Aquae Urbis Romae: The Waters of the City of Rome

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This session will demonstrate the classroom applications of a world-wide-web based historic and cartographic research and study tool for architecture, landscape, planning, urban design, and history students. *Aquae Urbis Romae: the waters of the City of Rome* is the first comprehensive, interactive study to examine water as a living system related to the 2800 year history of the urban development of Rome. Currently available as a prototype publication that is still under production, it is published on the world wide web by the Institute for Advanced Technology in the Humanities at the University of Virginia. This study is focused on the intimate correlation between water, gravity, and topography, and specifically investigates the relationships between natural water systems, (i.e. the existing hydrological structure of the landscape) and the delivery, distribution, use and display of imported water systems as they influenced urban growth and form. This hydrological complex includes the Tiber River, springs, streams, marshes, sewers, aqueducts, wells, conduits, cisterns, fountains, floods, and rainwater, all linked through topography. Together they provide the stimulus and mechanism for all urban life.

Why study water? Water in Rome, as in any other city, is a coherent urban system — one of the multiple "grids" of public infrastructure that, like roads unite with topography, as significant determinants of city growth, and urban form. One advantage of studying water as it relates to the process of urbanization is, as Dora Crouch points out,' "that the behavior of water, and therefore to a large extent the management of water, are 'culture free,"' and "therefore much less conditioned by human preference" than social practices or architectural styles, etc. Water responds to the same physical laws in Rome as in any other place in the world, and serves precisely the same functions for drinking, bathing, cooking, tending animals, and for industrial uses. Therefore the insights gained through this project, should be equally applicable in providing insights into the development of other cities.

The focus of *Aquae Urbis Romae* is concerned with how this water infrastructure impacts the public life of Rome — how it structures the larger landscape of streets, piazzas, markets, neighborhoods, and public parks that define much of the unique character of Rome. The historic center of Rome was chosen for this study because water is a profoundly important component of its form, history, experience and mythology, and because the city itself is used as a laboratory by hundreds of American students of architecture, landscape architecture, urban design and architectural history each semester. This resource was created first and foremost as a design tool these students.

For most American students, Rome is difficult to comprehend as an entity. Rather it is known, seen and experienced as a series of discrete monuments: the Pantheon, the Coliseum, the Vatican, etc. One remembers an individual building, or a piazza, but rarely "how to get there from here." Even among native Romans, the city is rarely understood as a single topography in which clear connections physically link these monuments. *Aquae Urbis Romae* seeks to unscramble this chaos by revealing this hidden infrastructure. It examines the role that water has played in the physical development of the city, and demonstrates how an analysis of infrastructure can lead to a clearer understanding of urban history and form. By exploring the city through water, students gain a richer understanding of urban form, history, and technology, and are able to ground their theoretical anddesign work more fully in the context of the city. By examining Rome (or Minneapolis, Bangkok, or Los Angeles) through its water infrastructure, students are able to see the city as a network of linked forces, which in turns brings a deeper understanding of the specifics of individual neighborhoods and places.

In spite of the importance of water, aqueducts, and public fountains to the social, cultural, political and physical life of Rome, there is no monograph, guide, or map that deals with water as a system in the city. Several important monographs have been published on the history of Roman fountains (principally from an iconographic or traditional art historical perspective) including *Le Fontane di Roma* by Cesare d'Onofrio and *The Waters of Rome* by H. V. Morton. Significant technical works dealing with the aqueducts include *Water Distribution in Ancient Rome,* by Harry Evans, *Roman Aqueducts and Water Supply* by A. Trevor Hodge, *The Aqueducts of Rome* by Thomas Ashby, and *De Aquae Urbis Romae* by Frontinus written in 97 AD. There is no single work that examines fountains, aqueducts, the Tiber River and its floods, topography, hydrography, fontanelle, animal troughs, underground conduits and distribution systems, and all the other components of the Roman hydrological history together as inter-related elements of a single urban system that has evolved over the last 2800 years. And, more importantly for designers, there has never been a comprehensive mapping of any of these features, either singly or together. Therefore it is extremely difficult to understand relationships between elements.

