time of his arrival, had no patent system and Meijer feared losing his invention to competitors. In an act of desperation, or marketing genius, he decided to slowly release information about his inventions into the public domain, as a series of plates published in their entirety as “L'arte di restituire à Roma la tralasciata navigatione del suo tevere.”

²⁰Karel Davids, 2 THE RISE AND DECLINE OF DUTCH TECHNOLOGICAL LEADERSHIP: TECHNOLOGY, ECONOMY AND CULTURE IN THE NETHERLANDS, 1350-1800 288 (2008).

²¹Klaas van Berkel, *Cornelius Meijer Inventor et Fecit: On the Representation of Science in Late Seventeenth-Century Rome*, in *MERCHANTS AND MARVELS: COMMERCE, SCIENCE, AND ART IN EARLY MODERN EUROPE* (Pamela Smith & Paula Findlen eds., 2002).

A Patent Model Spreads: an environmental and urban perspective

Patent law spread through Europe, to England, France, Germany, and the Netherlands after the Venetian Patent Statute on 1474. The historian Bruce Bugbee has even claimed “the international patent experience of nearly 500 years has merely brought amendments or improvements upon the solid core established in Renaissance Venice.”²² The ascendancy and integration of patents through Europe and the America’s brought with it elements of Venice’s model for urban and environmental innovation, including expert review of proposed technology, periods of time allocation and funding for testing new technologies, and linking patented process to particular geographical areas. It remains unclear if the hybrid between patent innovation and progress is physical infrastructure was formally attributed to Venice at the time, or simply migrated to these countries as an artifact of the genesis of patent law. Irrespective of origin, a compelling narrative emerges from the rereading of patent history through the lens of environment and urbanism.

Patent rights spread and permuted from Venice through France, Germany, the Netherlands, and England. Patents were issued in Germany from starting in 1484. In France, the first patent was issued to a Italian from Bologna in 1551, to produce “glassware according to the manner of venice.”²³ And, in England, Patent Rights find a distinct economic and political agency in the 15th and 16th century, eventually contributing to the explosion of technologies and manufacturing that typify the industrial revolution.²⁴ The spread of patent law had urban, regional and territorial impacts that extended beyond the realm of manufacturing and industry, into what Henry Lefebvre terms the “urban society” – a political and technological system of total urbanization.²⁵ In this milieu, where science, expertise, and the circulation of knowledge impacted cities, territories, and nations, the patent has played an important but surprisingly surreptitious role.

A rereading of English and American patent history is particular telling. Originally English patents, like Venetian, were essentially a mix of monopolies for particular trades and enterprises and rights granted to protect new inventions. Patent monopolies became tools for the English monarchy and guilds to maintain power over goods and labor. Queen Elizabeth granted nearly 80 patent monopolies for a range of goods and expertise, including the creation of white soap, saltpeter, knife handles, musical instruments, dredging machines, and important skills such as glass making, water drainage, and the mining of minerals. This led to an influx of skilled workers and inventors, including those involved in the drainage, dredge, and reclamation technologies from Venice

²²BRUCE WILLIS BUGBEE, *GENESIS OF AMERICAN PATENT AND COPYRIGHT LAW* 24 (1967).

²³Edward C. Walterscheid, *The Early Evolution of the United States Patent Law: Antecedents (Part 1)*, 76 J. PAT. & TRADEMARK OFF. SOC’Y 697, 711 (1994).

²⁴CHRISTINE MACLEOD, *INVENTING THE INDUSTRIAL REVOLUTION: THE ENGLISH PATENT SYSTEM, 1660-1800* (2002).

²⁵HENRI LEFEBVRE & ROBERT BONONNO, *THE URBAN REVOLUTION* (2003).

and the Netherlands.²⁶ Interestingly, one fifth (1/5th) of all patents granted between 1620-1640 were for methods to raise water and drain land for reclamation, revealing the scope and scale of innovation in this sector of technology.²⁷ The fens and lowlands of England would never be the same as drainage infrastructure was constructed through a complex process of technology transfer from Italy and Holland using patents.²⁸ The English Statute of Monopolies, approved on the 25th of May 1624.²⁹ The Statute was a defining moment in the transition of England from a feudal society to a capitalist society, and changed the relationship of inventor to the state.³⁰ A review of patents granted in civil engineering and architecture suggest that technological innovation also had a radical impact on urban infrastructure and building practices after the Statute of Monopolies through an explosion of new materials and structures.³¹

In America, patents are intimately intertwined with the nations founding, and elements of Venice's model for urban and environmental innovation remain evident in the early history of patent law in the new country. Prior to the American Revolution colonial patents mirrored pieces of European, and specifically English, patent law.³² Article 1 Clause 8 of the United States Constitution states that Congress has the power to "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries" which lead to the creation of the first U.S. Patent Act in 1790. Establishment of patent law was one of the first orders of business in the newly formed government, and the Patent Act of 1790 charted a distinctly American patent system founded exclusively on rights for new inventions and requiring that patents disclose enough information so that those skilled in any particular art might to make and use the technology.³³ The Act reads:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That upon the petition of any person or persons to the Secretary of State, the Secretary for the department of war, and the Attorney General of the United States, setting forth, that he, she, or they, hath or have invented or discovered any useful art, manufacture, engine, machine, or device, or any improvement therein not before known or used, and praying that a patent may be granted therefor, it shall and may be lawful to and for the Secretary of State, the Secretary for the department of war, and the Attorney General, or any two of them, if they shall deem the invention or discovery sufficiently useful and im-