PROJECT SCOPE

With *Aquae Urbis Rornae* it is possible to study this complex urban system in both linear and lateral modes including: typologically (aqueducts, fountains, floods, sewers, laundry fountains, water-driven mills, etc.); topographically (the Roman Forum, the Velabrum, the Campus Martius, Trastevere, the Borgo, etc.); and chronologically from approximately 800 BC to the late 20th century. The study is based on nearly two hundred completely new computer maps created especially for this project. The cartographic material

is supplemented by historic photographs, maps, prints and texts. Contemporary topographic levels are included at one meter intervals for the intramural city, and all typological and hydrological data is referenced by elevation, as well as location. This allows for the study of water movement through the city. It will also be possible to refine and update information as modern excavations reveal new data, and as the city itself makes changes to its infrastructure system. More than simply a tool for understanding Rome Aquae *Urbis* Romne also provides a hydrological model for looking at other cities, and as such will be useful in other studio settings, as a model in the design studio, and as a tool for urban analysis. It is not intended as an end in itself, but literally as a "jumping off place" for further research and analysis by others.

PROJECT DESCRIPTION

Typology

This section allows the user to create his or her own map by choosing up to three layers of typological data to overlay on any one of three base maps. Examples of possible choices include: ancient aqueducts; ancient sewers; ancient Imperial baths; ancient nymphaea: the distribution network of the Acqua Vergine in 1575, or its distribution today; all the public fountains in the Acqua Felice system; all public fountains commissioned by Pope Sixtus V, or all those commissioned by Mussolini; all public fountains designed by Bernini; all fountains at 15 meters above sea lever (or 20, 25, or 30 meters above sea level); or all the water features sponsored by Agrippa. Any combination of layers is possible. Ultimately there will be more than one hundred typological categories. Once the three layers have been selected they can be viewed on one of three base maps: 1) hydrological setting including the Tiber river, springs, streams, and marshes (default), 2) hydrological setting plus modern city streets and blocks, or 3) hydrological setting plus contemporary one-meter topography. Once the base has beenchosen the map may be viewed as a JPEG file, as a Colada file, or as a three-dimensional Virtual Reality model.

Chronology

This section allows the user to follow the urban and hydrological development of the city through a series of time-line maps from 753 BC to the present day. Each of the fifty "pre-cooked" maps covers a specific moment in time and shows existing features, and highlights new features. Each time period was determined based on the significance of hydrological changes in the urban landscape. For example, the map "Early Republic" begins in 312 BC, the year that the first Roman aqueduct was built. Some timeline maps cover several hundred years while others cover a period of only a few years. This reflects the amount ofdocumented hydrological activity. For example, little activity has been documented for the medieval period. Therefore the entire 900 years is covered in only three maps. However, the 50 year period from 1572 - 1622 was one of the most active in terms of changes to the Roman waterscape and is covered by three timeline maps, each referring to a specific pontificate: Gregory XIII, Sixtus V, and Paul V. Each of the fifty time periods can also be viewed on any one of the hydrological base maps (as described in the Typology section), and can also be viewed as a JPEG, Colada or VRML file. Ultimately it will be possible to view the introduction, growth and demise of certain features (such as both ancient and modern aqueducts) as animated "Quick-Time" movies.

Topography

This section is the most sophisticated element of the program and is most successfully used with a VRML plug-in. It provides access to a three-dimensional topographic model of the historic intramural city. The model is sampled at a vertical resolution of one meter. This vertical dimension is scaled 3:1 for clarity, however, in the **CD**-ROM version it will be possible to view it at any vertical dimension. The model allows the user to examine the topographic relationships between disparate areas of the city, and to understand the dynamics of the hydrological system. Sections and profiles can be called up, including profiles of the individual aqueduct systems and their major distribution lines. In addition, this section allows a comparative analysis of the levels of historic floods from 1230 **AD** to 1937 AD.

Other features include a search engine and journal, both of which are stillunder construction. For example, it will be possible to search the archive for specific hydrological features (Trevi Fountain), topographic elements (Caelian Hill), patrons (Pope Nicholas V), designers (Gian Lorenzo Bernini), authors (Sextus Julius Frontinus), or subjects (Gravity Flow Water Distribution). Historic prints, drawings, maps, photographs and texts that are no longer under copyright restriction are included. For example the complete series of engravings "Le Fontane di Roma" created by Gianbattista Falda in 1675 can be called up, as well as all of Narducci's 1898 sectional drawings of ancient and modern sewers. Images by Piranesi and others will be added as they become available from the collections of various archives and libraries. The journal feature allows the complete text of *Aquae Urbis Romae*, as well as articles contributed by other authors. It will also be an archive for the complete texts of important historical works on the hydrological history of Rome (such as those by Frontinus and Fabretti) in Latin, Italian or English.

Graphics Programs And Viewing Tools

As mentioned earlier each map can be viewed as a JPEG, Colada or Virtual Reality document. The JPEG displays a large image file which is most useful for its versatility. **A** JPEG can be downloaded. edited, printed, and shared in many different programs and contexts. By simply pointing to an object an identifier window pops up. What's more, by clicking the element. the user can automatically search the "Rome Archive" for a images and additional information on that particular item, and link to other historic and contemporary maps, text, photographs and historic documents.

The option for the Colada Applet is most useful as a tool for viewing and analysis on-line. With Colada the user can zoom in and out of map areas, and identify individual typological elements such as fountains, marshes, rivers, etc.

The Virtual Reality Markup Language (or VRML) option displays the selected map on top of a three-dimensional topographical model of the city. VRML is highly data intensive and requires the appropriate plug-in, but it is also highly rewarding as a visual tool. The user can make connections and gain familiarity with water systems much more readily by seeing the topography of the city in relief than by simply viewinga two-dimensional topographical map. All of these viewing methods provide the option to view the selected maps with an overlay of the contemporary city streets, or contemporary topography.

Methodology

1. The research phase of every architectural project begins with the site visit. Aquae *Urbis* Ronzne began in 1993 with a comprehensive, four month long walk along the Tiber River and every street within the intramural city to examine and map all existing water features. These include features such as fountains, aqueduct fragments, flood markers, conduit access markers, drinking fountains, and sewer mouths, etc. Over four hundred features were photographed, described, mapped, and sketched. This survey formed the basis for all subsequent work.

2. The new computer base map for *Aquae Urbis Romae* was created with the "Canvas 5" drawing program. It was based on the

1992 Cadastal Plan of Rome which was published by the Ufficio Speciale Centro Storico. Individual, contemporary water features (from the previously described walking survey) were then mapped. In addition, water elements from numerous historic maps and archaeological reports were redrawn by hand, by the author at the same scale and orientation for consistency. These elements include imperial baths, aqueducts, and other relevant archaeological fragments. They were then scanned and redrawn for the computer and incorporated into the base map.

3. Archival research was conducted in Rome at the following institutions: the Azienda Comunale Energia ed Ambiente (ACEA), Archivio di Statodi Roma, Archivio Capitolino, Ufficio Monumenti Mediovale e Moderni, Museo di Roma, Ufficio Speciale Centro Storico, Gabinetto Nazionale delle Stampe, and Museo del Folklore, as well as the Biblioteca Casanatense, and the Biblioteca Corsiana. In addition the libraries of the Biblioteca Herziana, the British School in Rome, and the American Academy in Rome, as well as the Getty Center and the Library of Congress in the United States were also consulted.

4. Contemporary topographic data was derived from spot elevations generated from aerial photography and subsequent plotting by S.A.R.A. Nistra, and published in *Atlante di Roma,* Venice, 1991. These were supplemented by data from scores of published archaeological reports. Interpolation between points was created by hand, by the author, based on on-site observations. "Aquae Urbis Romae" is the only existing one-meter interval topographic map in any format, either printed or electronic. It does not duplicate any existing map available to the public in either Italy or in the United States. The intent is to show the general flow of topography in the city, in order to better understand the relationship between water, topography, gravity, and water distribution.