²⁶Clive Holmes, *Drainage Projects in Elizabethan England: The European Dimension*, in EAU ET DÉVELOPPEMENT DANS L'EUROPE MODERNE (Salvatore Ciriacono dir., 2015).

²⁷WILLIAM HYDE PRICE, THE ENGLISH PATENTS OF MONOPOLY 63 (1906), available at <https://books.google.com/books?id=WNw9AQAAMAAJ>.

²⁸CIRIACONO, *supra* note 11 at 237.

²⁹William Letwin, *The English Common Law Concerning Monopolies*, 21 U. CHI. L. REV. 353 (1954).

³⁰G. A. Bloxam, *Letters Patent for Inventions: Their Use and Misuse*, 5 J. INDUS. ECON. 157 (1957).

³¹GREAT BRITAIN PATENT OFFICE LIBRARY, SUBJECT LIST OF WORKS ON ARCHITECTURE AND BUILDING CONSTRUCTION, IN THE LIBRARY OF THE PATENT OFFICE (1903).

³²P. J. Federico, *Colonial Monopolies and Patents*, 11 J. PAT. OFF. SOC'Y 358, 363 (1929).

³³Edward C. Walterscheid, *Charting a Novel Course: The Creation of the Patent Act of 1790*, 25 AIPLA Q. J. 445, 527 (1997).

portant, to cause letters patent to be made out in the name of the United States, to bear teste by the President of the United States . . .

Although it is common to associate American patents strictly with objects of commerce, it is important to note that from 1790 to 1849, the Patent Office was operated by the Department of State with patents being signed and countersigned by the Secretary of State, Attorney General, Secretary of War, and for a brief time the President. At the time, the Department of State was primarily concerned with domestic affairs and development, including managing innovation. The increasing rate of patent submissions and explosion of domestic concerns overwhelmed the State Department and led to the creation of the Department of Interior in 1849. Between 1849–1925 the patent office operated under the auspices of the Department of Interior, spanning an unprecedented period of national growth and development marked by canal building, railroads, electricity, sewers, paved roads, navigable waterways, and the first levee systems. The Department of Interior was formed through a strategic reorganization of the USPTO, General Land Office, Census Bureau, and Bureau of Indian Affairs and charged with the management of “home” affairs, including wilderness areas and new US territories. The combined interests of the Department of Interior made it the de facto “department of the west,” playing a vital role in the expansion and development of western states.

Although grand in ambition and scope, the actual footprint of the Department of Interior was remarkably small, and it was initially housed within the patent office building in Washington DC. These two seemingly disparate offices cohabitated for six decades, until the constant flow of tourism to the building and the growing piles of patent models forced the Department of Interior to move out. Richard Andrews, an environmental policy scholar, has argued that in an ideal world, the integration of interior, patent, land, and census departments might have provided the “foundation for integrated planning and management of the nation’s environment.”³⁴ By 1925, the patent office found its permanent home in the US Department of Commerce, where it remains today.

A review of patents granted in the United States from 1790–1925, reveals instances in which the government was directly involved in promoting innovation in the built environment as a form of infrastructure delivery. For example, in 1821 Congress waived the residency requirement to grant Englishman Thomas Oxley a patent for his “American Land Clearing Engine,” which promised to hasten development. In 1844, while pondering interstate communications, Congress passed acts to construct an experimental telegraph line from Washington to Baltimore following Samuel Morse’s patent for invention. Similarly, in 1845, Congress approved the creation of a panel of experts to test an experimental dredge machine, patented by J.R. Putnam, for the removal of sandbars at the mouth of the Mississippi River. And, in 1847 James Crutchett was commissioned to prototype and test his experimental gaslight in the US Capitol, proving the viability of artificial lighting in the urban landscape.³⁵

³⁴RICHARD N. L. ANDREWS, *MANAGING THE ENVIRONMENT, MANAGING OURSELVES: A HISTORY OF AMERICAN ENVIRONMENTAL POLICY* (1st ed. 1999).