5. The interactive topography was originally drawn in "Canvas" and then brought into "Form Z" as an "Illustrator" document. Several 3-D models were created in "Form Z" from the 2-D drawing. From "Form Z" the model was exported to "CosmoWorlds" as a DXF file and to "Electric Image" as a FACT file. A variety of VRML models were exported from "CosmoWorlds". In "Electric Image" the model was rendered and saved as "QuickTime" movies and JPEG image files. The "QuickTime" movies were further processed in "Premiere" and "AfterEffects". The "QuickTime" VR movies were further processed in "QuickTime VR Authoring Studio". The texture maps for the "Electric Image" model were created in "Canvas" and "Adobe Photo-shop". (Phases one to four were carried out in their entirety by the author. Phase five was created by Chris Jessee of the Institute for Advanced Technology in the Humanities. The staff of the Institute was responsible for incorporating the SGML and HTML program into the web site.)

Once the material is available on CD-ROM it will be possible to download the data onto your own computer at a usable scale for studio use, and to plot accurate, large format maps. Using the "Canvas" drawing program it will be possible for each student to build his or her own layers of related data directly onto the map. Also, using "Form Z" the user can cut sections and profiles anywhere in the city and select any single contour and follow it through the city. The Virtual Reality Model will allow the viewer to choose any vantage point, to fly over and to zoom in on topographic features.

PEDAGOGICAL GOALS

The goals of Aquae Urbis Romae are four-fold. The first is to provide a body of contemporary cartographic data that will be an analytical tool for use by architecture, landscape, planningandurban design students, particularly those using Rome as a design laboratory. In addition, historians, classicists, archaeologists, hydrologists, and geographers should also find the material useful. The second goal is to create an electronic archive of historic maps, texts, and images that deal specifically with Roman water history. Complete texts of major writers such as Sextus Julius Frontinus will be available. A third goal is the creation of an on-line refereed journal of Roman waterstudies, thereby eliminating much of the lag-time in publication of timely articles; and finally, the fourth goal is to develop a model for design and planning professionals to examine the hydrological structure and history of other cities in order to inform design and policy decisions at neighborhood, city and regional levels. Together these goals seek to foster a richer understanding of urban form, history and technology in order to ground practice and theory more deeply in the context of the city.

Maps are by their very nature personal narratives, and somewhat skewed interpretations of the places they purport to represent. The "Aquae Urbis Romae" presents its own particular interpretation of the city, with the streets and building blocks as a background against which water features are linked to reveal the structure of water in the city. Against this background each student can construct a personal map with layers of datareflecting auniqueunderstanding of the city. The map will help both student and professional to perceive the continuum between time and space in Rome.

I like to imagine a scenario in which a student (who has already consulted this resource before traveling to Rome, or while studying in Rome) sits on the steps of the Pantheon fountain, thoughtfully consuming a *granita di caffe con panna*, while drawing and dreaming the Pantheon. I imagine that the student will think not only of the glorious Pantheon, but also of the marshy land that existed on this very site 2000 years ago, and will mentally reconstruct the conduits that Agrippa built in ordertodrain the land. Which way did the water flow? Ah yes! It flowed south, just under the via della Minerva (to the left of the Pantheon) which recalls the course of an ancient stream. The student will remember the complex of bathing and recreational facilities that were once associated with the Pantheon, and of the footprints of those buildings hidden beneath the pavement just to the south and west, and that the water in this fountain comes from the same ancient aqueduct originally built by Agrippa for his imperial bath. Also it will be recalled that the water splashing here, is the same as that in the Trevi, Barcaccia and Quattro Fontane fountains. The student will realize that they are connected by invisible underground conduits, that create a kind of "constellation" of fountains, one of many in the city. And like the celestial stars they mimic, these fountain "constellations" guide the weary and hopeful traveler, helping to create order out of chaos, and enriching urban navigation.

NOTES

[1] Dora Crouch, *Water Management in Ancient Greek Cities* (New York: Oxford University Press, 1993), p. 3.