³⁵JOHN B. MILLER, *PRINCIPLES OF PUBLIC AND PRIVATE INFRASTRUCTURE DELIVERY* (2000) in 101 *INFRASTRUCTURE SYS-*

The process of patent innovation, expert review, and prototyping technology in the built environment continued in large-scale complex environmental systems. This is most clearly documented in the urbanization of the Heads of Passes, at the mouth of the Mississippi River, where novel devices and processes were developed in pursuit of navigable channels to the rivers inland waterways.³⁶

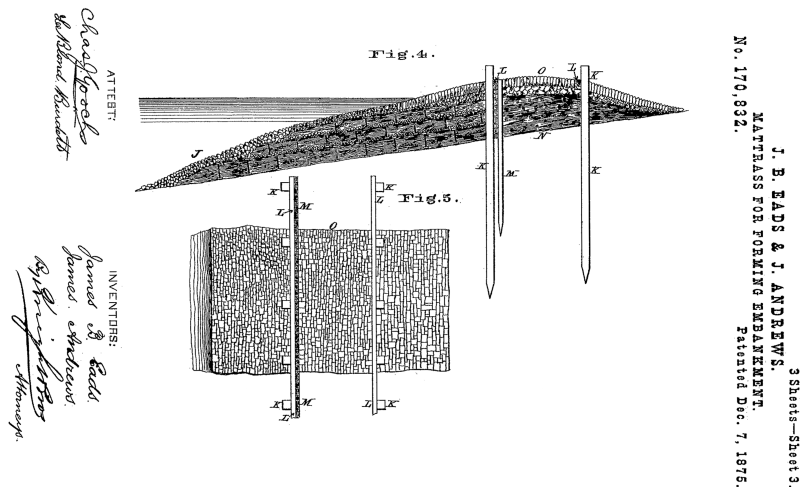


Figure 4: James Buchanan Eads' patent (1875) for a new jetty construction method using floatable brush mattresses. The system was implemented at the South, and Southwest, passes of the Mississippi River. Eads presented his plan to the U.S. Congress, and was awarded a 4-year contract to prototype the jetties.

The world-renowned engineer, James Buchanan Eads, himself had a patent to accompany his proposal for the establishment of navigable channels at the Heads of Passes.³⁷ Congress awarded Eads a contract for 4 years to prototype and test his system, and paid him based on success of the work.³⁸ News of ongoing work at the Heads of Passes also inspired others to submit their ideas to the USPTO, leading to a robust dossier of unrealized environmental imaginaries, that project forward a series of unrealized scenarios for the river.³⁹

TEMS: DELIVERY AND FINANCE.

³⁶Richard L. Hindle, *Prototyping the Mississippi Delta: Patents, Alternative Futures, and the Design of Complex Environmental Systems*, 12 J. LANDSCAPE ARCHITECTURE 32 (2017).

³⁷JAMES BUCHANAN EADS, MOUTH OF THE MISSISSIPPI. JETTY SYSTEM EXPLAINED (1874) (from Joseph Meredith Toner Collection (Library of Congress), and YA Pamphlet Collection (Library of Congress)).

³⁸Martin Reuss, *Andrew A. Humphreys and the Development of Hydraulic Engineering: Politics and Technology in the Army Corps of Engineers, 1850-1950*, 26 TECH. & CULTURE 1 (1985).

³⁹Richard L. Hindle, *Patent Scenarios for the Mississippi River*, 71 J. ARCHITECTURAL EDUC. 280 (2017).

Conclusion

Venice established precedents for patent law dating back to the 14th and 15th century, when “privileges” or “rights” were issued to inventors to promote the public benefits of innovation. In essence, Venice pioneered what is known in legal circles as the “patent bargain” in which an inventor agrees to disclose, or share, their inventions in exchange for protection from the state. In Venice, patent rights promoted innovation in every sector of technology, including the large-scale technological systems we now call the built environment. Reflecting on this process through the lens of urbanization reveals that Venice also pioneered an urban and environmental innovation model that allowed the city to negotiate its complex geography through technological means. The Venetian model for urban and environmental innovation involved expert review panels to vet proposed technologies, time allocations and funding for the realization of untested technology, and agreements for the use of a particular technology in a particular territory or part of the city. Venice incentivized inventors to contribute novel ideas to complex infrastructure problems, and kept the city at the leading edge of technology. Elements of this model can be observed as patent law spread through Europe and America, where new technologies were developed and tested to drain the fens, bring artificial light to cities, and build navigable channels at the mouth of the Mississippi in pursuit of its epic inland waterways. As contemporary cities confront issues of climate change, sea level rise, and increased rates of development, they must continue to innovate and new layers of infrastructure will be essential to resilience and adaptation. This will require diverse approaches to technology, investment in new devices and processes, and the ingenuity of the world's leading thinkers and tinkerers, as no single government agency is prepared or equipped to address massive global change and environmental indeterminacy. Given these prospects, maybe we can learn from 14th and 15th century Venetians and develop a novel approach to urban, and environmental innovation. Contemporary cities need a model for innovation that incentivizes sociotechnical processes, protects inventor's rights, provides funding and expert review to incubate novel technologies, and provide sites for infrastructuralists, planners, and architects to implement the next layer of infrastructure that will define the contemporary city of centuries to come. Patent law has played an integral role in building large-scale and complex infrastructure for six centuries, might it provide a framework for managing innovation in the age of the anthropocene as the boundaries between the technosphere and earth systems collapse and planetary innovation becomes essential to our survival?